DEPARTMENT OF **PRIMARY INDUSTRY AND FISHERIES**

STATUS OF KEY NORTHERN TERRITORY FISH STOCKS REPORT 2014

Fishery Report No. 115

NORTHERN TERRITORY GOVERNMENT

Status of Key Northern Territory Fish Stocks Report 2014

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July 2016

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July 2016

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Northern Territory Government (2016). Status of Key Northern Territory Fish Stocks Report 2014. Northern Territory Government. Department of Primary Industry and Fisheries. Fishery Report No. 115.

ISSN (print): 2205-6629
ISSN (online): 2205-6661

Fishery Report No. 115
ISSN (print): 0158-2224
ISSN (online): 2205-667X

Director's Message

Northern Territory fisheries are diverse in their area of operation and the species they target. From recreational anglers targeting Barramundi in freshwater billabongs to commercial trawl fishers targeting a range of tropical snapper species on the continental shelf and on the high seas, the Territory provides some of the best fishing experiences in the world.

It is the responsibility of the Fisheries Division of the Department of Primary Industry and Fisheries as the steward of these resources, to manage and utilise them for the benefit of all Territorians, both present and future generations, to the best of our abilities, based on the best science available.

This is the second *Status of Key Northern Territory Fish Stocks Report* produced by the Department following the national template for the *Status of Key Australian Fish Stocks Reports* which was first produced in 2012, with a subsequent report released in 2014. The change to the national reporting framework has been undertaken to improve the reporting of the status of shared stocks with other jurisdictions and to follow the national standard in species stock status reporting that is more rigorous than the process previously used in the *Fishery Status Reports*.

The *Status of Key Northern Territory Fish Stocks Report* covers 12 key species that underpin the Territory's wild-catch fisheries. It focuses on the ongoing sustainability of the harvest from these species, thereby providing scientific assessments of the status of the stocks.

The Report provides a scientifically robust and simple tool to inform fishers, seafood consumers, managers, policy makers and the broader community about the status of the key wild-caught fish stocks in the Northern Territory.

Glenn Schipp

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INTRODUCTION

The tropical waters of the Northern Territory (NT) are home to a wide variety of economically, socially and culturally important fish species. The Fisheries Division of the Department of Primary Industry and Fisheries (DPIF) is responsible for the ecologically sustainable development of these aquatic resources and publishes regular updates on their condition.

This report provides the status of key fish stocks in the NT following the format of the *Status of Key Australian Fish Stocks Reports 2014*[1]. The term 'fish' is used here to describe animals caught by wild-capture fisheries and includes crustaceans (such as Mud Crabs), echinoderms (such as Sea Cucumbers), finfish and sharks. Regional differences in common names for the same fish species have led to the development of the Australian Fish Names Standard (www.fishnames.com.au). This naming convention applies capitals to the titles of most commercially important fish species (and species groups) and is employed here to facilitate comparisons with other jurisdictional reports.

Fisheries management considers a range of factors beyond the harvest of the target species. These include the effects of fishing on the marine environment, the economic performance of fisheries and the governance structures, which control how they operate. Although these issues are considered in each stock status classification, this information is typically given in the form of comments regarding the effects of fishing on the marine environment and environmental effects on fish stocks. These summaries are included in response to the increasing interest in the state of fish stocks, the sustainability of fisheries and the health of the marine environment from fishers, seafood consumers, policy makers and the broader community.

Territorians value the healthy state of our fisheries. Many Aboriginal communities have strong customary links with the aquatic environment and rely on fish for food, culture and development opportunities. Our commercial fisheries and the aquaculture industry are valued at around $60 million per annum and provide high quality seafood (such as Mud Crabs, tropical snappers, Barramundi, shark and mackerel) to restaurants and retail markets.

New and innovative aquaculture projects have recently begun in partnership with local companies and remote Aboriginal communities. Advances in culture methods for Sea Cucumbers, Giant Clams and Tropical Rock Oysters have been encouraging, with pilot studies underway at Groote Eylandt, Goulburn Island and the Tiwi Islands.

Recreational fishing is also an intrinsic part of the NT lifestyle, with quality fishing experiences attracting many visitors and supporting a major guided fishing industry. Annual expenditure by recreational fishers and the guided fishing industry is estimated at over $100 million.

All NT managed fisheries have governance structures in place to control the harvest rate and minimise environmental impacts. Nonetheless, careful monitoring and management must continue in order to ensure the sustainable and optimal use of our aquatic resources, particularly in high-use areas near major population centres. For example, concerns regarding overfishing of Black Jewfish and Golden Snapper stocks near Darwin have led to the development of a new set of management controls to address this emerging problem. Ongoing vigilance is also required to prevent the introduction of aquatic pests and diseases into NT waters.

As a custodian of the aquatic resources of the NT, DPIF works with a diverse range of stakeholder groups (such as fishing guides, commercial fishers, recreational fishers, aquaculture enterprises and Aboriginal land councils) to promote fisheries and aquaculture development and facilitate access and sharing of fisheries resources. Representatives from these groups also provide advice to a number of management advisory groups and committees associated with specific fisheries or user groups.

Fisheries compliance is generally undertaken by the Water Police Section of the NT Police, Fire and Emergency Services, with the Australian Fisheries Management Authority being responsible for compliance in two offshore fisheries managed by DPIF. Indigenous marine ranger groups also play an increasingly valuable role in monitoring our fisheries and coastlines; DPIF provides training and support to enhance the skills and capacity of ranger groups to undertake these tasks.

FISH STOCKS

The *Status of Key Northern Territory Fish Stocks Report 2014* focuses on the status of biological stocks of fishes wherever possible; hence, it is important to distinguish between biological stocks and fisheries. Biological stocks are discrete populations of a fish species, usually in a given geographical area and with limited interbreeding with other biological stocks of the same species. Although one fish species may exist in many locations around Australia (or worldwide), fish caught in different areas may come from separate biological stocks. Individual biological stocks may be found in a single jurisdiction or may be shared across two or more jurisdictions. In some cases, individual biological stocks may also extend into the high seas.

The number and geographic range of individual biological stocks can vary greatly between species. For example, Australian Blacktip Sharks consist of two expansive stocks, one extending from Western Australia into the western NT and another extending from the eastern NT into western Queensland and down the eastern seaboard. By contrast, Barramundi consist of numerous, localised stocks, most of which are confined to individual river catchments. Because separate biological stocks have limited connectivity, fishing one stock may not affect the others. Hence, it is important to assess each biological stock separately, wherever possible.

Biological stocks are natural resources, and different biological stocks may have different natural abundance, growth rates and mortality rates. Different biological stocks may also be influenced by different environmental factors, depending on where they occur. Consequently, the amount of fish (of a given species) that can be sustainably harvested from one biological stock may be very different to that from another stock.

Fisheries differ from fish stocks in that they are management units engaged in the harvest of fish. Fisheries are typically defined in terms of the people involved, the species caught, the area of water or seabed fished, fishing methods and the types of boats used[2]. A single biological stock may be caught by one or a number of fisheries. Similarly, a single fishery may catch one or a number of different species, from one or more different biological stocks.

A key measure of fisheries management performance is the status of the fish stocks—the natural resource on which the fisheries depend. Therefore, this report provides status classifications for fish stocks. Where possible, this takes into account the impacts of all fisheries at the level of individual biological stocks. Where the stock delineation is not known (that is, it is not known exactly where one biological stock finishes and the next begins) or the numbers of biological stocks for a species are very high, reporting has been undertaken at the level of either the jurisdiction or the management unit. The level of reporting (biological stock management unit or jurisdiction) for each species is presented at the beginning of each chapter, along with the rationale for this choice. In these reports, the term ‘stock’ is used generically to refer to all three levels of stock status assessment—biological stocks, management units and populations assessed at the jurisdictional level. In future, most species currently assessed at the management unit or jurisdictional level will be assessed at the biological stock level, wherever research has revealed the biological boundaries of the stocks.

Stock status classification system

In general, stock status classifications assess whether the current abundance (i.e. number or biomass) of fish in a stock is at an adequate level and whether the level of fishing pressure (the amount of fish being removed through fishing) is adequately controlled through management.

The abundance of a wild fish stock is usually compared with the abundance of that same stock before fishing began. Abundance is considered to be adequate if there is sufficient adult stock remaining, such that the production of juveniles (recruitment) is not significantly reduced. That is, the abundance of adults has not been depleted to the point where there is an increased risk of recruitment failure. This level of adult abundance will vary between different species of fish.

In terms of fishing pressure, stock status considers whether the current level of fishing pressure is adequately constrained, such that stock abundance is not reduced to a point where production of juveniles is significantly reduced. Where information is available, the level of fishing pressure includes consideration of Indigenous and recreational (including charter) fishing as well as commercial fishing.

The classification system used here combines information on both the current stock size and the level of catch into a single classification for each stock (Table 1; Figure 1). To classify stocks into one of these categories, the current abundance and level of fishing pressure are compared with defined biological reference points (see 'Reference points', below). Each stock is then classified as a sustainable stock, transitional–recovering stock, transitional–depleting stock, overfished stock or environmentally limited stock.

Stocks are classified as environmentally limited if the spawning stock biomass has been reduced to the point where average recruitment levels are significantly reduced, primarily as a result of substantial environmental changes/impacts or disease outbreaks (that is, the stock is not recruitment overfished). Fisheries management must have also responded appropriately to the environmental change in productivity.

For ease of interpretation, the classifications are also depicted by a colour-coding system. An 'overfished stock' classification (red) indicates that a management response is required to ensure the sustainability of the stock in question.

The term 'sustainable stock' refers specifically to the biological status of fish stocks and does not take into account broader ecological or economic considerations. A sustainable stock classification is given to stocks that are above the biological limit reference point of 'recruitment overfished' (see below) and for which the level of current fishing mortality is considered unlikely to cause the stock to become recruitment overfished. Given the focus of the this report on stock status, the term does not have the broader meaning of such terms as 'ecologically sustainable' or 'ecologically viable', which consider the sustainability of the entire ecosystem and the role of specific stocks in the function of the ecosystem[3].

Table 1: Stock status terminology for the Northern Territory status of key fish stocks reports

	Stock status	Description	Potential implications for management of the stock
	Sustainable	Stock for which biomass (or biomass proxy) is at a level sufficient to ensure that, on average, future levels of recruitment are adequate (i.e. not recruitment overfished) and for which fishing pressure is adequately controlled to avoid the stock becoming recruitment overfished.	Appropriate management is in place.
↑	Transitional–recovering	Recovering stock—biomass is recruitment overfished, but management measures are in place to promote stock recovery and recovery is occurring.	Appropriate management is in place and the stock biomass is recovering.
↓	Transitional–depleting	Deteriorating stock—biomass is not yet recruitment overfished, but fishing pressure is too high and moving the stock in the direction of becoming recruitment overfished.	Management is needed to reduce fishing pressure and ensure that the biomass does not deplete to an overfished state.
	Overfished	Spawning stock biomass has been reduced through catch so that average recruitment levels are significantly reduced (i.e. recruitment overfished). Current management is not adequate to recover the stock, or adequate management measures have been put in place but have not yet resulted in measurable improvements.	Management is needed to recover this stock; if adequate management measures are already in place, more time may be required for them to take effect.
	Environmentally limited	Spawning stock biomass has been reduced to the point where average recruitment levels are significantly reduced, primarily as a result of substantial environmental changes/impacts, or disease outbreaks (i.e. the stock is not recruitment overfished). Fisheries management has responded appropriately to the environmental change in productivity.	Appropriate management is in place.
	Undefined	Not enough information exists to determine stock status.	Data required to assess stock status are needed.

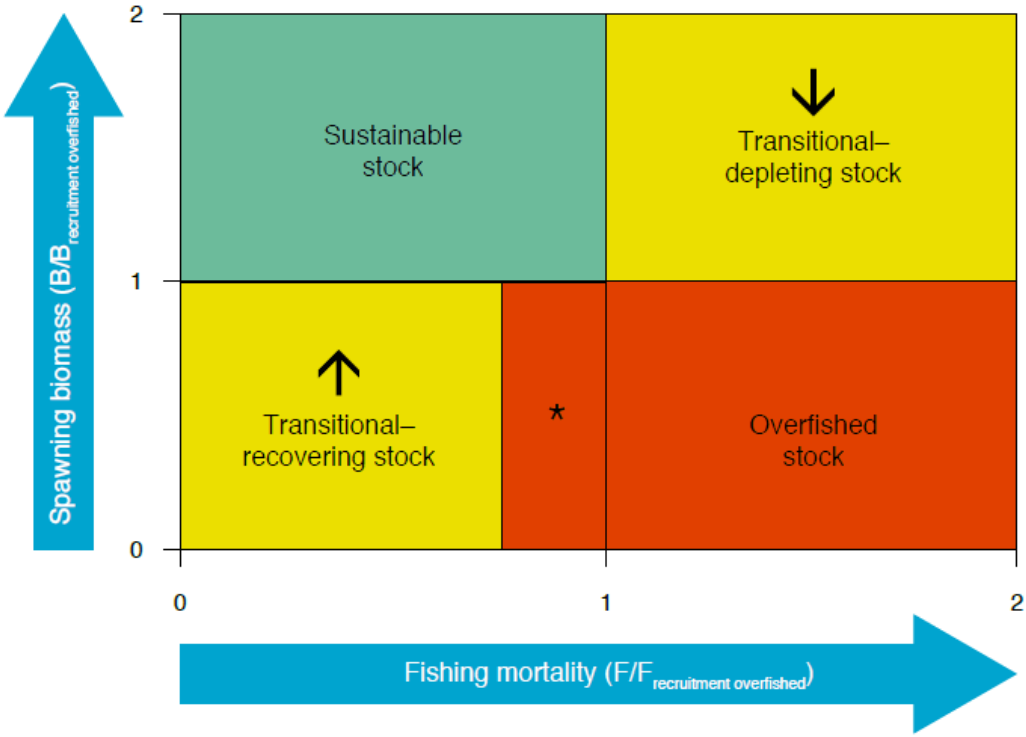

Figure 1: Diagrammatic representation of stock status classification system, with relative fishing mortality (the ratio of current fishing mortality to the fishing mortality that would cause the stock to become recruitment overfished) on the x axis and relative spawning biomass (the ratio of current spawning biomass to the recruitment overfished spawning biomass limit) on the y axis

* Note that part of the transitional–recovering block has been marked as 'overfished'. This represents stocks for which adequate management measures have been put in place, but these have not yet resulted in measurable improvements. Since environmentally limited stocks are not below the limit reference point as a result of fishing pressure, they are not included in this diagram.

Reference points

Biological reference points help to identify when stock abundance is too low or fishing pressure is too high. Formal reference points in a fishery generally include targets to indicate where we would like to be and limits to show what to avoid. Stock assessments usually produce estimates of abundance and fishing pressure over time, which can be assessed against biological reference points. The use of reference points to guide management decisions is consistent with the Food and Agriculture Organization *Code of conduct for responsible fisheries*[4].

Limit reference points

The limit reference points used to determine stock status for management response vary between fisheries and management agencies. In this report, 'recruitment overfished' is used as the biological limit reference point for determining whether or not a fish stock is overfished. 'Recruitment overfished' is defined as:

> *The point at which a stock is considered to be recruitment overfished is the point where the spawning stock biomass has been reduced through catch so that average recruitment levels are significantly reduced.*

The percentage of the unfished abundance that is considered to represent a recruitment overfished state can vary across species and stocks, based on differences in biology. Although limit reference points may also include economic considerations, or precautionary buffers against measurement uncertainty, these additional measures are not included in the strict definition of *biological* limit reference points used here.

With respect to fishing pressure, for a stock to be classified as a sustainable stock, the current level of fishing pressure must be at a level considered to be unlikely to cause the stock to become recruitment overfished—that is, recruitment overfishing should not be occurring.

Target reference points

Target reference points correspond to levels of biomass and fishing pressure that are considered to be ideal. Generally, fisheries management aims to ensure that stocks are maintained at these levels and away from limit levels. Target reference points commonly incorporate management objectives, such as maximising the sustainable yield or economic returns. For example, the Commonwealth Fisheries Harvest Strategy Policy seeks to maintain fish stocks, on average, at a target biomass equal to the biomass that would produce maximum economic yield[5].

There is no single agreed national target level, so it is not yet possible to include quantitative information based on targets in stock status determinations. Although the stock status determinations provided in these reports rely on limit reference points, it is envisaged that, in the future, stock status classification will consider stock status in relation to targets as well as limits.

Defining stock status—weight-of-evidence approach

Assessing the status of fish stocks can be a difficult task. The methods used to monitor and assess stock status vary, ranging from simple catch levels to complex stock assessments. Smaller-volume and lower-value stocks and fisheries often have fewer data available or limited resources to undertake quantitative stock assessments. If targeted catch from a stock is very low, or a species is only taken in small numbers as byproduct, it may not be cost-effective to invest in the development of resource-intensive quantitative stock assessment models. However, robust stock status assessments can be made without having quantitative stock assessments.

A weight-of-evidence approach is achieved by systematically considering a range of biological and fisheries information. The approach provides a structured, scientific process for assembly and review of indicators of biomass status and levels of fishing mortality. For most fish stocks, particularly in the smaller fisheries, only a subset of the types of evidence is available and/or useful. Expert judgment plays an important role in stock status determination, with an emphasis on documenting the key evidence and rationale for the decision. The decision-making process is undertaken separately for abundance and fishing pressure.

The lines of evidence used in the weight-of-evidence approach include:

- Empirical indicators, including catch, effort, catch rate, size- or age-based indicators, and spatial and temporal distribution of the fishery.
- Risk assessments.
- Fishery-independent surveys.
- Quantitative stock assessment models.
- Harvest strategies.

Stock assessments

Stock assessments are one of the main sources of information for determining stock status. Stock assessments are mathematical and statistical models that are used to predict the stock abundance and response to fishing. They typically incorporate information on growth, natural mortality, the stock–recruitment relationship and carrying capacity, and data from fishery-dependent sources (for example, catch and fishing effort) and fishery-independent sources (for example, surveys). The outputs of these assessments generally include an indication of the unfished stock abundance (that is, how big the stock was before fishing began), current stock abundance and current fishing pressure. In combination with biological reference points, the information from a stock assessment can be used to determine the stock status classification.

Abundance: Stock assessments of different species use different ways of expressing current stock size because of differences in biology and management systems. Abundance descriptors may include spawning stock biomass, total biomass, or egg/pup production. However, regardless of the type of descriptor used, the basic premise is that, for the stock to be classified as a sustainable stock, the level of abundance (biomass) must be above the level that results in the stock being recruitment overfished. This means that the abundance of adults will not have been reduced to the point where there is increased risk of recruitment failure.

Fishing pressure: In some cases, estimates of fishing mortality are explicitly stated for a stock, where they are available. In these cases, the actual fishing mortality can be compared with fishing mortality limits set by management rules to determine whether current fishing pressure is likely to cause the stock to become recruitment overfished. In other cases, stock assessment models are used to determine total allowable catches (TACs), which are designed to ensure that the stock remains at (or will return to) an adequate size—often defined by target reference points. In these cases, it is useful to compare the catch from a stock with that recommended by the TAC. If the catch is below or equal to a biologically meaningful TAC, the current level of fishing pressure is unlikely to cause the stock to become recruitment overfished.

Effects of fishing on the marine environment

The stock status classification provided for each stock does not take into account the effects of fishing on the marine environment. As discussed previously, these elements of the broader concept of ecologically sustainable development tend to be considered at the fishery level, rather than at the stock level. Although no formal classification has been given, the effects of fishing on the marine environment are briefly explored in each species' chapter and the measures that have been put in place to mitigate detrimental effects are described.

Assessments of Northern Territory fisheries under the *Environment Protection and Biodiversity Conservation Act 1999*

The environmental performance of NT managed fisheries that have an export component and/or operate in Commonwealth waters is assessed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The Australian Government's Department of the Environment assesses a fishery's management arrangements for consistency with the EPBC Act using criteria listed in the *Guidelines for the ecologically sustainable management of fisheries* (2nd edition)[3]. The guidelines outline specific principles and objectives to ensure a strategic and transparent way of evaluating the ecological sustainability of fishery management arrangements. The guidelines include the principles that:

- A fishery must be conducted in a manner that does not lead to overfishing; for those stocks that are overfished, the fishery must be conducted such that there is a high probability that the stock(s) will recover.
- Fishing operations should be managed to minimise their impact on the structure, productivity, function and biological diversity of ecosystems[6].

An assessment is undertaken if:

- product from the fishery is to be exported,
- the fishery is to operate in Commonwealth waters, and/or
- the fishery is to be managed by the Commonwealth.

Part 13A Export

An Australian native wildlife specimen can only be exported for commercial purposes if it is approved for export from a program, such as an approved wildlife trade operation, or is included in the list of exempt native specimens.

Part 13 Species and Communities

Under part 13 of the EPBC Act, it is an offence to harm listed threatened species (except a conservation-dependent species) in Commonwealth waters unless a fisher has obtained a permit or the management arrangements for the fishery are accredited under the Act. Management arrangements can be accredited under Part 13 if the Environment Minister is satisfied that:

- The management arrangements require individual fishers to take all reasonable steps to avoid killing or injuring a member of a species protected under the EPBC Act (that is, a threatened species, a listed migratory species, a listed marine species or cetacean).
- The fishery does not, or is not likely to, adversely affect the conservation status of protected species, or affect the survival and recovery of listed threatened species[6].

NT managed fisheries that have undergone EPBC Act assessments (and can export product) include the Aquarium Fishery, the Demersal Fishery, the Mud Crab Fishery, the Offshore Net and Line Fishery, the Spanish Mackerel Fishery, the Timor Reef Fishery and the Trepang Fishery. Details of these assessments are not presented in the species chapters of this report because they relate to the operation of individual fisheries rather than the stock status of individual species. The reader can, however, access all EPBC Act assessments for NT managed fisheries from: http://www.environment.gov.au/marine/fisheries/nt-managed-fisheries.

Environmental effects on stocks

Many fish stocks vary naturally as a result of the effects of the environment, even in the absence of fishing. For example, recruitment of Barramundi can be affected by rainfall[7, 8]. Weather events, ocean currents, changes in climate and disease can all affect fish abundance. Where links have been established between environmental factors and stock abundance for a given species, they are outlined in the species chapters.

Non-fishing factors that affect the sustainability of fish stocks

Human activities unrelated to fishing can have a substantial impact on the sustainability of fish stocks—for example, the clearing of mangroves for coastal development. Although the impacts of human activities are not discussed on a species-by-species basis, these factors may, in some cases, have a greater impact on fish stocks than fishing.

What to expect in each species report

Each chapter describes the distribution of stocks of key species in the NT and provides stock status classifications for each. In cases where biological stock delineation is known and the number of discrete biological stocks is small, information is presented at the level of biological stocks. Otherwise, information is presented at the management unit or jurisdictional level.

Catch estimates for each stakeholder group that harvests key species are provided in summary tables. The reader is advised that there are significant differences in the currency of catch data for the commercial, recreational and Indigenous fishing sectors. Historical catch estimates for recreational and Indigenous fishers cannot be assumed to be representative of current catches due to the inherent variability in annual catches seen in the tropics (primarily due to differences in wet season rainfall).

Additional catch per unit effort information for some commercial fisheries is presented where relevant. The effects of fishing on the marine environment (and associated mitigation measures) are also summarised, as are the environmental factors which affect fish stocks.

Reporting period

These reports present calendar year data to the end of 2014 and the results of stock assessments based on data collected to that point.

FISHING METHODS

Fishing gear and methods are designed to take into account the particular characteristics and behaviour of the target species, including their feeding, spawning, shoaling and migratory behaviour, their ecology or relationship with their habitat and their herding behaviour. The catchability of each species depends on the action of the gear; the composition of the catch from a particular fishing area may, therefore, depend on the type of gear used. The information presented here is based on the 1993 authoritative *Australian fisheries resources*[9] and is updated to reflect changes in fishing techniques and management over the past 20 years.

Nets

Fishing nets are used in a wide variety of configurations and designs, depending on the species targeted. Four main types of fishing gear use netting: gillnets and entanglement nets, surrounding nets, seine nets and trawls. The main components of a common net are described below.

The netting or mesh is the panel of net that fish will encounter and be retained in. Modern nets are typically constructed from synthetic fibres, such as monofilament nylon for gillnets and multiple twisted or braided polymer filaments for seine and trawl nets.

The top edge of the net is attached to a rope called the headline, float-line or cork-line. Floats are attached to the headline to provide buoyancy.

The bottom edge of the net is attached by hanging twine to a rope called the footrope or lead-line. Weights or sinkers made of lead or other materials are attached to the footrope and spread the net vertically in the water. The type and number of floats and weights used depends on whether the net is to be positively or negatively buoyant (see below).

Gillnets

Gillnets consist of a panel (or panels) of net held vertically in the water column, either in contact with the seabed or suspended from the sea surface. The size of the net mesh determines the size range of the species caught, since smaller fish are able to swim through larger mesh. In most cases, maximum net length and minimum mesh size are regulated. Gillnets are used in offshore and inshore waters and estuaries.

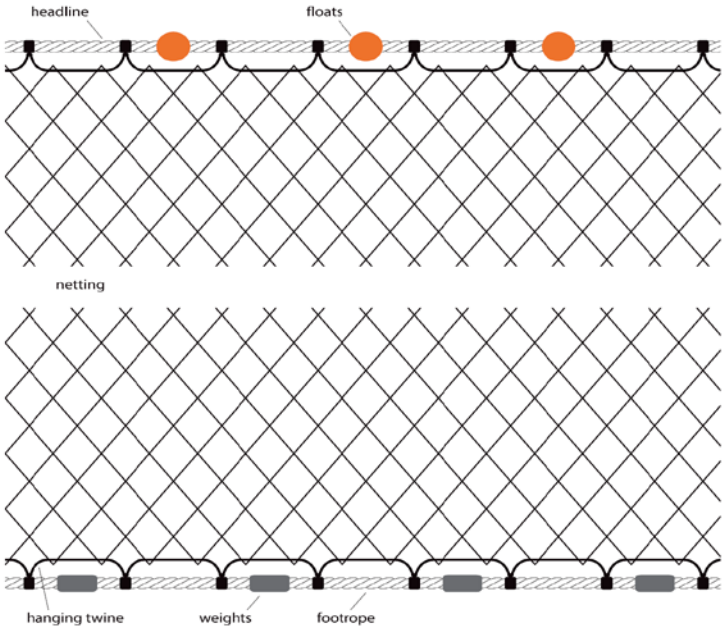

Figure 2: A common net

Fish are caught in gillnets in one of three ways:

- Gilled—the fish tries to swim through one or more meshes; if it cannot pass through, it becomes caught behind its gill covers as it tries to back out of the net.
- Wedged—the fish is tightly held in the net around the body by one or more meshes.
- Tangled—the fish is caught in the net by some part of its body, such as protruding fins or spines.

Pelagic gillnets (also known as (aka) drifting gillnets) are used in the NT Offshore Net and Line Fishery to target tropical sharks and mackerels. Pelagic gillnets are made up of individual net panels tied together, allowing easy removal or replacement of damaged sections. They are set in open water and can be set with the headline on the sea surface (*positively buoyant*) or suspended below the surface (*negatively buoyant*), with one end of the net remaining attached to the vessel.

Figure 3: A pelagic gillnet

Coastal, estuary and river-set gillnets are set in estuaries and the coastal inter-tidal zone. They are used in the NT Barramundi Fishery to target Barramundi and King Threadfin. Estuary-set gillnets are deployed from small dinghies and are typically orientated perpendicular to the direction of the tidal flow. The headline may be staked or anchored at one or both ends.

Seine nets

Seine nets usually have two long wings and a section that concentrates and retains the catch. Lengths of rope are added to the end of each of the wings. These ropes are negatively buoyant and extend the working area of the net while adding minimum drag to the hauling operation. The nets work on the principle that fish are reluctant to swim over a moving object in the water and instead try to swim in front of it. The fish are thus herded by the ropes and wing ends into the net.

Beach-seine nets are used by the NT Coastal Net Fishery to target Mullet and Blue Threadfin. The net may have a loose section of netting acting as a bunt area for retaining fish, or may have a bag at one end of the net or in the centre. Beach-seine nets can be set around a known school of fish, or in an area where fish regularly congregate. The net is set from a dinghy or can be walked out in shallow water, with the first length of rope being set perpendicular to the shore, the net set parallel to the shore and the second rope set back to the shore. The ropes are then hauled onto the beach evenly by hand or vehicle, herding the fish into the net. Hauling continues until the net and fish are dragged onto the shore, or the fish are concentrated in the bag.

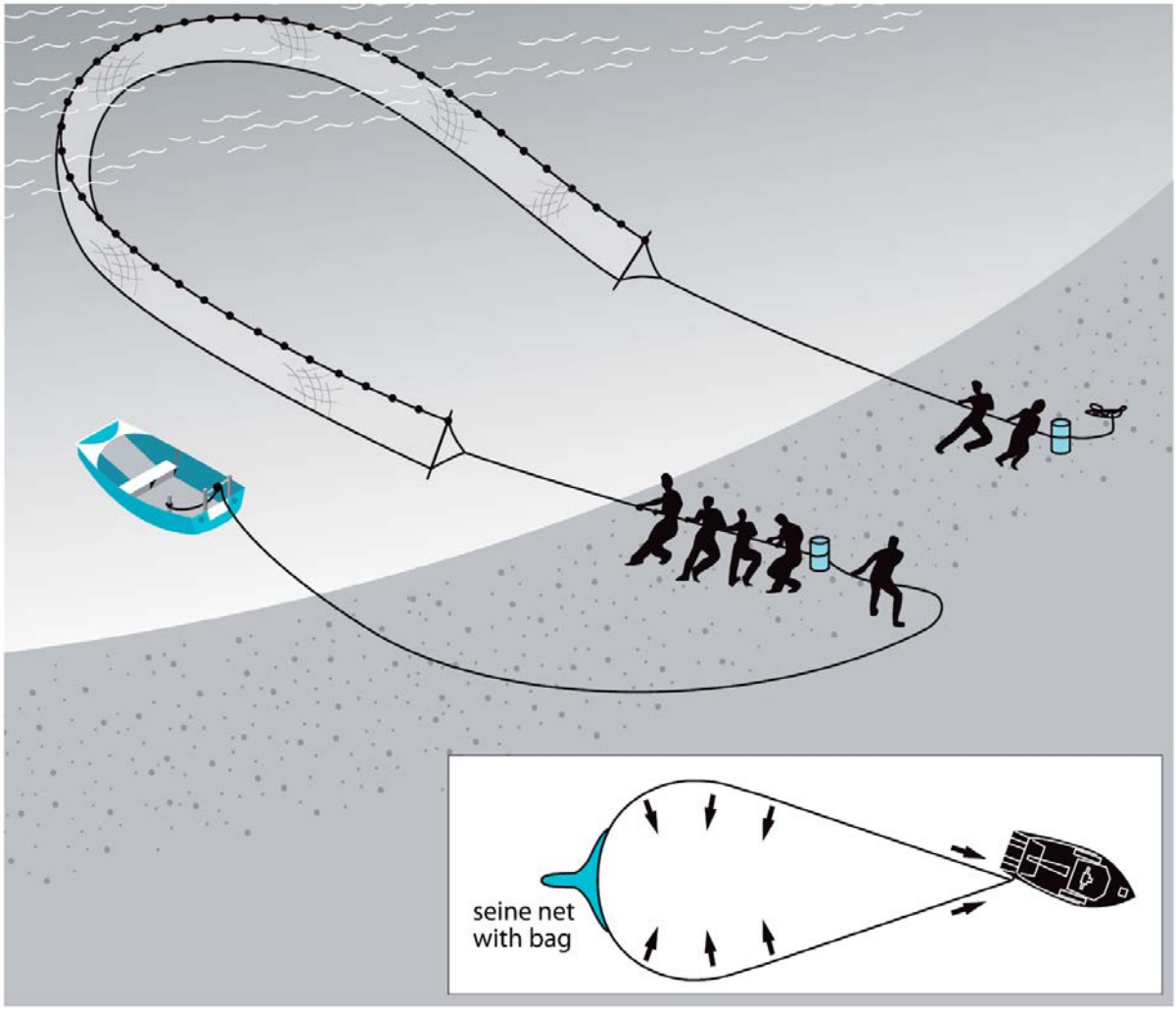

Figure 4: A beach-seine net

Cast nets

A cast net, also called a throw net, is a circular net with small weights distributed around its edge. The net is cast or thrown by hand in such a manner that it spreads out on the water and sinks. Fish are caught as the net is hauled back in. Cast nets are popular for catching small bait fish species by recreational anglers and are also used by commercial fishers in the Coastal Net Fishery.

Trawl

Trawling is performed in many ways in depths of water ranging from just a few metres to 1000 m. The design of trawl nets is more complex than the basic nets discussed above. Trawls are made up of components that perform specialised functions, as described below:

- *Warps* are wire ropes connecting the trawl boards to the vessel. They are stored on winch drums for ease of operation.
- *Trawl boards* (aka otter boards or trawl doors) keep the net open horizontally by acting as hydrodynamic kites. They also provide weight, which is required to keep the trawl at the desired depth of operation.
- *Backstrops* are short lengths of wire or chain that connect the trawl boards to the sweeps. Sweeps are used on demersal otter trawls to connect the backstrop to the bridle on each side of the net. Bridles connect the sweep on each side of the net to the headline and footrope on the wing ends of the net.
- *Ground gear* is a wire or chain that is attached to the footrope by short chain droppers. The ground gear has several rubber or steel bobbins and *spacers* threaded along its length. The purpose of the ground gear is to reduce damage from snagging by lifting the footrope and net clear of the seabed.
- *Body panels* are the panels of net that make up the body of the trawl; they comprise upper and lower sections.
- The *codend* or bag is the last section of the net, where fish are collected and held during trawling operations. This area has the smallest mesh size, which determines the size of fish that the trawl will retain. The end of the codend is tied with a quick-release knot so that the fish can be easily emptied from the net.
- The *lazy line* is sometimes used to pull the codend on board so that it can be emptied.

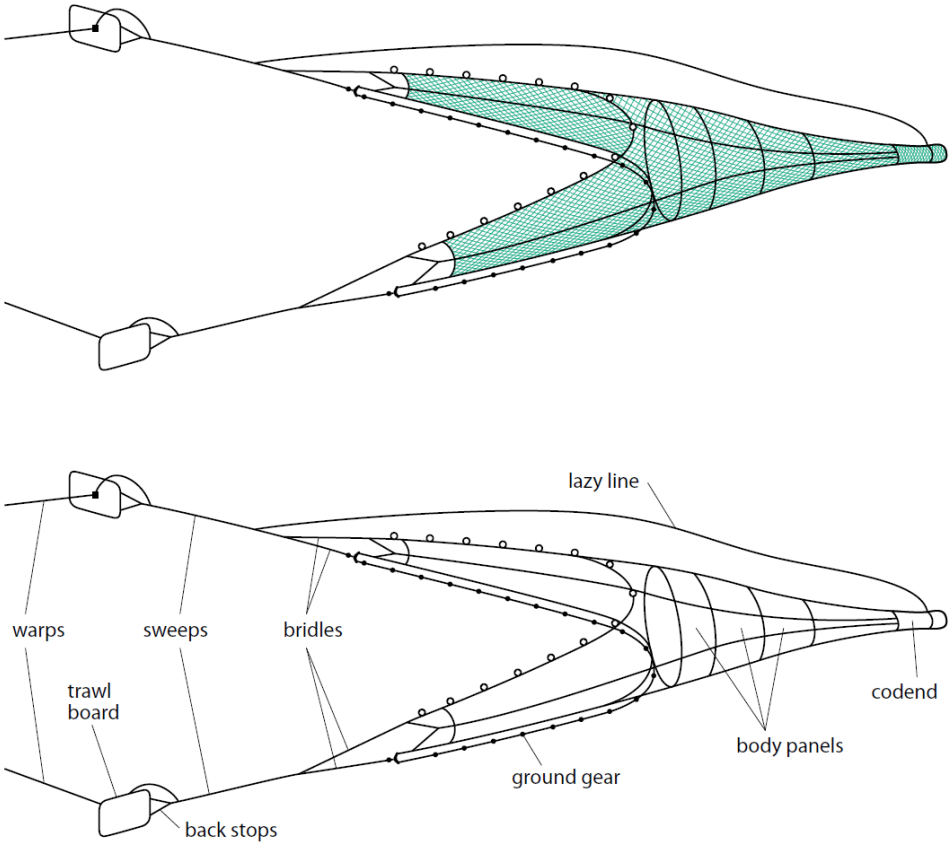

Figure 5: Trawl net configuration

Demersal otter trawling (aka stern trawling, bottom trawling, otter trawling or trawling) is employed by the NT Demersal Fishery to target tropical snappers. The trawl gear fishes close to the bottom, with the trawl boards, wing-end weights and chain droppers coming in contact with the seabed. The net is held open horizontally by trawl boards being dragged along the seabed, spreading the sweeps, bridles and net wings. These herd the fish towards the net, where they are retained in the codend.

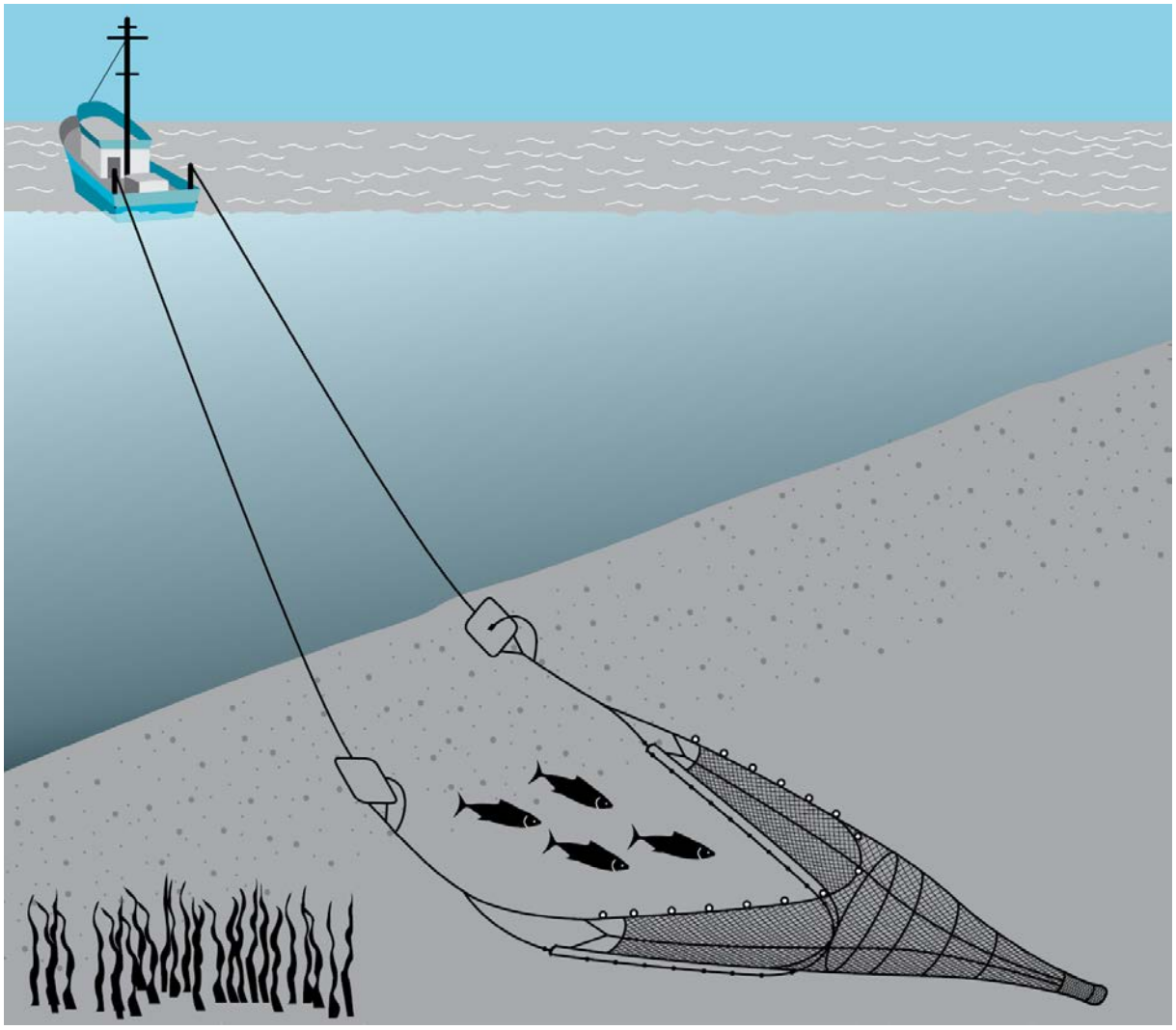

Figure 6: Demersal otter trawl gear

Hook and line

Hand lines, hand reels and powered reels (aka rod-and-line fishing or deep-water line fishing) are used in the NT Coastal Line Fishery. Hand lines are the simplest form of fishing; they consist of one or more baited hooks attached to a line, which is retrieved by hand. Hand lines are the most common traditional fishing method used by Indigenous fishers. Hand reels can be mounted on the side of a vessel or attached to a rod (rod and line). Rod and line is the predominant method used by recreational fishers in the NT. Reels are used to deploy and retrieve the line and are usually fitted with a drag system (a 'brake' system, which is designed to create resistance in the reel as the fish takes out line). To reduce the time and effort involved in setting and hauling the line, electric or hydraulic motors are fitted to some larger reels (powered reels).

Anchored longlines

Anchored longlines can be set vertically in the water column (dropline), horizontally along the seabed (bottom-set longline) or horizontally above the seabed (trotline).

Droplines have historically been used to target tropical snappers in the NT Demersal and Timor Reef fisheries. However, they have been replaced by more efficient gear types in recent years (trap and trawl). Droplines consist of a mainline of rope, wire or nylon that is anchored vertically in the water column with a weight on the bottom and floats attached at the surface. Short lengths of twine or nylon called snoods or traces have a clip attached to one end and a hook to the other. When being set for fishing, the desired number of pre-baited snoods (usually between 10 and 100) is clipped at regular intervals along the lower section of the mainline as it is fed out. Alternatively, the snoods may be permanently attached to the mainline

and are baited and lined up in order along individual shooting rails while the vessel is heading for the fishing grounds. When the weight is dropped overboard, they are pulled off the rails in turn as the line is set.

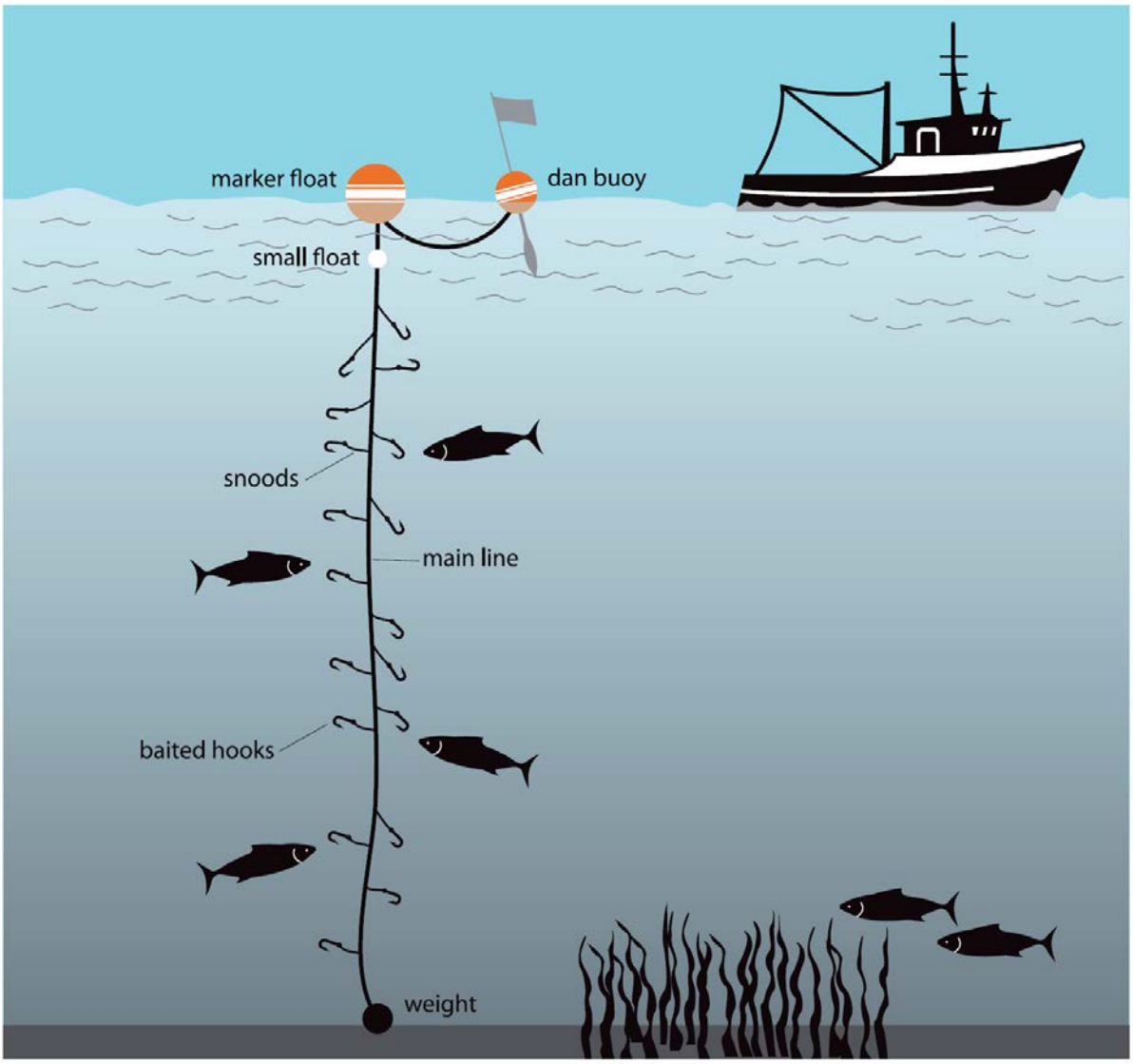

Figure 7: A dropline

Demersal longlines (aka bottom-set longlines) are used in the NT Offshore Net and Line Fishery to target blacktip sharks; they are also permitted in the NT Demersal and Timor Reef fisheries but are rarely used. One end of the haul-in line has a weight attached to anchor the end of the mainline and the other has a dan buoy (a small buoy, with a flag, used to temporarily mark a position at sea) and float. The line is left to fish for up to 6 hours. Setting and hauling of longlines can be mechanised by hydraulic line setters and haulers, with snoods stored in magazines and a baiting machine that attaches bait to the hooks as the line feeds over the vessel's stern.

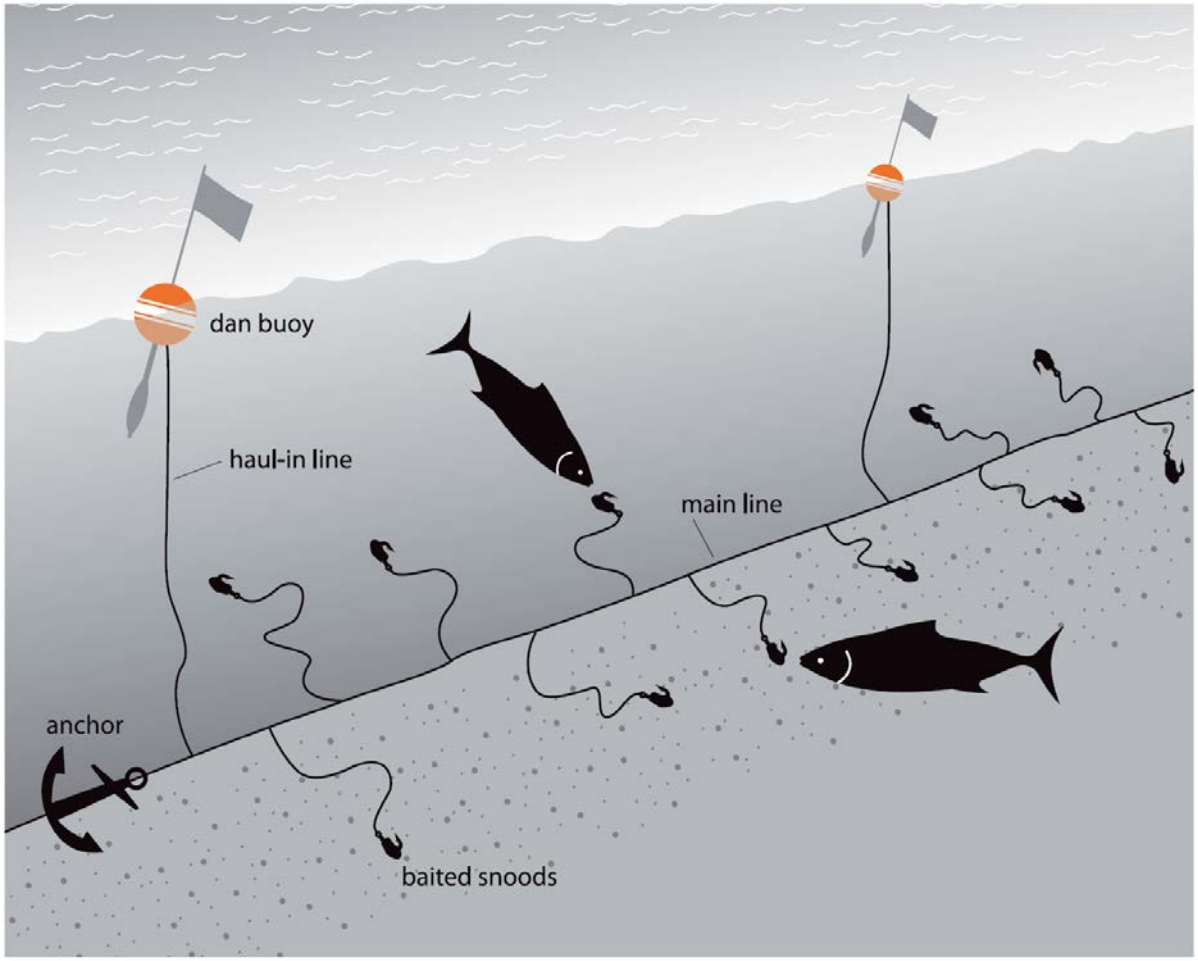

Figure 8: Demersal longline configuration

Trolling

Trolling is a simple method of fishing used by the NT Spanish Mackerel Fishery, in which lines with baits or lures are dragged behind a dory or mothership as it moves along at a speed of 2 to 10 knots. It is common for fishers to troll two to four lines behind a dory and up to eight lines from a mothership. A variety of lines, rig designs and lures or baits are used for trolling.

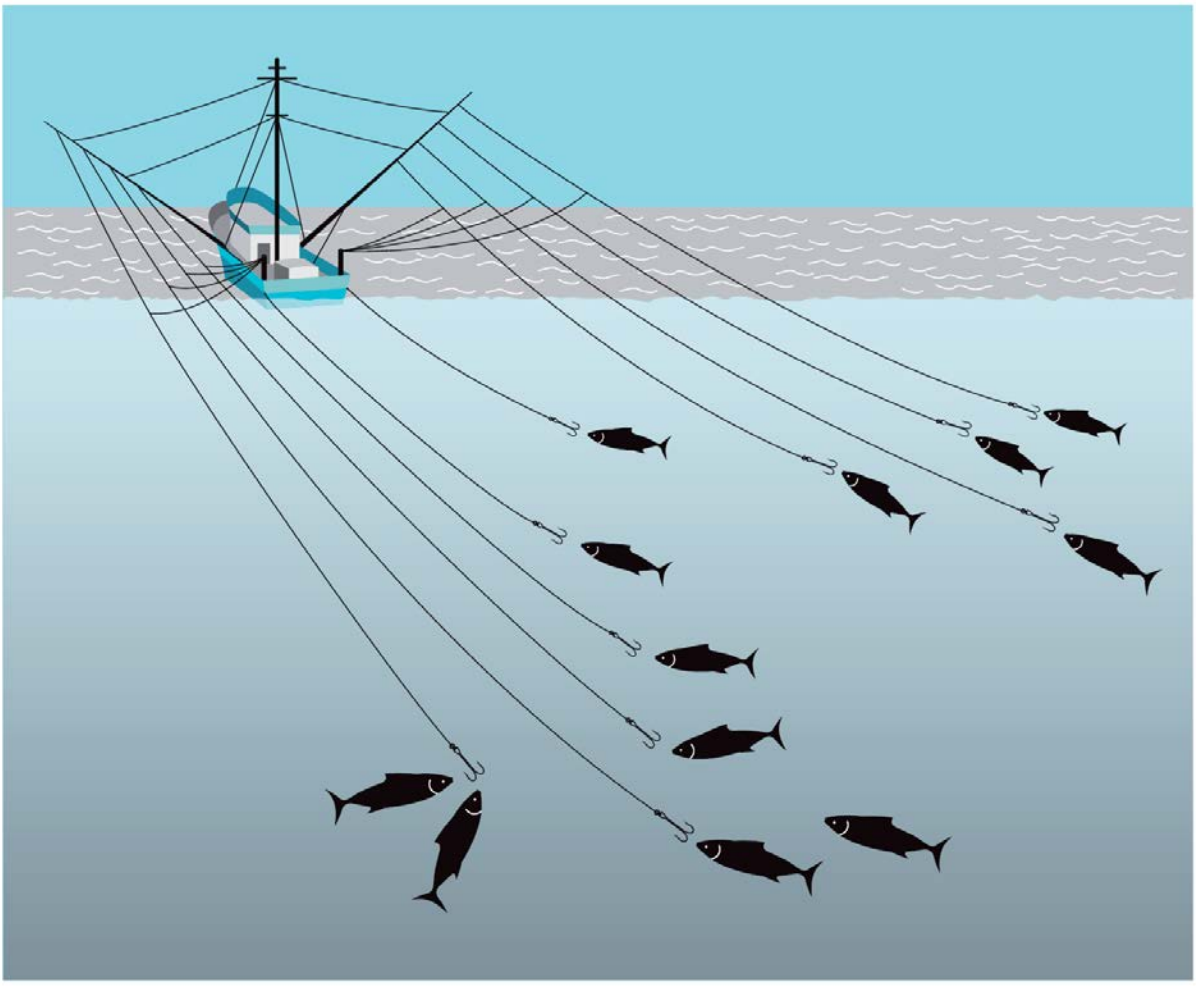

Figure 9: Trolling

Traps and pots

Traps and pots are enclosures or devices that entangle or entrap fish, crustaceans or molluscs. Animals are attracted to the enclosure either by bait or because it appears to provide refuge.

Most traps and pots are set on the seabed or riverbed with a haul-in line, surface float or dan buoy to mark their position. They can have one or more entrances on the top or sides, depending on the target species. A line hauler may be used to retrieve the gear for checking and re-baiting.

Fish traps

Fish traps can be set in water depths ranging from 2 m to hundreds of metres. They are made in a variety of shapes and sizes, depending on the target species. Most baited traps are set on the seabed, with at least one entrance facing down-current. The traps are left to fish for around 20 minutes to 24 hours.

Rectangular traps made of metal with tapered entrances on their sides (towards the base) are used in the NT Timor Reef, Demersal and Coastal Line fisheries to target a range of reef associated fish. The weight of these traps (approx. 100 kg) ensures that they fish on the seabed.

Crab pots

There are many different shapes and sizes of crab pots but most are less than 0.5 m^3 in volume and 80 cm in any dimension. They are baited and left to fish for around 6 to 24 hours.

Mud Crab pots can be constructed in several ways, but only rigid rectangular pots are used by commercial operators in the NT Mud Crab Fishery. These particular pots have one pair of opposing, horizontally-tapered, side-entry funnels. Some operators fit escape gaps to their pots to reduce the retention of undersized Mud Crabs. Most recreational Mud Crab fishers use collapsible polyethylene mesh pots with mesh sizes ranging from 25 mm x 25 mm to 50 mm x 50 mm.

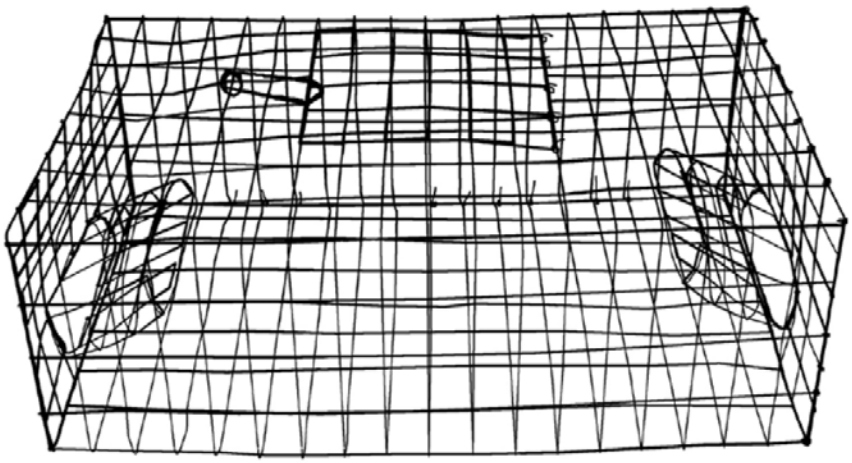

Figure 10: Mud Crab pot—rigid rectangular (Butcher et al. 2012)

Diving

Diving is used as a means to collect product by the NT Trepang and Aquarium fisheries. Divers in both fisheries rely on surface-supplied air (via an *air-line* from a compressor on board a support vessel), a method known as *hookah diving*. Items are collected by hand and stored in netted catch bags until the diver returns to the support vessel.

Hand-held implements

Hand-held implements, such as picks, spears, gaffs and landing nets, are used as primary or ancillary fishing gears in the NT. Small steel picks are used to dislodge coral fragments by Aquarium Fishery licensees, while spears are often used by Aboriginal fishers to harvest many fish species. Gaffs and landing nets are commonly used to land large fishes caught on hook and line gear.

Bycatch reduction devices

A number of bycatch reduction devices have been developed for Australian fisheries to allow various organisms and objects to exit fishing gear without being brought on board. Licensees in the NT Demersal Fishery fit turtle excluder devices and square-mesh panels to their trawl nets to reduce their environmental footprint and increase their efficiency (through reduced sorting time).

Turtle excluder devices consist of a metal grid across the mouth of the codend, which forces large objects out of the net while allowing smaller target species to be captured, thereby reducing turtle drownings and the retention of sharks, rays and benthic debris.

Square-mesh panels retain their shape under tension and provide a means of escape for smaller fish and non-target species prior to entering in the codend. In some cases, the entire codend is constructed from square-mesh netting, hung to maintain open meshes when the codend fills with catch.

Approximately one quarter of licensees in the NT Mud Crab Fishery fit escape vents to their crab pots. These devices consist of a hard plastic panel with a precision-cut opening, sized to allow the escape of under-sized crabs and small bycatch species while retaining legal-sized crabs.

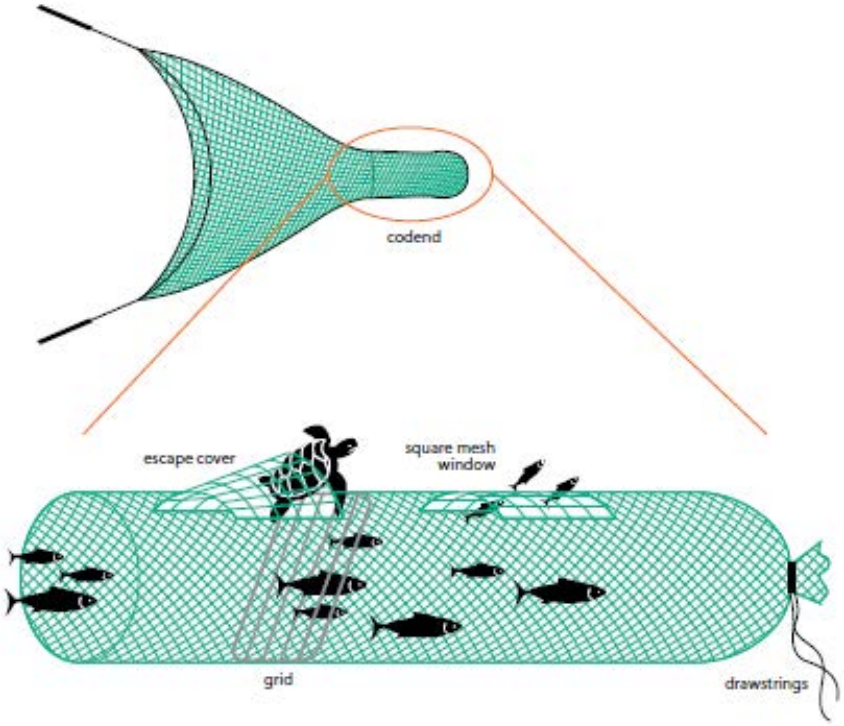

Figure 11: A typical design of a turtle excluder device in a trawl net

Figure 12: A turtle excluder device

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Line drawing: Allison Mortlock, AngelInk 2012.

OVERVIEW OF NORTHERN TERRITORY MANAGED FISHERIES

Fisheries operating in NT waters predominantly harvest marine and estuarine species from tidal waters. For the commercial sector, the outer boundaries of these fisheries vary, extending to 3, 15 or 200 nautical miles (nm) from the coast. Fisheries operating within 3 nm are typically referred to as "inshore" fisheries and almost all of the recreational and Indigenous sectors effort is concentrated in this area. Those fisheries operating out to 15 or 200 nm are referred to as "offshore" fisheries and the commercial sector is responsible for almost all of the effort in this area. Most fisheries span the entire coastline, although some (like the Coastal Net and Timor Reef fisheries) are restricted to discrete regions. Commercial and recreational fishers operating within estuaries must avoid Aboriginal sacred sites and observe any other area restrictions. Additionally, Section 53 of the *Fisheries Act 2011* recognises the customary fishing rights of local Aboriginal people, thereby exempting traditional harvest by Aboriginals from most management controls.

In general, fisheries are managed to ensure the ongoing sustainability of harvest from the fish stocks in that fishery. Management of fisheries also aims to optimise resource allocation (balancing social and economic considerations) and to minimise adverse impacts of fishing on the environment. Australian fisheries are managed in line with the United Nations Convention on the Law of the Sea (UNCLOS), which is reflected in the legislation and policy of the Commonwealth, states and territories. FAO *Code of Conduct for Responsible Fisheries* provides guidelines for the implementation of UNCLOS, with the high-level requirement that:

> *States should prevent overfishing and excess fishing capacity and should implement management measures to ensure that fishing effort is commensurate with the productive capacity of the fishery resources and their sustainable utilization. States should take measures to rehabilitate populations as far as possible and when appropriate*[1]*.*

Fisheries managers typically set limits on the amount of fishing effort (including when, where and with what gear catches can be taken—referred to as input controls) or the quantity of catch that can be taken from a stock (referred to as output controls). These decisions are usually based on the best available science at the time of the decision, but may also take into account other factors, such as economics. Fisheries management is generally an adaptive process because fish stocks can be influenced not only by the fishery's harvest but also by environmental effects and natural variation. Fisheries also change in response to changes in market demands, fuel prices and other factors.

Management arrangements for NT fisheries are primarily developed through advisory groups (or committees) related to specific fisheries or user groups. In most cases, these bodies consist of local representatives. However, the Timor Reef, Demersal and Offshore Net and Line fisheries are jointly managed by the NT and Commonwealth Governments through the NT Fisheries Joint Authority.

Catch and effort statistics for each fishery are derived from compulsory monthly logbooks submitted by commercial and Fishing Tour Operator (FTO) licensees. Recreational and Indigenous catch and effort statistics are derived from periodic surveys. The environmental performance of joint authority fisheries is routinely assessed by fishery observers on board commercial vessels. Furthermore, all fisheries operate in accordance with a number of local, national and international acts, plans and conventions. These include the *Territory Parks and Wildlife Conservation Act 2000*, the *Environment Protection and Biodiversity Act 1998*, the National Plan of Action for the Conservation and Management of Sharks 2012, and the Convention on the International Trade in Endangered Species.

All commercial licensees must attend an interview with a fishery manager prior to entering a fishery, or if more than five years have passed since their last interview. The purpose of these interviews is to familiarise the licensee with current legislation, the status of the fishery, fisheries research programs, reporting requirements and any industry codes of conduct or environmental management systems. Regular contact with licensees also allows the fishery manager to keep abreast of any emerging issues in the fishery.

The following sub-sections provide a background on each of the primary fisheries in the NT. This includes a description of the area of the fishery, the target species, the allowable gear and the restrictions on catch and/or effort. Catch, byproduct and bycatch statistics are also presented, as are the details of any recent compliance issues.

While most of this information refers to the commercial sector, where other sectors target the same species, the relative importance of these species to each user group (in terms of the catch/harvest fraction and/or the proportion of fishing effort) is provided. Relative (rather than absolute) estimates are given in these instances due to differences in the currency of catch estimates for the different sectors and the inherent variability in annual catches seen in the tropics. Catch statistics for FTOs are also expressed in relative terms because the FTO catch is reported by number rather than weight.

A1 Coastal Line Fishery

The NT Coastal Line Fishery extends seaward from the high water mark to 15 nm from the low water mark and primarily targets Black Jewfish (*Protonibea diacanthus*) and Golden Snapper (*Lutjanus johnii*) using hook and line gear. Most fishing activity is concentrated around rocky reefs within 150 km of Darwin.

Licensees are permitted to use several gear types. Rod and line, hand lines, cast nets (for bait only), scoop nets or gaffs can be used throughout the fishery. Droplines and a maximum of five fish traps may also be used beyond 2 nm from the coast. A maximum of five hooks may be fitted to hand lines and rod and line gear. Droplines may be rigged with a minimum of six and a maximum of 40 hooks. Fish traps have not been used in this fishery over the last decade and the use of droplines comprises less than 5% of fishing effort by licensees.

A total of 140 tonnes (t) of fishes were harvested by Coastal Line Fishery licensees in 2014, with Black Jewfish and Golden Snapper forming most of the harvest (94% and 2.8%, respectively). Grass Emperor (*Lethrinus lentjan*) was the only byproduct species taken in any significant quantity (0.9% of the harvest). No bycatch was reported in this fishery during 2014. The total value of the catch in this fishery is estimated at $0.7 million.

Recreational anglers and FTO clients predominantly use rod and line gear to target the same reef-associated species as licensees, often at the same location. The harvest by these groups is constrained through the use of personal possession limits.

Snappers of the genus *Lutjanus* account for almost one in four of all fishes caught by recreational fishers in the NT. The retention rate of different species encountered during recreational reef fishing varies markedly, from around 75% for snappers, emperors (Family Lethrinidae) and Black Jewfish to less than 5% for catfish (Family Ariidae) and sharks (primarily Family Carcharhinidae)[2]. Reef fishing constitutes around 40% of all fishing effort (in hours) expended by FTO clients. The catch composition and retention rate of reef fishes by FTO clients is similar to that of recreational fishers.

Forty five per cent of all fishing events by Indigenous fishers in the NT involve line fishing, with most of this effort (93%) concentrated onshore. Less than 2% of the fishes caught by Indigenous fishers are released, as fishing is undertaken as a subsistence activity[3].

Coastal Line Fishery licensees, recreational fishers and FTO clients are all capable of exerting substantial impacts on reef-associated species and recent sustainability concerns have led to the development of new management controls on the harvest of these species.

The primary fishing gear used in the Coastal Line Fishery (hook and line) poses little risk of interaction with threatened, endangered and protected species (TEPS) (such as turtles, dugongs and sawfish) and there

were no reported interactions between the Coastal Line Fishery and TEPS in 2014. Similarly, the actions of this fishery are considered to have little impact on other ecosystem components.

There have been few reported problems with compliance in the Coastal Line Fishery and there is no evidence of systematic non-compliance. The primary area of concern is the potential for the black market sale of fish by unlicensed operators. In particular, the illegal sale of Black Jewfish airbags has increased due to the recent higher prices for this product.

A2 Coastal Net Fishery

The NT Coastal Net Fishery extends seaward from the high water mark to 3 nm from the low water mark and harvests a range of species, including Mullets (Family Mugilidae), Blue Threadfin (*Eleutheronema tetradactylum*), sharks and Queenfish (*Scomberoides* spp.).

The fishery is regionalised and the five licensees can only fish in one of three discrete zones: Darwin (from Cape Hotham to Native Point and Cape Ford to Cape Dooley); Gove (between Cape Arnhem and Cape Wilberforce); or Borroloola (between Bing Bong Creek and Pelican Spit).

Licensees are permitted to use a gillnet of no more than 300 m in length, with a maximum drop of 5 m and a mesh size not exceeding 65 mm. Nets may be anchored at one end only. Licence holders are also permitted to use a cast net with a diameter of not more than 6 m and mesh size not exceeding 25 mm. Based on historical use, one operator is permitted to use a gillnet with a mesh size up to 100 mm. Nets must be cleared in water not less than 30 cm deep to facilitate the release of any bycatch or prohibited species.

A total of 6.5 t of fishes were harvested by Coastal Net Fishery licensees in 2014, 76% of which was Mullet. Byproduct species included Whiting (Family Sillaginidae), catfish, Garfish (Family Hemiramphidae), Blue Threadfin, sharks and Queenfish. There was no reported bycatch in this fishery during 2014. The total value of the catch in this fishery is estimated at $32 000.

Recreational fishers can use drag nets and cast nets to target fish and prawns for bait or human consumption. Drag nets must not exceed 16 m in length, a 2-m drop, or have a mesh size of more than 28 mm. The dimensional limits for recreational cast nets are the same as those for licensees. The use of nets by recreational fishers and FTO clients accounts for less than 1% of the fishing effort (in hours) by these groups[2]. Around 10% of all fishing events by Indigenous fishers in the NT involve the use of some form of net[3].

The small number of licensees in the Coastal Net Fishery (five) in conjunction with the restricted area of the fishery limits the risk of interactions with TEPS. There were no reported interactions between the Coastal Net Fishery and TEPS in 2014. Similarly, the actions of this fishery are considered to have little impact on other ecosystem components.

There have been few reported problems with compliance in the Coastal Net Fishery and there is no evidence of systematic non-compliance. The primary areas of concern are the illegal use of nets and the potential for the black market sale of fish by unlicensed operators.

A4 Spanish Mackerel Fishery

The NT Spanish Mackerel Fishery extends seaward from the high water mark to the outer limit of the Australian Fishing Zone (AFZ) and targets Spanish Mackerel (*Scomberomorus commerson*) using trolled lures or baited lines. The primary fishing grounds include waters near Bathurst Island, New Year Island, the Wessel Islands around to Groote Eylandt and the Sir Edward Pellew Group of islands.

Licensees typically fish from a mother ship and/or dories, with a maximum of two dories permitted per licence. They may use any number or combination of troll lines, floating hand lines or rods. Operators generally troll two to four lines behind a dory and up to eight lines from a mother boat.

A total 290 t of fish were harvested by Spanish Mackerel Fishery licensees in 2014. Almost all (99.2%) of this catch was Spanish Mackerel with the other 0.8% comprising Grey Mackerel and Trevally species. There was no recorded bycatch during 2014. The total value of the catch in this fishery is estimated at $2.2 million.

Recreational fishers and FTO clients target Spanish Mackerel in waters close to population centres, such as Darwin, Nhulunbuy and Borroloola, using baited hooks and lures. Only 1% of all fishes caught by recreational fishers in the NT are Spanish Mackerel; 50% of these fish are released[2]. Incidental catches during targeted recreational fishing for Spanish Mackerel include other mackerels (*Scomberomorus* spp.), trevallies and Queenfish, many of which are released alive.

The Spanish Mackerel Fishery is managed through a catch-sharing arrangement between all user groups. This agreement aims to maintain the cumulative harvest of Spanish Mackerel within a precautionary allowable catch of 450 t per annum. The proportion of the allowable catch allocated to each user group was based on historical logbook data and catch estimates from the National Recreational and Indigenous Fishing Survey[3] as follows: 76% (342 t) to Spanish Mackerel Fishery licensees, 3% (13.5 t) to Offshore Net and Line Fishery licensees, 1% (4.5 t) to Demersal Fishery licensees, 3% (13.5 t) to FTO licensees, 16% (72 t) to recreational fishers and 1% (4.5 t) to Indigenous fishers.

The primary fishing gear used by the Spanish Mackerel Fishery (trolled lures and baited lines) poses little risk of interaction with TEPS and there were no reported interactions between the Spanish Mackerel Fishery and TEPS in 2014. Similarly, the actions of this fishery are considered to have little impact on other ecosystem components.

There have been few reported problems with compliance in the Spanish Mackerel Fishery and there is no evidence of systematic non-compliance.

A5 Offshore Net and Line Fishery

The NT Offshore Net and Line Fishery extends seaward from the high water mark to the outer limit of the AFZ and targets Australian Blacktip Sharks (*Carcharhinus tilstoni*), Common Blacktip Sharks (*C. limbatus*) and Grey Mackerel (*Scomberomorus semifasciatus*) using a variety of gear.

Demersal longlines can be used throughout the fishery whereas pelagic gillnets and pelagic longlines can only be used beyond 2 nm and 3 nm off the coast, respectively. Pelagic gillnets are the primary gear used by this fishery and are generally set within 15 nm of the coast, in the Gulf of Carpentaria. Longlines have not been used in the fishery since 2013, primarily as a result of the drop in shark fin price.

Licensees can use nets up to 2000 m in length, but most choose to use nets in the order of 1000 m to 1500 m. The drop of the net must not exceed 100 meshes and the size of each mesh panel typically ranges from 160 mm to 185 mm when stretched. Pelagic gillnets are weighted and have a buoyed headline. Pelagic longlines must not exceed 15 nm in length and cannot have more than 1000 snoods (hooks) attached. Automated baiting gear is prohibited.

Two of the target species in this fishery, the Australian Blacktip Shark and the Common Blacktip Shark, are very difficult to separate by eye and have traditionally been reported as “Blacktip Shark”. Although the shark identification skills of many licensees are improving, some grouping still occurs in logbook returns. The grouping convention is also used here so as not to misrepresent the harvest of either species.

A total of 699 t of fishes were harvested by Offshore Net and Line Fishery licensees in 2014. Grey Mackerel formed the bulk of the harvest (72%) followed by the Blacktip Shark group (10%) and Spot-tailed Sharks (3%). The primary byproduct species were Hammerhead Sharks (*Sphyrna* spp.) (4%). Bycatch (by weight) was less than 1% of the harvest during 2014. Non-retained species included the Tawny Shark (*Nebrius ferrugineus*), rays (Family Dasyatidae), trevallies and Queenfish. The proportion and composition of bycatch in this fishery is routinely validated by on-board observers. The total estimated value of the catch in this fishery is $2.3 million.

Grey Mackerel form a minor component (less than 1%) of the overall catch by other fishing parties in the NT. Sharks are taken in significant quantities by Indigenous fishers, the vast majority of whom (93%) fish from shore[3]. By contrast, sharks are rarely targeted (or retained) by recreational fishers[2] or FTO clients. This being the case, there is very little overlap in the harvest activities of the Offshore Net and Line Fishery and other marine user groups.

The Offshore Net and Line Fishery operates beyond the geographical range of many TEPS and so the risk of interaction with this group of species is low. In 2014, licensees reported interactions with 22 sawfish, 22 turtles, 15 mobulid rays, two river sharks and one dolphin during the course of 621 days of fishing (equating to less than one TEPS interaction per week of fishing). The actions of this fishery are considered to have minimal impact on other ecosystem components.

There have been few reported problems with compliance in this Offshore Net and Line Fishery and there is no evidence of systematic non-compliance.

A6 Demersal Fishery

The NT Demersal Fishery extends from 15 nm from the low water mark to the outer limit of the AFZ (excluding the area of the Timor Reef Fishery) and targets a range of tropical snappers (*Lutjanus* spp. and *Pristipomoides* spp.) using a variety of gear. Fish traps, hand lines and droplines are permitted throughout the fishery and demersal trawl nets are permitted in two defined zones.

The harvest by the Demersal Fishery is limited through a set of TACs applied to goldband snappers (*Pristipomoides* spp.) (400 t), red snappers (*L. malabaricus* and *L. erythropterus*) (2500 t) and a “grouped fish” category (915 t). The latter group includes all fishes other than Barramundi (*Lates calcarifer*), King Threadfin (*Polydactylus macrochir*), Spanish Mackerel, shark and Mud Crabs (*Scylla* spp.). Any protected species that are caught must also be released.

A total of 2762 t of fishes were harvested by Demersal Fishery licensees in 2014. Red snappers and goldband snappers formed the bulk of the harvest (75% and 11%, respectively) with Painted Sweetlip (*Diagramma pictum*) being the primary byproduct species (5% of the total). Reported bycatch (by weight) during 2014 was less than 1% of the trap harvest and 12% of the trawl harvest (346 t). Non-retained species included trevallies, scads (Family Carangidae) and sharks. The proportion and composition of bycatch in the trawl component of this fishery is routinely verified by on-board observers and the average bycatch recorded by observers in 2014 was 20% for the trawl harvest. The total estimated value of the catch in this fishery is $14 million.

Relatively few recreational fishers, Indigenous fishers or FTOs fish outside 15 nm of the NT coast and there is little overlap in the harvest activities of the Demersal Fishery and other marine user groups. However, the numbers of recreational anglers and FTOs fishing these grounds has increased in recent times due to a combination of increases in boat size, technology and weather forecasting.

The Demersal Fishery operates beyond the geographic range of many TEPS and so the risk of interaction with this group of species is low. Licensees voluntarily use turtle excluder devices and square mesh codends

to reduce the retention of non-target species and increase the value of the landed product. Fishery observers reported 18 TEPS interactions during 40 days of fishing in 2014. Bycatch species included sea snakes, Narrow Sawfish (*Anoxypristis cuspidata*) two dolphins and a turtle (released alive). The trawl gear used by the Demersal Fishery does disturb the benthic environment and the area impacted each year is less than 1% of the total fishable area.

There have been few reported problems with compliance in the Demersal Fishery and there is no evidence of systematic non-compliance.

A7 Barramundi Fishery

The NT Barramundi Fishery operates within 3 nm of the low water mark and targets Barramundi and King Threadfin using gillnets. The inner boundary of the fishery is convoluted, with some rivers (or parts thereof) open to netting and others closed. Licensees are not permitted to set nets within Kakadu National Park, the Mary River Fish Management Zone, Bynoe Harbour, Darwin Harbour or Shoal Bay. Furthermore, operators may not set nets or anchor within the Dugong Protection Area in the south-western Gulf of Carpentaria.

The commercial fishing season extends from 1 February through to 30 September each year, with most of the catch taken from Anson Bay, Van Diemen Gulf, East Arnhem Land, Central Arnhem Land and Limmen Bight. Gillnets set in the open sea must have a mesh size of at least 150 mm (6 inches), while those set in rivers must have a mesh size of at least 175 mm (7 inches). No more than 1000 m of net can be used under a licence and there are restrictions on the amount of spare net that may be stored on board vessels.

A total of 656 t of fishes were harvest by Barramundi Fishery licensees in 2014. Barramundi and King Threadfin formed the bulk of the catch (62% and 32%, respectively), with Blue Salmon (2%), Black Jewfish (1%) and sharks (1.3%) taken as byproduct. Bycatch (by weight) during 2014 was less than 1% of the total harvest. Non-retained species included catfish, Blue Threadfin, Queenfish, trevallies and other sharks. The total value of the catch in this fishery is estimated at $5.3 million.

Recreational fishers target Barramundi using baited hooks and artificial lures, with the latter being more popular[2]. Around 20% of all fishes caught by recreational fishers in the NT are Barramundi, the highest proportion of any species. Seventy two per cent of all Barramundi caught by this sector are released. Blue Threadfin, King Threadfin, snappers, grunters (Family Terapontidae) and catfish are incidentally caught during targeted recreational fishing for Barramundi.

Approximately 50% of all fishing effort (in hours) expended by FTO clients in the NT is directed towards the capture of Barramundi. The release rate of Barramundi by FTO clients is similar to that of recreational fishers, as is the mix of incidental captures.

The commercial sector is excluded from many estuarine systems and consists of relatively few licensees (14). These factors, in conjunction with restrictions on the length and operation of gillnets, limit the risk of interactions with TEPS. Commercial operators reported interactions with a small number (less than 100) TEPS during 2014. These primarily consisted of saltwater crocodiles and sawfish (*Pristis* spp.); almost all were released alive. Similarly, the actions of this fishery are considered to have little impact on other ecosystem components.

There were relatively few compliance issues in Barramundi Fishery during 2014 and no evidence of systematic non-compliance. Detected offences related to the use of excess gillnets, fishing in closed waters and inadequate marking of gear. Recreational fishing offences that year included exceeding the Barramundi possession limit, retaining undersize Barramundi, removing skin from fillets and fishing in seasonally-closed areas.

A8 Mud Crab Fishery

The NT Mud Crab Fishery is confined to the tidal waters of the Top End and targets Mud Crabs (*Scylla* spp.) using baited pots. Licensees are not permitted to operate in Darwin Harbour and in most creeks adjoining Shoal Bay, Leaders Creek, Kakadu National Park or parts of the Cobourg Marine Park.

There are 98 units of entitlement in the fishery, each permitting the use of up to 30 crab pots (i.e. 2940 pots in total). A licensee must hold at least two units of entitlement (60 pots) to be able to enter the fishery. Most licensees operate in the Gulf of Carpentaria, with a small number based along the Arnhem Land coast or near Darwin. Crab pots are set within estuaries or along the coastal fringe and are checked and re-baited daily.

Licensees may also use restricted bait nets (gillnets) up to 100 m in length to catch fish for use as crab bait. These nets may only be set in the open sea within 3 nm of the coast and the fisher must attend the net at all times. The use of this gear is prohibited between Bing Bong and the Queensland border and in a number of other areas around the coast.

A total 235 t of Mud Crabs were harvested by Mud Crab Fishery licensees in 2014; the estimated value of this catch is $4.7 million. No byproduct or bycatch was reported in this fishery during 2014. Licensees also caught 38 t of fishes in restricted bait nets. The majority of the catch was catfish (32%), followed by sharks (28%), Blue Salmon (27%) and mullet (12%).

Recreational fishers may harvest Mud Crabs using pots, dillies, spears, crab hooks, hook and line, hand net, cast net or drag net. A gear limit of five pots or dillies per person applies, with a maximum of 10 pots/dillies per vessel. The use of pots and traps accounts for around 15% of fishing effort (in hours) by recreational fishers in the NT[2]. However, this statistic includes soak times of “cherabin pots” used to target Giant Freshwater Prawns (*Macrobrachium spinipes*) and Redclaw (*Cherax quadricarinatus*). Approximately 95% of the recreational Mud Crab harvest is taken between Nhulunbuy and the NT/WA border, with the remainder caught from the Gulf of Carpentaria[2].

Eighty five per cent of Mud Crabs harvested by Indigenous fishers are taken by hand or with spears. These two collection methods account for around 50% of all fishing events by Indigenous fishers in the NT[3]. Very few FTO clients target Mud Crabs, with “crabbing” constituting around 1% of the reported fishing effort (in hours) by this user group.

The gear used by the Mud Crab Fishery (pots and gillnets) is either highly selective or is operated in such a manner that minimises the risk of interactions with TEPS. There were no reported interactions between the Mud Crab Fishery and TEPS in 2014. Similarly, the actions of this fishery are considered to have little impact on other ecosystem components.

There were few compliance issues in the Mud Crab Fishery in 2014 and there is no evidence of systematic non-compliance. Those offences that were detected included the possession of either under-sized crabs or commercially unsuitable (soft-shelled) crabs.

A12 Aquarium Fish/Display Fishery

The NT Aquarium Fish/Display Fishery operates in both tidal and non-tidal waters of the Top End, to the outer limit of the AFZ. The fishery supplies a range of aquarium fishes, plants and invertebrates (including corals) to local and interstate pet retailers and wholesalers. Some specimens are also sold to overseas buyers.

Aquarium Fishery licensees can operate in most areas, but must have permission to access private land or sea country. Harvesting is not permitted in designated protected areas, such as Doctor’s Gully and East

Point Aquatic Life Reserves in Darwin Harbour, Aboriginal sacred sites, aquaculture farm leases and sanctuary zones.

Aquarium Fishery/Display Fishery licensees can use several types of nets, hand pumps, freshwater pots and hand-held instruments to collect specimens. The harvest consists of a wide range of fish and invertebrates, as well as coral rubble and substrates covered in encrusting organisms (known as “live rock”).

Licensees are permitted to harvest some species listed under Appendix II of CITES in strictly controlled amounts. For example, the annual harvest of corals in the NT is limited to between 10 kg and 200 kg (depending on species), while that of giant clams (*Tridacna* spp.) is restricted to 200 individuals.

Members of the public wishing to collect specimens for personal aquaria must comply with recreational fishing controls, such as minimum legal sizes and personal possession limits.

The small number of Aquarium Fish/Display Fishery licensees (12) in conjunction with the selective fishing methods used, minimises the risk of interactions with TEPS. No interactions between the Aquarium Fish/Display Fishery and TEPS were reported in 2014. Similarly, the actions of this fishery are considered to have little impact on other ecosystem components.

There have been few reported problems with compliance in the Aquarium Fish/Display Fishery and there is no evidence of systematic non-compliance.

A13 Trepang Fishery

The NT Trepang Fishery extends seaward from the high water mark to 3 nm from the coast and targets Sandfish (*Holothuria scabra*), a type of Sea Cucumber, by means of hookah diving. The fishery is regionalised, with three licensees permitted to operate to the west of Cape Grey and three to the east of this landmark. Most fishing activity is concentrated along the Arnhem Land coast, from Cobourg Peninsula to Groote Eylandt.

Sea Cucumbers may only be taken by hand and must attain a minimum legal size, which differs between species. The number of collectors permitted under a licence is limited to four. Collection is generally restricted to neap tides during the dry season when water clarity improves.

Although licence conditions permit the harvest of all types of sea cucumbers, Sandfish is the only species to have been taken in the last decade.

All six commercial Trepang Fishery licences are owned by a single entity. Sea Cucumbers are not targeted by other fishing parties and so management arrangements for the fishery are negotiated with the single licensee. There was no fishing activity in this fishery in 2014.

Selective harvesting by the Trepang Fishery avoids bycatch and poses negligible risk of interaction with TEPS. Similarly, the actions of this fishery are considered to have little impact on other ecosystem components.

The recreational harvest of trepang is not known, but is likely to be low. No trepang catch has been reported by recreational fishers during surveys conducted for this sector.

No catch of trepang by Indigenous fishers was reported during the National Recreational and Indigenous Fishing Survey of northern Australia (Henry and Lyle 2003). Information collected during survey visits suggested that trepang were never used as food by the Indigenous people of the NT.

There have been few reported problems with compliance in the Trepang Fishery and there is no evidence of systematic non-compliance.

A18 Timor Reef Fishery

The Timor Reef Fishery operates offshore in a zone covering roughly 8400 nm^2 to the north-west of Darwin and targets tropical snappers (*Lutjanus* spp. and *Pristipomoides* spp.) using a variety of gear. The majority of the catch is taken using baited traps, but hand lines, droplines and demersal longlines may also be used.

The harvest by this fishery is limited through a set of TACs applied to goldband snappers (900 t), red snappers (1300 t) and "group fish" (415 t). The composition of these groups is the same as those for the Demersal Fishery. A total of 590 t of fishes was harvested by licensees in 2014, with goldband snappers and red snappers constituting most of the harvest (44% and 35% of the total, respectively). The total estimated value of the catch in this fishery is $3.65 million.

Bycatch (by weight) in 2014 was less than 3% of the total harvest. Non-retained species included sharks, tropical snappers (*Lutjanus* spp.), triggerfish (Family Balistidae), catfish (Family Ariidae), Red Bass (*Lutjanus bohar*) and Chinamanfish (*Symphorus nematophorus*). The proportion and composition of bycatch in this fishery is routinely validated by on-board observers.

Relatively few recreational fishers, Indigenous fishers or FTOs fish outside 15 nm of the NT coast and there is little overlap in the harvest activities of these user groups and the Timor Reef Fishery. However, the numbers of recreational anglers and FTOs fishing these grounds has increased in recent times due to a combination of increases in boat size, technology and weather forecasting.

The Timor Reef Fishery operates beyond the geographic range of most TEPS and the primary gear used (fish traps) poses little risk of interaction with this group of species. No interactions between the Timor Reef Fishery and TEPS were reported in 2014. Similarly, the actions of this fishery are considered to have little impact on other ecosystem components.

There have been few reported problems with compliance in the Timor Reef Fishery and there is no evidence of systematic non-compliance.

D2 Fishing Tour Operator Fishery

FTOs assist their clients in the pursuit of a wide range of sport fish in the non-tidal and tidal waters of the Top End to the outer limit of the AFZ. Guide vessels range in size from small dinghies to luxury mother ships. Some operators also utilise fan-propelled "air boats" or helicopters.

Most FTOs are based near coastal population centres (such as Darwin, Nhulunbuy and Borroloola) and operate in areas accessible to the general public. However, some licensees negotiate financial agreements with Aboriginal or pastoral landholders for exclusive rights to access certain areas and, in some cases, build and maintain fishing camps or lodges.

All persons engaged in guided fishing trips in the NT must observe recreational fishing regulations. Clients typically use rod and line gear, rigged with either baited hooks or artificial lures. The latter may be trolled or cast, depending on the target species. Around three quarters of the fish caught by FTO clients are released. Barramundi form the highest proportion of the catch (31%) with other common species, including Golden Snapper (10%), Stripey Snapper (*L. carponotatus)* (7%), Saddletail Snapper (*L. malabaricus)* (5%) and Grass Emperor (*Lethrinus laticaudus)* (5%).

While the survivorship of released Barramundi is high, the same is not true for reef-associated species, such Golden Snapper and Black Jewfish. Both species are susceptible to pressure-induced injuries (barotrauma), with the rate of injury and post-release mortality proportional to capture depth. Concerns regarding the

impacts of barotrauma on reef fishes (and other factors) have led to the development of new management controls on the harvest of these species.

The primary fishing gear used by FTO clients (hook and line) poses little risk of interaction with TEPS and there were no reported interactions between FTOs and TEPS in 2014. Similarly, the actions of this fishery are considered to have little impact on other ecosystem components.

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Mud Crabs *Scylla serrata, S. olivacea*

Mark Grubert

Table 1: Stock status determination

Stock	North-West Australian	Gulf of Carpentaria
Stock status	Sustainable	Transitional depleting
Indicators	Commercial catch and catch per unit effort	Commercial catch and catch per unit effort

Stock structure

Two species of Mud Crabs are found in Northern Territory (NT) waters: the Giant Mud Crab (*Scylla serrata*), which constitutes around 99% of the commercial harvest and the Orange Mud Crab (*S. olivacea*), which forms the remainder[1]. There is no published information on the biology of the Orange Mud Crab in Australian waters; all biological information presented here relates to the Giant Mud Crab only.

Egg-bearing female Giant Mud Crabs migrate up to 95 km offshore to release their offspring[2], which average around 5 million per individual[3]. These features, coupled with a planktonic larval stage that can last for several weeks[4], assist in facilitating gene flow between areas. Genetic evidence suggests that there are at least two biological stocks of Giant Mud Crabs in Australian waters: one to the west and another to the south-east of Torres Strait[5] (commonly referred to as the Northern Australian and East Coast Biological Stocks, respectively).

Large differences in the commercial catch of Mud Crabs (but similar catch rates) in different regions of the NT in recent years suggest that there may be further genetic separation within the “Northern Australian” stock. The (negative) slope of the line fitted to the Gulf of Carpentaria (GOC) catches for the last four years (consistent with the estimated maximum life span of Mud Crabs) is 3.6 times greater than the slope for the

corresponding plot for the remainder of the NT coastline. Such a disparity would not be expected if there was strong demographic connectivity across northern Australia.

The reported lack of genetic differentiation between Mud Crabs in the GOC and areas to the west may be a function of the timing of sample collection (i.e. primarily in the early 1990s) relative to the expansion of the NT Mud Crab Fishery into the GOC (from the mid-1990s onwards) in conjunction with a suspected increase in fishing power over time. The argument presented here is that the analyses were conducted before the application of significant fishing pressure (akin to sampling a virgin population) and could not detect finer scale population structure which may only become apparent once fishing begins.

For the purposes of this analysis, Giant Mud Crabs in the NT are treated as two separate stocks: a North-West Australian stock and a Gulf of Carpentaria stock. The Gulf of Carpentaria stock encompasses waters to the East of 135°E and to the South of 13°S (within the NT), whereas the North-West stock extends westward along the coast from 13°S into Western Australia.

Table 2. Giant Mud Crab biology, [6,7]

Longevity and maximum size	3–4 years; 23 cm CW, but rarely exceeds 20 cm CW
Maturity (50%)	Varies by sex and location but generally 12–15 cm CW

CW = carapace width

Stock status

The commercial sector accounts for the majority of the Mud Crab harvest in the NT and provides the only continuous time series of substantial catch and fishing effort data for this species. This being the case, the status determinations given below are based on information from this sector only. Annual catches by all sectors (where available and discernible) are shown in Figure 1, noting the data is pooled across stocks.

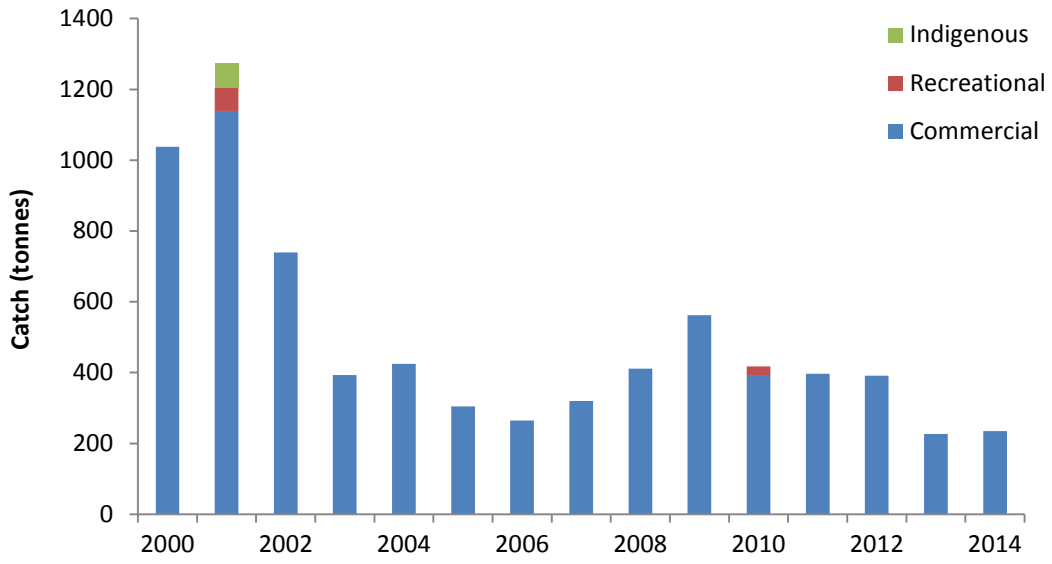

Figure 1. Total catch of Giant Mud Crab in the Northern Territory, 2000 to 2014

Estimates of Indigenous and recreational Giant Mud Crab catches are only available for one year (2001[8]) and two years (2001[8] and 2010[9]), respectively. Annual catches of around 1 tonne by Fishing Tour Operator clients are not shown because they are indistinguishable from catches by other sectors. The increase in the commercial minimum legal size implemented in 2006 had a significant impact on the fraction of the catch that commercial fishers can retain, particularly in the Gulf of Carpentaria. Any comparison of commercial catches before and after this time must be made with extreme caution.

North-West Australian Mud Crab stock

The four-year average commercial catch (to 2013) from the NT component of the North-West stock was 123 tonne (t); with the annual catch in 2014 being 122 t (i.e. within historical limits; Figure 2). There was however, a significant decline in the catch rate from this stock in 2014 relative to the previous four-year average (i.e. 0.33 kg/pot-lift vs 0.55 kg/pot-lift, respectively). This was primarily driven by a shift in effort from the GOC into the remaining parts of the NT in 2014 and increased competition within a few key crabbing areas.

Relatively stable catches, combined with low fishing effort across large areas of Mud Crab habitat, the productive biology of Mud Crabs, and management controls which restrict fishing impacts, suggest that this part of the biological stock has not been overfished and that overfishing is not occurring. Consequently, the NT component of the North-West Australian stock is classified as a **sustainable stock**.

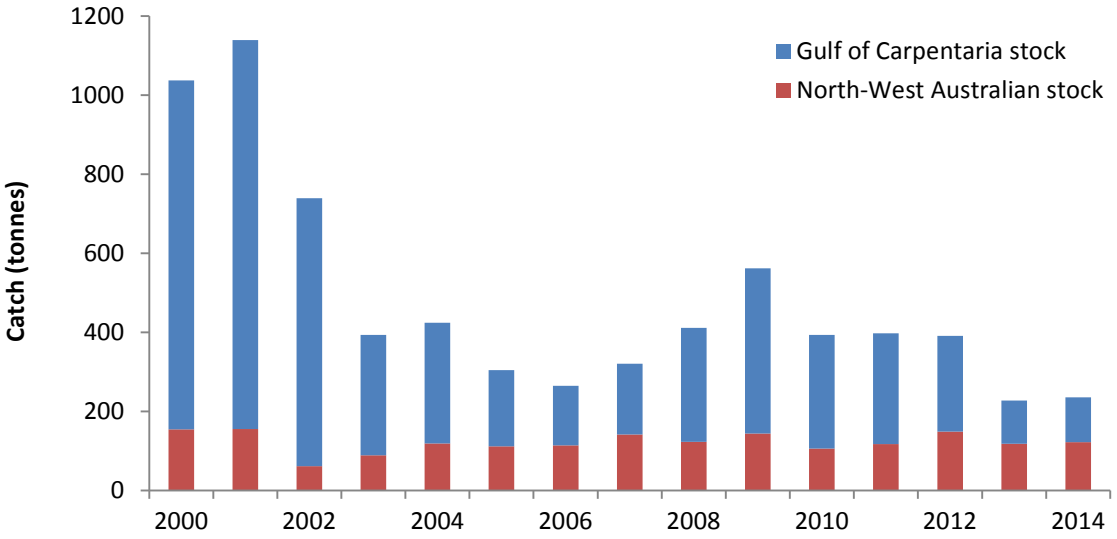

Figure 2. Commercial catches from two Giant Mud Crab stocks in the Northern Territory, 2000 to 2014

The increase in the commercial minimum legal size implemented in 2006 had a significant impact on the fraction of the catch that commercial fishers can retain, particularly in the Gulf of Carpentaria. Any comparison of commercial catches before and after this time must be made with extreme caution.

Gulf of Carpentaria Mud Crab stock

Harvest policies for Mud Crabs in the eastern and western portions of the GOC differ and patterns in catch and effort under contrasting management regimes can assist in the determination of stock status in the NT section of the GOC. Queensland (Qld) prohibits the harvest of female crabs and imposes a minimum legal size (MLS) of 15 cm CW for male crabs. By contrast, the NT permits both sexes to be taken, with a commercial MLS of 14 cm CW and 15 cm CW for male and female crabs, respectively.

Management controls in the Qld GOC have resulted in generally smaller, but more stable, catches over time. Minimum and maximum catches in the Qld GOC between 2005 and 2014 were 136 t and 199 t, respectively (with a decadal average catch of 170 t). Corresponding figures for the NT GOC during the same period were 109 t and 419 t, respectively (with a decadal average catch of 227 t). While there has been significant variation in annual rainfall in the GOC over this time (which appears to influence recruitment and catch rates), the more conservative management arrangements in Qld appear to provide a greater buffering effect during poor rainfall years.

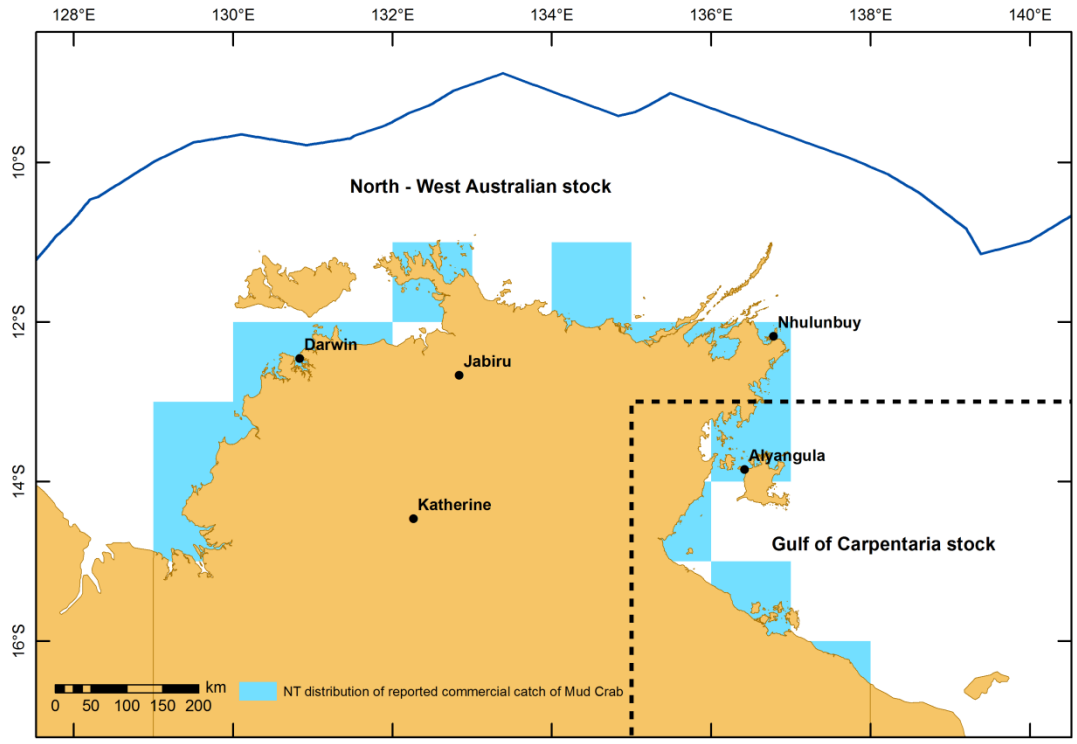

Figure 3. Distribution of reported commercial catch of Giant Mud Crab in Northern Territory waters, 2014

The boundary separating the two stocks is indicative only and will be revised once new stock structure information is available.

One example of this is the recent decline in catch rates observed in both the NT and Qld sections of the GOC, coincident with a period of lower than average rainfall. The catch rate in the NT GOC fell by 30% between 2012 and 2014, while the decrease in the Qld GOC was 13% during the same period.

The catch in the NT GOC dropped abruptly between 2012 and 2013 then remained at a similar level in 2014 (Figure 2) whereas the decline in catch in the Qld GOC was more gradual (i.e. 199 t to 174 t to 146 t, respectively). Although Mud Crab recruitment does appear to be influenced by environmental conditions, the potential impacts of fishing on recruitment in the NT section of the GOC cannot be ignored and are considered in the status determination for this stock.

The relatively high natural mortality rate of Mud Crabs (~1.2)[6] means that there is little carry-over of one year class to the next and less than 0.5% of crabs live beyond three years of age. Although Mud Crabs are highly fecund[4] the heavy reliance on crabs of one to three years of age (and particularly the one to two–year olds) means that there is a risk that fishing may affect recruitment during extreme and prolonged climatic events.

While some indicators for the NT component of the GOC stock fit within the “environmentally limited” category under the national assessment framework (see Table 1 in the Introduction), others align with the “transitional depleting stock” category. Mud Crab catches in the GOC during 2013 and 2014 were low (suggesting that recruitment was also low in these years) and it is possible that sustained fishing effort in this region may compromise future recruitment if unfavourable environmental conditions persist. Consequently, the NT component of the GOC Mud Crab stock is conservatively classified as a ***transitional depleting stock***.

Table 3: Main features and statistics for the Northern Territory Mud Crab Fishery, 2014

Sector	Commercial	Recreational	Indigenous
Fishing methods			
Trap	✓	✓	✓
Rod and line		✓	✓
Dilly net	✓	✓	✓
Scoop net		✓	✓
Cast net		✓	✓
Beach seine net		✓	✓
Hand collection		✓	✓
Spearfishing		✓	✓
Management methods			
Limited entry	✓		
Spatial closures	✓	✓	
Size limits	✓	✓	
Catch limits		✓	
Gear restrictions	✓	✓	✓
Protection of berried females	✓	✓	
Hard-shell only harvest	✓		
Catch			
	113 t (GOC stock) 122 t (NW stock)	66 t (2000-01) 24 t (2009-10)	69 t (2000-01)
Active commercial licences	49		

GOC = Gulf of Carpentaria
NW = North-West Australian

Effects of Mud Crab fishing on the marine environment

Discard rates of undersized Mud Crabs can be as high as 70% of the total catch[10]. Research by the Department of Primary Industry and Fisheries (DPIF) and the New South Wales Department of Primary Industries has demonstrated the value of escape vents in reducing the retention of undersized Mud Crabs and fish bycatch in a variety of Mud Crab traps[11–13]. DPIF has also developed inexpensive escape vents to fit rectangular wire mesh traps, with around 25% of licensees in the NT using them on a voluntary basis.

Limb loss (due to entanglement) can occur when Giant Mud Crabs are caught in, or removed from, traps with the injury rate related to the style of trap used[14]. Although limb loss appears to have little impact on the short-term survivorship of Giant Mud Crabs[14], repeated limb damage may potentially compromise their growth

and/or reproductive success (based on observations of other crab and lobster species[15–17]). Over 20% of Giant Mud Crabs caught in monofilament tangle nets (also known as witch's hat nets) lose one or more limbs during capture or removal from the net[14]. For this reason, the use of monofilament tangle nets is prohibited in NT waters.

Environmental effects on Mud Crabs

Commercial catch rates generally show positive correlations with environmental factors, such as rainfall and/or sea surface temperature, depending on location[18]. Catch rates are more strongly linked to sea surface temperatures at higher latitudes and wet season rainfall at lower latitudes.

Juvenile Giant Mud Crabs prefer to settle on seagrass rather than mud or sand[19]. Therefore, any significant reduction in seagrass area (through man-made or natural disturbances, such as cyclones) could affect recruitment success.

Mud Crabs may potentially benefit from moderate climate change in some areas[20]. Increased water temperatures at higher latitudes might increase growth rates and reproductive activity, while greater rainfall in the tropics might increase primary and secondary productivity, thereby providing more food for juvenile crabs. Any such benefits will only occur within the physiological tolerances of the particular developmental stage affected.

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Sandfish *Holothuria scabra*

Mark Grubert

Table 1: Stock status determination

Stock	Northern Territory (TF)
Stock status	Undefined
Indicators	Catch, effort, CPUE

CPUE = catch per unit effort; TF = Trepang Fishery

Stock structure

Sandfish (*Holothuria scabra*) (also known as trepang) are widespread in the tropical Indo-West Pacific between latitudes 30˚ N and 30 ˚S, but no farther east than Fiji [1]. Genetic analyses of Sandfish from NT waters suggest that there are separate stocks either side of the Wessel Islands[2]. However, there is insufficient data available to assess these stocks separately so Sandfish stock status is assessed at the jurisdictional level here.

Stock status

The harvest of Sandfish in northern Australia dates back to at least the 1700s, when traders from Makassar (Ujung Pandang) visited the area to fish for the delicacy. Fishing activity in what is now the NT (but formerly part of South Australia) declined around 1880, and the South Australian Government ceased issuing licences to Macassans in 1907[3].

Small catches continued until 1945, but exports were almost non-existent from then until the early 1980s. Prior to this downturn, commercial fishing operations were coordinated by European Australians with assistance from the Indigenous people of Arnhem Land.

Increasing interest in the late 1980s led to the re-emergence of the NT Trepang Fishery. Catches of Sandfish peaked at 247 tonnes (t) in 2000 and fluctuated between 100 t and 200 t for the next seven years (Figure 1). Catches thereafter were comparatively low because of a four-fold decrease in annual fishing effort. Fishers have indicated that this reduction in fishing effort was caused by difficulties in sourcing divers and crew rather than any noticeable decline in Sandfish abundance. None of the six commercial licences were active in 2014.

The recreational and Indigenous take of Sandfish has not been quantified and is assumed to be negligible. Limited knowledge of the fishery biology of Sandfish in NT waters combined with highly variable catch, effort and CPUE in recent years means that it is not possible to confidently classify the status of this species.

On the basis of the evidence provided above, Sandfish in the NT is classified as an **undefined stock**.

Table 2: Sandfish biology[1,4]

Longevity and maximum size	Longevity unknown; maximum length 38 cm
Maturity (50%)	Two years of age and 16–25 cm in other parts of the range

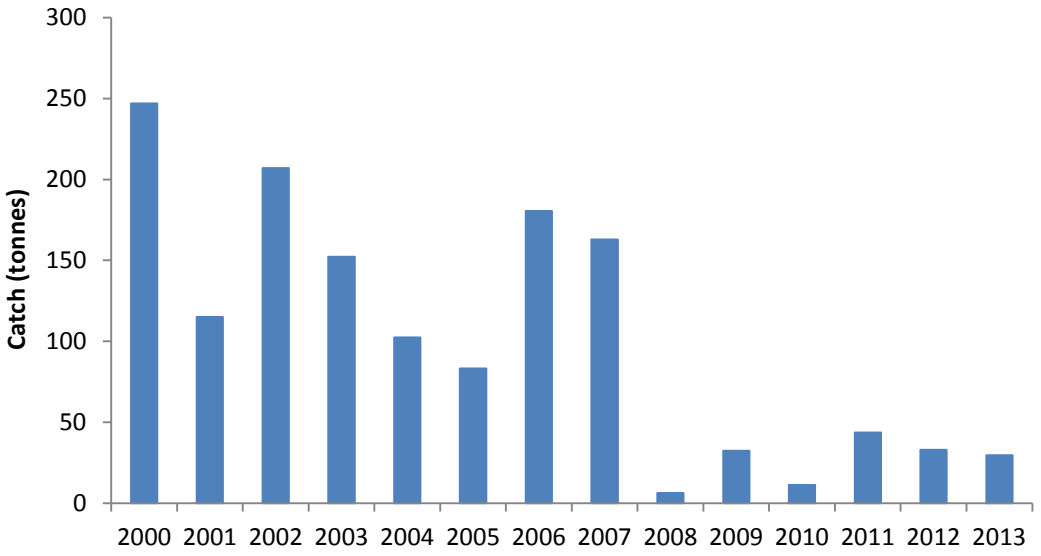

Figure 1: Total commercial catch of Sandfish in Northern Territory waters, 2000 to 2013; there was no reported catch in 2014 **Table 3:** Main features and statistics for the Northern Territory Trepang Fishery, 2014

Sector	Commercial	Recreational	Indigenous
Fishing methods			
SCUBA or hookah diving	✓	✓	
Hand collection	✓	✓	✓
Management methods			
Limited entry	✓		
Spatial closures	✓	✓	
Spatial zoning	✓		
Size limits	✓		
Gear restrictions	✓		
Catch			
	0 t	Unknown	Unknown
Active commercial licences	None		

Effects of Sandfish fishing on the marine environment

Sandfish harvesting in the NT has little direct impact on the marine environment or other benthic species as the primary collection method (diving) allows for careful selection of the target species.

Environmental effects on Sandfish

Sandfish are unable to regulate their ionic balance and populations can experience significant mortality events if exposed to freshwater run-off for extended periods of time. Intense wave action (such as that caused by cyclones) may also cause death or damage to Sandfish inhabiting shallow waters.

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Australian Blacktip Shark *Carcharhinus tilstoni* and Common Blacktip Shark *C. limbatus*

Grant Johnson and Thor Saunders

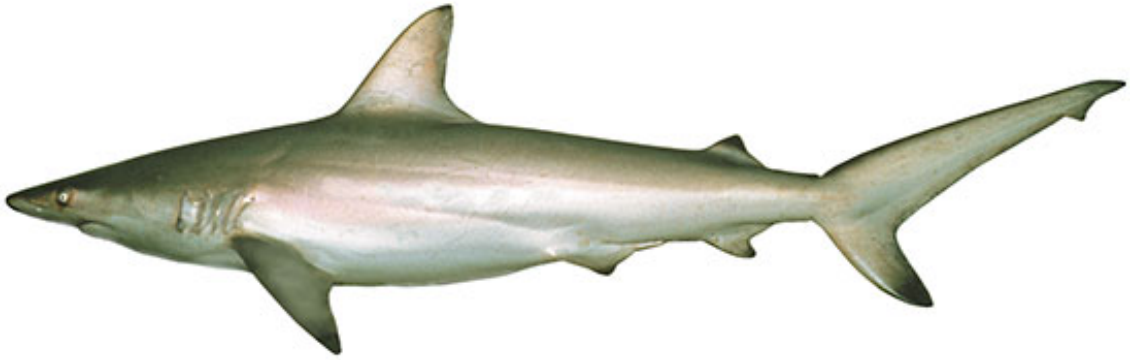


Table 1: Stock status determination

Stock	North and west coast (ONLF)	Gulf of Carpentaria (ONLF)
Stock status	Sustainable	Undefined
Indicators	Catch, CPUE, stock reduction analysis	

CPUE = catch per unit effort; ONLF = Offshore Net and Line Fishery

Stock structure

In the Northern Territory (NT), the term Blacktip Shark refers to two similar looking Carcharhinidae (whaler sharks) species: *Carcharhinus tilstoni* and *C. limbatus*. The distribution of *C. tilstoni* is confined to waters off northern Australia, while *C. limbatus* is globally distributed in tropical and warm temperate waters. In Australian waters, genetic studies have identified two biological stocks of *C. tilstoni* (a western biological stock extending from the western NT into northern Western Australia and an eastern biological stock extending from the Gulf of Carpentaria (GOC) to the east coast of Queensland and New South Wales), and three biological stocks of *C. limbatus* (one across Western Australia and the NT, one in the GOC and one on the east coast of Queensland and New South Wales)[1].

Carcharhinus limbatus and *C. tilstoni* are very similar in appearance and can only be taxonomically differentiated by genetic analyses, pre-caudal vertebral counts or differences in size of maturity (although recent evidence of these species' hybridisation may affect the accuracy of these techniques[2,3]). Because of this, reliable species differentiation is not practical during fishing operations. Although the Blacktip Shark species complex comprises two species with differing stock structures, in the NT, stocks of both species share similar boundaries, the first along the north and west coasts and a second in the GOC.

Stock status

North and west coast biological stock

The most recent assessment using data up to 2011 indicated that the stocks declined substantially because of high Taiwanese catches in the 1970s and 1980s, but have since recovered with cessation of foreign fishing and more stringent management of the domestic fishery. In 2011, a stock assessment estimated biomass was at 93% of unfished levels, which is well within sustainable harvest limits[4]. A mark-recapture

study in the NT supports the stock assessment results for Blacktip Sharks, indicating that current harvest levels are sustainable[5].

Although there is uncertainty in the species composition and magnitude of historical Blacktip Shark catches from Western Australia, these species are not currently harvested in that jurisdiction. In 2014, 38 tonnes (t) of Blacktip Sharks were caught in the NT jurisdiction of the north and west coast biological stock. Evidence from both jurisdictions indicates that the biomass of this biological stock is unlikely to be recruitment overfished and that current catch levels are unlikely to cause the biological stock to become recruitment overfished.

On the basis of the evidence provided above, the biological stocks are classified as **sustainable stocks**.

Gulf of Carpentaria biological stock

Queensland and the NT share management of the GOC stock of Blacktip Shark. Since 2007, combined NT and Queensland catches have fluctuated between 200 t and 460 t with the NT accounting for 43% of the catch on average. In 2014, 28 t of Blacktip Sharks were caught in the NT jurisdiction. Since species identification of sharks has only been undertaken in the GOC Inshore Fin Fish Fishery (Queensland) from 2006, it has been difficult to obtain enough data specific to catches of Blacktip Sharks for stock assessment purposes. Consequently, the impact of current catch levels on these biological stocks is unknown and there is insufficient information to confidently classify their status.

On the basis of the evidence provided above, the biological stocks are classified as **undefined stocks**.

Table 2: Blacktip Shark biology[3,6-8]

Longevity and maximum size	*C. tilstoni*: females 15 years, males 13 years; 200 cm TL* *C. limbatus*: maximum age unknown; 250 cm TL*
Maturity (50%)	*C. tilstoni*: 5-6 years; females 135–140 cm TL, males 120 cm TL* *C. limbatus*: males 180 cm, females unknown*

TL = total length
*These biological estimates do not account for hybridisation between *C. tilstoni* and *C. limbatus*.

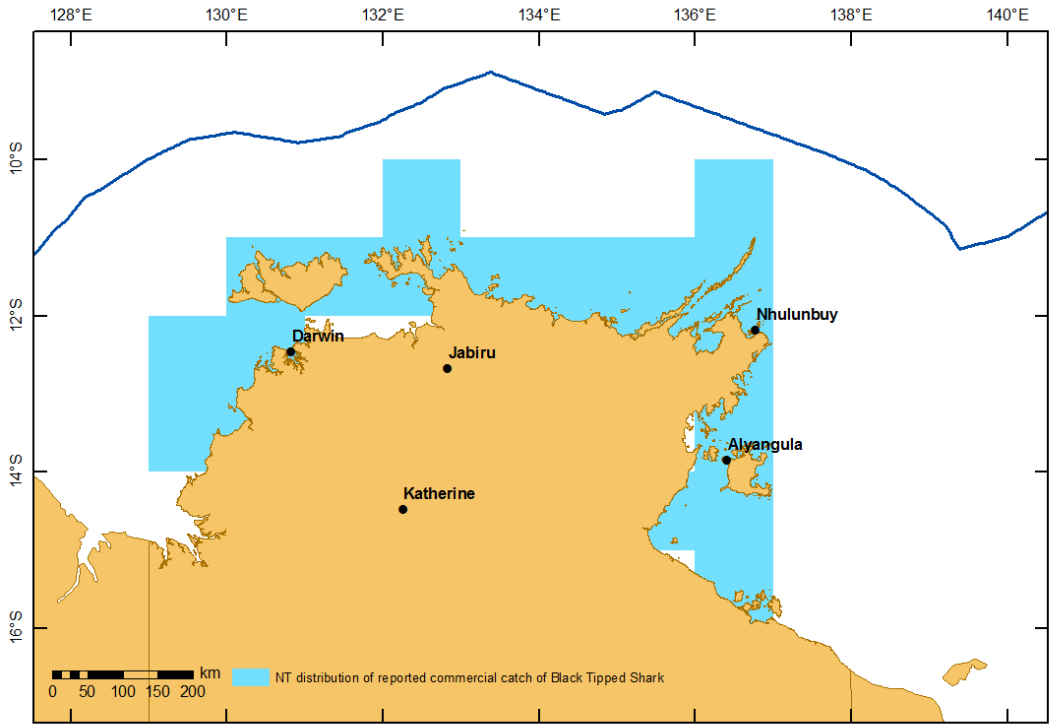
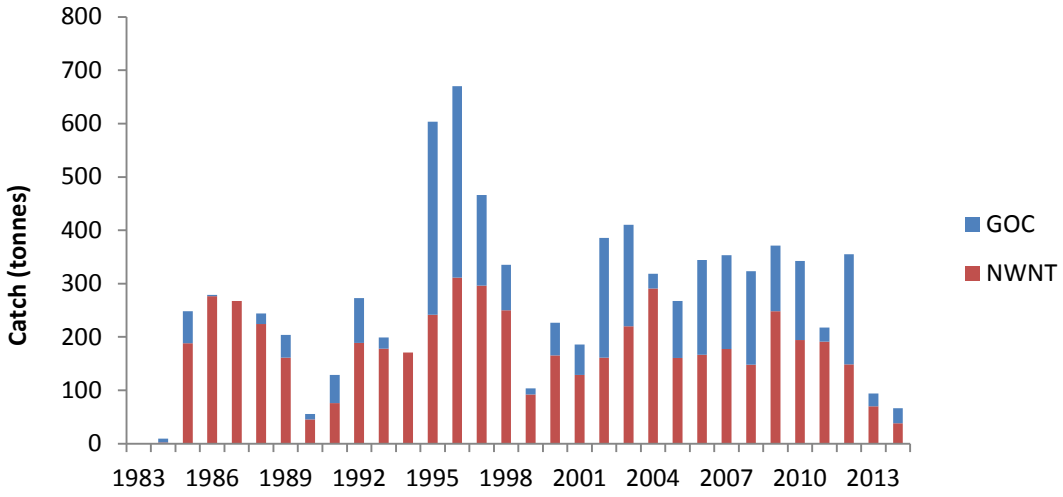


Figure 1: Distribution of reported commercial catch in the Offshore Net and Line Fishery of Blacktip Shark in Northern Territory waters, 2014



GOC = Gulf of Carpentaria; NWNT = north-west Northern Territory

Figure 2: Commercial Blacktip Shark catch in the Offshore Net and Line Fishery, 1983 to 2014

Table 3. Main features and statistics for the sectors harvesting Blacktip Sharks, 2014

Sector	Commercial	Recreational	Indigenous
Fishing methods			
Pelagic gillnet	✓		
Anchored longlines	✓		
Rod and line		✓	
Spearfishing		✓	✓
Hand line		✓	✓
Management methods			
Limited entry	✓		
Vessel restrictions	✓		
Spatial closures	✓	✓	
Total allowable effort	✓		
Gear restrictions	✓	✓	✓
Possession limits		✓	
Catch			
	66 t	Unknown	Unknown
Active commercial licences	12 (ONLF)		

ONLF = Offshore Net and Line Fishery

Effects of fishing on the marine environment

Pelagic gillnets and longlines - the gears permitted for use in the Offshore Net and Line fishery - are not intended to come into contact with the seabed and under normal circumstances they have no impact on benthic habitats. The physical characteristics of these gears and the way in which they are used to fish are also selective for the target species and size classes. Demersal gillnets contact the seabed but are not permitted in the ONLF. However, these fishing methods do interact with threatened, endangered and protected species (TEPS). Although reported interactions are low, the impact on the populations of most TEPS is either unknown or assessed as negligible to low[9].

Environmental effects on Blacktip Shark

The impact of environmental factors on biological stocks of Blacktip Shark is unknown. These species are adapted to a range of environmental conditions and are therefore likely to be resilient to environmental changes.

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Barramundi *Lates calcarifer*

Thor Saunders

Table 1: Stock status determination

Stock	Northern Territory (BF)
Stock status	Sustainable
Indicators	Catch, CPUE, length and age frequencies, harvest rate

BF = Barramundi Fishery; CPUE = catch per unit effort

Stock structure

Separate biological stocks of Barramundi exist at the scale of individual catchments across northern Australia[1,2]. However, it is difficult to obtain relevant biological and catch-and-effort information to assess each individual biological stock because Barramundi have been assessed as a single management unit in the Northern Territory (NT). The assessments of this management unit are based on the biological stocks that receive the highest harvest rates (Daly and Mary rivers) and whose status is assumed to be representative of the highest level of exploitation that occurs on any stock within this unit.

Stock status

Commercial catches in the NT Barramundi Fishery are stable and well within historical levels (Figure 2) and monitored stocks have a healthy size and age distribution. Catch rates have increased over the past five years (Figure 3). While there was a substantial decrease in the 2013 catch rate, associated with a poor wet season and several experienced operators selling their licences, there was an increase in the catch rate in 2014. Recaptures from tagging programs suggest that the annual harvest rate from all sectors combined is consistently below 5%. Abundance surveys indicate high levels of recruitment during high-rainfall wet seasons. The above evidence indicates that the stocks in this management unit are unlikely to be recruitment overfished and that current catch levels are unlikely to cause the stocks to become recruitment overfished.

On the basis of the evidence provided above, the management unit is classified as a **sustainable stock**.

Table 2: Barramundi biology[3]

Longevity and maximum size	35 years; 150 cm TL
Maturity (50%)	Northern Territory: males 2–5 years, 73 cm TL; females 5–7 years, 91 cm TL

TL = total length

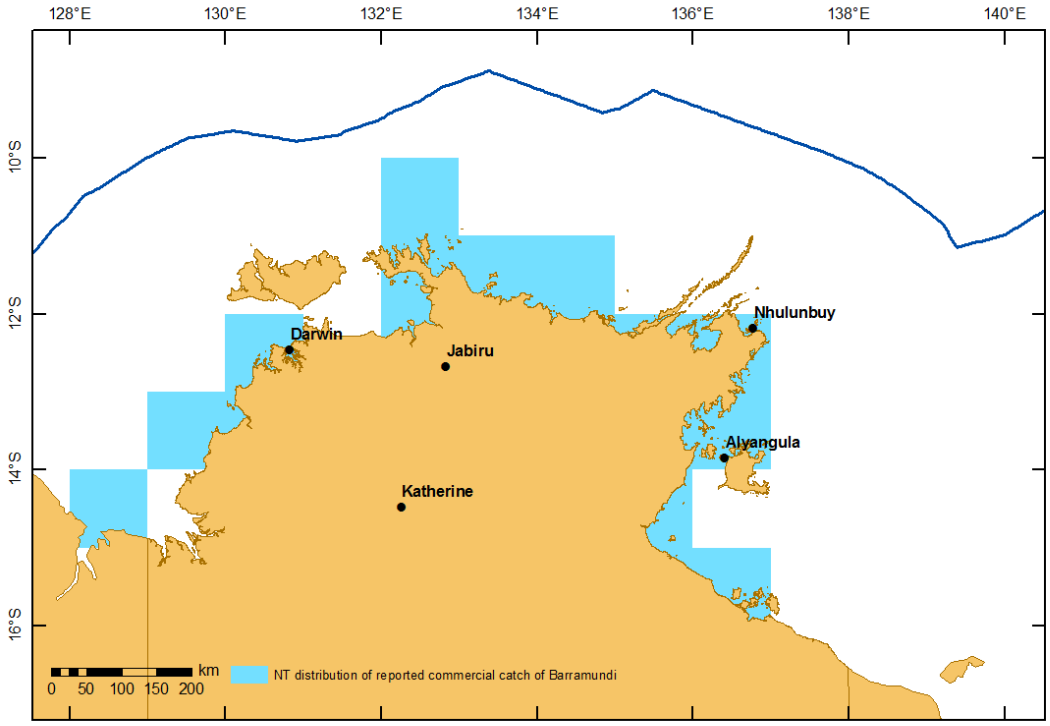
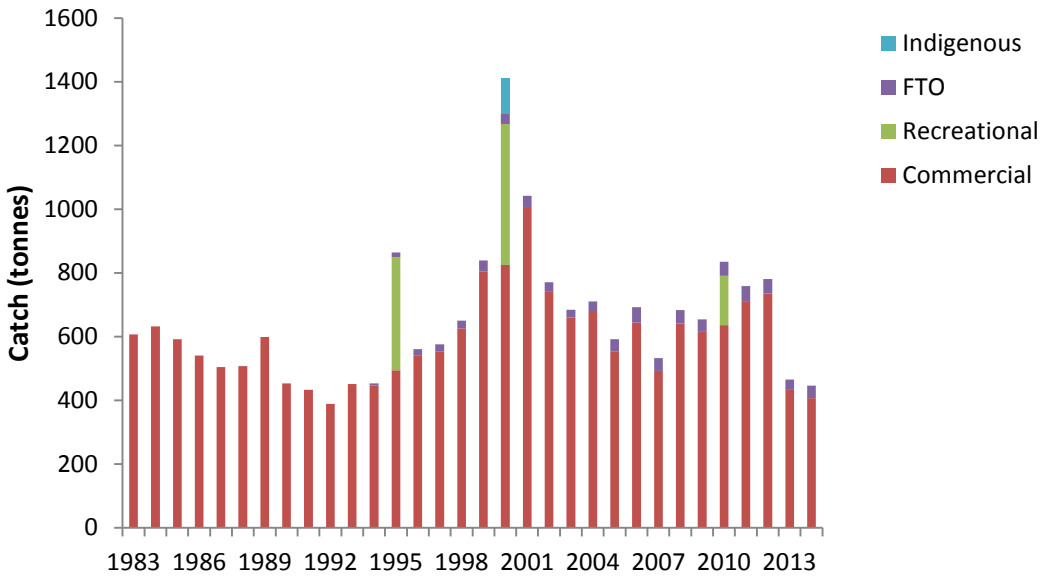


Figure 1: Distribution of reported commercial catch of Barramundi in Northern Territory waters, 2014



FTO = Fishing Tour Operator

Figure 2: Catch by sector of Barramundi in Northern Territory waters, 1983 to 2014

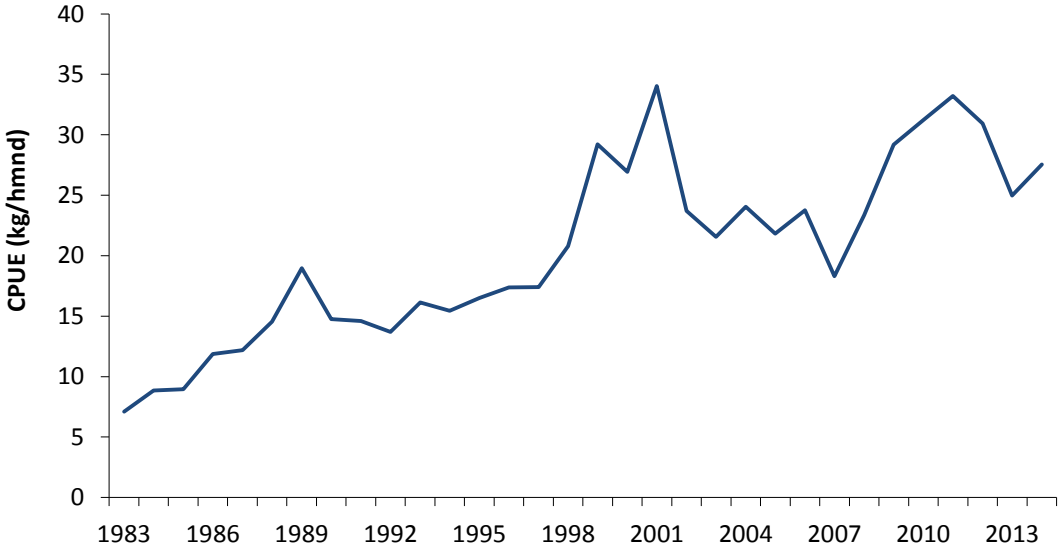


Figure 3: Commercial catch per unit effort (CPUE) for Barramundi (kg/100 m of net/day), 1983 to 2014

Table 3: Main features and statistics for the Northern Territory Barramundi Fishery, 2014

Sector	Commercial	Recreational	Indigenous
Fishing methods			
Gillnet	✓		
Rod and line		✓	✓
Spearfishing		✓	✓
Hand line		✓	✓
Management methods			
Size limits	✓	✓	
Limited entry	✓		
Spatial zoning	✓	✓	
Vessel restrictions	✓		
Catch limits		✓	
Spatial closures	✓	✓	
Temporal closures	✓	✓	
Gear restrictions	✓	✓	✓
Possession limits	✓	✓	✓
Catch			
	407 t	155 t (2010)[4] 39 t FTO	110 t (2000)
Active commercial licences	14		

FTO = Fishing Tour Operator

Effects of fishing on the marine environment

Commercial gillnets have limited direct impact on the environment and are quite selective, with bycatch making up only a small proportion of the catch[5]. However, commercial gillnets do interact with threatened, endangered and protected species (TEPS). In the NT Barramundi Fishery, reported bycatch represents less than 1% of the total catch and typically consists of Queenfish, unwanted shark species, catfish and Blue Threadfin. The most common TEPS interactions primarily involve saltwater crocodiles (less than 50 interactions annually), which are highly unlikely to impact on populations of this species given that they have recovered from unregulated hunting pre-1970 to carrying capacity in most NT catchments[6]. Other TEPS that this fishery interacts with in very low numbers (less than 10/year) include Green and Freshwater Sawfish, turtles and dugongs. The low bycatch and TEPS interaction levels in this fishery have been supported by observer coverage on board commercial vessels.

Environmental effects on Barramundi

The duration, magnitude and timing of the wet season strongly drive biomass and harvest of Barramundi stocks, with long wet seasons resulting in higher recruitment than shorter wet seasons[6,8].

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Black Jewfish *Protonibea diacanthus*

Chris Errity

Table 1: Stock status determination

Stock	Northern Territory (BF, CLF, DF, FTO, TRF)
Stock status	Overfished
Indicators	Biomass, egg production, catch, CPUE

BF = Barramundi Fishery; CL = Coastal Line Fishery; CPUE = catch per unit effort; DF = Demersal Fishery; FTO = Fishing Tour Operator; TRF = Timor Reef Fishery

Stock structure

Black Jewfish is a widespread Indo-Pacific species found from the Kimberley in Western Australia across Northern Australia, to the east coast of Queensland. The stock structure for this species is currently under investigation and is presently undefined; hence, status is reported at the management jurisdiction/unit level rather than as individual biological stocks. The assessments of these units are based on the stocks that receive the highest harvest rates so their status can be assumed to be representative of the highest level of exploitation that occurs on any stock within each management unit.

Stock status

The most recent assessment (2011) estimates that the biomass of Black Jewfish is at approximately 62% of unfished spawning stock biomass[1]. Additionally, egg production is approximately only 38% of unfished levels resulting in a high probability (71%) that Black Jewfish stocks have been overfished and a moderate probability (21%) that current fishing pressure is continuing to cause overfishing[1]. It was estimated that the fishing pressure needs to be reduced by a further 20% to allow for the biomass of Black Jewfish stocks to recover[1]. The immediate area of concern is in waters around Darwin where most of the fishing pressure occurs and where catch and catch rate have substantially declined since 2004[2]. The evidence provided indicates these stocks are recruitment overfished.

On the basis of the evidence provided above, the management unit is classified as an **overfished stock**.

Table 2: Black Jewfish biology[4]

Longevity and Maximum size	15 years; 150 cm TL, 30 kg
Maturity (50%)	NT: 89 cm TL (2 years)

TL = total length

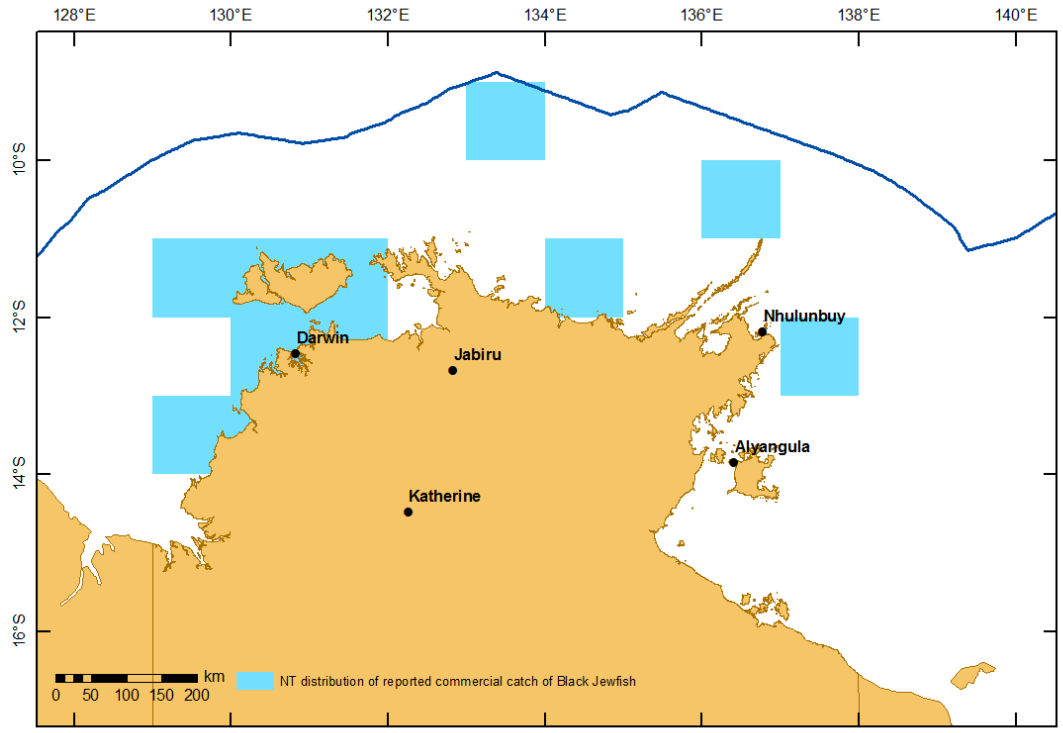
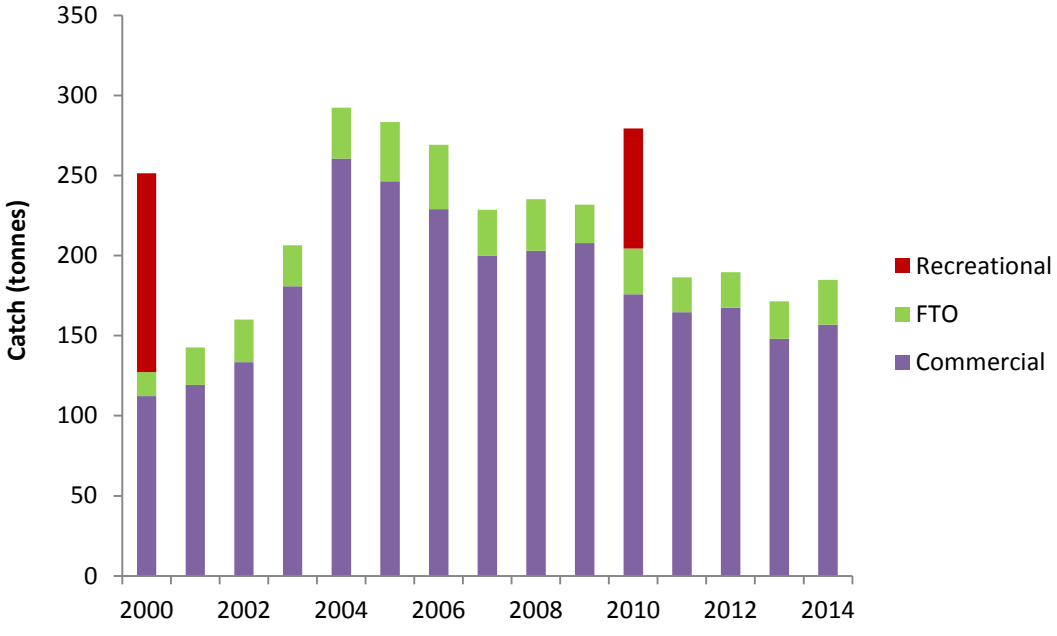


Figure 1: Distribution of reported commercial catch of Black Jewfish in Northern Territory waters, 2014



FTO = Fishing Tour Operator

Figure 2: Catch by sector of Black Jewfish in Northern Territory waters, 2000 to 2014

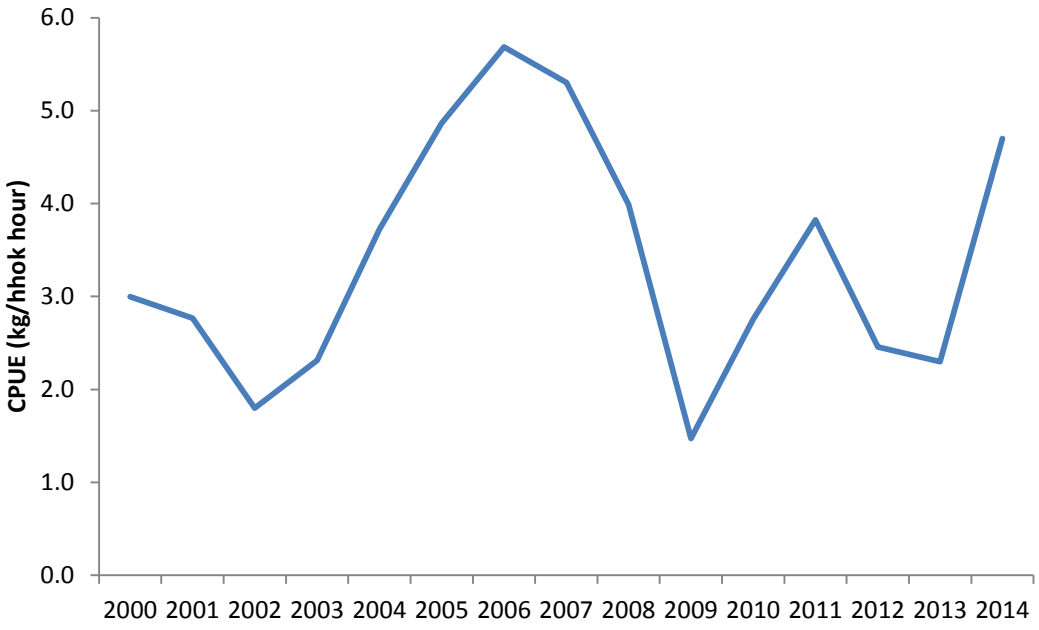


Figure 3: Commercial catch per unit effort (CPUE) for the Coastal Line Fishery (2000 to 2014)

Table 3: Main features and statistics for sectors harvesting Black Jewfish, 2014

Sector	Commercial	Recreational	Indigenous
Fishing methods			
Gillnet	✓		
Rod and line	✓	✓	
Trawl	✓		
Fish trap	✓		
Hand line	✓	✓	✓
Management methods			
Spatial zoning	✓	✓	
Limited entry	✓		
Gear restrictions	✓	✓	✓
Spatial closures	✓	✓	✓
Vessel restrictions	✓		
Catch limits		✓	✓
Possession limits		✓	✓
Catch			
	156 t[a]	75 t (2010)[3] 28 t (FTO)	Unknown
Active commercial licences	40		

[a] Commercial catch (Coastal Line Fishery – 131.8 tonnes (t); Demersal Fishery – 12.8 t; Barramundi Fishery – 6.3 t; Timor Reef Fishery – 5.4 t; Offshore Net and Line Fishery – 0.3 t).
FTO = Fishing Tour Operator

Effects of fishing on the marine environment

Black Jewfish are targeted by fishers in all sectors using hand lines and rods. Beyond the removal of target and a small proportion of bycatch species, there is little evidence to suggest that this gear significantly impacts on benthic or pelagic ecological communities.

Coastal river and estuary-set gillnets have been shown to have minimal impact on the environment and are quite selective in their harvest. Bycatch is generally low when compared with the harvest of the target species.

Commercial trawl gear used in waters across northern Australia has the potential to impact on the benthic habitat. However, trawl finfish trawl nets have been designed to fish off the seabed, reducing interaction with benthic habitats. Additionally, the trawl fishery across northern Australian waters comprises a very small fleet and only fishes approximately 7% of the available area[5].

Environmental effects on Black Jewfish

The impact of environmental factors on Black Jewfish is largely unknown; however, juveniles mainly inhabit coastal estuaries and embayments, making these phases of their lifecycle sensitive to in-ocean current strength and direction, rainfall and river flow and water temperature, salinity and pH[6].

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King Threadfin *Polydactylus macrochir*

Thor Saunders

Table 1: Stock status determination

Stock	Northern Territory
Stock status	Sustainable
Indicators	Catch, CPUE, length and age frequencies

CPUE = catch per unit effort

Stock structure

Separate biological stocks have been found to exist between King Threadfin collected in Chambers Bay in Van Diemen Gulf and the western side of the Gulf of Carpentaria[1]. However, finer scale sampling was conducted in Queensland and Western Australia that suggested King Threadfin have numerous populations across northern Australia and are separated by distances at the scales of tens to hundreds of km or by large, coastal geographical features[1]. Given the difficulty in obtaining relevant biological and catch-and-effort information to assess each individual biological stock, King Threadfin have been assessed as a single management unit in the Northern Territory (NT).

Stock status

Commercial catches in the NT Barramundi Fishery are stable and well within historical levels (Figure 2), and monitored stocks have a healthy size and age distribution. Catch rates have increased substantially over the past 10 years with the 2014 value among the highest in the history of the fishery (Figure 3). The above evidence indicates that the stocks in this management unit are unlikely to be recruitment overfished and that current catch levels are unlikely to cause the stocks to become recruitment overfished.

On the basis of the evidence provided above, the management unit is classified as a **sustainable stock**.

Table 2: King Threadfin biology[2]

Longevity and maximum size	22 years; 160 cm TL
Maturity (50%)	Males 2 years, 61 cm TL; females 6 years, 100 cm TL

TL = total length

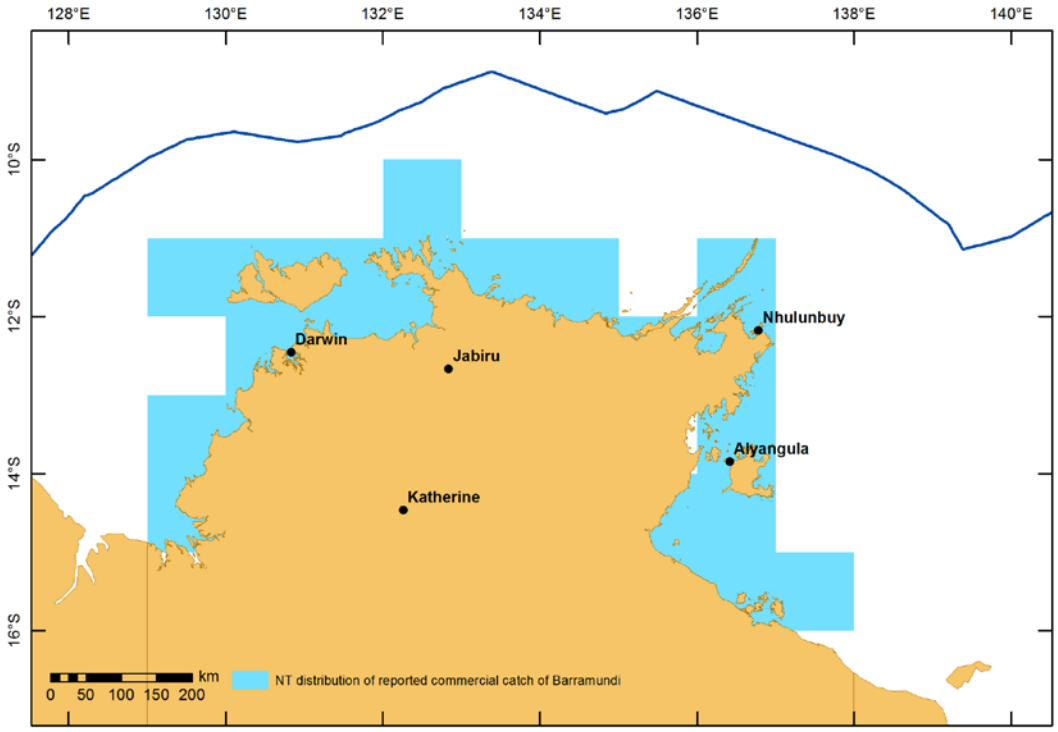
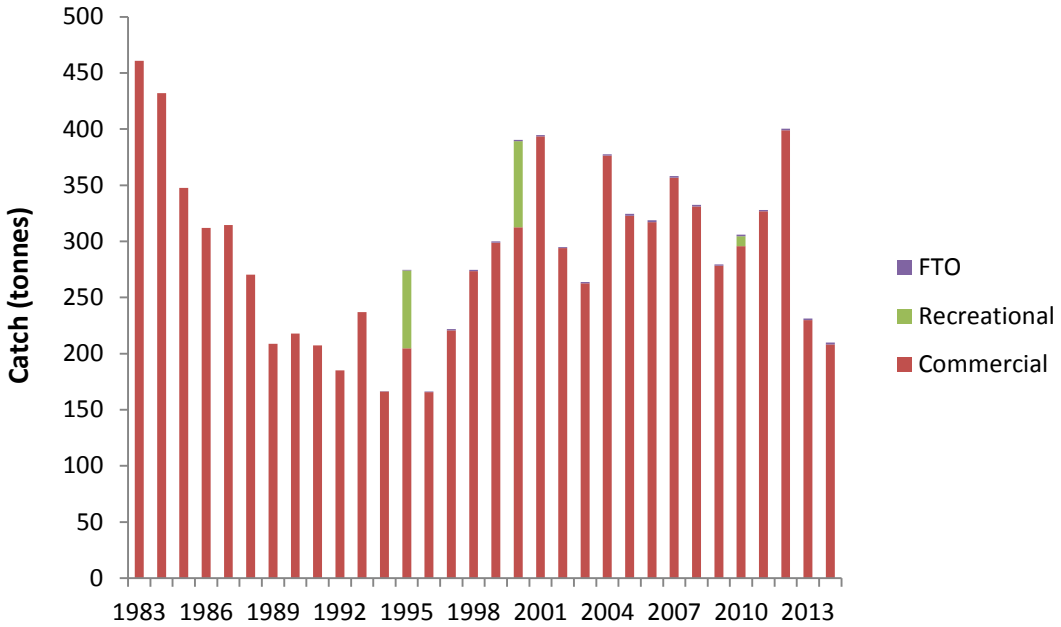


Figure 1: Distribution of reported commercial catch of King Threadfin in Northern Territory waters, 2014



FTO = Fishing Tour Operator

Figure 2: Catch by sector of King Threadfin in Northern Territory waters, 1983 to 2014

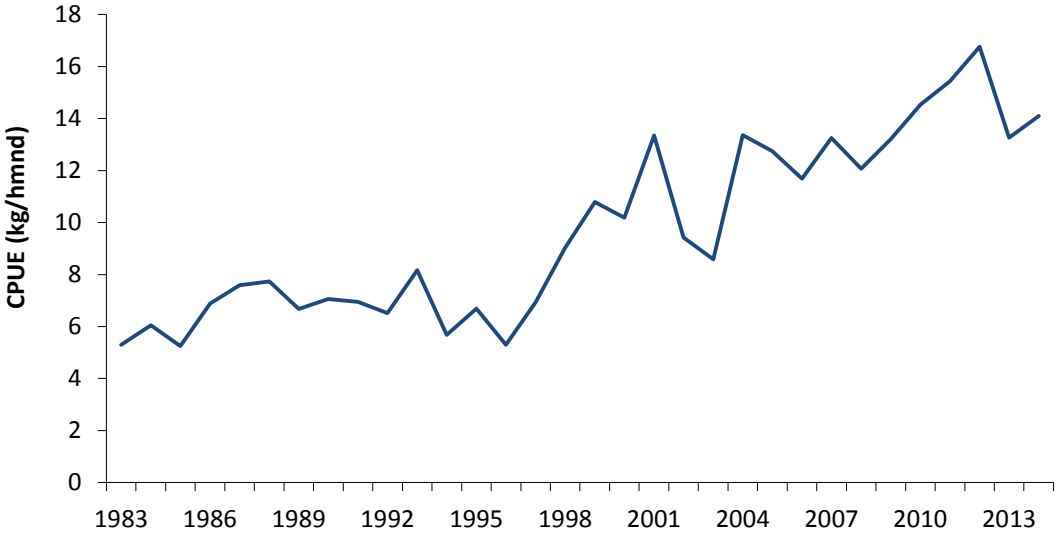


Figure 3: Commercial catch per unit effort (CPUE) for King Threadfin (kg/100 m of net/day), 1983 to 2014

Table 3: Main features and statistics for the sectors harvesting King Threadfin, 2014

Sector	Commercial	Recreational	Indigenous
Fishing methods			
Gillnet	✓		
Rod and line		✓	✓
Spearfishing		✓	✓
Hand line		✓	✓
Management methods			
Size limits	✓	✓	
Limited entry	✓		
Spatial zoning	✓	✓	
Vessel restrictions	✓		
Catch limits		✓	
Spatial closures	✓	✓	
Temporal closures	✓	✓	
Gear restrictions	✓	✓	✓
Possession limits		✓	✓
Catch			
	208 t	9 t (2010)[3] 1.5 t FTO	Unknown
Active commercial licences	14		

FTO = Fishing Tour Operator

Effects of fishing on the marine environment

Commercial gillnets have limited direct impact on the environment and are quite selective, with bycatch making up only a small proportion of the catch[4]. However, commercial gillnets do interact with threatened, endangered and protected species (TEPS). In the NT Barramundi Fishery, reported bycatch represents less than 1% of the total catch and typically consists of Queenfish, unwanted Shark species, Catfish and Blue Threadfin. The most common TEPS interactions primarily involve Saltwater Crocodiles (less than 50 interactions annually) which are highly unlikely to impact populations of this species given that they have recovered from unregulated hunting pre-1970 to carrying capacity in most NT catchments[5]. Other TEPS that this fishery interacts with in very low numbers (less than 10/year) include Green and Freshwater Sawfish, turtles and dugongs. The low bycatch and TEPS interaction levels in this fishery have been supported by observer coverage on board commercial vessels.

Environmental effects on King Threadfin

The duration, magnitude and timing of the wet season have been shown to influence the catchability of King Threadfin[6,7].

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Spanish Mackerel *Scomberomorus commerson*

Thor Saunders and Graham Schultz

Table 1: Stock status determination

Stock	Northern Territory Spanish Mackerel (DF, NTSMF, ONLF)
Stock status	Sustainable
Indicators	Stock rate, egg production

DF = Demersal Fishery; SMF = Spanish Mackerel Fishery; ONLF = Offshore Net and Line Fishery

Stock structure

Genetic evidence indicates that there are three biological stocks of Spanish Mackerel across northern Australia[1]; however, evidence from otolith microchemistry, parasite analysis and limited adult movement (at scales greater than 100 km) indicates that there are likely to be a number of smaller biological stocks with limited interaction[1–3]. Although the Northern Territory (NT) is likely to have multiple biological stocks within its boundaries, the difficulty in obtaining relevant biological and catch-and-effort information to assess each stock individually has meant that Spanish Mackerel has been grouped into a single management unit within this jurisdiction. The assessments are based on the populations that receive the highest harvest rates; their status can be assumed to be representative of the highest level of exploitation that occurs on any population within the NT.

Stock status

Spanish Mackerel stocks have been assessed at an NT-wide level, including information up to 2011. The results indicated that stocks declined substantially because of high Taiwanese catches in the 1970s and 1980s, but have since recovered as a result of more stringent management. In 2011, egg production was estimated at 79% of unfished levels, which is well within sustainable limits for a species such as Spanish Mackerel, and it was suggested that increases in catch could occur[4]. This assessment is supported by increased catch rates over the past 10 years, with the 2014 value being among the highest recorded in the history of the fishery (Figure 3). The evidence provided indicates that the biomass of this management unit is unlikely to be recruitment overfished and the current level of fishing mortality is unlikely to cause this management unit to become recruitment overfished.

On the basis of the evidence provided above, Spanish Mackerel in the NT is classified as a **sustainable stock**.

Table 2: Spanish Mackerel biology[5,6]

Longevity and maximum size	26 years; 240 cm FL
Maturity (50%)	~2 years; 80 cm FL

FL = fork length

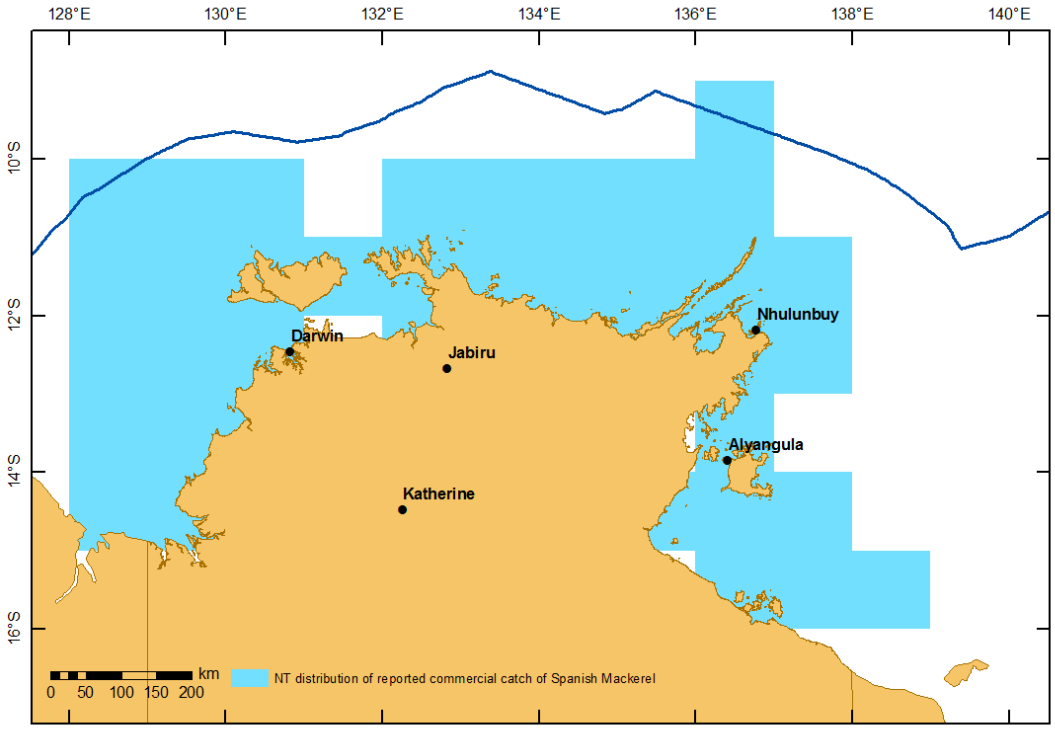
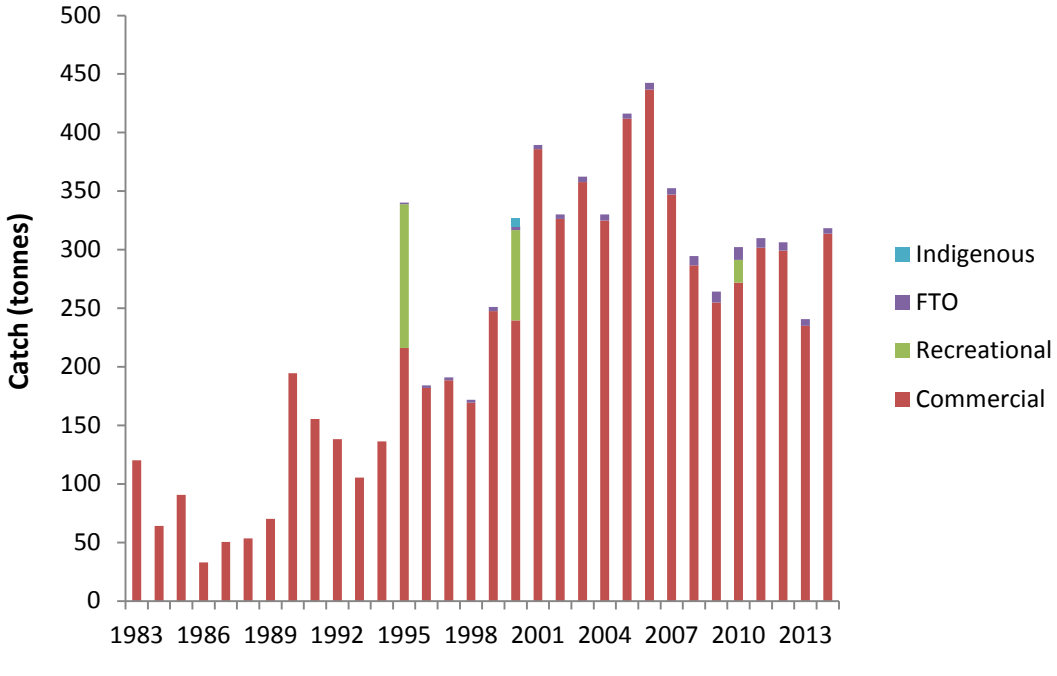


Figure 1: Distribution of reported commercial catch of Spanish Mackerel in Northern Territory waters, 2013



FTO = Fishing Tour Operator

Figure 2: Commercial catch of Spanish Mackerel in the Northern Territory, 1983 to 2014

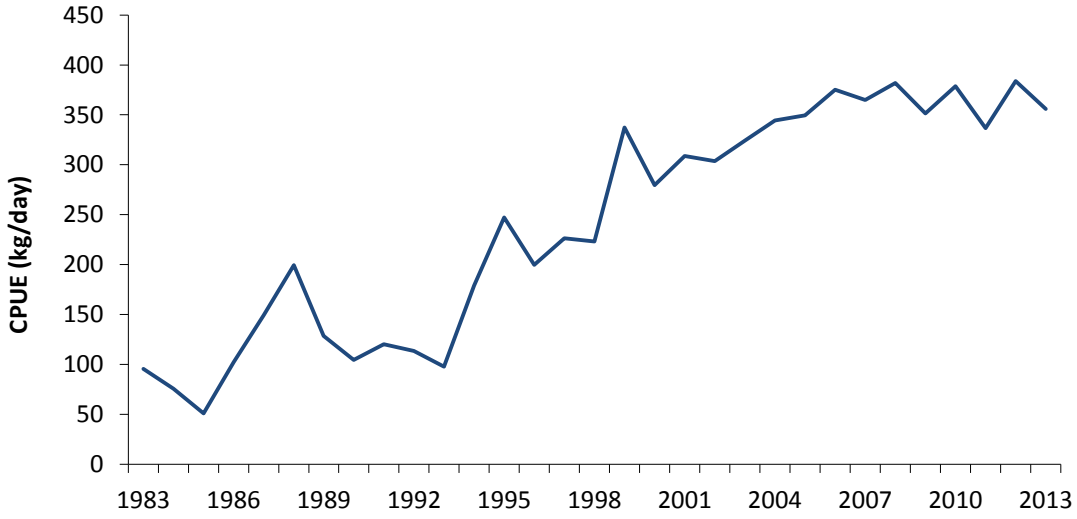


Figure 3: Commercial catch per unit effort (CPUE) of Spanish Mackerel in the Northern Territory, 1983 to 2013

Table 3: Main features and statistics for the sectors harvesting Spanish Mackerel, 2014

Sector	Commercial	Recreational	Indigenous
Fishing methods			
Trolled baits	✓	✓	
Lures	✓	✓	
Gillnet	✓		
Trawl	✓		
Rod and line		✓	
Spearfishing		✓	✓
Hand line		✓	✓
Management methods			
Limited entry	✓		
Vessel restrictions	✓		
Catch limits	✓	✓	
Spatial closures	✓	✓	
Gear restrictions	✓	✓	✓
Possession limits		✓	✓
Catch			
	287 t SMF 26.24 t ONLF	19 t (2010)[7] 4.74 t FTO	7 t (2000)
Active commercial licences	15		

FTO = Fishing Tour Operator; SMF = Spanish Mackerel Fishery; ONLF = Offshore Net and Line Fishery

Effects of fishing on the marine environment

Targeted fishing for most Spanish Mackerel fishing uses trolled lines. This method has almost no direct impact on the habitats where it is used and results in little bycatch.

Commercial gillnets interact with threatened, endangered and protected species. Although reported interactions are low, the impact on the populations of these species is unknown.

Commercial trawl gear used in the NT has the potential to impact on the benthic habitat. However, trawl nets in the NT have been designed to fish off the seabed, reducing interaction with benthic habitats[8]. The trawl fishery in the NT comprises a small fleet and only fishes around 7% of the available area.

Environmental effects on Spanish Mackerel

Annual recruitment strength of Spanish Mackerel appears to be negatively correlated with spring sea surface temperature, with cooler years positively influencing recruitment on the Queensland east coast[9].

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Grey Mackerel *Scomberomorous semifasciatus*

Grant Johnson

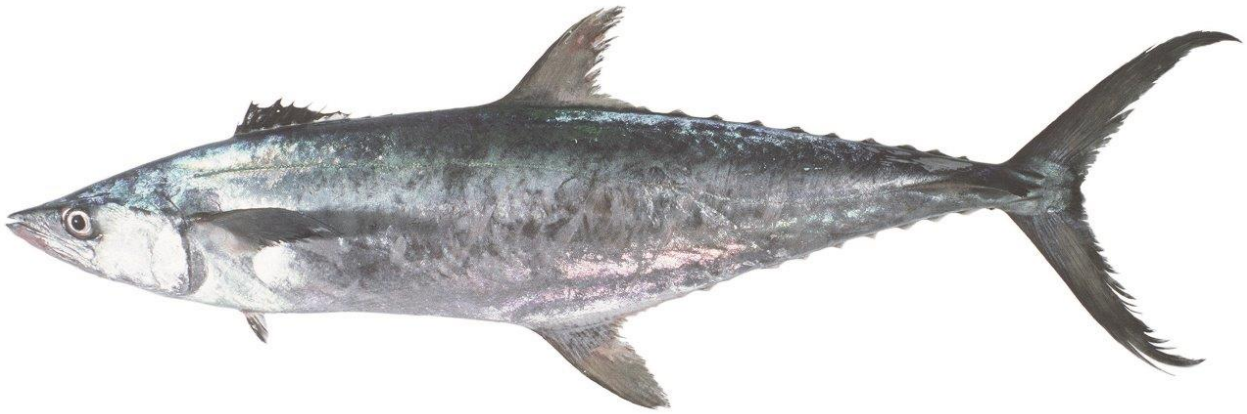


Table 1: Stock status determination

Stock	North-west Northern Territory (ONLF)	Gulf of Carpentaria (ONLF)
Stock status	Sustainable	Sustainable
Indicators	Stock reduction analysis, catch, CPUE, harvest rate, fishing mortality	Stock reduction analysis, catch, CPUE, length and age frequencies, harvest rate, fishing mortality

CPUE = catch per unit effort; ONLF = Offshore Net and Line Fishery

Stock structure

There are at least five Grey Mackerel biological stocks across northern Australia, of which two reside in Northern Territory (NT) waters. Using multiple approaches (genetics, parasites, otolith stable isotopes and growth data) to identify and define these stocks, it was discovered that there was one stock on the north-west coast of the NT while there was a second stock in the Gulf of Carpentaria (GOC)[1-5].

Stock status

North-west Northern Territory biological stock

Most (78%) of the Grey Mackerel catch in the NT is taken from this stock. This stock has been assessed using a stock reduction analysis (SRA), including data up to 2011. The results indicated that the stock declined substantially as a result of the high Taiwanese catches in the 1970s and 1980s but has since recovered, with the cessation of foreign fishing and more stringent management of the domestic fishery. In 2011, biomass was estimated at 81% of unfished levels, which is well within sustainability limits[6]. Supporting this assessment is the fact that catch per unit effort has increased over the last 10 years, while catches have remained relatively consistent (Figures 2 and 3). Consequently, Grey Mackerel stock in the north-west NT is not considered to be recruitment overfished and the current level of fishing mortality is unlikely to cause the stock to become recruitment overfished.

On the basis of the evidence provided above, the management unit is classified as a **sustainable stock**.

Gulf of Carpentaria biological stock

Queensland and the NT share management of the GOC Grey Mackerel stock through the respective Queensland and NT Fisheries Joint Authorities. Queensland takes the majority of the commercial harvest (average 80 to 95%) compared with the NT, which reported 109 tonnes (t) in 2014. There has been a rising trend in commercial catch rate since targeted fishing of Grey Mackerel began in the GOC in 1990[3]. Queensland catches and catch rates reached record levels in 2010 and 2012, respectively[7]. Although the Queensland catch rate dropped in 2013, the rate (54 kg/100 m net) was still above the previous 10-year average (52 kg/100 m net)[7]. An SRA of Grey Mackerel in the GOC using Queensland and NT catches concluded that the biomass in 2011 was at 74% of the unfished biomass, which is well within sustainability limits[6]. The biomass of this stock is not considered to be recruitment overfished. Queensland also reduced the total allowable effort by two-thirds in the offshore component of the net fishery and also reduced the capacity for boats to target Grey Mackerel in the inshore fishery[8]. Consequently, the current allowable level of fishing pressure is unlikely to cause the stock to become recruitment overfished.

On the basis of the evidence provided above, the management unit is classified as a **sustainable stock**.

Table 2: Grey Mackerel biology[9]

Longevity and Maximum size	12 years; 120 cm TL
Maturity (50%)	Females: 2 years; 70 cm TL; males: 1–2 years; 66 cm TL

TL = total length

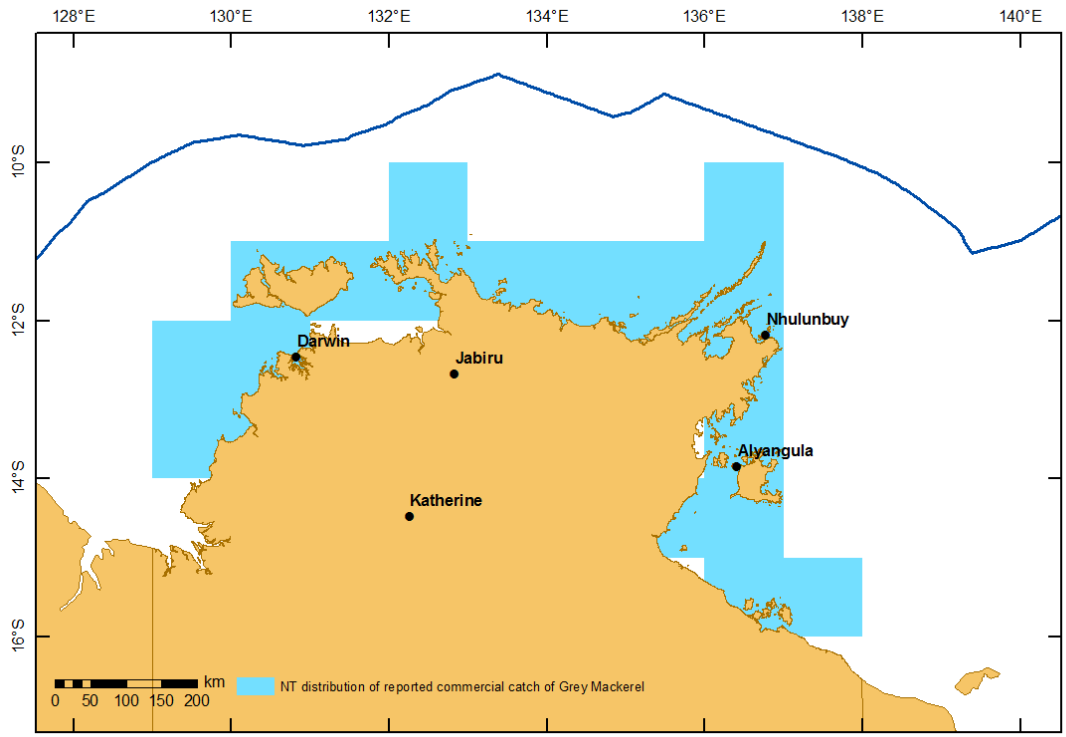
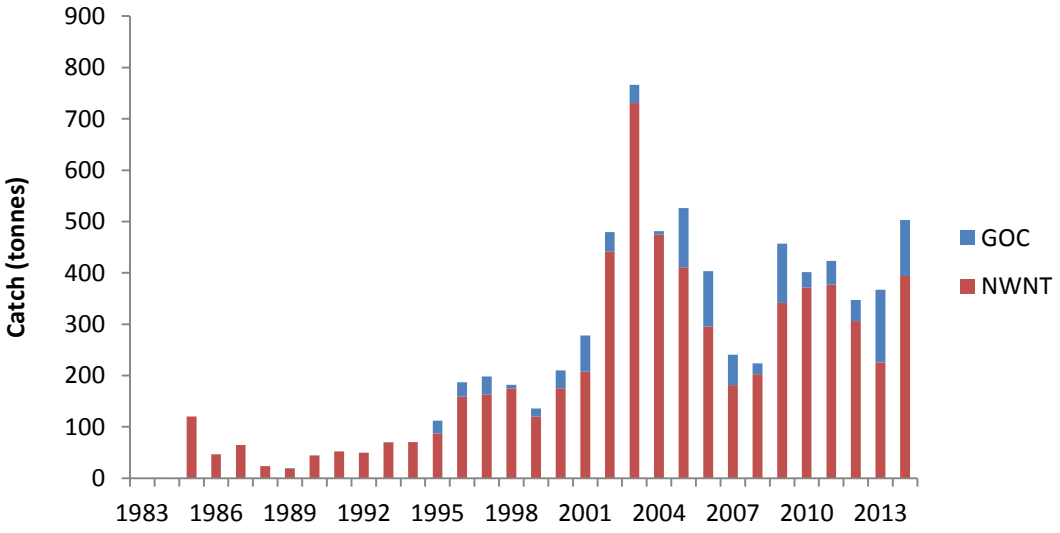


Figure 1: Distribution of reported commercial catch of Grey Mackerel in Northern Territory waters, 2014



GOC= Northern Territory proportion of Gulf of Carpentaria stock; NWNT= north-west Northern Territory stock

Figure 2: Commercial Grey Mackerel catch in the Northern Territory, 1983 to 2014

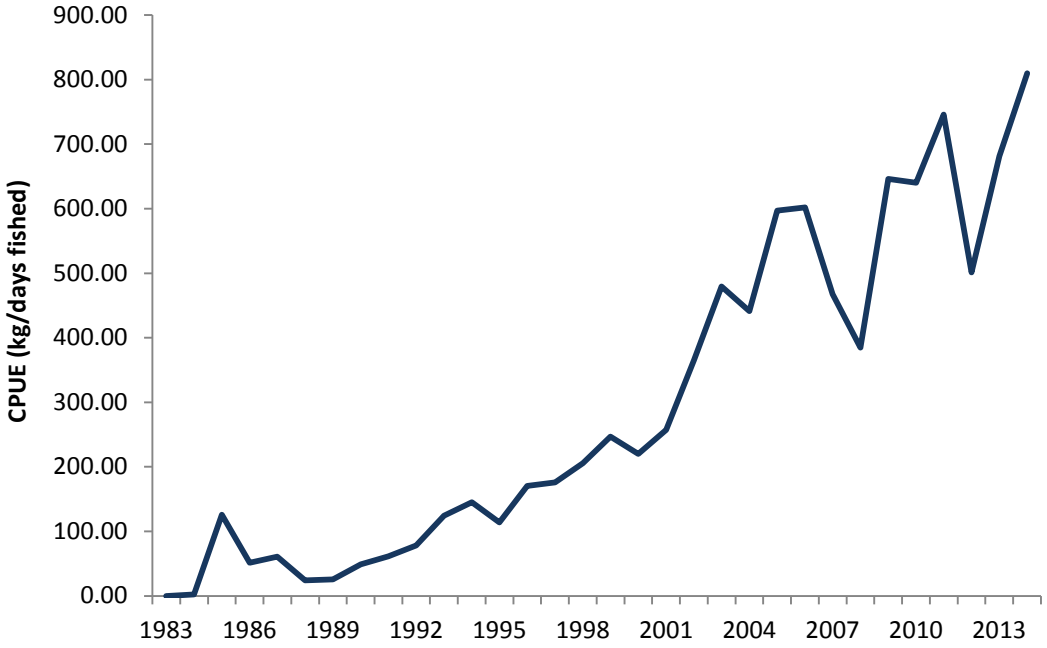


Figure 3: Commercial catch per unit effort (CPUE) for north-west Northern Territory stock of Grey Mackerel (kg/day fished), 1983 to 2014

Table 3: Main features and statistics for the sectors harvesting Grey Mackerel, 2014

Sector	Commercial	Recreational	Indigenous
Fishing methods			
Gillnet	✓		
Rod and line		✓	
Spearfishing		✓	✓
Hand line		✓	✓
Management methods			
Limited entry	✓		
Vessel restrictions	✓		
Spatial closures	✓	✓	
Gear restrictions	✓	✓	✓
Effort restrictions	✓		
Possession limits		✓	
Catch			
	503 t	10 t (2010)[10]	Unknown
Active commercial licences	12 (ONLF)		

ONLF = Offshore Net and Line Fishery

Effects of fishing on the marine environment

Pelagic gillnets, which are the principal gear used to target Grey Mackerel in the ONLF, have almost no impact on coastal habitat and are quite selective, with bycatch, making up only a small proportion of the catch[11]. However, commercial gillnets do interact with threatened, endangered and protected species (TEPS). Although reported interactions are low, the impact on the populations of TEPS is unknown, or assessed as negligible to low.

Environmental effects on Grey Mackerel

The duration and magnitude of the wet season are likely to impact on the overall biomass of coastal stocks like Grey Mackerel that depend on nearshore waters for breeding and feeding[12]. A widespread drought in the GOC region in 2013 is thought to have affected the abundance of a number of commercially important species, including Grey Mackerel. Low rainfall in the southern GOC resulted in decreased freshwater flows, turbidity and primary productivity in nearshore areas, which are critical to Grey Mackerel larval survival and juvenile/adult feeding. For other species, research has shown that large wet seasons result in higher recruitment than smaller wet seasons[12].

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Crimson Snapper *Lutjanus erythropterus*

Julie Martin

Table 1: Stock status determination

Stock	Northern Territory (DF, TRF)
Stock status	Sustainable
Indicators	Stock reduction analysis, catch, CPUE

CPUE = catch per unit effort; DF = Demersal Fishery; TRF = Timor Reef Fishery

Stock structure

Crimson Snapper (*Lutjanus erythropterus*) is a widespread Indo-Pacific species found throughout tropical Australian waters. Genetic studies indicate that within Northern Territory (NT) waters (including the Timor Sea, Arafura Sea and the Gulf of Carpentaria) the species is comprised of one biological stock[1]. The species occurs over a wide depth range, from coastal to offshore areas and is fished in waters up to 150 m in depth (Figure 1).

Stock status

The NT manages the commercial harvest of Crimson Snapper and Saddletail Snapper together as red snapper. Crimson Snapper has made up around 22% of the red snapper catch for the last 15 years and is assessed on the basis of the status of the main species, Saddletail Snapper, as an indicator for the combined group. Analysis of Saddletail Snapper in 2013 using a stochastic stock reduction analysis model estimated egg production to be around 80% of that prior to the start of the fishery, well above conventional fishery targets[2]. Therefore, this part of the Crimson Snapper biological stock is not considered to be recruitment overfished.

The combined NT total allowable commercial catch for red snappers is 3800 tonnes (t) and the commercial catch of Crimson Snapper in 2014 was 338 t (Figure 2). The 2013 assessment confirmed that the current harvest rate of red snappers is well below that required to achieve maximum sustainable yield. This low level of fishing mortality compared with the total allowable catch is unlikely to cause this part of the biological stock to become recruitment overfished.

On the basis of the evidence provided above, the biological stock is classified as a **sustainable stock**.

Table 2: Crimson Snapper biology[3,4]

Longevity and maximum size	42 years; 47 cm SL
Maturity (50%)	Males 27–28 cm SL, females 35–37 cm SL

SL = standard length

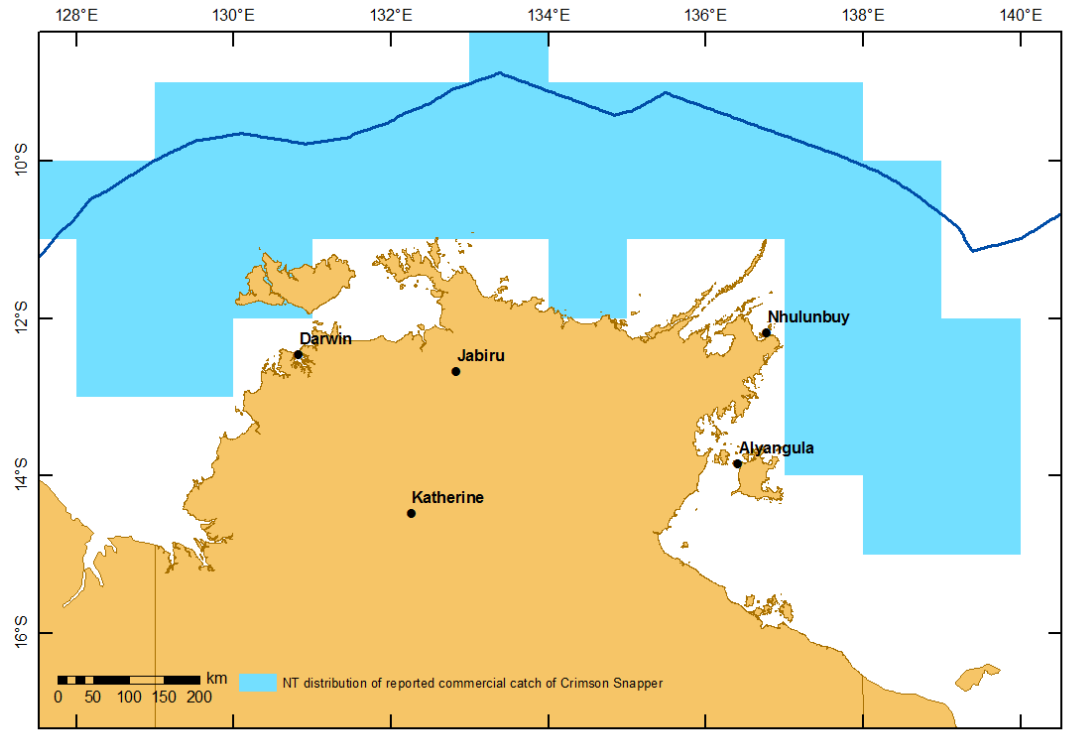
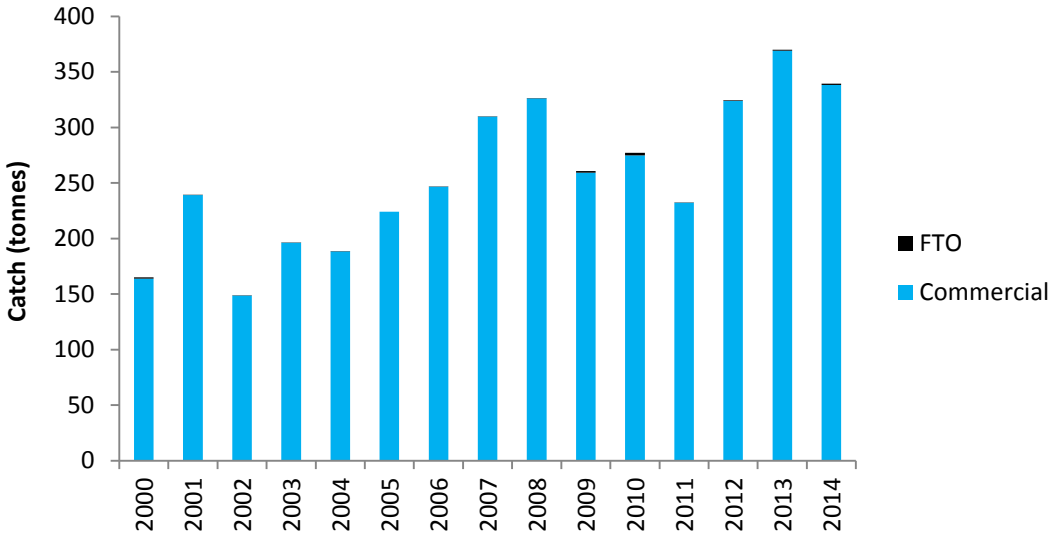


Figure 1: Distribution of reported commercial catch of Crimson Snapper in Northern Territory waters, 2014



FTO = Fishing Tour Operator. Recreational catch is not included because Crimson Snapper and Saddletail Snapper have been combined in catch statistics

Figure 2: Catch by sector of Crimson Snapper in Northern Territory waters, 2000 to 2014

Table 3: Main features and statistics for the sectors harvesting Crimson Snapper, 2014

Sector	Commercial	Recreational[a]	Indigenous
Fishing methods			
Hand line	✓[b]	✓	
Rod and line		✓	
Dropline	✓		
Longline	✓		
Fish trap	✓		
Fish trawl	✓		
Management methods			
Spatial zoning	✓		
Total allowable catch	✓		
Gear restrictions	✓	✓	✓
Possession limits		✓	
Catch			
	338 t	Rec: 55 t (in 2010)[c] FTO: 1.6 t	Unknown[d]
Active commercial licences	8 (DF) 9 (TRF)		

DF = Demersal Fishery; TRF = Timor Reef Fishery
[a] Recreational includes the Fishing Tour Operator (FTO) sector.
[b] Hand lines, droplines and longlines together constituted less than 1% of the total commercial catch.
[c] Includes the recreational catch of both Crimson Snapper and Saddletail Snapper, which were combined during the 2010 recreational fishing survey[5].
[d] Crimson Snappers have been combined in the group "tropical snappers" during surveys[6].

Effects of fishing on the marine environment

The impacts of traps and lines on the benthic habitat are limited to the effects of line weights and traps on the seabed. To avoid excessive interaction with the seabed, traps are set separately and not attached to one another. In 2014, trap gear covered less than 0.0001% of the total fishery area. "Ghost fishing" (i.e. the continued fishing by lost traps) is not considered to be significant in terms of either its impact or occurrence. Underwater video observation of traps during commercial fishing operations in northern Australia has shown the unimpeded entry and exit of fish from traps of the same design as used in the fisheries targeting Crimson Snapper.

The impact of trawl gear is limited to the multi-gear zones in the Demersal Fishery and the area trawled in 2014 covered 1.17% of these zones. Trawl nets in the NT have been designed to fish off the seabed, reducing interaction with benthic habitats[7].

There are few bycatch issues associated with trap and line-based fishing. Management objectives for trawl gear specify that bycatch must remain below 35% of the total catch. In 2014, the average bycatch recorded by observers was 20% of the total trawl catch and non-retained species consisted mainly of trevally, scads and small sharks. The catch of larger animals, including rays and large sharks, has significantly declined since the introduction of bycatch reduction devices (BRDs) in 2006.

Interactions with protected species, including dolphins and turtles, can occur in the fish trawls, but this has decreased significantly since the introduction of BRDs. Given the area of distribution and estimated population size of these protected species, the impact of fish trawl gear on the stocks of these protected species is likely to be minimal.

Environmental effects on Crimson Snapper

Climate change and variability have the potential to impact on fish stocks in a range of ways, including influencing their geographic distribution (for example, latitudinal shifts in distribution). However, it is unclear how climate change may affect risks to the sustainability of this species. Slow growing and long-lived species, such as Crimson Snapper, are less likely to be affected by short duration environmental changes (of one or a few years), with adult stocks comprising fish recruited over many years.

Changes in ocean chemistry, such as ocean acidification, have the potential to impact on the replenishment rates of fish populations by affecting larval survival[8] and also individual growth rates and spawning output[9].

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Goldband Snapper *Pristipomoides multidens*

Julie Martin

Table 1: Stock status determination

Stock	Northern Territory (DF, TRF)
Stock status	Sustainable
Indicators	Stock reduction analysis, catch, CPUE

CPUE = catch per unit effort; DF = Demersal Fishery; TRF = Timor Reef Fishery

Stock structure

Goldband Snapper is widely distributed throughout northern Australia and the tropical Indo-West Pacific. Analysis of otolith stable isotopes indicates that the Northern Territory (NT) has a separate biological stock within this distribution[1,2]. The species occurs over a wide depth range, but is commercially fished from 80 to 150 m in depth (Figure 1).

Stock status

The NT Goldband Snapper biological stock (encompassing the Arafura and Timor seas) was assessed in 2011 and 2013 using a stochastic stock reduction analysis (SRA) model[3,4]. Egg production was estimated to be around 65% of that prior to the start of the fishery, well above conventional target levels. For this reason, the biological stock is not considered to be recruitment overfished.

The total allowable commercial catch for Goldband Snapper is 1300 tonnes (t); 900 t in the Timor Reef Fishery and 400 t in the Demersal Fishery. In 2014, the total commercial catch of Goldband Snapper was 606 t (Figure 2). The SRA assessments indicated that the harvest rate was below that required to achieve maximum sustainable yield. This low level of fishing mortality is unlikely to cause the biological stock to become recruitment overfished.

On the basis of the evidence provided above, the biological stock is classified as a **sustainable stock**.

Table 2: Goldband Snapper biology[5]

Longevity and maximum size	30 years; 70 cm FL, 81 cm TL
Maturity (50%)	8 years; 47 cm FL, 55 cm TL

FL = fork length; TL = total length

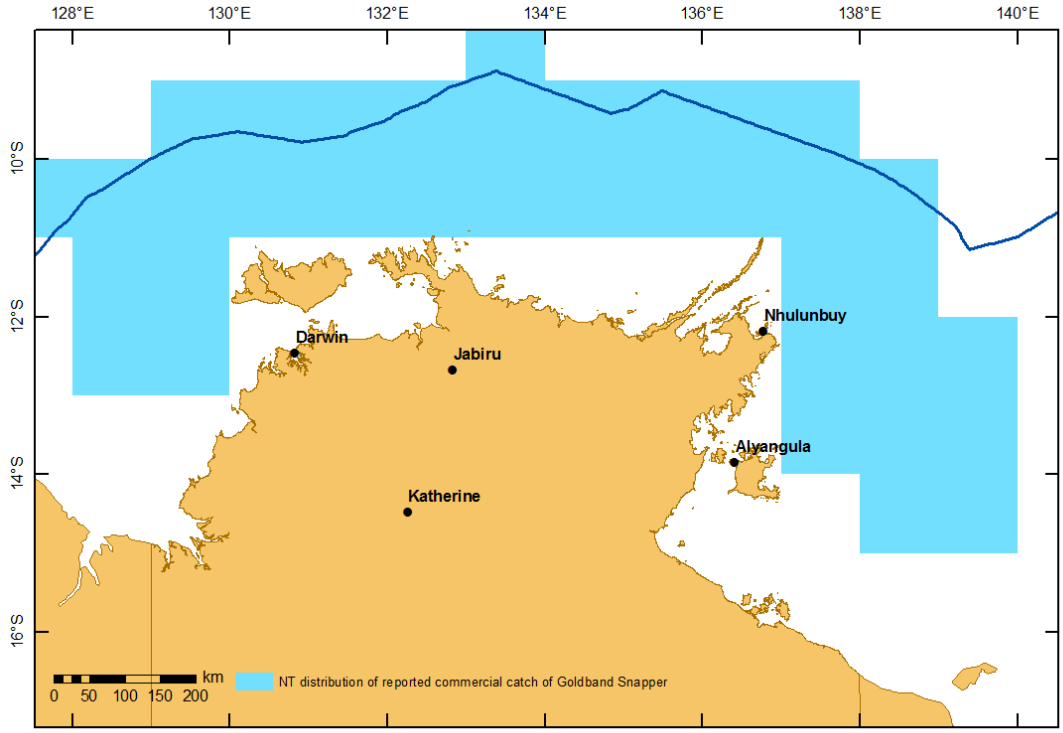
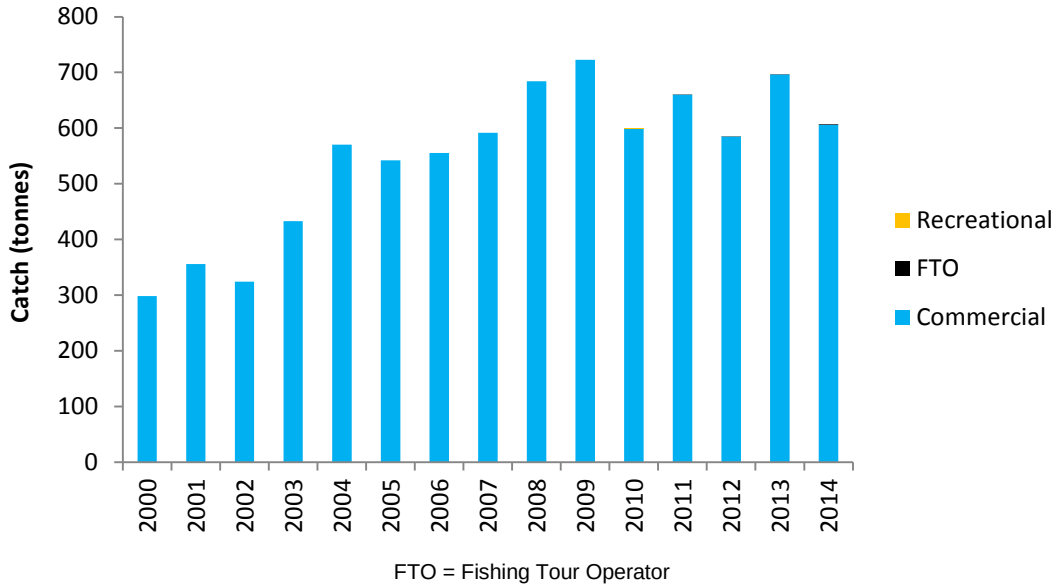


Figure 1: Distribution of reported commercial catch of Goldband Snapper in Northern Territory waters, 2014



FTO = Fishing Tour Operator

Figure 2: Catch by sector of Goldband Snapper in Northern Territory waters, 2000 to 2014

Table 3: Main features and statistics for the sectors harvesting Goldband Snapper, 2014

Sector	Commercial	Recreational[a]	Indigenous
Fishing methods			
Hand line	✓[b]	✓	
Rod and line		✓	
Dropline	✓		
Fish trap	✓		
Fish trawl	✓		
Management methods			
Spatial zoning	✓		
Total allowable catch	✓		
Gear restrictions	✓	✓	✓
Possession limits		✓	
Catch			
	606 t	Rec: 0.5 t (2010) FTO: 1.1 t	Negligible
Active commercial vessels	8 (DF) 9 (TRF)		

DF = Demersal Fishery; TRF = Timor Reef Fishery.
[a] Recreational includes the Fishing Tour Operator (FTO) sector.
[b] Longlines and droplines together constituted less than 1% of the total commercial catch.

Effects of fishing on the marine environment

The impacts of traps and lines on the benthic habitat are limited to the effects of line weights and traps on the seabed. To avoid excessive interaction with the seabed, traps are set separately and not attached to one another. In 2014, trap gear covered less than 0.0001% of the total fishery area. “Ghost fishing” (i.e. the continued fishing by lost traps) is not considered to be significant in terms of either its impact or occurrence. Underwater video observation of traps during commercial fishing operations in northern Australia has shown the unimpeded entry and exit of fish from traps of the same design as used in the fisheries targeting Goldband Snapper.

The impact of trawl gear is limited to the multi-gear zones in the Demersal Fishery and the area trawled in 2014 covered 1.17% of these zones. Trawl nets in the NT have been designed to fish off the seabed, reducing interaction with benthic habitats[8].

There are few bycatch issues associated with trap and line-based fishing. Management objectives for trawl gear specify that bycatch must remain below 35% of the total catch. In 2014, the average bycatch recorded by observers was 20% of the total trawl catch and non-retained species consisted mainly of trevally, scads

and small sharks. The catch of larger animals, including rays and large sharks, has significantly declined since the introduction of bycatch reduction devices (BRDs) in 2006.

Interactions with protected species, including dolphins and turtles, can occur in the fish trawls, but this has decreased significantly since the introduction of BRDs. Given the area of distribution and estimated population size of these protected species, the impact of fish trawl gear on the stocks of these protected species is likely to be minimal.

Environmental effects on Goldband Snapper

Climate change and variability have the potential to impact on fish stocks in a range of ways, including influencing their geographic distribution (for example, latitudinal shifts in distribution). However, it is unclear how climate change may affect risks to the sustainability of this species. Slow-growing and long-lived species, such as Goldband Snapper, are less likely to be affected by short duration environmental changes (of one or a few years), with adult stocks comprising fish recruited over many years.

Changes in ocean chemistry, such as ocean acidification, have the potential to impact on the replenishment rates of fish populations by affecting larval survival[9], and also individual growth rates and spawning output[10].

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Golden Snapper *Lutjanus johnii*

Chris Errity

Table 1: Stock status determination

Stock	Northern Territory Golden Snapper (CLF, DF, FTO, TRF)
Stock status	Overfished
Indicators	Catch, biomass, egg production

CLF = Coastal Line Fishery; DF = Demersal Fishery; FTO = Fishing Tour Operator; TRF = Timor Reef Fishery

Stock structure

Golden Snapper is a widespread Indo-Pacific species found from the Pilbara region in Western Australia across northern Australia to the east coast of Queensland. The stock structure for this species is currently under investigation and is presently undefined; hence, status is reported at the management jurisdiction/unit level rather than as individual biological stocks. The assessments of these units are based on the stocks that receive the highest harvest rates so their status can be assumed to be representative of the highest level of exploitation that occurs on any stock within each management unit.

Stock status

The most recent assessment (2011) estimates that the biomass of Golden Snapper is at approximately 25% of unfished spawning stock biomass[1]. Additionally, egg production is approximately only 10% of unfished levels[1]. The immediate area of concern is in waters around Darwin where most of the fishing pressure occurs and where catch and catch rate have substantially declined over the last 10 years[2]. The evidence provided in combination with the vulnerable life history traits of Golden Snapper indicate these stocks are recruitment overfished.

On the basis of the evidence provided above, the management unit is classified as an **overfished stock**.

Table 2: Golden Snapper biology[4,5]

Longevity and Maximum size	30 years; 90 cm TL, 15 kg
Maturity (50%)	NT: males 52 cm TL (7 years); females 56 cm TL (8 years)

TL = total length

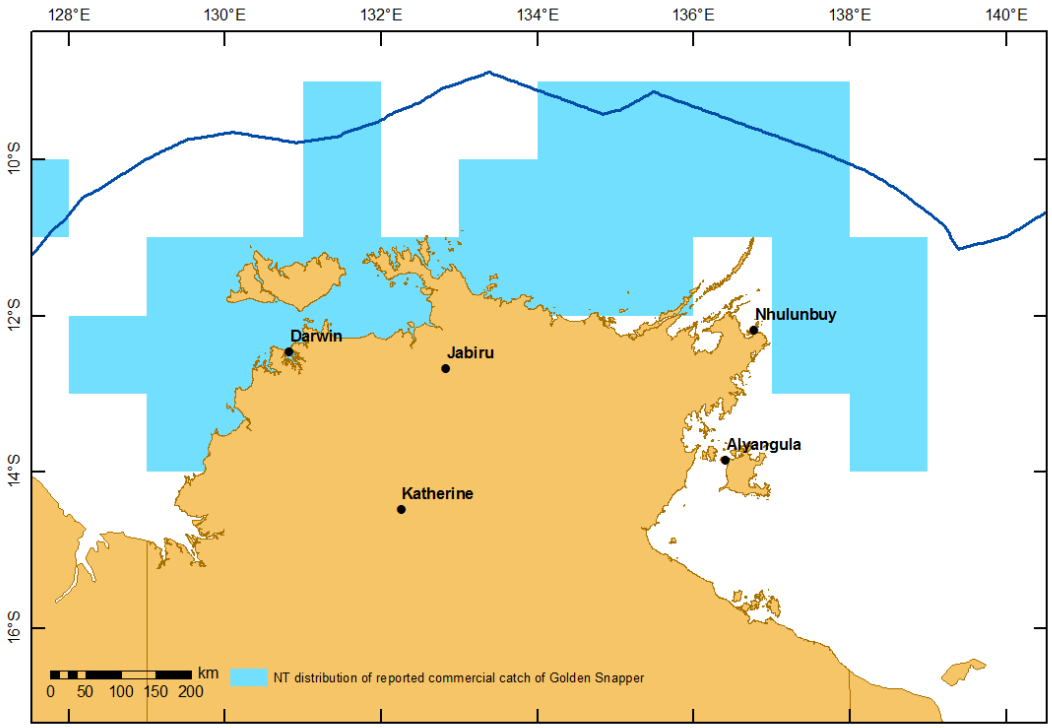

Figure 1: Distribution of reported commercial catch of Golden Snapper in Northern Territory waters, 2014

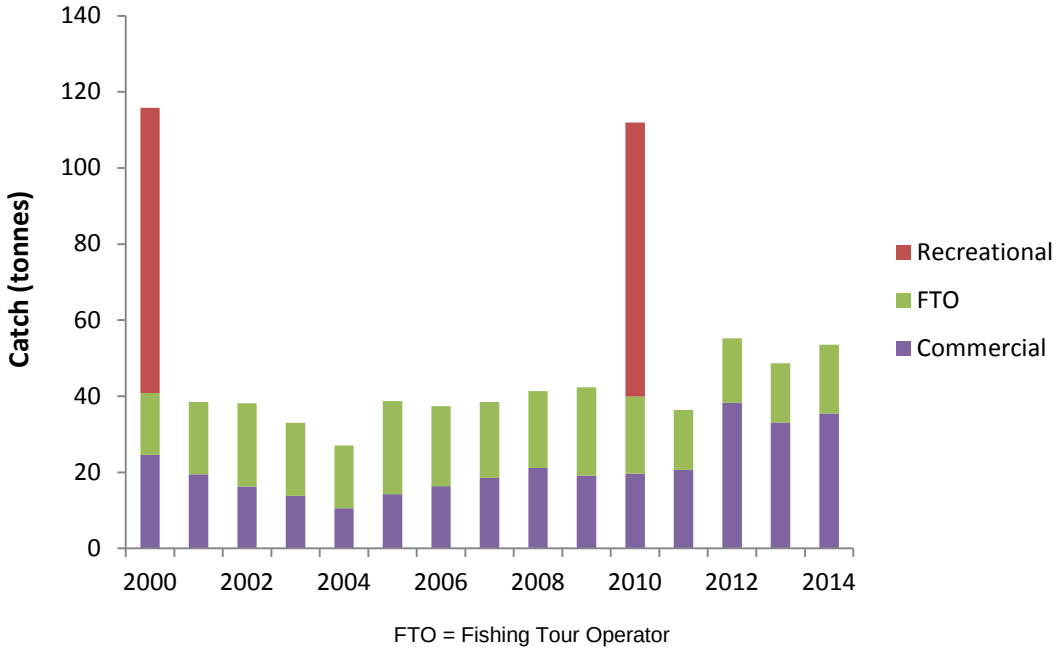

Figure 2: Catch by sector of Golden Snapper in Northern Territory waters, 2000 to 2014

Table 3: Main features and statistics for the sectors harvesting Golden Snapper, 2014

Sector	Commercial	Recreational	Indigenous
Fishing methods			
Gillnet	✓		
Rod and line	✓	✓	✓
Trawl	✓		
Fish trap	✓		
Hand line	✓	✓	✓
Management methods			
Spatial zoning	✓	✓	
Limited entry	✓		
Gear restrictions	✓	✓	✓
Spatial closures	✓	✓	✓
Vessel restrictions	✓		
Catch limits		✓	✓
Possession limits		✓	✓
Catch			
	35 t[a]	72 t (2010)[3] 18 t (FTO)	
Active commercial licences	40		

FTO = Fishing Tour Operator

[a] Commercial catch (Demersal Fishery – 17.1 tonnes (t); Timor Reef Fishery – 12.3 t; Coastal Line Fishery – 3.9 t; Barramundi Fishery – 1.5 t; Offshore Net and Line Fishery 0.5 t).

Effects of fishing on the marine environment

Golden Snapper is targeted by fishers in all sectors using hand lines and rods. Beyond the removal of target and a small proportion of bycatch species, there is little evidence to suggest that this gear significantly impacts on benthic or pelagic ecological communities.

Commercial trawl gear used in the NT has the potential to impact on the benthic habitat. However, trawl nets in the NT have been designed to fish off the seabed, reducing interaction with benthic habitats[6]. The area trawled in 2013 covered 1.14% of the Demersal Fishery trawl zones.

Environmental effects on Golden Snapper

The impact of environmental factors on Golden Snapper stocks is largely unknown; however, the juvenile and larval phases of this species inhabit estuaries and coastal embayments, making these phases of their life cycle vulnerable to changes in ocean current strength and direction, rainfall and river flow and water temperature, salinity and pH[7].

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Saddletail Snapper *Lutjanus malabaricus*

Julie Martin

Table 1: Stock status determination

Stock	Northern Territory Saddletail Snapper
Stock status	Sustainable
Indicators	Stock reduction analysis, catch, CPUE

CPUE = catch per unit effort

Stock structure

Saddletail Snapper (*Lutjanus malabaricus*) is a widespread Indo-Pacific species found throughout tropical Australian waters. Genetic studies indicate that within Northern Territory (NT) waters (including the Timor Sea, Arafura Sea and the Gulf of Carpentaria) the species is comprised of one biological stock[1,2]. The species occurs over a wide depth range, from coastal to offshore areas and is fished in waters up to 150 m in depth (Figure 1).

Stock status

The NT Saddletail Snapper biological stock was assessed in 2013 using a stochastic stock reduction analysis model[3]. Egg production was estimated to be around 80% of that prior to the start of the fishery, indicating that this part of the biological stock is not recruitment overfished.

The NT manages the commercial harvest of Saddletail Snapper and Crimson Snapper together as 'red snappers' with a combined total allowable commercial catch of 3800 tonnes (t). Saddletail Snapper has averaged 78% of the annual red snapper catch over the last 10 years with a commercial catch of 1928 t in 2014 (Figure 2). The 2013 assessment indicated that the current harvest rate of Saddletail Snapper is well below that required to achieve maximum sustainable yield. This level of fishing mortality is unlikely to cause this part of the biological stock to become recruitment overfished.

On the basis of the evidence provided above, the biological stock is classified as a **sustainable stock**.

Table 2: Saddletail Snapper biology[4,5,6]

Longevity and maximum size	33 years; 68 cm SL
Maturity (50%)	9 years; males 27–28 cm SL; females 35–37 cm SL

SL = standard length

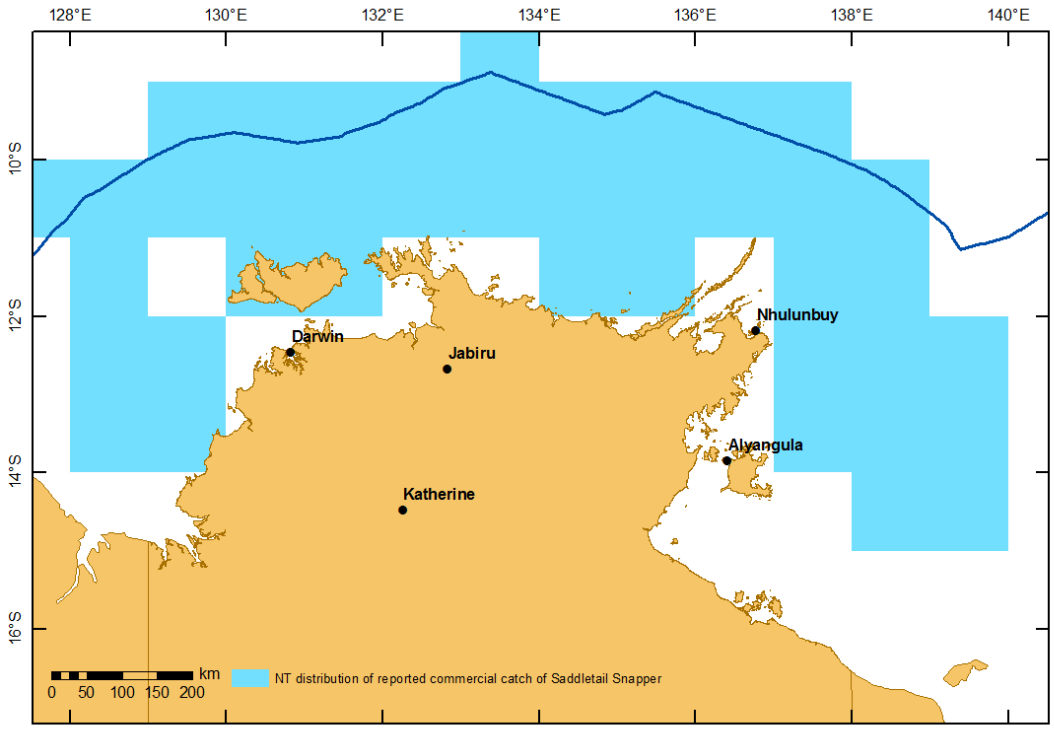
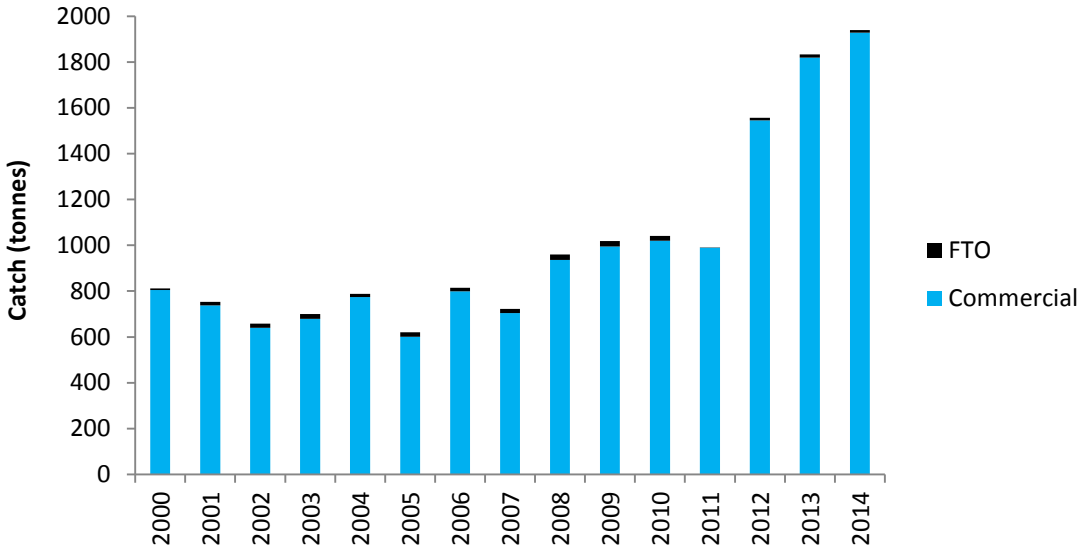


Figure 1: Distribution of reported commercial catch of Saddletail Snapper in Northern Territory waters, 2014



FTO = Fishing Tour Operator. Recreational catch is not included because Saddletail Snapper and Crimson Snapper have been combined in catch statistics.

Figure 2: Catch by sector of Saddletail Snapper in Northern Territory waters, 2000 to 2014

Table 3: Main features and statistics for the sectors harvesting Saddletail Snapper, 2014

Sector	Commercial	Recreational[a]	Indigenous
Fishing methods			
Hand line	✓[b]	✓	
Rod and line		✓	
Longline	✓		
Fish trap	✓		
Fish trawl	✓		
Management methods			
Spatial zoning	✓		
Total allowable catch	✓		
Gear restrictions	✓	✓	✓
Possession limits		✓	
Catch			
	1928 t	Rec: 55 t (in 2010)[c] FTO: 11 t	Unknown[d]
Active commercial licences	8 (DF) 9 (TRF)		

DF = Demersal Fishery; TRF = Timor Reef Fishery.
[a] Recreational includes the Fishing Tour Operator (FTO) sector.
[b] Hand lines, droplines and longlines together constituted less than 1% of the total commercial catch.
[c] Includes the recreational catch of both Saddletail Snapper and Crimson Snapper which were combined during the 2010 recreational fishing survey[7].
[d] Saddletail Snappers have been combined in the group "tropical snappers" during surveys[8].

Effects of fishing on the marine environment

The impacts of traps and lines on the benthic habitat are limited to the effects of line weights and traps on the seabed. To avoid excessive interaction with the seabed, traps are set separately and not attached to one another. In 2014, trap gear covered less than 0.0001% of the total fishery area. "Ghost fishing" (i.e. the continued fishing by lost traps) is not considered to be significant in terms of either its impact or occurrence. Underwater video observation of traps during commercial fishing operations in northern Australia has shown the unimpeded entry and exit of fish from traps of the same design as used in the fisheries targeting Saddletail Snapper.

The impact of trawl gear is limited to the multi-gear zones in the Demersal Fishery and the area trawled in 2014 covered 1.17% of these zones. Trawl nets in the NT have been designed to fish off the seabed, reducing interaction with benthic habitats[9].

There are few bycatch issues associated with trap and line-based fishing. Management objectives for trawl gear specify that bycatch must remain below 35% of the total catch. In 2014, the average bycatch recorded by observers was 20% of the total trawl catch and non-retained species consisted mainly of trevally, scads

and small sharks. The catch of larger animals, including rays and large sharks, has significantly declined since the introduction of bycatch reduction devices (BRDs) in 2006.

Interactions with protected species, including dolphins and turtles, can occur in the fish trawls, but this has decreased significantly since the introduction of BRDs. Given the area of distribution and estimated population size of these protected species, the impact of fish trawl gear on the stocks of these protected species is likely to be minimal.

Environmental effects on Saddletail Snapper

Climate change and variability have the potential to impact on fish stocks in a range of ways, including influencing their geographic distribution (for example, latitudinal shifts in distribution). However, it is unclear how climate change may affect risks to the sustainability of this species. Slow-growing and long-lived species, such as Saddletail Snapper, are less likely to be affected by short duration environmental changes (of one or a few years), with adult stocks comprising fish recruited over many years.

Changes in ocean chemistry, such as ocean acidification, have the potential to impact on the replenishment rates of fish populations by affecting larval survival[10], and also individual growth rates and spawning output[11].

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GLOSSARY

A

Aggregation. Group of fish that come together, often to feed or spawn.

Area closure. Closure of a given area/fishing ground, often for a defined period. Used as a tool in the management of a fishery.

Australian Fishing Zone (AFZ). The area extending seaward of coastal waters (that is, from 3 nautical miles from the territorial sea baseline) to the outer limits of the Exclusive Economic Zone (EEZ). In the case of external territories, such as Christmas Island, the AFZ extends from the territorial sea baseline to the outer limit of the EEZ. The AFZ is defined in the *Fisheries Management Act 1991*, which also specifies a number of 'excepted waters', notably in Antarctica and the Torres Strait, that are excluded from the AFZ.

B

Benthic. Associated with the bottom of a water body.

Berried female. Female crustacean carrying eggs.

Biodiversity. Biological diversity; variety among living organisms, including genetic diversity, diversity within and between species, and diversity within ecosystems.

Biological reference point. Biomass or fishing mortality level used to guide management decisions. Can be either a 'target reference point' or a minimum biologically acceptable limit ('limit reference point').

Biological stock. Functionally discrete population that is largely distinct from other populations of the same species and can be regarded as a separate entity for management or assessment purposes.

Biomass. Total weight of a stock or a component of a stock.

Biomass proxy. A relative biomass level used in place of a quantitatively estimated biological reference point when the latter is not available. For example, the biomass that sustains maximum economic yield (B_{MEY}).

Bioregion. 'A region defined by common oceanographic characteristics in its marine environment, and by climate/rainfall characteristics in its inland river systems'.

Boat-days. A measure of fishing effort. Refers to the number of 'days' that a fishing licence holder is permitted to fish/has fished.

Bycatch. A species that is (a) returned to the sea either because it has no commercial value or because regulations preclude it being retained, or (b) is affected by interaction with the fishing gear, but does not reach the deck of the fishing vessel.

Bycatch reduction device (BRD). A device that allows fish and other animals to escape immediately after being taken in or with fishing gear.

Byproduct. A species taken incidentally in a fishery during fishing for another species. The species is retained for sale because it has some commercial value.

C

Carapace. The exoskeleton covering the upper surface of the body of a crustacean.

Catch per unit effort (CPUE). The number or weight of fish caught by a unit of fishing effort. Often used as a measure of fish abundance.

Catch rate. *See* Catch per unit effort.

Coastal waters. The waters extending seaward from the territorial sea baseline to a distance of 3 nautical miles. The states and the Northern Territory have jurisdiction over the coastal waters adjacent to them.

Codend. The closed end of a trawl net.

Cohort. Individuals of a stock born in the same spawning season.

Conservation dependent species. The *Environment Protection and Biodiversity Conservation Act 1999* dictates that a native species is eligible to be included in the conservation dependent category at a particular time if, at that time, (a) the species is the focus of a specific conservation program the cessation of which would result in the species becoming vulnerable, endangered or critically endangered; or (b) the following subparagraphs are satisfied: (i) the species is a species of fish; (ii) the species is the focus of a plan of management that provides for management actions necessary to stop the decline of, and support the recovery of, the species so that its chances of long-term survival in nature are maximised; (iii) the plan of management is in force under a law of the Commonwealth or of a state or territory; and (iv) cessation of the plan of management would adversely affect the conservation status of the species.

Continental shelf. The continental shelf has been defined in a number of ways. It can mean the area of relatively shallow water that fringes a continent from the shoreline to the top of the continental slope. The top of the continental slope is often defined by the 200 m isobath. Continental shelf is also a defined maritime zone and comprises the continental shelf where it extends beyond the limit of the Exclusive Economic Zone to the limit of the continental margin. This area is also sometimes referred to as the 'extended continental shelf', and its limit is determined by the United Nations Commission on the Limits of the Continental Shelf.

Continental slope. Region of the outer edge of a continent between the relatively shallow continental shelf and the abyssal depths; often characterised by a relatively steep slope.

Cryptic mortality. Substantial mortality of a fish stock, occurring in part of the fishery, that cannot be detected in fishery data.

D

Decision rules. Agreed responses that management must make under predefined circumstances regarding stock status. Also called 'control rules' or 'harvest control rules'.

Demersal. Found on or near the benthic habitat (*c.f.* Pelagic).

Developmental fishery. A fishery managed under developmental fishery permits. Developmental fishing involves fishing in an area of Australian jurisdiction as specified in the permit; activities include (a) assessing the commercial viability of a fishery, and (b) assessing the commercial viability of kinds of fishing activities, vessels or equipment specified in the permit.

Discarding. Any part of the catch that is returned to the sea, whether dead or alive.

E

Ecologically sustainable. 'Use of natural resources within their capacity to sustain natural processes while maintaining the life-support systems of nature and ensuring that the benefit of the use to the present generation does not diminish the potential to meet the needs and aspirations of future generations'.

Ecological risk assessment. A process of estimating the effects of human actions on a natural resource.

Ecologically sustainable development (ESD). ESD principles require that:

- decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equity considerations
- if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation
- the principle of inter-generational equity: that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations
- the conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making and
- improved valuation, pricing and incentive mechanisms should be promoted.

Ecosystem. A complex of plant, animal and microorganism communities that, together with the nonliving components, interact to maintain a functional unit.

Effort. A measure of the resources used to harvest a fishery's stocks. The measure of effort appropriate for a fishery depends on the methods used and the management arrangements. Common measures include the number of vessels, the number of hooks set, and the number of fishing days or nights.

Effort restriction. Restriction of the permitted amount of fishing effort (for example, the total number of hooks) in a particular fishery; used as a management tool.

Endangered species. Species in danger of extinction because of its low numbers or degraded habitat, or likely to become so unless the factors affecting its status improve. The *Environment Protection and Biodiversity Conservation Act 1999* dictates that a native species is eligible to be included in the endangered category at a particular time if, at that time, (a) it is not critically endangered, and (b) it is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.

Endemic species. Species that occurs naturally and exclusively in a given place.

Environmentally limited. The agreed national reporting framework for the *Status of key Australian fish stocks reports* defines the term 'overfished stock' as follows: Spawning stock biomass has been reduced to the point where average recruitment levels are significantly reduced, primarily as a result of substantial environmental changes/impacts or disease outbreaks (i.e. the stock is not recruitment overfished). Fisheries management has responded appropriately to the environmental change in productivity.

***Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).** Australia's national environment law. The legislation focuses on protecting matters of national importance, such as World Heritage sites, national heritage places, wetlands of international importance (Ramsar wetlands), nationally threatened species and ecological communities, migratory species, Commonwealth marine areas and nuclear actions.

Escapement. The number, expressed as a percentage, of fish that survive a particular event (for example, predation, natural mortality, fishing mortality), often to spawn.

Exclusive Economic Zone (EEZ). The area that extends from the limit of the territorial sea, which is 12 nautical miles offshore from the territorial sea baseline, to a maximum of 200 nautical miles, measured from the territorial sea baseline. The EEZ is less than 200 nautical miles in extent where it coincides with the EEZ of another country. In this case, the boundaries between the two countries are defined by treaty. Australia has sovereign rights and responsibilities over the water column and the seabed in its EEZ, including the exploration and exploitation of natural resources.

Exploitation rate. The fraction of total animal deaths caused by fishing, usually expressed as an annual value. Can also be defined as the proportion of a population caught during a year.

F

Fecundity. Number of eggs an animal produces each reproductive cycle; the potential reproductive capacity of an organism or population.

Fishery-dependent data (survey). Data collected directly on a fish or fishery from commercial fishers, processors and retailers. Common methods include logbooks, fishery observers and port sampling (*c.f.* Fishery-independent data [survey]). More difficult to interpret than fishery-independent data because the fishery-dependent data are influenced by fishers' attempts to maximise economic returns.

Fishery-independent data (survey). Data collected by systematic survey, carried out by research vessels or contracted commercial fishing vessels, to gather information independently of normal commercial fishing operations.

Fishing effort. Amount of fishing taking place, usually described in terms of gear type, and the frequency or period of operations (for example, hooks, trawl hours, net length).

Fishing mortality (F). The instantaneous rate of fish deaths due to fishing a designated component of the fish stock. F reference points may be applied to entire stocks or segments of the stocks, and should match the scale of management unit. Instantaneous fishing mortality rates of 0.1, 0.2 and 0.5 are equivalent to 10 per cent, 18 per cent and 39 per cent, respectively, of deaths of a stock due to fishing. *See also* Mortality, Natural mortality (M).

Fishing power. Effectiveness of a vessel's fishing effort relative to that of other vessels or in other periods of time. Also used to describe the average fishing mortality per unit of effort of a fishing fleet—this often tends to increase with time as a result of improvements in technology and fisher knowledge.

Fishing season. The period during which a fishery can be accessed by fishers. Sometimes referred to as fishing year.

Fishing year. *See* Fishing season.

Fork length (FL). Length of a fish measured as the distance between the tip of the snout and the point of the fork or 'V' of the tail. Commonly used to record the length of commercial fish because it is little affected by damage to the tail fin (*c.f.* Total length). Fork length is measured flat, from point to point, not by stretching a tape along the body surface, which would result in a longer measurement for full-bodied fish like tuna. *See also* Lower-jaw fork length.

G

Gear restriction. Restriction on the amount and/or type of fishing gear that can be used by fishers in a particular fishery; used as a management tool.

Generation time. Average time taken for an individual animal to replace itself in a population.

Ghost fishing. Capture of fish in gear—usually nets or traps—that has been lost.

Gross value of production (GVP). A value obtained by multiplying the volume of catch (whole weight equivalent) by the average per unit beach price. In the case of a multispecies fishery, the fishery's GVP is the sum of the GVP of each species.

H

Harvest control rules. See Decision rules.

Harvest strategy. A set of management actions necessary to achieve defined biological and economic objectives in a given fishery.

High seas. Waters outside national jurisdictions (that is, outside Exclusive Economic Zones).

Hyperstability. A relationship between catch per unit effort (CPUE) and abundance in which, initially, CPUE declines more slowly than true abundance.

I

Incidental catch. *See* Bycatch

Index of abundance. Relative measure of the abundance of a stock (for example, catch per unit of effort).

Index of annual recruitment. Estimate of the relative number of individuals entering the fishery each year, usually based on a data source dedicated to the purpose.

Individual transferable effort (ITE). Shares of a total allowable effort that are allocated to individuals. They can be traded permanently or temporarily. Analogous to individual transferable quotas in a fishery managed with a total unit allowable catch. Usually issued at the start of a fishing season.

Individual transferable quota (ITQ). Management tool by which portions of the total allowable catch quota are allocated to fishers (individuals or companies). The fishers have long-term rights over the quota, but can trade quota with others. *See also* Quota.

Input controls. Management measures that place restraints on who fishes (licence limitations), where they fish (closed areas), when they fish (closed seasons) or how they fish (gear restrictions).

Inshore waters. Waters of the shallower part of the continental shelf, usually less than 3 nautical miles from the coast.

Intrinsic productivity. The natural rate of growth of a population, measured as births minus deaths per capita in the absence of environmental constraints on population increase.

J

Joint authority. An Offshore Constitutional Settlement arrangement whereby a fishery is managed jointly by the Australian Government and one or more states or territories under a single (Commonwealth, or state or territory) jurisdiction.

K

Key commercial species. A species that is, or has been, specifically targeted and is, or has been, a significant component of a fishery.

Key threatening process. The *Environment Protection and Biodiversity Conservation Act 1999* defines a key threatening process as a process that threatens the survival, abundance or evolutionary development of a native species or ecological community, requiring the formal development of a threat abatement plan. A threatening process is eligible to be treated as a key threatening process if (a) it could cause a native species or an ecological community to become eligible for listing in any category, other than conservation dependent, or (b) it could cause a listed threatened species or a listed threatened ecological community to become eligible to be listed in another category representing a higher degree of endangerment, or (c) it adversely affects two or more listed threatened species (other than conservation dependent species) or two or more listed threatened ecological communities.

L

Latency. Fishing capacity that is authorised for use but not currently being used. Depending on how a fishery is managed, latency might appear in effort (for example, unused vessel statutory fishing rights [SFRs], gear SFRs, quota SFRs, permits or nights fishing) or in quota (for example, where total allowable catches [TACs] are not fully caught in a quota-managed fishery). It is a low-cost indicator of fishers' views about the profitability of a fishery. High levels of latency can suggest that low expected profits in the fishery do not justify fishing. It is likely that fisheries in which latency exists are close to the open-access equilibrium. Apart from being an indicator of efficiency, a high level of latency in a fishery may be detrimental to the fish stock and to any chances the fishery has of being profitable in the future. For example, a significant increase in the market price of a fishery's product is likely to entice inactive effort into the fishery. In input-controlled fisheries, if enough inactive effort is triggered, the fish stock could be jeopardised and/or profits dissipated as soon as they arise if the fishery is driven to a point of open-access equilibrium. In an output-controlled fishery, this is less of a problem, provided that TACs are set in accordance with appropriate targets.

Limited-entry fishery. Fishery in which the fishing effort is controlled by restricting the number of operators. Usually requires controlling the number and size of vessels, the transfer of fishing rights and the replacement of vessels (*c.f.* Open-access fishery).

Logbook. Official record of catch-and-effort data completed by fishers. In many fisheries, a licence condition makes the return of logbooks mandatory.

M

Mark–recapture. A method for estimating population size and other parameters by tagging and releasing fish, and comparing the ratios of marked (tagged) to unmarked (untagged) individuals in future catches.

Maximum economic yield (MEY). The sustainable catch level for a commercial fishery that allows net economic returns to be maximised. For most practical discount rates and fishing costs, MEY implies that the equilibrium stock of fish is larger than that associated with maximum sustainable yield (MSY). In this sense, MEY is more environmentally conservative than MSY and should, in principle, help protect the fishery from unfavourable environmental impacts that could diminish the fish population.

Maximum sustainable yield (MSY). The maximum average annual catch that can be removed from a stock over an indefinite period under prevailing environmental conditions. MSY defined in this way makes no allowance for environmental variability, and studies have demonstrated that fishing at the level of MSY is often not sustainable.

Migration. Non-random movement of individuals of a stock from one place to another, often in groups.

Minimum size (minimum legal size). Size below which a captured animal may not legally be retained. Usually specified by species. May be varied as a management tool.

Model (population). Hypothesis of how a population functions; often uses mathematical descriptions of growth, recruitment and mortality.

Mortality. Deaths from all causes (usually expressed as a rate or as the proportion of the stock dying each year).

Multispecies fishery. A fishery in which fishers' profits depend on the catch of more than one species. Fishery data from multispecies fisheries are more difficult to interpret because of uncertainty around the relative targeting of individual species.

N

Natural mortality (M). Deaths of fish from all natural causes except fishing. Usually expressed as an instantaneous rate or as a percentage of fish dying in a year. *See also* Fishing mortality (F), Mortality.

Nautical mile (nm). A unit of distance derived from the angular measurement of one minute of arc of latitude, but standardised by international agreement as 1852 metres.

Nominal catch. The sum of the catches that are landed (expressed as liveweight equivalent). Nominal catches do not include unreported discards.

Non-target species. Species that is unintentionally taken by a fishery or not routinely assessed for fisheries management. *See also* Bycatch, Byproduct.

O

Observer. A certified person on board fishing vessels who collects scientific and technical information for the management authority on the fishing operations and the catch. Observer programs can be used for monitoring fishing operations (for example, areas fished, fishing effort, gear characteristics, catches and species caught, discards, collecting tag returns). Observers may or may not have legal coercion powers, and their data may or may not be used for nonscientific purposes (for example, enforcement), depending on the situation.

Oceanic. Open-ocean waters beyond the edge of the continental shelf.

Offshore Constitutional Settlement (OCS). The 1982 package of uniform national, state and territory laws that forms the basis for Australian governments (national, state and territory) to enter into agreements for specified fisheries to be managed by a particular government or group of governments. A fishery might be managed by the Australian Government, one or more state or territory governments, or any combination of the two acting through a joint authority. Fisheries for which OCS arrangements are not in place may be managed under joint control or continue under current management arrangements.

Open-access fishery. Fishery in which there is no limit on the number of operators or vessels allowed to operate in the fishery (*c.f.* Limited-entry fishery). Such a fishery is liable to suffer the 'tragedy of the commons', where a 'race to fish' generally leaves a fish stock below its maximum sustainable yield and unable to support an economically sustainable fishery. Under open access, a fishery operates with a harvest and effort that result in total revenue-equalling costs, with no economic profits being generated. The fishing effort employed at this point exceeds the level that would achieve maximum economic yield.

Otoliths. Bone-like structures formed in the inner ear of fish. The rings or layers can be counted to determine age.

Otolith microchemistry. A technique used in fisheries management and fisheries biology to delineate stocks, and characterise movements and natal origin of fish.

Output controls. Management measures that place restraints on what is caught, including total allowable catch, quota, size limits and species.

Overfished stock. The agreed national reporting framework for the *Status of key Australian fish stocks reports* defines the term 'overfished stock' as follows: Spawning stock biomass has been reduced through catch, so that average recruitment levels are significantly reduced (i.e. recruitment overfished). Current management is not adequate to recover the stock, or adequate management measures have been put in place but have not yet resulted in measurable improvements.

Ovigerous. Carrying or bearing eggs.

P

Panmictic. A panmictic population is one where all individuals have equal opportunity of mating. This assumes that there are no mating restrictions, either genetic or behavioural, on the population.

Pelagic. Inhabiting surface waters rather than the sea floor. Usually applied to free-swimming species such as tunas and sharks (*c.f.* Demersal).

Performance indicator (performance measure). Parameter used to assess the performance of a fishery against predetermined sustainability objectives.

Planktonic larval stage. An early life stage of many marine organisms, when larvae are dispersed in the water column before settling on suitable habitat and developing into their adult form.

Population modelling. Mathematical description of a population that is designed to fully simulate the life cycle of animals in that population. Can project the effects on the population of environmental factors or biological characteristics of these animals.

Possession limit. The maximum number of fish that a person is allowed to have in their possession at any time. It discourages the accumulation of large quantities of fish by recreational fishers.

Precautionary approach. Approach to fisheries management where the absence of adequate scientific information should not be used as a reason for postponing or failing to take measures to conserve target species, associated or dependent species and non-target species and their environment.

Pre-recruits. The proportion of a population that has not yet entered a fishery (that is, not able to be caught or retained).

Productivity (biological). An indication of the birth, growth and death rates of a stock. A highly productive stock is characterised by high birth, growth and mortality rates, and can sustain high harvesting rates.

Productivity (economic). The ability of firms or an industry to convert inputs (labour, capital, fuel, etc.) into output. Economic productivity is often measured using productivity indexes, which show whether more or less output is being produced over time with a unit of input. The index is calculated by comparing changes in total output (fish) to changes in total inputs such as fuel, labour and capital.

Protected species. As per the meaning used in the *Environment Protection and Biodiversity Conservation Act 1999*.

Q

Quota. Amount of catch allocated to a fishery as a whole (total allowable catch), or to an individual fisher or company (individual transferable quota).

Quota species. Species for which catch quotas have been allocated.

R

Recruit. Usually, a fish that has just become susceptible to the fishery. Sometimes used in relation to population components (for example, a recruit to the spawning stock).

Recruitment failure. A situation in which a population is not able to naturally produce viable offspring as a consequence of physical factors (for example, damaged spawning areas) or biological factors (for example, inadequate numbers of fish).

Recruitment overfished. The point at which a stock is considered to be recruitment overfished is the point at which the spawning stock biomass has been reduced through catch, so that average recruitment levels are significantly reduced.

Recruitment overfishing. A level of exploitation that, if maintained, would result in the stock falling to levels at which there is a significant risk of recruitment and stock collapse. The corresponding term for the state of the stock is 'recruitment overfished', in which the average annual recruitment to the stock is significantly reduced. Both terms define a limit reference point (for exploitation rate or stock size) beyond which urgent management action should be taken to reduce exploitation and recover the stock.

The following uses of the term provide some guidance to how it should be interpreted and applied.

The FAO fisheries glossary (**www.fao.org/fi/glossary/default.asp**) defines recruitment overfished as 'a situation in which … annual recruitment … has become significantly reduced. The situation is characterized by a greatly reduced spawning stock, a decreasing proportion of older fish in the catch, and generally very low recruitment year after year'.

Cook[a] defines recruitment overfished as a situation in which 'a reduction in the proportion of fish caught would be more than compensated for by the increased number of recruits to the fishery as a result of increased escapement of mature fish'.

The EPBC *Guidelines for the ecologically sustainable management of fisheries*[b] define recruitment overfishing as occurring 'where fishing activities are causing a reduction in recruitment in succeeding years and cause the mortality of too many fish in total, too many pre-productive fish, or too many fish that have only spawned a few times. The end result is that the stock can no longer replenish itself adequately'.

Various jurisdictions have defined a biomass limit reference point (B_{LIM}) that also corresponds to this concept of recruitment overfishing. These limit reference points (LRPs) are often related to the biomass at which maximum sustainable yield (MSY) occurs. Examples of LRPs include the following:

$B_{LIM} = 0.5B_{MSY}$ (Commonwealth of Australia).
$B_{LIM} = 0.5B_{MSY}$ (or greater) (United States).
B_{LIM} is usually defined relative to fishing mortality rates rather than biomass (European Union).
$B_{LIM} = 0.5B_{MSY}$ (or greater—for example, for forage fish) (Marine Stewardship Council).

New Zealand explicitly uses the concept of recruitment overfishing, which is defined as occurring 'when excessive fishing effort or catch reduces the spawning stock biomass to a level below which future recruitment levels may be jeopardised; this spawning biomass level should correspond closely to the biomass limit reference point'.

No jurisdictions appear to have explicitly defined how much recruitment would be reduced to constitute recruitment overfishing, perhaps because recruitment tends to fluctuate much more than overall stock biomass.

Reference point. Indicator of the level of fishing (or stock size); used as a benchmark for assessment (*see also* Biological reference point).

Relative abundance. The number of living individuals at a point in time, expressed as a fraction of the average number of living individuals estimated before the beginning of fishing.

Risk analysis. Analysis that evaluates the possible outcomes of various harvesting strategies or management options.

[a] Cook, JG 1984, Glossary of technical terms, in RM May (ed.), *Exploitation of marine communities*, Springer-Verlag, Berlin, 341–348.
[b] Australian Government Department of the Environment and Water Resources 2007, *Guidelines for the ecologically sustainable management of fisheries*, 2nd edn, DEWR, Canberra.

S

Seasonal closure. Closure of a fishing ground for a defined period; used as a management tool, often to protect a particular component of the stock.

Settlement. Transition from a pelagic larval stage to a substrate-associated juvenile or adult existence.

Shared biological stock. A biological stock that spans the waters of more than one jurisdiction.

Shark finning. The removal and retention of shark fins. The remainder of the body is generally discarded, often still alive. The process has been banned in Australian waters, and management measures are in place to reduce or restrict targeting of sharks for fin markets by illegal, unreported and unregulated fishing.

Size frequency. *See* Length-frequency distribution.

Spatial closure. A method of fisheries management that prevents fishing in a defined area.

Spawning biomass (SB). The total weight of all adult (reproductively mature) fish in a population.

Species complex. Group of similar species that are often difficult to differentiate without detailed examination.

Species group. *See* Species complex.

Standardised data. Data that have been adjusted to be directly comparable to a unit that is defined as the 'standard' one. Standardised catch-per-unit-effort data are often used as an indicator of fish abundance.

Standard length (SL). The length of a fish measured from the tip of the snout to the posterior end of the last vertebra or to the posterior end of the midlateral portion of the hypural plate.

Statutory fishing right (SFR). Right to participate in a limited-entry fishery. An SFR can take many forms, including the right to access a particular fishery or area of a fishery, the right to take a particular quantity of a particular type of fish, or the right to use a particular type or quantity of fishing equipment.

Stochastic demographic modelling. Stock assessment method used to estimate the intrinsic productivity and response to fishing of fish stocks, based on age structure, allowing for variation in annual recruitment. Mostly used for stock assessment of shark species.

Stock. Within the *Status of key Australian fish stocks reports*, the term 'stock' is used generically in reference to all three levels of stock status assessment—that is, biological stocks, management units and populations assessed at the jurisdictional level. *See also* Biological stock.

Stock–recruitment relationship. Relationship between the size of the parental biomass and the number of recruits it generates. Determination of this relationship is difficult, and involves studying the population's size–age composition, and growth and mortality rates.

Stock reduction analysis. A method of inferring the extent to which a fisheries stock is likely to have been reduced by fishing, assuming constant recruitment. Requires only a time series of total catch data, but can also incorporate other information.

Stock synthesis model. A statistical framework for calibration of a population dynamics model, using a range of fishery and survey data. It is designed to accommodate both age and size structure in the population, and multiple stock subareas. Selectivity can be cast as age specific only, size specific in the observations only, or size specific with the ability to capture the major effect of size-specific survivorship. The overall model contains subcomponents that simulate the population dynamics of the stock and fisheries, derive the expected values for the various observed data, and quantify the magnitude of difference between observed and expected data.

Sustainable stock. The agreed national reporting framework for the *Status of key Australian fish stocks reports* defines the term 'sustainable stock' as follows: Stock for which biomass (or biomass proxy) is at a level sufficient to ensure that, on average, future levels of recruitment are adequate (that is, not recruitment overfished) and for which fishing pressure is adequately controlled to avoid the stock becoming recruitment overfished.

T

Tagging. Marking or attaching a tag to an animal so that it can be identified when recaptured; used to study fish growth, movement, migration, stock structure and size.

Target fishing (targeting). Fishing selectively for particular species or sizes of fish.

Target species. *See* Key commercial species.

Temporal closure. Closure that is implemented to protect fish stocks during specific stages of their life cycle (for example, while spawning).

Territorial sea (12 nautical mile limit). 'The Territorial Sea is a belt of water not exceeding 12 nautical miles in width measured from the territorial sea baseline. Australia's sovereignty extends to the territorial sea, its seabed and subsoil, and to the air space above it. This sovereignty is exercised in accordance with international law as reflected in the Convention on the Law of the Sea.

The major limitation on Australia's exercise of sovereignty in the territorial sea is the right of innocent passage for foreign ships. The territorial sea around certain islands in the Torres Strait is 3 nautical miles'[c].

Territorial sea baseline. The baseline from which all the zones (for example, the Exclusive Economic Zone) of Australia's maritime jurisdiction are measured. The baseline is defined as the level of lowest astronomical tide, but straight baselines and bay or river closing lines may be drawn further out from the low-water mark to encompass areas such as the mouths of rivers, bays, ports and fringing reefs.

Threatened species. As per the meaning used in the *Environment Protection and Biodiversity Conservation Act 1999*.

Total allowable catch (TAC). For a fishery, a catch limit set as an output control on fishing (*see also* Output controls). Where resource-sharing arrangements are in place between commercial and recreational fishers, the term total allowable commercial catch (TACC) applies. The term 'global' is applied to TACs that cover fishing mortality from all fleets, including Commonwealth, state and territory fleets.

Total allowable catch (TAC), actual. The agreed TAC for the species with amendments applied, such as carryover or debits from the previous year.

Total allowable commercial catch (TACC). *See* Total allowable catch (TAC).

Total allowable effort (TAE). An upper limit on the amount of effort that can be applied in the fishery.

Total length (TL). The length from the tip of the snout to the tip of the longer lobe of the caudal fin, usually measured with the lobes compressed along the midline. It is a straight-line measure, not measured over the curve of the body (*c.f.* Fork length).

Transitional–depleting stock. The agreed national reporting framework for the *Status of key Australian fish stocks reports* defines the term 'transitional–depleting stock' as follows: A deteriorating stock—biomass is not yet recruitment overfished, but fishing pressure is too high and moving the stock in the direction of becoming recruitment overfished.

[c] Geoscience Australia 2012, *Maritime boundary definitions*, Geoscience Australia, Canberra, **www.ga.gov.au/marine/jurisdiction/maritime-boundary-definitions.html.**

Transitional–recovering stock. The agreed national reporting framework for the *Status of key Australian fish stocks reports* defines the term 'transitional–recovering stock' as follows: A recovering stock—biomass is recruitment overfished, but management measures are in place to promote stock recovery, and recovery is occurring.

Trigger points. Pre-specified quantities (total catch, spawning biomass, etc.) that indicate the need for a review of fishery management.

U

Undefined stock. The agreed national reporting framework for the *Status of key Australian fish stocks reports* defines the term 'undefined stock' as follows: Not enough information exists to determine stock status.

Unfished biomass. Biomass of a stock that has not been fished (also called the 'unfished' or 'unexploited' biomass or unfished level).

V

Vessel monitoring system (VMS). Electronic device that transmits the identity and location of a vessel.

Virgin biomass. *See* Unfished biomass.

Vulnerable species. Species that will become endangered within 25 years unless mitigating action is taken. *See also* Endangered species. The *Environment Protection and Biodiversity Conservation Act 1999* dictates that a native species is eligible to be included in the vulnerable category at a particular time if, at that time (a) it is not critically endangered or endangered, and (b) it is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.

W

Warp strike. Incident of seabirds striking trawl gear while interacting with fishing activity. Often results in mortality.

Weight-of-evidence approach. The systematic consideration of a range of biological and fisheries information for assembly and review of indicators of biomass status and levels of fishing mortality, to support a status determination. Lines of evidence used in the weight-of-evidence approach include empirical indicators (catch, effort, catch rate, size- or age-based indicators, spatial and temporal distribution of the fishery), risk assessments, fishery-independent surveys, quantitative stock assessment models and harvest strategies.

Y

Yield. Total weight of fish harvested from a fishery.

Yield-per-recruit analysis. Analysis of how growth and natural mortality interact to determine the best size of animals to harvest; for example, it may be more economically beneficial to catch fish when they are young and plentiful, or when they are older and larger but fewer. Biological reference points based on yield-per-recruit analysis will be expected to lack precaution because the potential for reduced future recruitment resulting from decreased parental biomass is not considered.