Fishery Report No. 106

Fishery Status Reports 2010

November 2011

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GPO Box 3000
Darwin NT 0801
AUSTRALIA

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November 2011

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Northern Territory Government (2011). Fishery Status Reports 2009. Northern Territory Government Department of Resources. Fishery Report No. 106.

Fishery Report No. 106
ISSN 1832-7818

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INTRODUCTION

The Northern Territory is fortunate to have a large coastline with a comparatively small population, resulting in a relatively pristine marine environment and healthy fish stocks.

The Northern Territory Government is committed to the ecologically sustainable development of our fisheries and aquatic resources. A wide range of users depend upon or enjoy the healthy state of our fisheries. Many Aboriginal communities have strong customary links with our aquatic environments and rely on fish for food, culture and potential economic development opportunities. Our commercial fisheries provide valuable supplies of high quality seafood such as mud crab, tropical snappers, barramundi, shark and mackerel to restaurants and retail markets. Recreational fishing is an intrinsic part of the Territory lifestyle and quality fishing experiences attract visitors to the Territory and also support a growing fishing tour operator industry.

The government continues to support and assist the development of the Territory's aquaculture industry through difficult economic times. New and innovative aquaculture projects are also being actively explored in partnership with local companies and remote Indigenous communities. Recent advances in culture methods for sea cucumbers, giant clams and tropical rock oysters have been encouraging with some of these projects moving to pilot scale trials at Groote Eylandt and Goulburn Island.

The Fisheries Division of the Department of Resources (DoR) works in partnership with all of the fishing industry sectors to assist wild fisheries and aquaculture development and facilitate access and sharing of fish resources between Aboriginal, recreational and commercial users. We also work closely with the Water Police Unit of NT Police, Fire and Emergency Services which delivers fisheries compliance and enforcement programs. Community Marine Ranger groups also play a valuable role in monitoring our fisheries and coastlines.

This report summarises the Fisheries division's activities during 2010, including an assessment of the status of our fish stocks and management directions in each of our fisheries.

These summaries confirm that overall, NT fisheries are in a healthy condition with governance structures in place to ensure their development in a ecologically sustainable manner. Nonetheless, careful management is still required if we are to ensure optimum use of our fish and aquatic resources, particularly in high use areas around population centres.

I would like to thank all fisheries staff who have contributed to this annual assessment of the status of our fisheries and those indigenous, commercial and recreational stakeholders who have assisted in our fisheries monitoring, research and management programs.

Ian Curnow
Executive Director, Fisheries

NT FISHERIES – 2010 HIGHLIGHTS AND 2011 PRIORITIES

DEVELOPING FISHERIES WHILST MAINTAINING ECOLOGICAL VALUES

Highlights

To better utilise the offshore snapper stocks, an Individual Transferable Quota was implemented in the Timor Reef Fishery.

A proposed new management framework was developed for Demersal and Finfish Trawl fisheries for consideration by the Northern Territory (NT) Fishery Joint Authority.

The Aquarium and Trepang fisheries were re-accredited under Australia's *Environment Protection and Biodiversity Conservation Act.*

Consultations were commenced with stakeholders on the future management of inshore coastal species.

An analysis was commenced of recreational fishing survey results.

New recreational fishing controls were implemented for barramundi and cherabin in the Mary and Daly rivers.

The Fisheries Research and Development Corporation's (FRDC) project with Queensland Fisheries on determining the stock structure of threadfin was completed. Several scientific papers were also published from this research.

The FRDC's project with Queensland Fisheries on sustaining productivity of tropical red snappers was completed.

The feasibility of introducing electronic fishery monitoring methods in the Timor Reef Fishery was assessed.

A discussion paper on proposed amendments to the *Fisheries Act* was released for public comment.

A project assessing the ability of escape vents to improve gear selectivity of mud crab fisheries was funded by FRDC.

Priorities

Implement a new management framework for the Demersal and Finfish Trawl fisheries.

Develop new management arrangements in the Coastal Line and Spanish mackerel fisheries to better control catches of targeted species.

Finalise re-accreditation of the Offshore Net and Line Fishery under Australia's *Environment Protection and Biodiversity Conservation Act.*

Complete a review of the Fishing Tour Operator industry to promote its development.

Implement legislation to further enhance the protection of threatened, endangered and protected species.

Assess the status of key NT fish species, including barramundi, mud crab, golden snapper and black jewfish.

Develop a three-to-five-year strategic fisheries research plan.

Complete legislative amendments to the *Fisheries Act*.

SHARING FISH RESOURCES BETWEEN THE INDIGENOUS, RECREATIONAL AND COMMERCIAL SECTORS

Highlights

The Barramundi Fishery Management Advisory Committee was re-established to provide advice on the future management of the fishery.

A partnership was established on Groote Eylandt to trial sea-based trepang aquaculture.

Negotiations were conducted with Aboriginal Land Councils for a practical outcome to the Blue Mud Bay decision.

Priorities

Establish an Indigenous Fisheries Network in the East Arnhem region to promote and support the development of Indigenous fisheries and aquaculture-related businesses and activities.

Explore the potential for the establishment of an inshore fishery targeting small species, such as pilchards and herring, which would directly benefit Indigenous communities, with the first stage of the project determining suitability and abundance of fish stocks in regional areas.

Continue to progress and facilitate opportunities for Indigenous economic development with respect to fisheries and aquaculture projects.

Develop resource-sharing arrangements that ensure the equitable use of barramundi stocks by all fishers.

Publish recreational fishing survey results and review the appropriateness of existing recreational fishing controls.

Continue to assist in negotiations with Aboriginal land councils for a practical outcome to the Blue Mud Bay decision.

PROTECTING AQUATIC ECOSYSTEMS FROM PESTS AND DISEASES

Highlights

A marine pest survey of Darwin Harbour was completed according to national standards as part of the National System for the Prevention and Management of Marine Pest Incursions (NSPMMPI).

Aquatic biosecurity procedures were documented, including emergency response protocols.

A more cost-effective aquatic biosecurity vessel inspection program was implemented, which is underpinned by a stringent risk management approach.

The NT's marine pest monitoring program was implemented.

Aquatic biosecurity procedures were documented, including emergency response protocols.

Priorities

Continue to implement NSPMMPI.

Continue to monitor for marine pests, including on vessels, in accordance with vessel inspection protocols.

ASSISTING IN THE DEVELOPMENT OF THE AQUACULTURE INDUSTRY

Highlights

Produced and sold over 1 million barramundi fingerlings to barramundi farmers.

Produced juvenile giant clams in partnership with the aquarium industry.

Assisted the industry to improve the production of juvenile sea cucumbers.

Collaborated with international researchers on sea-cucumber ranching.

Participated with Aboriginal rangers to trial grow-out of giant clams at sea.

Commenced sea-based feasibility trials with Aboriginal communities for sea-cucumber ranching.

Conducted a feasibility study for the culture of edible oysters at the Tiwi Islands.

Priorities

Continue to produce juvenile barramundi to assist the industry's expansion.

Cooperate with a remote Aboriginal school that is attempting to engage children in aquaculture.

Maintain strong research partnerships with existing and emerging aquaculture industries.

Maintain a responsive and effective aquatic animal health diagnostic service.

Ensure all aquaculture programs and services are aligned with the industry's priorities.

Participate with Indigenous communities to conduct pilot programs for sea farming in remote locations.

Identify and address constraints to involvement by Aboriginal people in aquaculture.

Ensure the NT's aquaculture industry operates in accordance with relevant environmental management plans.

PROMOTE THE AVAILABILITY OF FISHING FACILITIES AND ACCESS OPPORTUNITIES

Highlights

Completed a $4 million upgrade to the Palmerston boat ramp. Upgrades to Leaders Creek, Gove, King Ash Bay, Corroboree Billabong and Adelaide River boat ramps.

Expanded the NT's artificial reef network at Lee Point and Fenton Patches to enhance recreational fishing.

Priorities

Continue upgrades of recreational fishing infrastructure across the NT, including works at Corroboree Billabong, Hardies Lagoon, Saltwater Arm, Middle Arm, Southport Boat Ramp, Buffalo Creek and Milne Inlet.

Release the draft Recreational Fishing Development Plan for public comment.

Investigate the implementation of Fish Attracting Devices for pelagic species.

Explore opportunities to negotiate recreational fishing access through pastoral and Indigenous land.

COMMERICAL WILD HARVEST

AQUARIUM FISHERY STATUS REPORT 2010

INTRODUCTION

The Northern Territory (NT) Aquarium Fishery is a small-scale, multi-species fishery operating in fresh water, coastal and oceanic waters, extending to the outer boundary of the Australian Fishing Zone (AFZ).

The fishery is based on the harvest of a wide range of fish, plant and coral species from freshwater and marine environments for the purposes of display. Most of the product is sold to interstate distributors.

The fishery harvest up to now has been small by national and international standards, both in numbers and value. However, the demand for aquarium species continues to increase. In 2008, it was made possible for licences in the fishery to be transferred either permanently or temporarily, which enabled new operators to enter the fishery. Harvesting techniques, and transport and packaging have improved significantly over the past 10 to 15 years, enabling the industry to provide a quality product to a growing interstate market and potential export markets.

The NT Aquarium Committee (NTAC), which is the peak body representing licensees of the NT Aquarium Fishery, works with the Department of Resources (DoR) to determine future development opportunities and management arrangements for the fishery within the principles of ecologically sustainable development (ESD).

A report was submitted to the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) in 2008 to reassess the management arrangements of the fishery under the Guidelines for the Ecologically Sustainable Management of Fisheries. As a result, the fishery was accredited as a Wildlife Trade Operation (WTO) under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The WTO declaration endorses the export of product from the sustainable fishery for a period of three years. The assessment demonstrated that the fishery was managed in a manner that does not lead to over-fishing, and that fishing operations have minimal impact on the structure, productivity, function and biological diversity of the ecosystem. The Aquarium Fishery is due to be reassessed in 2011.

PROFILE OF THE FISHERY

Commercial Sector

There are three licence categories in the fishery:

- Aquarium Fishing/Display licence (A12), which permits the collection, sale and display of aquarium species. The number of licences is limited to 12.
- Aquarium Trader licence (D3), which permits the sale and trade of aquarium species but does not permit the harvesting of aquarium species. There is no limit on the number of licences, which can be issued.
- Public Aquarium licence (D5), which allows the display of live fish and aquatic life for profit. There is no limit on the number of licences, which can be issued.

Out of the 12 Aquarium Fishing/Display licences permitted in the fishery, eight recorded fishing activity in 2010. Nine new Aquarium Trader licences and two Public Aquarium licences were issued 2010.

Following a review of the fishery in 2004-05, all Aquarium Fishing/Display Fishery licence holders were permitted to collect limited quantities of coral and associated benthic species. However, coral and associated benthic species cannot be collected from Darwin or Gove Harbours. Regional triggers for the harvest of coral and associated benthic species were introduced in 2009 to reduce the likelihood of localised depletion.

The management objectives, performance indicators, performance measures, triggers and management actions used in the fishery are shown in Table 3 along with the harvest status for 2010.

Area

Licensees in the fishery may harvest from all inland, estuarine and marine waters to the outer boundary of the AFZ. However, harvesting is not permitted from a number of 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.

Most freshwater and estuarine species are collected from streams and creeks close to Darwin, and from the Adelaide and Daly river systems. Although commercial harvesting of marine species is concentrated in coastal waters near Nhulunbuy, a small collection also occurs in the greater Darwin area.

Fishing Method

Aquarium Fishing/Display Fishery licensees can use barrier, cast, scoop, drag and skimmer nets, hand pumps, freshwater pots and hand-held instruments to collect aquarium species.

Catch

The quantity of organisms harvested in the fishery is recorded either by weight or number of individuals/pieces. Tables 1 and 2 show the harvest totals for 2010.

Hermit crabs and corals comprised much of the invertebrate harvest in 2010. Approximately 1265 kg of live rock (mostly pieces of dead hard coral that had detached from the reef and had been colonised by other organisms) was taken. Over 145 kg of small shrimp (*Acetes* spp.), which occur in massive numbers at certain times of the year, were harvested. Ninety three giant clams (*Tridacna squamosa*) were also collected, however; the catch of this species is highly regulated (harvest of more than 2000 individuals triggers management action).

Eel-tailed catfish and archerfish were the most popular groups of fishes taken, followed by grunters, gudgeons, and rainbowfish (Table 2). All of the fish harvested in the fishery are widespread and abundant in the NT.

In 2010, 7942 Group A finfish (silver and spotted scats, common archerfish, chequered and black-banded rainbowfish, sailfin perchlet and black catfish) were harvested. The estimated harvest of coral and associated benthic species was 4.5 tonnes, well below the trigger point of 60 tonnes.

Effort

It is difficult to quantify effort in this fishery because of the wide range of species targeted, each with its own specific harvesting technique.

The fishery operates on a small scale, using highly selective harvesting methods. Harvesting is restricted by weather conditions for much of the year and the majority of the harvested species have a wide distribution. These factors, in conjunction with strict controls and low participant numbers, result in minimal fishing effort. The total effort in 2010 was 275 days, almost double the 152 days reported in 2009, but below the 10-year average of 314 days.

Marketing

Advances in affordable aquarium technology have led to increased demand for a wider range of aquarium species by private aquaria, including corals, sponges and live rock, in addition to freshwater fish species. Most of the product harvested by the Aquarium Fishing/Display Fishery licensees is exported interstate by air.

Table 1. Invertebrate species/groups taken by the Aquarium Fishing/Display Fishery in 2010 (number or weight - minimum of 50)

Invertebrate	Harvest
Acetes shrimp	145 kg
Anemones	2209 individuals
Cherabin	212 individuals
Corallimorphs	350 kg / 6371 individuals
Coral other	89 kg / 3934 individuals
Crabs (other than hermit)	398 individuals
Gastropod molluscs (all)	1845 individuals
Giant clams	93 individuals
Hermit crabs	22 104 individuals
Live rock	1265 kg / 14 pieces
Prawns	62 individuals
Red claw crayfish	466 individuals
Shrimp	1151 individuals
All others	75 individuals

Recreational Sector

A prohibition of the recreational harvest of giant clams came into effect on 1 January 2010. Otherwise, there are no specific regulations on collecting fish for personal aquaria other than the recreational fishing rules and regulations regarding minimum sizes and possession limits. For example, recreational aquarium hobbyists may not possess under-size barramundi unless they have proof of purchase from a licensed aquarium trader. Similarly, recreational fishers cannot posses more than 30 fish outside of their place of permanent residence.

Fishing Method

Targeted species may be collected by hand or by using a cast or scoop net, hand pump or a freshwater pot.

Catch

The actual recreational harvesting of aquarium species is not known, but is assumed to be very low. Surveys of recreational fishers in 1995 and 2000-01 reported no aquarium fish being collected, despite the inclusion of a specific question examining this issue (Coleman 1998, Coleman 2004).

Table 2. Fish species/groups numbers taken by the Aquarium Fishing/Display Fishery in 2010 (minimum of 100)

Fish	Harvest (Individuals)
Anemone fish (all)	390
Archerfish (all)	4547
Catfish (other)	977
Eel-tailed catfish (all)	8106
Grunters (all)	2517
Gudgeons (all)	2147
Hardy heads (all)	1715
Mangrove jack	281
Mouth almighty	143
Mudskipper	209
Mullet (all)	315
Nursery fish	110
Puffer fish (all)	492
Rainbowfish (all)	2040
Saratoga	1038
Scats (all)	1434
Sole	307
Spangled perch	352
Tarpon	503
All others	475

Non-retained Species

There is little bycatch taken in the fishery, primarily due to the highly selective fishing methods used and licensing requirements to ensure that all non-target species are immediately returned to the water as soon as practicable with as little damage as possible. Observers from DoR accompanying licensees during their harvesting activities have verified the extremely low bycatch and mortality rate in all species caught within this fishery.

Threatened Species Interaction

The EPBC Act requires fishers to report to SEWPaC within seven days of becoming aware of any interaction with threatened, endangered and protected (TEP) species found in Commonwealth waters.

Hard corals, giant clams and the occasional sawfish (for display purposes) are the only groups of organisms listed on the Convention on International Trade in Endangered Species (CITES) harvested by operators in the fishery. While listed under CITES, low numbers of these species are allowed to be harvested provided their collection is within acceptable sustainability limits for the fishery. Harvest trigger limits for these species are outlined in Table 3. A number of other factors also provide protection for these species, including the extensive area of the fishery, seasonal closures and the wide distribution of the species. No TEP species were harvested in 2010 and there were no reported interactions with TEP species.

Ecosystem Impact

The potential impact of this fishery on the environment is limited due to its small size and the unique climatic and regional characteristics of the NT. Monsoonal weather conditions render large portions of the NT inaccessible or unsafe for several months each year. Furthermore, the biology of many species limits the frequency at which they can be caught in commercially-viable numbers.

The distance between collection sites and population centres imposes economic constraints on aquarium collectors, which has led to a concentrated effort around Darwin and Nhulunbuy. The combination of these factors acts to protect extensive areas of coastline from commercial or recreational exploitation.

Social Impact

The harvesting of coral in areas adjacent to major population centres is an important issue of concern for DoR, due largely to a lack of community awareness regarding the real impacts of coral harvesting. In an effort to minimise social conflict, DoR and NTAC have negotiated the closure of Darwin and Gove Harbours to commercial collection of coral and associated benthic species.

Economic Impact

Based on market sales, the catch value of the fishery was estimated at over $350 000 in 2010.

STOCK ASSESSMENT

Monitoring

Licensees are required to complete and submit monthly logbook returns reporting catch and effort data from their operations. Observer trips are also undertaken when necessary. Monitoring provides significant information on the areas fished and capture methods used. Common aquarium species targeted by licensees at a particular point in time are also identified.

No observer trips were undertaken during 2010. However, future observer monitoring trips will be undertaken periodically to validate logbook data.

Current Harvest Status

The current level of harvest is low and the impact on the resource by commercial operations is considered to be insignificant.

All Aquarium Fishery species/groups were below their total harvest trigger reference points in 2010. However, many of the trigger reference

points relating to the percentage difference between the 2010 catch and the mean of the previous three years' harvest were exceeded, with both large increases and decreases. This type of trigger reference point is of limited biological meaning because it does not take into account variations in the time spent targeting the particular species/group (i.e. fishing effort). Hence, these trigger reference points may fluctuate widely from year to year in response to changes in market demand. For this reason, trigger points will continue to be reviewed.

Future Assessment Needs

Future assessment needs of the Aquarium Fishing/Display Fishery will be driven by the requirements for ESD reporting.

RESEARCH

Summary

The Department of Natural Resources, Environment, The Arts and Sport has been monitoring coral reefs around Nhulunbuy and Cobourg Peninsula for several years. In 2005, Cyclone Ingrid destroyed some regions of reef within the fishery. Bleaching of corals, possibly related to high water temperatures, has also been documented in these reefs (Gomelyuk 2003).

Scientists from the Museum of Tropical North Queensland in Townsville and Kansas State University are currently clarifying the taxonomy and identification of anemones, corallimorphs and hard corals in the Nhulunbuy area, using morphology and genetic techniques.

A project titled 'A Comprehensive Analysis of the Freshwater Fish Faunas and their Key Management Issues across Northern Australia', coordinated by James Cook and Griffith universities with DoR's participation was completed in 2008. The study provided information to map the geographic distribution, biodiversity and habitat requirements of freshwater fish in all major catchments across the NT. The data provided a wealth of information on which to base future decisions regarding the harvest of freshwater fish species.

A pilot study was conducted by DoR in the Darwin area in 2008 on the biology and potential sustainable yield of the land hermit crab (*Coenobitat variabilis*). Tagged empty shells were distributed over a hermit crab habitat to determine if shells were a limiting resource for hermit crabs. A number of hermit crabs were tagged at each site to assess movement and a sample was retained for assessment of fecundity. The results showed that hermit crabs quickly utilised the empty shells that were provided, suggesting that abundance of adults is limited by the number of available shells. In addition, adult hermit crabs showed fairly restricted movement, averaging less than 11 m/day; the largest movement was 70 m/day. Gravid females found during this work typically contained more than 200 eggs. Furthermore, gravid hermit crabs were found between October and February, suggesting that the crabs have a protracted spawning period of at least five months duration.

Current Research

A freshwater fish study was initiated in 2009 at Scott's Creek, approximately 50 km east of Darwin. Water levels fall very low in this creek during the dry season and form a series of isolated pools, many of which dry out towards the end of the season. Electro-fishing was undertaken in 2009 and 2010 in several of these pools to identify the diversity and abundance of fish that are predated upon or killed as the water in the pools evaporates.

MANAGEMENT/GOVERNANCE

Management

Objective

The fishery is managed in accordance with the NT Fisheries Regulations 1993 and conditions of licence. Management objectives, performance indicators, measures, triggers and management actions for the fishery are outlined in Table 3.

Management arrangements for the fishery aim to ensure the ecological sustainability of collected species with minimal impact on TEP species and the aquatic environment. This is achieved through a combination of input and output controls, including catch, area and gear restrictions. Licence conditions stipulate what gear may be used and areas where harvesting is permitted.

The impact on the resource by commercial operations is considered to be relatively insignificant due to the small number of participants, low harvest levels, multiple species targeted, and a large area of habitat available to the species and the selective nature of the fishery. The fishery is also subject to natural seasonal closures.

The recreational capture of marine and freshwater fish and benthic species by hobby aquarists is managed by the same regulations as for recreational fishing, including controlling the gear that may be used, access to areas, and the size and possession limits for managed species.

History

From the 1970s, aquarium fish collecting, trading and aquaculture were permitted under a "C" Class licence. These licences were specifically endorsed for trading, collection and aquaculture of aquarium species.

In 1993, C Class licences were separated into three individual licences, depending on the original endorsement: 1) Aquarium Fishing/Display Fishery licence permitting the collection, display and sale of aquarium species; 2) Aquarium Trader licence, predominantly for importers of aquarium species; and 3) Aquaculture licence.

The Aquarium Fishing/Display Fishery licence authorises the licensee to harvest aquarium species from the wild for subsequent supply to the aquarium trader. The Aquarium Trader licensee is generally an importer of product, mostly from interstate.

Until 1994, all aquarium collecting licensees were permitted to collect coral. In 1994, a prohibition on coral harvesting was imposed. In response to subsequent submissions from a number of licensees, some aquarium collectors were permitted to take restricted quantities of coral.

A moratorium on the issue of new aquarium collecting licences was implemented in 2001 in response to concerns over coral collection and the need for a comprehensive review of the fishery.

The review process resulted in changes to licence conditions for both the Aquarium Fishing/Display Fishery and the Aquarium Trader licences. The new conditions allowed all Aquarium Fishing/Display Fishery licence holders to collect limited amounts of coral and associated benthic species. The collection of coral and associated benthic species is linked to a maximum trigger point, and collection is prohibited in Darwin and Gove Harbours as well as in designated protected areas, such as Doctor's Gully and East Point Aquatic Life Reserves.

The Aquarium Trader licence conditions were changed to allow the licensee the ability to establish display aquaria. However, the collection of aquatic life is strictly prohibited under an Aquarium Trader licence.

The management arrangements for the fishery were initially assessed in 2006 by SEWPaC under the Guidelines for the Ecologically Sustainable Management of Fisheries. A WTO approval was granted for two years subject to conditions associated with on-going sustainability of the fishery. Performance indicators were developed for the fishery as a result of those recommendations (see Table 3).

In accordance with the agreed outcomes of the review, Aquarium Fishing/Display Fishery licences became transferable in October 2008. In addition, it was also agreed that a Public Aquarium licence would be introduced to enable the establishment of new public display aquariums within the NT. This licence category

was introduced in early 2008 and is known as the Public Aquarium licence.

In 2008, the management arrangements for the fishery were re-assessed under the Guidelines for the Ecologically Sustainable Management of Fisheries. A WTO was granted for three years enabling the continued export of the product harvested in the fishery. Re-assessment of the fishery is due in June 2011.

Current Issues

In line with the National Strategic Approach to the Management of Ornamental Fish, DoR is committed to developing a similar strategic approach for the NT. In 2007 DoR, in conjunction with industry representatives and relevant technical experts, established an Ornamental Fish Management Implementation Group (OFMIG) to address the national commitments and provide advice regarding the ongoing management and control of ornamental fish in the NT. The working group agreed that the national assessment process for imported aquatic species should be incorporated into existing NT Fisheries procedures. The working group used a uniform approach and identified a list of noxious fish species that should be prohibited throughout Australia. This list was legislated after public consultation. In 2009, OFMIG proposed a second group of 'high risk' species for addition to the list. The proposed species were identified as being of high risk to Australia's environment through an agreed scientific risk assessment method, and were considered to be of low interest to the industry and to hobbyists by OFMIG's technical working group.

Logbooks were revised in 2009 to record GPS data and ensure more accurate and consistent reporting of aquarium species. Harvest trigger levels for corals and associated benthic species were also set at 60 tonnes in 2009 (divided equally among three bioregions – the Gulf of Carpentaria, Arafura Sea and Bonaparte Gulf). The regional trigger levels and performance indicators will enable sustainable growth of the industry and provide appropriate safeguards to ensure protection for corals and associated benthic species.

Future Plans

DoR will maintain a monitoring program with logbooks and observer trips aligned with the management objectives and performance indicators for the fishery (Table 3). These will ensure the ESD of the resource with a view to maintaining the export status of the fishery under the EPBC Act. It is likely that further refinement of the performance indicators for the fishery will be required, particularly in relation to the harvest of coral and associated benthic species. DoR will continue to work with NTAC to meet SEWPaC recommendations to retain, if not improve, on the WTO approval.

Compliance

The Water Police Section of the NT Police, Fire and Emergency Services, ensures operators comply with the management arrangements for the fishery through random on-the-spot inspections of harvesting activities and targeted enforcement programs with fishers and traders. There were no recorded convictions for compliance breaches in the fishery in 2010.

Consultation, Communication and Education

DoR works with stakeholders in the fishery individually and through NTAC, as well as through specific stakeholder groups.

In addition, a series of Aboriginal consultative committees were formed to provide DoR with the opportunity to consult with coastal Aboriginal communities on all aspects of fishing, including aquarium species.

Senior Research Scientist – Dr Mark Grubert
Aquatic Resource Management Officer – Ms Tricia Beatty

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Table 3. Management objectives and harvest status against the performance indicators for the Aquarium Fishing/Display Fishery

Species or group	Management objective	Performance indicator	Performance measure	Harvest status for 2010	Management response to be taken
Group A finfish (silver and spotted scat, common archerfish, chequered and black-banded rainbowfish, sailfin perchlet, and black catfish).	Ensure intergenerational equity by maintaining ecologically sustainable annual catches in all sectors.	Significant increase or decline in the annual catch.	The harvest of any Group A finfish species has a trigger point of 30 000 individuals per species. The harvest of any Group A finfish species increases or decreases by 70% compared with the mean of the previous three years.	The combined total of Group A finfish species harvested in 2010 was less than 8000 individuals – trigger reference point not reached. The % difference between the 2010 catch and the mean of the previous three years' harvest for each Group A finfish species was: 1. Negative 65% for chequered rainbow fish. 2. Negative 95% for black-banded rainbowfish. 3. Negative 86% for sailfin perchlet. 4. Positive 44% for black catfish 5. Negative 94% for silver scats 6. Negative 34% for common archerfish. The trigger reference point was reached for all but Chequered rainbow fish and common archerfish.	DoR to review the fishery, after consultation with industry stakeholders and make recommendations on appropriate management responses to the Executive Director of Fisheries (EDF). Advice provided to the EDF within three months of being made aware of trigger being reached.
Coral and associated benthic species.	Ensure intergenerational equity by maintaining ecologically sustainable annual catches in all sectors.	Significant increase or decline in the annual catch.	Coral and associated benthic species have a total trigger value of 60 tonnes. The harvest of any coral and associated benthic species increases or decreases by 50% when compared with the mean of the previous three years.	Total harvest of coral and associated benthic species for 2010 was estimated at 4.5 tonnes – trigger reference point not reached. The % difference between the 2010 catch and the mean of the previous three years' harvest for corals and associated benthic species was positive 26%. The trigger reference point was not reached.	DoR to review the fishery after consultation with industry stakeholders and make recommendations on appropriate management responses to the EDF. Advice provided to the EDF within three months of being made aware of trigger being reached.

Species or group	Management objective	Performance indicator	Performance measure	Harvest status for 2010	Management response to be taken
Giant fluted clams.	Ensure intergenerational equity by maintaining ecologically sustainable annual catches in all sectors.	Significant increase or decline in the annual catch.	Giant fluted clams are harvested within a trigger value of 2000 individuals The harvest of giant fluted clams increases or decreases by 50% compared with the mean of the previous three years.	A total of 93 giant fluted clams were harvested in 2010 – trigger reference point was not reached. The % difference between the 2010 catch and the mean of the previous three years' harvest for giant fluted clams was negative 52%. The trigger reference point was exceeded by 2%.	DoR will review the fishery after consultation with industry stakeholders and will make recommendations on appropriate management responses to the EDF. Advice provided to the EDF within three months of being made aware of trigger being reached.
Narrow sawfish (*Anoxypristis cuspidate*).	Ensure intergenerational equity by maintaining ecologically sustainable annual catches in all sectors.	Significant increase or decline in the annual catch.	*Anoxypristis* species are harvested within a trigger value of 20 individuals. The harvest of any *Anoxypristis* species increases or decreases by 50% compared with the mean of the previous three years.	No *Anoxypristis* species were harvested in 2010 – the trigger reference point was not reached, n/a – none harvested in 2010.	DoR will review the fishery after consultation with industry stakeholders and make recommendations on appropriate management responses to the EDF. Advice provided to the EDF within three months of being made aware of trigger being reached.
Syngnathid species, other than *Hippocampus* (seahorses) – NT waters only.	Ensure intergenerational equity by maintaining ecologically sustainable annual catches in all sectors.	Significant increase or decline in the annual catch.	Syngnathids other than *Hippocampus* are harvested within a trigger value of 150 individuals. The harvest of any syngathids, other than *Hippocampus* increases or decreases by 50% compared with the mean of the previous three years.	No syngnathids other than *Hippocampus* spp. were harvested in 2010 – the trigger reference point was not reached, n/a – none harvested in 2010.	DoR will review the fishery after consultation with industry stakeholders and make recommendations on appropriate management responses to the EDF. Advice provided to the EDF within three months of being made aware of trigger being reached.
Hippocampus (seahorses) – NT waters only.	Ensure intergenerational equity by maintaining ecologically sustainable annual catches in all sectors.	Significant increase or decline in the annual catch.	*Hippocampus* is harvested within a trigger value of 50 individuals. The harvest of any *Hippocampus* increases or decreases by 50% compared with the mean of the previous three years.	No *Hippocampus* species were harvested in 2010 – the trigger reference point was not reached, n/a – none harvested in 2010.	DoR will review the fishery after consultation with industry stakeholders and make recommendations on appropriate management responses to the EDF. Advice provided to the EDF within three months of being made aware of trigger being reached.

Species or group	Management objective	Performance indicator	Performance measure	Harvest status for 2010	Management response to be taken
Hermit crabs.	Ensure intergenerational equity by maintaining ecologically sustainable annual catches in all sectors.	Significant increase or decline in the annual catch.	A precautionary trigger is set at 120 000 hermit crabs per year. The harvest of hermit crabs increases or decreases by 70% compared with the mean of the previous three years.	Just over 22 000 hermit crabs were harvested in 2010 – the trigger reference point was not reached. The % difference between the 2010 catch and the mean of the previous three years' harvest for hermit crabs was negative 21%. The trigger reference point was not reached.	DoR will review the fishery after consultation with industry stakeholders and make recommendations on appropriate management responses to the EDF. Advice provided to the EDF within three months of being made aware of trigger being reached.
EPBC Act listed species (excluding Syngnathids) in NT waters.	Ensure the continued protection of species and communities listed under the EPBC Act.	Endangered, threatened or protected species and/or communities are identified in NT waters.	Identifiable impacts observed by DoR, commercial fishers, or other agencies regarding EPBC Act listed species or communities.	There were no identifiable impacts on EPBC species or communities observed in 2010. The trigger reference point was not reached.	DoR will review the fishery after consultation with industry stakeholders and make recommendations on appropriate management responses to the EDF. Advice provided to the EDF within three months of being made aware of trigger being reached.
EPBC Act listed species in Commonwealth waters.	Ensure the continued protection of TEP species.		No EPBC Act listed species may be taken in Commonwealth waters.	There were no EPBC Act listed species taken during 2010. The trigger reference point was not reached.	Advice provided to EDF and SEWPaC regarding any interactions in Commonwealth waters.
Ecosystem components.	Minimise effects on ecosystem components.	Identification of threatening processes.	Identification of significant negative ecosystem impacts on aquarium fishing grounds.	There were no negative ecosystem impacts observed in 2010. The trigger reference point was not reached.	DoR will make recommendations after consultation with industry stakeholders to the EDF regarding appropriate remedial action. Advice provided to the EDF within three months of being made aware of trigger being reached.
Harvest of TEP species intended for trade to public aquariums (except coral and associated benthic species).	Continuation of public education while ensuring the ongoing protection of species and communities listed under the EPBC Act, *Territory Parks and Wildlife Conservation Act 2001* and CITES.	Significant increase or decline in the annual catch.	The harvest of any TEP species increases or decreases by 50% compared with the mean of the previous three years.	Identifiable impacts observed by DoR, commercial fishers, or other agencies regarding EPBC Act listed species or communities. There were no impacts on TEP species or communities observed in 2010. The trigger reference point was not reached.	DoR will make recommendations after consultation with industry stakeholders to the EDF regarding appropriate remedial action. Advice provided to the EDF within three months of being made aware of trigger being reached.

BARRAMUNDI FISHERY STATUS REPORT 2010

INTRODUCTION

Barramundi (*Lates calcarifer)* is widely distributed in the Indo-Pacific region and northern Australia. It is valued for the quality of its flesh, its fighting ability, size and readiness to take artificial lures. This has made it an iconic species that supports major commercial and recreational fishing industries. Barramundi is also fished by Aboriginal people, who value it for its economic, health and cultural importance.

The Barramundi Fishery's current annual catch is well within sustainable limits, after recovering from a period of over-fishing in the 1970s. Since the management improvements that were introduced in the 1980s, catch rates have increased both in the commercial and recreational sectors.

In 2009, the Northern Territory (NT) Government commenced a voluntary buy-back of Barramundi Fishery licences, with the aim of removing three licences from the fishery and investigating possible area closures to commercial barramundi fishing. Four licences were removed from the fishery and in 2010 the Bynoe Harbour and the Finniss River, including a large portion of Fog Bay, were closed to commercial barramundi fishing.

PROFILE OF THE FISHERY

Commercial Sector

Area

The commercial sector of the fishery operates from the high water mark to 3 nautical miles seaward from the low water mark and is restricted to waters seaward from the coast, river mouths and legislated closed lines. Fishing is not permitted within the confines of Kakadu National Park, the Mary River Fish Management Zone, Bynoe Harbour, Darwin Harbour and Shoal Bay in various key river systems. In addition, fishers may not operate or anchor within the dugong protection area in the south-western Gulf of Carpentaria. The Barramundi Fishery Management Plan specifies closure lines, defining the inland boundary of the fishery.

The commercial fishing season operates each year from 1 February through to 30 September. The areas where commercial fishing is most concentrated have changed over time. Historically, the highest catches came from Chambers and Anson bays. However, over the last ten years, the highest catches have occurred in Van Diemen Gulf, East Arnhem Land, Anson Bay, Central Arnhem Land and Limmen Bight.

Commercial operators fish over tidal mud flats and associated gutters and inside a restricted number of rivers, using monofilament gillnets. Nets are set and retrieved from dinghies and fish are processed on board mother ships. Nets can only be set across half a watercourse and must not be set within 25 m of another net in rivers. Outside river mouths, the minimum legal mesh size is 150 mm (6 inches) and within a river, the minimum legal mesh size is 175 mm (7 inches). The maximum net allowance per licence is 1000 m (10 units of 100 m) and there are restrictions on the amount of spare net that may be stored onboard vessels.

Catch

The primary target species are barramundi and king threadfin (*Polydactylus macrochir*). Barramundi are generally large enough at three years of age to be caught in a 150-mm gillnet. Commercial operators target barramundi that are usually three to eight years old.

The commercial catch in 2010 consisted of 635 tonnes of barramundi and 295 tonnes of king threadfin. This represents an increase over the 2009 harvest of 615 tonnes of barramundi and 278 tonnes of king threadfin (Figure 1).

A number of byproduct species are also taken in the commercial fishery, depending on their marketability. The most commonly byproduct species retained in 2010 were black jewfish

(*Protonibea diacanthus*), jewelfish *(Nibea squamosa),* tripletail (*Lobotes surinamensis*) and blue threadfin (*Eleutheronema tetradactylum*) (Figure 2). Sharks are also a common byproduct although the amount that can be taken is restricted to 500 kg of converted whole shark weight on board each vessel at any time.

The total amount of byproduct retained in 2010 was 37 tonnes, constituting 4% of the total harvest, which was a decline of 7 tonnes from the 44 tonnes retained in 2009. Overall, the catch of most byproduct species declined, with a noticeable exception of jewelfish and blue threadfin (Figure 2).

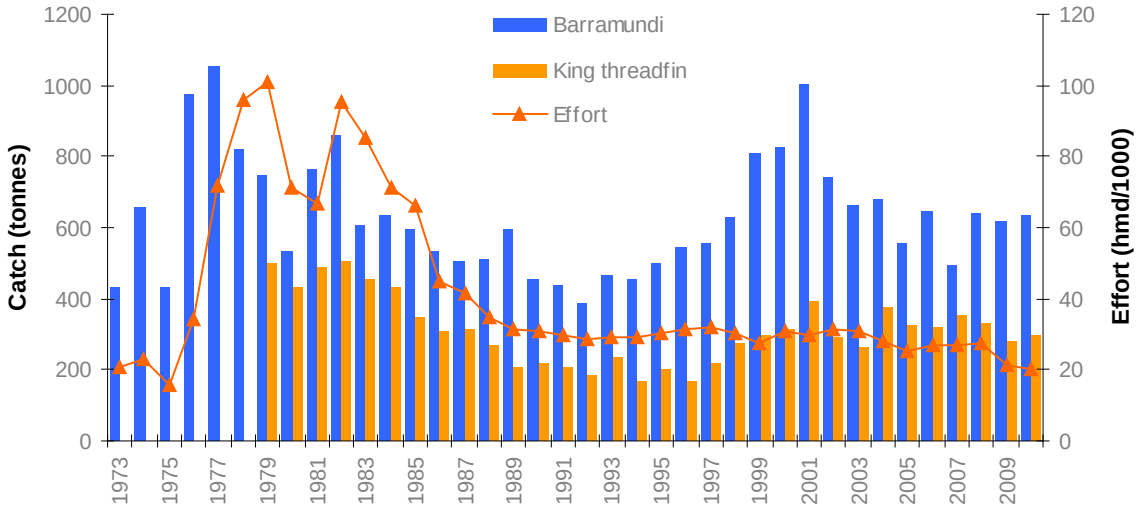

Figure 1. Catch and effort in the commercial Barramundi Fishery from 1973 to 2010

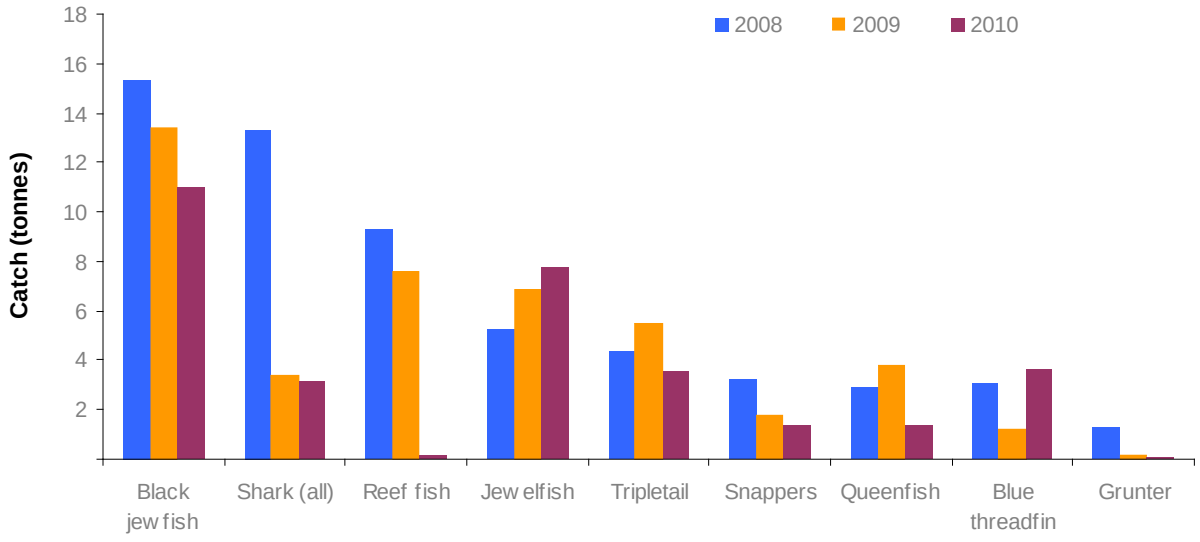

Figure 2. Byproduct composition in the Barramundi Fishery from 2008 to 2010

Effort

There were 20 fully transferable licences in the commercial fishery in 2010, all of which were fully utilised. Most of them were 'full 10 unit' licences (1 unit = 100 m net) equating to a total of 16 500 m of net. Effort is measured in '100 m net days' (hmnd), where one hmnd equals 100 m of gillnet set for one day.

In 2010, 20 336 hmnd were expended in the commercial Barramundi Fishery, a decline from the 21 0761 hmnd of effort in 2009 (Figure 1). The 2010 effort figure is the lowest recorded in this fishery since 1975. However, despite the buy-back of four licences in 2009, catches have remained high, suggesting either an increase in operator efficiency, or an increase in abundance of fish stocks and/or advances in technology. Given that commercial operators have not changed their gear since the inception of the fishery, it is likely that barramundi numbers have increased and fishers are becoming more efficient at catching them.

The distribution of commercial effort has changed significantly over the past 10 years, moving away from areas where recreational activity has increased (e.g. Chambers Bay, Darwin area and Anson Bay) to more remote areas, such as Arnhem Land and Van Diemen Gulf.

Catch Rates

The catch per unit of effort (CPUE) for barramundi showed a sharp downward trend in the late 1970s and early 1980s, reaching levels as low as 7.1 kg/hmnd. This decline was probably caused by a combination of several consecutive years of poor rainfall during the wet season and excessive fishing effort. Following management changes, CPUE has steadily increased, peaking at 34.0 kg/hmnd in 2001. Thereafter, CPUE declined dropping below 20 kg/hmnd in 2008. However, barramundi CPUE has subsequently increased to 31.2 kg/hmnd in 2010, which is the second highest value recorded in the history of the fishery (Figure 3).

In recent years, CPUE for king threadfin has shown a very similar trend to that of barramundi catches. These trends indicate that the fishery has largely recovered from the period of overexploitation during the 1970s, when CPUE was as low as 5.0 kg/hmnd. In 2010, CPUE for king threadfin was 14.5 kg/hmnd, which is the highest value recorded in the history of the fishery for this species (Figure 3).

While fluctuations in CPUE for both species most likely reflect annual variation in environmental conditions, recent increases suggest that fish numbers have increased.

Marketing

Historically, barramundi and king threadfin have been sold as frozen fillets to local and interstate markets. However, many fishers are now providing barramundi wings and swim bladders, and are selling whole barramundi and king threadfin fresh on ice to local and southern markets.

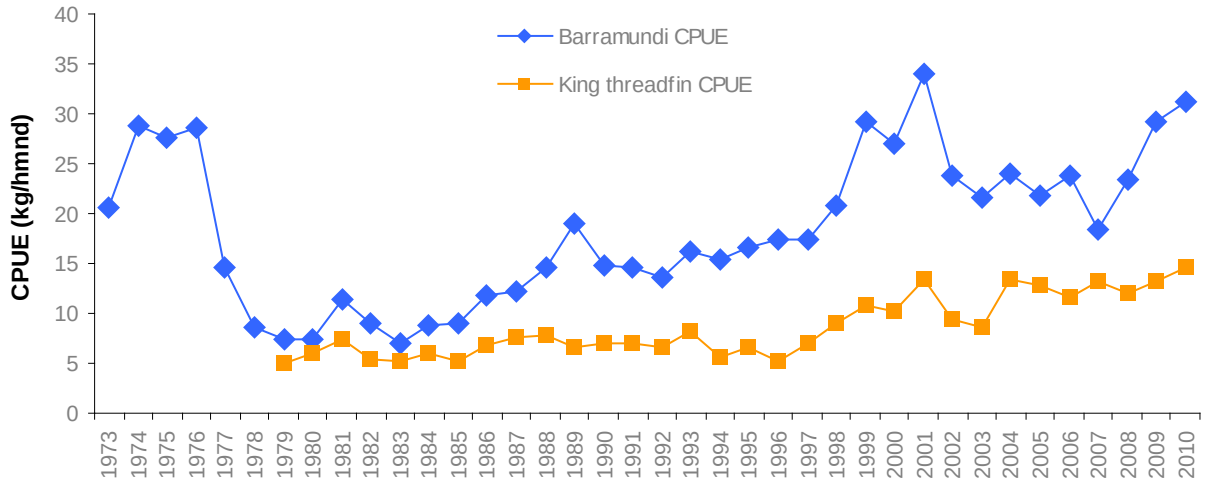

Figure 3. CPUE for barramundi and king threadfin in the Barramundi Fishery from 1973 to 2010

Recreational Sector

Area

Barramundi have historically been caught by anglers throughout inland billabongs and the upper reaches of rivers and creeks. Improvements in technology and greater access to the coast have allowed many anglers to now target larger barramundi in the tidal mouths of rivers and estuaries.

Seasonal closures are currently in place, restricting recreational fishing from spawning grounds near the mouths of the Daly and Mary rivers, between 1 October and 31 January, each year.

Darwin Harbour, Bynoe Harbour, Shoal Bay, and the Adelaide, Mary, Daly, Finniss and Alligator rivers are important fishing locations due to their proximity to Darwin. Farther south, the Victoria, Roper and McArthur rivers are also well utilised by regional NT and interstate anglers.

Fishing Method

Recreational fishing for barramundi is mostly carried out from boats of between 4 and 6 m in length, using light-weight rods and reels, fly fishing gear and hand lines to cast or troll a wide range of lures. Live bait is also effective. Mullet are the most popular live-bait species used in estuaries, while freshwater prawns or 'cherabin' (*Macrobrachium rosenbergii*) are favoured in billabongs and the upstream portions of rivers.

Gear restrictions apply in the Mary River Fish Management Zone and additional controls, including a prohibition on the use of bait or double and treble hooks, are in place within 100 m of the Shady Camp barrage.

Catch

Recreational fishers target the same species caught by the commercial sector. Many species caught by recreational fishers are released.

Barramundi caught in the non-tidal reaches of rivers and billabongs are generally one to five years old, whereas those caught in the tidal reaches near river mouths can range between one and 15 years old. Fish of three to ten years of age are most common.

In 2000, Coleman (2004) identified barramundi as the most popular target species, with an estimated total catch of over 400 000 and an annual harvest of 100 400. The total number of barramundi caught was 67% higher than that recorded in 1995 (240 000), although the actual number of retained fish has remained about the

same (Coleman 1998; Coleman 2004). Recreational fishing surveys indicate an increasing trend in catch and release within the recreational sector of the fishery. In 2000, it was estimated that 76% of the barramundi caught were released, an increase from the 58% recorded in the 1995 survey.

Another recreational fishing survey in the NT was initiated in 2009. The results are expected in 2011. With an increasing population, better technology and larger boats, it is expected that the catch of barramundi by this sector will increase substantially.

A specific possession limit of two barramundi applies in the Mary River Fish Management Zone with a limit of five applicable elsewhere in the NT. A minimum length of 55 cm for barramundi applies for both the recreational and commercial sectors throughout the NT.

Effort

Recreational fishers often fish for a range of species. Barramundi fishing is quite specific in the choice of fishing equipment and location. In 1995, targeted barramundi fishing accounted for 38% of the total recreational fishing effort in the NT, amounting to over 840 000 hours. In 2000, targeted barramundi fishing effort increased to 43% of the total recreational fishing effort, but the number of hours fished declined from those in 1995 to 788 726.

Catch Rates

Angler creel surveys in the Mary River indicate that the total catch rate increased from 0.11 barramundi per angler hour in 1986 to 0.23 barramundi per angler hour in 1995. The subsequent FISHCOUNT survey (Coleman 1998) and the National Recreational Fishing Survey: the Northern Territory (Coleman 2004) determined that the number of fish caught per hour (all species) in the Mary River region remained consistent at 0.54 fish per angler hour. However, the proportion of barramundi caught in 2000 had increased significantly accounting for 63% of all fish caught compared with only 43% of all fish caught in 1995.

Fishing Tour Operator Sector

The number of Fishing Tour Operators (FTOs) utilising the NT's aquatic resources is growing, driven primarily by client demand.

Area

FTOs have traditionally targeted barramundi in Darwin Harbour, the Daly and Mary rivers and the Tiwi Islands. However, an increase in the use of larger boats has led to recent expansions by this sector into the western coastline of the NT, Anson Bay, Van Diemen Gulf, Cobourg Peninsula and Central Arnhem Land. Generally, FTOs utilise the mouths of rivers to target large barramundi at the end of the wet season and switch to freshwater billabongs during the dry season.

Fishing Method

FTOs and their clients use the same fishing gear as recreational fishers. Casting or trolling of artificial lures account for roughly 95% of targeted barramundi fishing effort (line-hours), while live bait accounts for the remaining 5%. The relative proportions of lure and bait fishing have remained reasonably stable since 1995.

Catch

In 2010, FTO clients caught 54 104 barramundi, representing an increase of 13% on the 2009 FTO catch. According to FTO logbook information, 89% (47 892) of barramundi caught in 2010 were released and 11.5% (6212) were retained. Assuming a post- release mortality rate of 10% (de Lestang et al. 2004), the FTO sector would therefore have removed around 11 000 barramundi in 2010.

The proportion of fish released by FTO clients has remained relatively stable since 1995. FTO clients generally retain a smaller proportion of caught barramundi than do non-guided recreational fishers. The higher release rate is probably related to more fishing education by guides as well as participation by clients who are generally more interested in the experience of catching a barramundi rather than taking it home.

The most productive areas where barramundi were caught in 2010 were the Mary and Daly river systems, Arnhem Land and Tiwi Islands.

In 2010, FTO clients caught 2623 king threadfin, representing an increase of 30% on the 2009 FTO catch. According to FTO logbook information, 65% (1701) of king threadfin caught in 2010 were released and 35% (922) were retained. The most productive areas for king threadfin include the Tiwi Islands, the Mary River and Darwin/Bynoe/Dundee areas.

Effort

In 2010, 85 442 line-hours were spent targeting barramundi, which was an increase from the 77 893 line-hours spent in 2009.

Catch Rates

The catch rate remained stable from 1995 to 1998 at 0.5 barramundi per hour. From 1998, it gradually increased to 0.8 barramundi per hour by 2001, but declined to 0.4 barramundi per hour in 2003. In 2010, the catch rate improved to 0.63 barramundi per hour. The fluctuations in FTO catch rates have followed a similar trend to the commercial fishery. Catch rate fluctuations are likely to be linked to recruitment to the fish population, which is affected by rainfall and river flows.

Indigenous Sector

Barramundi are harvested by Aboriginal people in coastal and some inland areas of the NT. Barramundi have significant economic, health, cultural and totemic values for Aboriginal people.

Area

Most fishing for barramundi occurs in inland rivers that drain into the sea or in inshore coastal waters.

Fishing Method

Over 90% of all fishing is shore-based, using baited lines or spears.

Catch

Coleman (2004) found that Indigenous fishers harvested 44 134 barramundi in 2000; few fish were released.

Non-retained Species

Commercial gillnets placed on mudflats and in rivers are relatively selective for barramundi and king threadfin. Non-target species may be either retained as byproduct or discarded as bycatch, depending on market price.

A small percentage of bycatch that is often discarded includes catfish, blue threadfin, queenfish, trevally and some shark species. Bycatch has been noted to increase when nets are set in deep channels rather than over shallow mud flats.

The Barramundi Licensee Committee has agreed on restrictions limiting the take of shark, as part of the National Plan of Action on Sharks. Commercial barramundi fishers must have no more than 500 kg of converted whole shark weight on board each vessel at any time and must unload all shark products prior to commencing their next voyage. Recent declines in sharks taken by commercial fishers indicate that these actions have successfully reduced the number of sharks taken by this fishery.

In 2000, recreational fishers targeting barramundi also caught threadfins, snappers, grunters and catfish. Overall, 35.9% of all these were retained (Coleman 2004). Some species were more likely to be retained than others, as most threadfins were retained, whilst most catfish were released.

FTO logbook returns indicate that blue salmon, tarpon, saratoga, sooty grunter and catfish were all caught while targeting barramundi. Overall, 10% of these were retained, with blue salmon and sooty grunters having the highest retention rate.

Threatened Species Interaction

Data on interactions with threatened, endangered and protected (TEP) species in the fishery has been collected since 2003 as part of the

commercial fishing logbook process. Gillnets are relatively selective in catching targeted finfish species; however, the incidental capture of dugongs, crocodiles, sawfish and turtles has been previously recorded in the fishery.

There were a small number of TEP species interactions recorded by onboard observers during 2010; almost all were released alive. To assist in minimising the incidental capture of TEP species in the future, the commercial fishery has conducted a comprehensive review of its Environmental Management System and associated Code of Practice.

To minimise dugong interaction, a Dugong Protection Area is in place in the south-western Gulf of Carpentaria, which effectively excludes commercial fishers from fishing and anchoring in this area.

Ecosystem Impact

The full effects of removing numbers of predators, such as barramundi, and quantities of biomass from such systems are unknown. Previous stock assessment models suggest that less than 10% of the total barramundi stock is harvested annually. This suggests ecosystem impacts are unlikely to be excessive.

Social Impact

The commercial sector of the fishery employs around 100 people as crew and another 50 in the processing, trading and marketing of barramundi to local and interstate markets. A large service industry also supplies gear and consumables to barramundi operators, services equipment and freights the product.

Barramundi fishing is an iconic feature of the NT and a popular recreational pastime. About 30% of the resident population go fishing and most recreational fishers target barramundi at some time. Recreational fishers also purchase gear, bait, fuel and service for equipment from local businesses (Coleman 2004).

Many interstate and overseas tourists come to the NT to catch wild barramundi as the NT has a reputation for providing high numbers of large fish. Visitors accounted for 37% of the total fishing effort (hours) in the NT in 2000, an increase from 23% in 1995 (Coleman 1998; Coleman 2004).

Barramundi also holds a totemic value in some Indigenous communities. Abundance of barramundi is important not only as a major source of food to some coastal communities, but is an important component of Indigenous wellbeing.

Economic Impact

At the point of first sale in 2010, the overall catch value of the commercial Barramundi Fishery was $5.05 million. In 2010, the barramundi component was $4.03 million and the king threadfin component was $0.92 million. The value of byproduct sold in 2010 was $0.10 million.

The recreational sector contributes to the NT economy, especially in the service and fishing tackle industries. In 2000, it was estimated that over $35 million was spent on recreational fishing in the NT, although this cannot be directly attributed to any one fishery (Coleman 2004).

Whilst the fishery is not the most valuable of the NT's fisheries in terms of catch value at first point of landing, its return to the community is substantial.

STOCK ASSESSMENT

Monitoring

Monitoring of the fishery is largely focused on analysis of catch and effort trends in the commercial fishery based on monthly catch returns provided by licence holders. The information provided by recreational fishers is also used.

An observer was present on commercial barramundi boats for 15 days in 2010. Of the 1044 fish caught during these trips, 47% were barramundi, 19% king threadfin and 16% blue

threadfin. Overall, 10% of the catch was discarded comprising mainly sharks and catfish. Pending funding allocations, the current monitoring program will be modified from 2011 to include annual monitoring trips in all of the major river systems. This will increase the amount of information on size structure of target species across the NT and catch composition of byproduct and bycatch species, thus providing more detailed data for stock assessment models.

Stock Assessment Methods and Reliability

The fishery was first assessed using catch and effort data in 1978 and 1979; it has been assessed a number of times since then. The early assessments were not completely successful due to poor knowledge of barramundi stock structure. However, improved knowledge in this area as well as the development of better modelling techniques have made subsequent models of the fishery more reliable.

A new model was expected in 2008 (Grace et al. 2008). However, the amount of time and money still to be invested to make it functional has rendered its completion infeasible. Currently, exploitation rate data (from commercial and FTO logbook returns and tag returns) is being examined to assess its suitability as a substitute for assessing stocks of barramundi across the NT.

The barramundi population of the NT has largely recovered from the overexploitation of the 1970s. Given the near record levels of the current CPUE in the commercial fishery the current level of exploitation in all targeted stocks is considered to be highly sustainable.

Current Harvest Status

Harvest rates in the Daly, Roper and Victoria rivers were all estimated to be less than 10% from tag-recaptures. This is an extremely low figure for such a reproductive species and is one of the reasons the NT barramundi stocks are so healthy. The barramundi tagging program will be expanded to other catchments during 2011.

None of the management trigger reference points were reached during 2010 (see Table 1) suggesting that target, byproduct and bycatch species are being fished sustainably within the fishery. More refined trigger points and performance measures will be developed and incorporated into the Barramundi Fishery Management Plan. The trigger points will be reviewed annually to assist in setting the harvest rate of the fishery.

Future Assessment Needs

Currently, independent monitoring of the barramundi stocks is only conducted in a small section of the Mary River system. Genetic and scale microchemistry studies have revealed that each river system and associated embayment holds separate populations of barramundi in the NT (Shaklee and Salini 1985; Keenan 1994; Pender and Griffin 1996; Chenoweth et al. 1998). Consequently, the current monitoring program requires expansion into many of the major river systems in the NT to facilitate independent assessment of the health of each population.

Catch and release fishing is becoming increasingly popular as anglers become aware of barramundi biology and conservation values. Increasingly, fish that could legally be retained are being released. Research has been conducted on the physiological effects and survival of released juvenile barramundi. However, there is still a need for research on the lethal and sub-lethal effects of catching and releasing large size (>90 cm) barramundi, given that most of them are likely to be females. Specifically, identifying the effect catch and release have on the fecundity of large females is important to determine the effect of recreational fishing on egg production in barramundi.

Given that king threadfin comprise a large proportion of the catch in the fishery, the reproductive biology, habitat use and genetic stock structure of this species need to be further understood.

Future assessment of the commercial sector of the fishery is needed to meet the NT and

Australian Governments' commitment to ecologically sustainable development. This assessment includes identifying the impact of the fishery on bycatch species, byproduct stocks and the environment in general.

RESEARCH

Summary

Research on barramundi in NT waters began in 1972 with sampling and tagging on the Mary River and sampling on the Victoria and Roper river systems. The after effects of Cyclone Tracy prevented barramundi research between 1974 and 1977. Research recommenced in late 1978 with an assessment of the fishery and an extensive sampling to establish baseline biological information on barramundi stocks. Results of the 1978-79 assessment highlighted substantial over-fishing, which led to licence reductions and identified the rising significance of recreational fishing.

During the mid-1980s, concerns were raised about the status of barramundi stocks in the Mary River system. Between 1986 and 1987 a major assessment of the status of barramundi was undertaken in the Mary River system. This included intensive monitoring of both commercial and recreational catches. Results from this study showed that the stock was over-fished, with evidence of a substantial reduction in the numbers of mature fish. The results of that study forced a seasonal closure to protect spawning fish accompanied by a reduced recreational bag limit (Griffin 2006). The closure was an industry-led initiative to ensure long-term viability of the fishery.

In addition, an annual fishery-independent monitoring study has been conducted on Corroboree Billabong since 1987. Results from the study revealed a very consistent pattern of cyclical abundance with high numbers of recruits every second year.

Research effort between 1996 and 2001 focussed on the assessment of the possible impacts of saline intrusion control activity on barramundi in the Mary River wetlands region (de Lestang and Griffin 2000; de Lestang et al. 2001). Placing saline intrusion control walls (barrages) along the wetlands significantly reduced the composition and relative numbers of barramundi and other fish in areas affected by control works. This may possibly reduce growth and survival of juvenile barramundi. Placing spillways that allowed fish to cross the walls reduced these negative effects.

Between 2002 and 2004, research effort concentrated on quantifying the survival and physiological effects of recreational catch-and-release on barramundi in a freshwater habitat. This showed that around 90% of barramundi survive being caught and released in fresh water. Barramundi that had been caught on a line had higher levels of stress hormones (cortisol) and showed signs of muscle fatigue (lactate), which suggests that fish were stressed by being line-caught. Survival also varied significantly throughout the year. Those fish sampled in warmer months suffered more stress and lower survival (80%) after three days compared with fish caught in cooler months, which showed 100% survival after three days (de Lestang et al. 2004). Another trial found that "fish-friendly" knotless landing nets caused less damage to fish skin and fins than more traditional knotted mesh landing nets (de Lestang et al. 2008). Knotless landing nets are recommended to minimise injuries and increase the chance of post-release survival.

Incorporation into Management

Monitoring of the barramundi stock in the Mary River during 1986 and 1987 provided vital information to support major changes to the management of commercial and recreational sectors.

Research in the Mary River wetlands identified the beneficial effects of spillways within saline intrusion control walls. This has been incorporated into saline intrusion control works.

Data from creel surveys and population monitoring in the Mary River has made a

significant contribution to adjustment of fishing controls in the region, including the size limit and the banning of the use of live bait and treble hooks at the Shady Camp barrage.

The long-term monitoring of barramundi numbers in Corroboree Billabong has led to a greatly improved understanding of the reasons behind fluctuations in the population and informed responses to concerns about reported and perceived declines in fishing success.

The results from the post-release survival study strongly support the use of catch-and-release as a management tool in freshwater environments. The effect of season on both the stress response and post-release survival of barramundi is significant and will be used as a guide for future management strategies.

Current Research

On-going research projects include:

- Annual assessment of barramundi recruitment and populations in the Mary River.
- On-board monitoring of the commercial Barramundi Fishery.
- Investigations into how different river flow patterns affect barramundi and king threadfin populations.
- Tag/recapture programs on the Daly, Mary, Roper and Victoria rivers.
- Comprehensive survey of recreational fishing catch and effort across the NT.

MANAGEMENT/GOVERNANCE

Management

Objective

Management objectives, performance criteria and trigger points for the fishery will be defined by a future review of the Barramundi Fishery Management Plan. The proposed objectives for the fishery are listed in Table 1. Such measures will assist in the long-term sustainability of the fishery.

History

Conservative management, focussing on the containment of fishing effort, protection of breeding stocks through seasonal closures and a minimum size limit reducing fishing pressure on juvenile fish, has been adopted to protect the barramundi resource. The fishery has been actively managed since the 1960s and controlled under the Barramundi Fishery Management Plan since 1991.

Current Issues

The Barramundi Fishery Management Advisory Committee (BFMAC) was reformed in 2010 to provide advice to the Executive Director of Fisheries on issues of relevance to the management of barramundi stocks in the NT. BFMAC membership is derived from a wide range of stakeholder interest groups.

The issues currently facing the management of barramundi stocks in the NT relate mainly to resource sharing between the commercial and recreational fishing sectors. Improvements in technology have allowed recreational fishers to travel farther a field in search of barramundi. This has meant that recreational and commercial fishers now often fish for barramundi in the same waters, which has led to conflict in some of the more popular areas, such as Chambers Bay and the Finniss River area.

In 2010, Bynoe Harbour and the Finniss River area were closed to commercial barramundi fishing in line with an appropriate removal of effort from the commercial sector with the buy-back of four licences in 2009.

There is a specific need to resolve questions concerning the impact of recreational catches on barramundi stocks in heavily-utilised areas, increased targeting of mature female barramundi, user conflict issues, land and sea access issues for pastoral leases, Aboriginal land and Kakadu, as well as localised habitat issues, such as saltwater intrusion in the Mary River catchment and minimising interactions with TEP species.

Future Plans

It is anticipated that there will be a buy-back of more commercial licences from the fishery in the future.

It is also proposed that BFMAC will provide advice to the Executive Director of Fisheries with respect to resource sharing issues in the Barramundi Fishery. Additionally, BFMAC will provide advice on the strategic direction and management objectives for the fishery, and amendments to the Barramundi Fishery Management Plan.

A review of barramundi (and cherabin) management arrangements in the Daly River area was recently completed for the recreational fishery. Following the release of a public discussion paper, the Minister has announced that the management arrangements for this area will change in 2011. The new arrangements will include the formation of the Daly River Management Zone, in which the barramundi possession limit will be reduced to three per person. This reduction in the barramundi possession limit is to further protect the important Daly River fishery in light of increasing recreational use; it was fully supported by the Amateur Fishermen's Association of the NT (AFANT). The Minister has also announced that the barramundi possession limit in the Mary River Fish Management Zone will be increased from two to three per person on that same date. This increase in possession limit is in response to an increase in barramundi numbers resulting from good long-term management and commendable stewardship by the recreational sector.

The results of the recreational fishing survey of the NT in 2009-10 will provide valuable information concerning the recreational harvest of barramundi stocks. This data will be incorporated into future modelling and stock assessments to further define the state of the fishery.

Compliance

Monitoring, compliance and enforcement activities are undertaken by the Water Police Section of the NT Police, Fire and Emergency Services, under the NT *Fisheries Act 1988*. Major issues of concern during 2010 with respect to compliance in the commercial sector were the use of gillnets in excess of entitlement, fishing in closed waters and the inadequate marking of gear. Recreational fishing issues include non-compliance with general possession limits, retaining undersize barramundi, removing skin from fillets and fishing in seasonally closed areas.

Consultation, Communication and Education

Key stakeholder groups, such as the Barramundi Licensee Association, AFANT and the Guided Fishing Industry Association of the NT, are consulted on matters related to the sustainable management of the fishery.

BFMAC consists of representatives from various stakeholder groups and government and provides advice to the Executive Director of Fisheries on issues relevant to the fishery.

A series of Aboriginal Consultative Committees have been formed to enable the Department of Resources to engage with Indigenous groups on matters relevant to the sustainable management of fish and aquatic life in the NT.

Prior to commencing fishing operations, all new entrants to the commercial fishery must attend an interview with the Aquatic Resource Manager responsible for the fishery. These interviews provide the fisher with an understanding of the legislation, status of the fishery, research, management, compliance issues and reporting requirements for interactions with TEP species. In addition, a SeaNet extension officer provides information and advice on reducing environmental impacts and works directly with the industry, managers and researchers to develop and implement improved fishing gear technology and methods.

An information package is available for recreational fishers on all aspects of barramundi fishing in the NT. It includes information on fishing methods, locations of boat ramps, catch and release practices, as well as a copy of the recreational fishing controls booklet outlining regulations applying to the recreational sector.

Presentations are made to schools, community groups and fishing clubs on best practice handling techniques and issues affecting sustainability of the resource.

Senior Research Scientist – Dr Thor Saunders
Aquatic Resource Management Officer – Mr Steven Matthews

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Table 1. Harvest status against planned management objectives, performance indicators, trigger points and management actions for the Barramundi Fishery

Species or group	Management objective	Performance indicator	Performance measure	Harvest status for 2010	Management action
Target species barramundi, king threadfin.	To maintain the sustainability of the barramundi fishery resource.	Significant decline in the annual catch or a significant increase in fishing effort.	If catch or effort by any sector, or the fishery as a whole, increases or decreases by 20% for each year for two consecutive years.	**Commercial sector** Barramundi catch decreased by 14% in 2009 then increased by 3% in 2010 - trigger reference point not reached. King threadfin catch decreased by 16% in 2009 then increased by 6% in 2010. The trigger reference point was not reached. Effort decreased by 23% in 2009 and by 4% in 2010. The trigger reference point was not reached. **FTO sector** Barramundi catch decreased by 1.4% in 2009 then increased by 13% in 2010. The trigger reference point was not reached. King threadfin catch increased by 7% in 2009 then increased by 30% in 2010. The trigger reference point was not reached.	Stakeholders to make recommendations to the Executive Director of Fisheries (EDF) regarding appropriate remedial action. Amended arrangements to be implemented within 12 months of trigger being reached.
Target species barramundi, king threadfin.	Each sector (FTO, recreational, commercial, Indigenous) to optimise the monetary value of their catch.	That all sectors are achieving the maximum worth from their catch.	If the monetary value of fishing by a fishery sector changes by more than 20% for each year for two consecutive years.	N/A	Stakeholders to make recommendations to the EDF regarding appropriate remedial action. Amended arrangements to be implemented within 12 months of trigger being reached.
Target species Barramundi.	Maintain and enhance quality fishing experiences for recreational fishers into the future.	A significant number of recreational fishers or FTO clients do not enjoy their barramundi fishing experience.	If more than 20% of participants in stakeholder fishing surveys or FTO clients state that they are unsatisfied with their barramundi fishing experience.	N/A	Stakeholders to make recommendations to the EDF regarding appropriate remedial action. Amended arrangements to be implemented within 12 months of trigger being reached.

Species or group	Management objective	Performance indicator	Performance measure	Harvest status for 2010	Management action
Byproduct species jewfish, shark (all), reef fish, sand bass, tripletail, snappers, queenfish, blue threadfin. and, grunter.	Ensure ecological sustainability of byproduct species.	Monitoring of commercial logbook returns and on-board monitoring of commercial vessels.	If any byproduct species increases or decreases by 50% for each year for two consecutive years.	Catches for all byproduct species remained within trigger point limits. The trigger reference point was not reached.	Stakeholders to make recommendations to the EDF regarding appropriate remedial action. Amended arrangements to be implemented within 12 months of trigger being reached.
Bycatch species.	Ensure ecological sustainability of bycatch species.	Monitoring of commercial logbook returns and on-board monitoring of commercial vessels.	If bycatch species increase by more than 50% in any year for two consecutive years.	Bycatch remained within trigger point limits. The trigger reference point was not reached.	Stakeholders to make recommendations to the EDF regarding appropriate remedial action. Amended arrangements to be implemented within 12 months of trigger being reached.
Threatened endangered or protected (TEP) species and/or communities.	Ensure the continued protection of species and communities listed under *EPBC Act* and as listed under the NT's *Parks and Wildlife Conservation Act 2001.*	TEP species and or communities are identified in NT waters.	Identifiable impacts observed by commercial fishers, fisheries observers or other agencies regarding *EPBC Act* listed species or communities.	There were no identifiable impacts observed on the *EPBC Act* listed species or communities. The trigger reference point was not reached.	Stakeholders to make recommendations to the EDF regarding the implementation of a threat abatement plan, if required. Amended arrangements to be implemented within 12 months of trigger being reached.
Ecosystem components.	Minimise the effects on the ecosystem components.	Identification of threatening processes.	Identification of significant negative interaction with components of the natural ecosystem.	There were no significant negative interactions within the ecosystem where the Barramundi Fishery occursThe trigger reference point was not reached.	Stakeholders to make recommendations to the EDF regarding appropriate remedial action. Amended arrangements to be implemented within 12 months of trigger being reached.

COASTAL LINE FISHERY STATUS REPORT 2010

INTRODUCTION

The Coastal Line Fishery operates in the near-shore waters of the Northern Territory (NT) and harvests a wide range of species, mostly using hook and line gear. The fishery mainly targets black jewfish (*Protonibea diacanthus*) and golden snapper (*Lutjanus johnii*). Key secondary species include emperors, cods and other snappers.

The fishery comprises commercial, recreational, charter and Indigenous sectors, and there is considerable overlap in the range of species harvested. Conservative estimates suggest that the recreational harvest of black jewfish, snappers and emperors surpasses the total commercial take of these species. The Indigenous and Fishing Tour Operator (FTO) harvest is also significant.

The Department of Resources (DoR), in consultation with the Coastal Line Fishery Management Advisory Committee (CLFMAC), is currently reviewing the management arrangements for the fishery to maintain the sustainable harvest of coastal fish species by all sectors.

PROFILE OF THE FISHERY

Commercial Sector

Area

The fishery extends from the high water mark to 15 nautical miles (nm) from the low water mark along the NT coast. Some finer-scale access restrictions apply around registered Aboriginal sacred sites and protected areas.

Fishing Method

Coastal Line Fishery licensees are permitted to use several gear types. Vertical lines, cast nets (for bait only), scoop nets or gaffs can be used from the high water mark out to 2 nm from the low water mark. Drop lines and a maximum of five fish traps per licence may also be used from 2 nm out to the 15 nm limit. Commercial fishers are permitted to use up to five hooks per vertical line, but most choose to use only two. They may also use up to 40 hooks per drop line, but typically use from six to 20.

Vertical lines were the preferred fishing method in the fishery in 2010.

Catch

The total reported catch for the fishery in 2010 was 178 tonnes (216 tonnes in 2009), a decline from the peak catch of 311 tonnes in 2004 (Figure 1). Historical data indicates that the catch fluctuated between 60 and 138 tonnes from 1990 to 1998 (data not shown), and then steadily increased until 2004.

There have been significant changes in the catch composition of the fishery over time (Figure 1). A mix of reef fish dominated the catch from 1990 to 1998 (data not shown). Since then, the proportion of black jewfish in the catch has steadily increased and now makes up between 85 and 90% of the total catch for the fishery. Over the same period, the catch of golden snappers, as a proportion of the total catch, has declined from an average of around 16% to 3% in 2010.

The catch of byproduct species in the fishery is minimal given the targeted nature of the fishery and the use of line tackle.

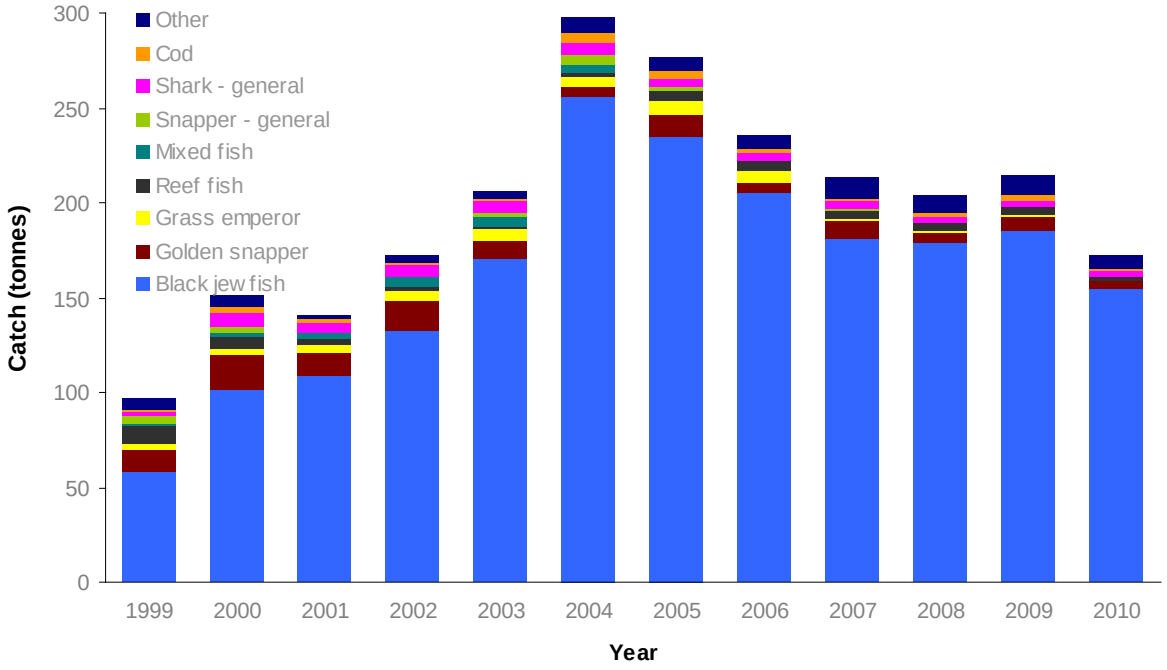

Figure 1. Catch composition (tonnes) for the line-only component of the Coastal Line Fishery, 1999-2010

Effort

The number of active licences varies each year. In 2010, there were 19 licences active in the fishery, compared with 25 in 2009 and 23 in 2008.

Figure 2 shows the catch and effort (hook-hour) totals for the line-only component of the Coastal Line catch. Due to confidentiality constraints (i.e. less than five active licensees), the dropline components of the fishery is not displayed. Between 1999 and 2008, fishing effort (for the line-only component of the fishery) fluctuated between ~ 42 000 hook-hours and ~86 000 hook-hours. The 2010 figure of 66 268 hook-hours was within this range, but was 55% lower than the 2009 effort of 145 776 hook-hours. The higher level of effort in 2009 was mostly attributed to a small number of new operators entering the fishery and undertaking exploratory fishing.

Catch Rates

The catch per unit effort (CPUE) for the line-only component of the fishery increased steadily from 2.3 kg/hook-hour in 2003 to 5.7 kg/hook-hour in 2006 (Figure 2). It declined markedly to 1.5 kg/hook-hour in 2009, primarily due to the aforementioned exploratory fishing activities by a few new operators. It has since increased again to 2.6 kg/hook-hour in 2010.

It is noted that catch rates for aggregating species (such as black jewfish) can be artificially inflated through fisher behaviour. This phenomenon, known as hyper-stability, occurs when an operator fishes until there are no more bites (or the last fish is caught) then moves onto a new area to maintain high catch rates. As such, the effects of variable fisher skill level and hyper-stable catch rates may have cumulative or opposing impacts on CPUE estimates. It is hoped that with further research, more reliable indicators of stock abundance will be available.

Figure 2. Catch (tonnes), effort (hook-hours/500) and CPUE (kg/hook- hour/500) for the line-only component of the Coastal Line Fishery, 1999-2010

Marketing

Most fish are sold fresh on ice, usually gilled and gutted, filleted or trunked (whole fish from which the head and viscera have been removed). Trunking is convenient for cold-storing larger fish like black jewfish. The swim bladder of black jewfish is also sold as a high-value product. Due to limited local demand, most of the product is sold to southern markets.

Recreational Sector

Area

Recreational coastal line fishing takes place over most of the near-shore waters of the NT. The most popular regions include the coastal strip from the Daly to the Adelaide rivers and the Nhulunbuy area. In 2000-01, 31% of the total NT recreational fishing catch was from the Darwin area (Coleman 2004).

Fishing Method

A variety of fishing gear is used by the recreational sector of the fishery. Most fishing is by line (84%), using lures or bait. Over 75% of the time spent fishing in the NT takes place from a boat (Coleman 2004).

Catch

The National Recreational and Indigenous Fishing Survey (NRIFS) conducted in 2000-01 indicated that of the ~600 000 fish harvested (i.e. caught and kept) by recreational fishers in the NT, the most common were snappers (23% of the total harvest). Within the snapper group, golden snappers and stripey snappers (also known as Spanish flag) accounted for the largest portion of the harvest, estimated at 68 000 and 22 000, respectively (Henry and Lyle 2003; Coleman 2004). Black jewfish (~18 000) and emperors (~12 000), were also significant components of the harvest.

Effort

Line fishing in coastal waters accounts for 30 to 50% of recreational fishing effort in the NT (Coleman 1998; Coleman 2004). These figures include both dedicated reef fishing and non-specific target fishing.

Most of the fishing effort for reef fish and 'non-specific target' fishing in 1995 occurred within the Darwin Harbour area (Coleman 1998). In 2000, the Darwin Harbour area was still the most important fishing area, accounting for 39% of the recreational coastal line fishing effort (Coleman 2004).

Fishing Tour Operator Sector

Area

Most Fishing Tour Operators (FTOs) operate around Darwin, Fenton Patches, Bynoe Harbour, Fog Bay to Point Blaze and the Peron Islands. A small number also operate out of Nhulunbuy, Borroloola and across Arnhem Land.

Fishing Method

FTOs are subject to the same gear controls and possession limits as recreational fishers, and use baited hooks 95% of the time spent reef fishing.

Catch

Logbook data for 2010 reveals that the FTO sector catch and release large numbers of coastal fish, most notably, stripey snappers, (Spanish flag - 12 427 landed, 70% released), golden snappers (15 382 landed, 53% released), trevally (8063 landed, 93% released), saddle-tail snappers (9560 landed, 83% released), grass emperor, (tricky snappers - 9091 landed, 59% released) and cods (6556 landed, 79% released).

Effort

Reef fishing effort has steadily increased since 1995, with the total reef fishing line-hours in recent years being over six times those recorded in 1995. In 2010, this type of fishing activity accounted for 72 159 hours fished by FTO clients, a decline of about 12% from 2009. The decline in activity is consistent with a decline in client numbers since 2009.

Indigenous Sector

Area

Most fishing effort is localised and centred close to communities or outstations.

Fishing Method

NRIFS (2001) revealed that over 90% of all Indigenous fishing in the NT was shore-based, with half of fishers using baited lines (Henry and Lyle 2003).

Catch

Mullet and snappers form the bulk of the harvest by Indigenous fishers.

The Indigenous component of NRIFS estimated that 83 000 mullet were harvested by Indigenous subsistence fishers in the NT over a 12-month period. Other harvested species included catfish (60 000), snappers (27 500), sharks and rays (12 000), salmon (8500) and trevally (8000).

Non-retained Species

Whilst the commercial sector of the fishery primarily targets black jewfish and snappers, over 40 different species have been retained in recent years. Fisheries Regulations prohibit Coastal Line Fishery licensees from taking barramundi, king threadfin, Spanish mackerel or mud crabs. Coastal Line Fishery licensees have, at the request of the Offshore Net and Line Fishery Licensee Committee, accepted the introduction of limits on shark catches in the fishery.

Recreational fishers catch a wide variety of species during targeted reef fishing. The retention rate of popular table fish, such as snappers, emperors and jewfish, is up to 76%. By contrast, the retention rate of such species as sharks, rays and catfish is less than 5%. The number of reef fish released by Indigenous fishers is negligible, with fishing being essentially a subsistence activity.

Threatened Species Interaction

No interactions with threatened, endangered or protected (TEP) species were recorded in 2010. The targeted nature of the fishery minimises the risk of interactions with TEP species.

Ecosystem Impact

There is little information on the direct impact of the fishery on the marine environment. However, the targeted nature of hook and line fishing combined with negligible physical damage to the benthos means that the fishery has minimal impact on the ecosystem.

Social Impact

In 2010, there were 19 active Coastal Line Fishery licences, which provided both direct and indirect local employment. A large proportion of the NT seafood harvest is consumed

domestically, with the industry supplying products to major national seafood markets. Subsistence fishing and recreational fishing continue to form an important component of the lifestyle and culture of many NT residents.

Economic Impact

At the point of first sale in 2010, the catch value of the commercial sector of the fishery was $0.43 million. The black jewfish component was $0.37 million and for golden snappers, it was $18 501. The recreational fishing sector's service and tackle industries also contribute to the NT economy.

STOCK ASSESSMENT

Monitoring

Catch and effort trends in the commercial and charter sectors are monitored through analysis of logbook data submitted by fishers on a monthly basis as a condition of the licence. Regular fishery-dependent sampling has also commenced on commercial and FTO vessels to expand the range of information being collected on target species in the fishery, including length, age and sex.

Stock Assessment Methods and Reliability

A major workshop was held in 1996 to provide advice on the status of fish stocks in the NT. The review found that although coastal fish stocks were not heavily utilised, there were signs of sequential, localised depletion, particularly around major population centres.

Using the limited data available (commercial catch and effort data and preliminary biological information), the annual catch was estimated to be 100 to 1000 tonnes. Since then, annual estimates of recreational catch have been released and it appears that the total harvest from the fishery by all sectors (including the Indigenous) is approaching the upper estimate of the original stock assessment estimates.

Current Harvest Status

The most recent assessment of the harvest status of the largest component of the fishery (i.e. the recreational sector) took place in 2000-01. Therefore, it is difficult to quantify the current harvest status of the entire fishery. A broad estimate would describe it as between moderate and high in the greater Darwin area.

Future Assessment Needs

There is a lack of information on the biology, stock structure and sustainable harvest limits for many of the NT's reef species. Regular monitoring trips on both commercial and FTO vessels are providing additional data, which will help describe the size and age structure of fish stocks harvested by the fishery and subsequently confirm the status of the stocks.

A comprehensive 12-month survey of recreational fishing in the NT that commenced in 2009 will provide up-to-date recreational catch estimates. The results are expected in 2011 and will be included in future fishery assessment reports.

RESEARCH

Summary

Concerns raised by stakeholders in 1995 regarding the sustainability of the fishery resulted in a four-year coastal fish research program. The project revealed important biological information on the age and growth of key coastal species and led to several legislative changes. The key findings of this work were:

- Black jewfish have a fast growth rate, reaching sexual maturity at around 97 cm in total length (TL) at four years of age.
- Golden snappers are a long-lived and late-maturing fish. Fifty per cent of females reach sexual maturity at 63 cm TL (eight to ten years old). Males reach maturity at a smaller size, with 50% maturing at 47 cm TL. The oldest golden

snapper sampled was 23 years old with a fork length of 82 cm.
- Grass emperors (tricky snapper) undergo a sex change, beginning life as females and developing into functional males at around 37 cm TL, at six years of age.

Since 2005, DoR has taken part in two multi-faceted, collaborative projects funded by the Fisheries Research and Development Corporation (FRDC), focusing on black jewfish. The key findings of the projects are listed below.

Age and Reproduction Studies

Studies of the age/length frequency of some 1000 black jewfish and the reproductive status of 500 black jewfish caught between August 2004 and August 2006, revealed that:

- Black jewfish in NT waters grow extremely fast, reaching around 60 cm TL in their first year and 90 cm in their second year.
- Black jewfish live for at least 12 years (specimens 140–142 cm TL).
- Fifty per cent of black jewfish are sexually mature at 89 cm TL (two years old).
- Spawning occurs over several months and peaks in December.

Habitat Mapping and Acoustic Tagging Studies

Acoustic Doppler current profiler surveys were conducted for 44 black jewfish at aggregation sites at Chambers Bay and Channel Point in 2006. The studies showed that:

- Black jewfish aggregation sites vary significantly in terms of bottom contour and current profiles as revealed in 2-D and 3-D maps.
- Black jewfish have an affinity for particular aggregation sites, with fish recorded in the same area up to 18 months later.
- Some fish appeared to be permanent residents at the aggregation sites, while others moved away and returned up to nine months later.

Barotrauma Study

Autopsies conducted on 108 black jewfish (obtained from commercial fishers and research fishing) revealed that they were highly susceptible to barotrauma, showing a range of conditions, including, haemorrhage (bleeding) and exopthalmos (bulging) of the eyes, hyperinflation or rupturing of the swim bladder (as a consequence of over-inflation), displacement and damage to visceral organs and damage to the circulatory system.

Black jewfish landed from less than 10-m deep water showed few signs of barotrauma and were likely to survive if released. Of the black jewfish landed from depths of 10 to15 m and from 15 to 20 m, 46% and 100%, respectively had injuries that rendered them unlikely to survive.

Unlike water depth at capture, the size of the fish, and the method of fishing, did not appear to affect the type or extent of barotrauma.

Ecological Risk Assessment

A risk assessment workshop was held for the fishery in June, 2009. Risks to the sustainability of each of the target and primary byproduct species (or group) were identified, providing the foundation for the management and research priorities for the multi-species, multi-sector fishery. Black jewfish and golden snapper showed the highest risk values in both low and high fishing effort areas and were identified as having the highest priority for management.

Incorporation into Management

Early research on NT reef fishes resulted in the implementation of a five-fish possession limit for black jewfish and golden snapper (within the general possession limit of 30 fish). The more recent work on black jewfish led to a further reduction in the possession limit for this species to two. The barotrauma project provided advice for recreational fishers on the catch and release of black jewfish.

Current Research

Current research projects include a program which involves the collection of tropical snapper frames from recreational anglers and FTOs across the Top End. The project has been extremely successful, with over 700 frames collected so far, which will provide important information on the size and age structure of snapper populations. The project has been extended for a further 12 months.

A golden snapper tagging program has commenced in Darwin and Bynoe harbours, with the support of the Amateur Fishermen's Association of the NT (AFANT). Fisheries staff, selected recreational anglers and FTO operators have to date, tagged over 300 juvenile fish in shallow waters in order to describe the movement and growth of this popular, but data-poor species.

MANAGEMENT/GOVERNANCE

Management

Objective

A range of short and long-term management objectives have been agreed by CLFMAC to ensure that the fishery remains sustainable. These include maintaining ecologically sustainable catches in all sectors and protecting key target species in populated regions from over-fishing.

History

Prior to the introduction of the NT Fisheries Regulations in 1993, the number of Coastal Line licences (formerly Inshore Reef licences) peaked at around 160. This number was reduced to 65 in the early 1990s through a moratorium on both the renewal of inactive licences and the issuing of new licences.

In 1995, significant amendments to the regulations governing the Coastal Line and Demersal fisheries came into force. These included extending the outer boundary of the fishery from 2 nm to 15 nm and allowing the transfer of Coastal Line licences. To avoid an overlap between fisheries, the inner boundary of the Demersal Fishery was shifted from 2 nm out to 15 nm. Demersal Fishery licensees who did not already hold a Coastal Line licence were issued with one, leading to the creation of 26 additional Coastal Line licences. This measure was accompanied by a two-for-one licence reduction scheme that allowed for the transfer of Coastal Line licences and removed excess fishing capacity. At present, there are 54 Coastal Line licences.

The re-adjustment of the fishery was undertaken to enhance its economic viability and productivity, and assist in the sustainable management of the resource. The need for the licence reduction program was reiterated during an FRDC-funded workshop conducted in 1996. Uncertainties in stock size estimates, excessive amounts of latent effort and increasing recreational fishing effort were identified as the major issues for the fishery.

Current Issues

The biology and life history traits of many key target species in the fishery make them vulnerable to over-fishing and localised depletion. Increasing fishing pressure on inshore fishing grounds has the potential to cause significant declines in the abundance of these species. Although recent research indicates that NT jewfish stocks are generally in good condition, there are concerns about particular aggregation sites in areas of high fishing activity. A shortage of detailed biological and stock assessment data on golden snapper also raises their level of risk to over-exploitation. CLFMAC is currently considering such issues and is in the process of developing a long-term management strategy for the fishery to ensure its future sustainability.

Various personal possession limits are in place to help regulate the impact of the recreational fishing sector. The recreational possession limit for jewfish was reduced from five to two on 1 January, 2010. Recreational fishers may also take no more than five golden snapper (as part of the general possession limit of 30 fish per person).

Future Plans

Ensuring that the harvest of coastal fish by all sectors is sustainable remains a primary management objective. The review of existing management arrangements will continue in 2011.

Compliance

The Water Police Section of the NT Police, Fire and Emergency Services is responsible for all fisheries compliance and enforcement in the NT.

There have been few reported problems with compliance in the fishery. The primary area of concern is the potential for the black market sale of fish by unlicensed fishers.

Consultation, Communication and Education

The NT Seafood Council, the Coastal Line Fishermen's Association and AFANT take an active role in the formulation of management policy for this fishery. Additionally, there are a number of regional coastal consultative committees, which provide formal advice from Aboriginal constituents on all aspects of fishing, including coastal species.

CLFMAC, which is a forum for key stakeholder groups, was re-established in 2008 to provide advice to government on management strategies and research on the fishery.

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COASTAL NET FISHERY STATUS REPORT 2010

INTRODUCTION

The Coastal Net Fishery operates within the inshore waters of the Northern Territory (NT) and may harvest a range of species, particularly mullet, blue threadfin, shark and queenfish. Commercial operators are not permitted to retain barramundi, king threadfins, Spanish mackerels or mud crabs. They are also required to clear their nets in water not less than 30 cm deep to facilitate the release of bycatch.

Commercial fishing effort in the fishery is relatively small and variable. A voluntary licence buy-back scheme for the fishery (with the purpose of closing Darwin Harbour and Shoal Bay to coastal net fishing) was undertaken in 2007. This reduced the number of licences in the fishery from 14 to five.

Recreational and Indigenous fishers are permitted to use amateur drag nets to take fish without a licence. These fishers often target the same species as commercial Coastal Net licensees.

Potential conflict between the commercial and recreational sectors was minimised in 2007 by the reduction of commercial effort in the fishery through the voluntary licence buy-back scheme.

PROFILE OF THE FISHERY

Commercial Sector

Area

The inshore fishery extends from the high water mark to 3 nautical miles from the low water mark. The fishery is regionalised, with licensees only able to fish in the single region nominated on their licence. The regions include:

- The Darwin region (from Cape Hotham to Native Point and Cape Ford to Cape Dooley).
- The Gove region (between Cape Arnhem and Cape Wilberforce).
- The Borroloola region (from Bing Bong Creek and Pelican Spit).

Some further access restrictions may apply around registered Aboriginal sacred sites and protected areas.

Fishing Method

Coastal Net Fishery licensees are permitted to use a coastal net of no more than 300 m in length, with a maximum drop of 5 m and mesh size not exceeding 65 mm. Nets may be anchored at one end only. Licensees 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 fishery licensee is permitted to use a gillnet with a mesh size up to 100 mm.

Catch

The total reported catch in 2010 was 7.4 tonnes, which was about half of the 14.1 tonnes caught in 2008 and a quarter of the 34.4 tonnes caught in 2007 (see Figure 1). The fishery averaged around 36 tonnes per year between 2001 (peak catch of 54 tonnes) and 2007, fluctuating between 25 and 35 tonnes annually. Much of the inter-annual variation in catch, effort and catch rate is probably due to licensees, many of whom hold licences for other fisheries, alternating between different fisheries, depending on such factors as catch rates and market demand. A reduction in the number of licences in the fishery has also contributed to the decrease in reported catch and effort.

Over 40 species have been retained by the commercial fishery since the introduction of log returns. Whilst mullet, blue threadfins, sharks and queenfish account for the majority of the catch, other common species include garfish, snappers and whiting.

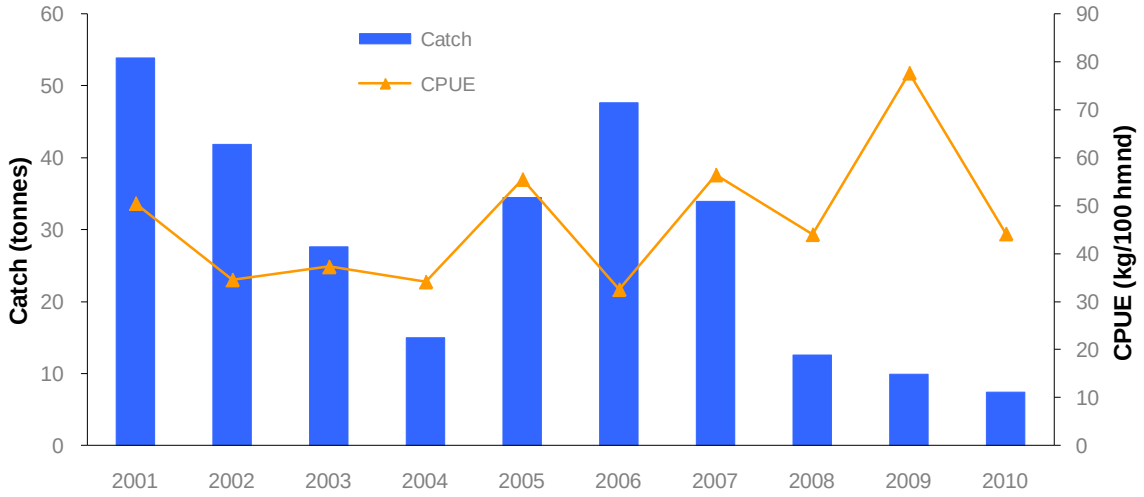

Figure 1. Commercial catch and catch per unit effort (CPUE) for the Coastal Net Fishery, 2001 to 2010

Effort

Three of the five licences in the fishery were active in 2010.

Effort in the fishery is expressed in '100 m net days' (hmnd). One hmnd equates to 100 m of net used for one day. Fishing effort in 2010 was 168 hmnd, an increase on the 2009 figure of 127 hmnd but well below the 10 year average of 672 hmnd.

Catch Rates

The CPUE for the fishery has averaged 46.7 kg/hmnd since 2001. The CPUE in 2010 was 44.1 kg/hmnd, which represents a close to average CPUE over the past decade.

Marketing

Most of the fish is sold fresh on ice whole, gilled and gutted or fillets. Most sales are to local markets close to the port of landing.

Recreational Sector

Area

Most recreational fishing effort is concentrated around Darwin, Gove and Borroloola.

Fishing Method

Amateur drag nets are used by some recreational fishers who target small fish and prawns for bait or for human consumption.

The use of amateur drag nets does not require a licence but the net must not exceed 16 m in length, a 2-m drop, or have a mesh size of more than 28 mm. Conditions are also placed on where the nets can be operated (i.e. seaward of the coastline) and how they are retrieved (i.e. by hand hauling only). The NT component of the National Recreational and Indigenous Fishing Survey (NRIFS) conducted in 2000-01, estimated that the total soak time for recreational nets set in NT waters was close to 10 000 hours (Coleman 2004).

Catch

Many of the key species harvested by commercial coastal net operators also form an important component of the recreational fishery of the NT.

Results from NRIFS indicated that mullet and salmon were important recreational fishing species. Sharks, prawns and bait fish are also important.

It is not clear what proportion of the catch of these species is used for human consumption and what proportion as bait.

Fishing Tour Operator Sector

Area

Fishing Tour Operators (FTOs) must have a licence to operate in NT waters and their clients are subject to the same controls as recreational fishers. They are restricted to waters of tidal influence excluding those in Kakadu National Park.

In 2010, FTOs were active throughout the coastal waters of the NT, with the majority concentrated in and around the Darwin area.

Fishing Method

Although FTO clients are permitted to use amateur drag nets (according to the rules and regulations for recreational fishers) very few choose to do so.

Catch

The FTO catch by drag net is considered negligible.

Indigenous Sector

Area

A large number of Indigenous communities and outstations are located along the NT coastline. Fishing effort is greatest near the large Indigenous communities on the Tiwi Islands and at Maningrida, Port Keats and Borroloola.

Fishing Method

Indigenous fishers in the NT typically use drag nets, cast nets and spears to harvest inshore fish and shark species.

Catch

A comparison of NRIFS data suggests a significant overlap in the harvest of primary species by Indigenous, recreational and commercial fishers.

Approximately 83 000 mullet are taken annually by Indigenous fishers (Henry and Lyle 2003). Other fish of importance to Indigenous fishers and the fishery include catfish (60 000), snappers (27 500), sharks (12 000), threadfins (8500) and trevally (8000) (Henry and Lyle 2003).

Non-retained Species

Commercial licensees are prohibited from retaining barramundi, king threadfins, Spanish mackerels or mud crabs. Operators are required to clear their nets in water not less than 30 cm deep to facilitate the release of any bycatch of these or other prohibited species.

Threatened Species Interaction

Fisheries Regulations prohibit the take of aquatic life listed as protected under the NT's *Parks and Wildlife Conservation Act*. The species vulnerable to capture in the fishery include dugong, turtles and crocodiles. However, the risk of interaction with these species is reduced through the requirement for all licensees to use only haul or surrounding nets and therefore be in continuous attendance of their gear when it is in use.

In 2010, there were no reported interactions with threatened, endangered and protected species.

Ecosystem Impact

There is little information on the direct impact of the fishery on the marine environment. However, the low level of fishing effort and the geographic extent of the fishery combined with negligible physical damage to the benthos means the fishery is considered to have an insignificant impact on the ecosystem.

Social Impact

Three licences were active in 2010 providing nominal employment opportunities. A large proportion of the NT wild harvest is dedicated to domestic consumption, with the commercial seafood industry supplying products to every major Australian seafood market. Subsistence fishing and recreational fishing continue to form an important component in the lifestyles and culture of a large proportion of people residing in the NT.

Economic Impact

At the point of first sale in 2010, the commercial sector of the fishery was valued at $33 236. The mullet component in 2010 was valued at $23 145.

STOCK ASSESSMENT

Monitoring

Activity in the fishery is monitored through the analysis of information from monthly catch and effort returns submitted as a statutory requirement under the NT *Fisheries Act 1988*.

Stock Assessment Methods and Reliability

No stock assessment has been undertaken of this fishery, primarily because of the small number of operators, limited catch and effort, and a wide range of species taken.

Current Harvest Status

Effort in the fishery is relatively low and the combined harvest by all sectors is considered to fall within ecologically sustainable limits.

Future Assessment Needs

Continued monitoring of catch rates and catch (including bycatch) composition of the fishery is required.

RESEARCH

Summary

Gear trials that assessed the suitability of various netting methods were undertaken during the early stages of the fishery. Fishery-dependent monitoring trips were also conducted at that time. A desktop study on the fishery was completed in 1997.

Incorporation into Management

Early gear trials led to changes in fishing methodology, such as modifications to mesh sizes and anchoring techniques.

Current Research

Current research in Queensland and Western Australia on tropical coastal species may be of relevance to this fishery.

A survey of recreational fishing in the NT began in April 2009. It will quantify resident and visitor catch, harvest, effort and expenditure. Results from this survey will provide an understanding of the recreational harvest of coastal species.

An FRDC project titled 'Defining the Stock Structure of Northern Australia's Threadfin Salmon Species' was completed in 2010. This work found that both king and blue threadfins show limited adult and larval movement between localised stocks separated by as little as several tens of kilometres. These findings suggest that management arrangements for both species need to be reviewed.

MANAGEMENT/GOVERNANCE

Management

Objective

The fishery will be cooperatively managed in such a way that the harvest of aquatic resources is equitable, in line with nationally-agreed principles of ecologically sustainable development, which optimises the benefit to the NT community now and in the future.

History

In 1986, four experimental special purpose (Haul Net) licences were issued to ascertain the feasibility of taking mullet and blue salmon by haul netting. The number of species harvested and the fishing methods used progressively expanded in subsequent years.

The fishery first became regulated following the implementation of the NT Fisheries Regulations. At that time, licences were offered to those persons who held an existing Special Purpose (Haul Net) Fishery licence, or a Bait Fishery licence.

Following an announcement by the NT Government in mid 2000 that Darwin Harbour and Shoal Bay would be closed to the fishery, a review was undertaken of its management arrangements along with the Bait Net and Aboriginal Coastal Net fisheries. Future management options were developed to minimise conflict between these commercial fisheries and the recreational sector, and simultaneously reduce pressure on coastal fish stocks adjacent to Darwin.

Current Issues

1. Economic viability - the industry considers that new areas and new gear are required to increase catches.

2. Indigenous interest in inshore fisheries may increase pending the outcome of negotiations with land councils following the Blue Mud Bay court decision.

3. Resource conflict with recreational fishers.

Future Plans

Future management options for the fishery may be revised following the outcomes of the Blue Mud Bay negotiations.

Compliance

The Water Police Section of the NT Police, Fire and Emergency Services is responsible for compliance and enforcement for all fisheries in the NT. This includes targeting the illegal use of nets by commercial and recreational fishers.

There have been few reported compliance problems in the fishery. However, as with all small-mesh net fisheries, there is a current concern regarding the alleged taking of juvenile managed species, such as barramundi and king threadfin.

Consultation, Communication and Education

The Department of Resources has maintained a regular, on-going dialogue with the Coastal Net Licensee Committee, the NT Seafood Council and the Amateur Fishermen's Association of the NT since the inception of the fishery. Such liaison is central to the sustainable management of the resource.

Senior Research Scientist – Dr Mark Grubert
Aquatic Resource Management Officer – Ms Patti Kuhl

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DEMERSAL FISHERY STATUS REPORT 2010

INTRODUCTION

The Demersal Fishery extends between 15 nautical miles (nm) from the coast and the outer edge of the Australian Fishing Zone (AFZ), excluding the waters of the Timor Reef Fishery. The catch is comprised mainly of gold-band snappers (*Pristipomoides* spp.) and red snappers (*Lutjanus malabaricus, L. erythropterus*). Red emperor (*L. sebae*) and cods (Family Serranidae) are key byproduct species. Drop lines and traps are the main gears used in the fishery.

Fishing effort in the fishery declined substantially in 2010 as many demersal fishers (who also hold Timor Reef Fishery licences) resumed fishing in the Timor Reef Fishery area for gold-band and red snappers.

Most of the fish taken by the Demersal Fishery licensees were marketed whole 'fresh on ice' on the Australian domestic market.

Red snappers and red emperor were also caught by the recreational and Fishing Tour Operator (FTO) sectors, primarily by hook and line. However, there was limited spatial or temporal overlap with commercial operators, given the offshore nature of the fishery. For similar reasons, no Indigenous harvesting was recorded in this fishery.

The fishery was assessed in 2009 by the then Australian Government's Department of Environment, Water, Heritage and the Arts (DEWHA) against the Guidelines for the Ecologically Sustainable Management of Fisheries and received full Export Exempt accreditation under the Australian *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The assessment demonstrated that the fishery was managed in a manner that did not lead to over-fishing, and that fishing operations had minimal impact on the structure, productivity, function and biological diversity of the ecosystem. The fishery is due for reassessment in May 2014.

PROFILE OF THE FISHERY

Commercial Sector

Area

The fishery operates in waters from 15 nm from the coastal baseline to the outer limit of the AFZ, excluding the area of the Timor Reef Fishery (Figure 1). Most of the fishing effort in the fishery occurs in areas east of the Timor Reef Fishery.

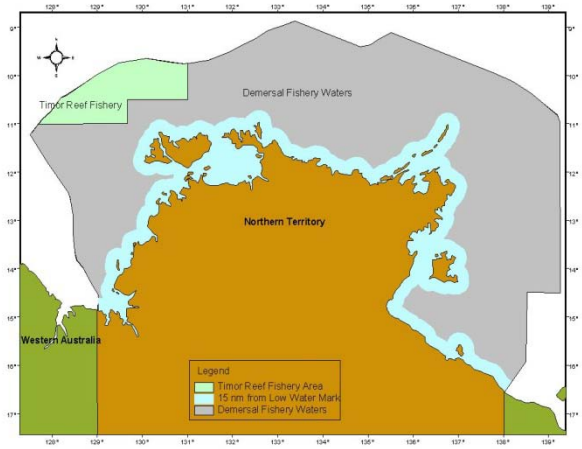

Figure 1. Location of the commercial Demersal Fishery

Fishing Method

Commercial operators are authorised to use baited traps and vertical lines, including hand lines and drop lines. These methods are consistent with those permitted for use in the Timor Reef Fishery. Since 2006, most operators have been using traps. This trend continued in 2010, when one vessel used drop lines and 11 used traps.

Catch

There are two principal target groups in the fishery: gold-band and red snappers. There are three gold-band snapper species: *Pristipomoides multidens, P. typus* and *P. filamentosus*. Together, they made up 44% of the total catch in 2010, with *P. multidens* the most common (>90%).

Red snappers are the other major target group, consisting of saddle-tail snapper (*Lutjanus malabaricus*) and crimson snapper (*L. erythropterus*), constituting 44% of the catch in 2010. Byproduct species are red emperor (*L. sebae*) and cods (Family Serranidae) (Figure 2).

The total commercial catch from the fishery in 2010 was 208 tonnes, representing a decline of almost 59% in the total catch compared with 2009 (505 tonnes). The gold-band snapper catch was 92 tonnes compared with 279 tonnes in 2009, and the combined red snapper catch was also 92 tonnes, compared with 181 tonnes in 2009.

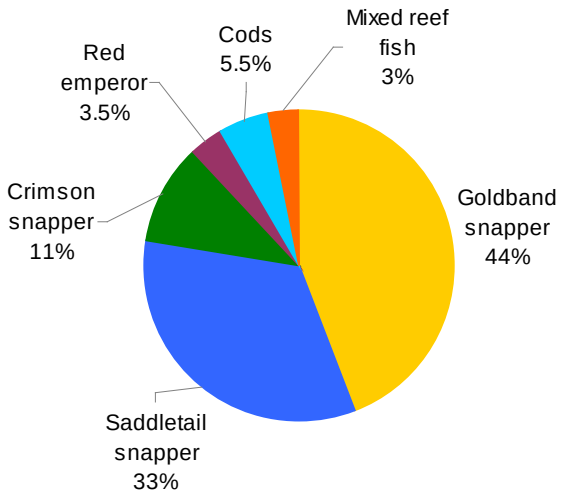

Figure 2. Overall catch composition of the Demersal Fishery in 2010

Byproduct Species

The byproduct catch (comprising mixed reef fish, cod and red emperor) accounted for 12% of the total catch, which is an increase of around 30% compared with 9% in 2009. This percentage exceeds the trigger reference point for byproduct species under the Management Objectives for the Demersal Fishery (Table 1). In response, the fishery and management arrangements will be reviewed during 2011 and recommendations will be made to the Executive Director of Fisheries at the completion of the review.

Effort

Twenty active licences (using 12 vessels) fished for 321 boat-days in the fishery in 2010. In comparison, there were only 10 active licences in 2009, which fished for 505 boat-days (Figure 3). The decline in effort most likely reflects the presence of part-time operators exploring demersal grounds or business decisions by other operators to fish in the nearby Timor Reef Fishery.

Catch Rates

Catch per unit effort (CPUE) has fluctuated considerably over the history of this fishery (Figure 4). Scientific evidence suggests that this is not due to changes in fish abundance or sustainability concerns; rather, the fluctuating CPUE reflects the small number of operators, their developing knowledge of the fishery and environmental factors, such as the La Nina weather pattern.

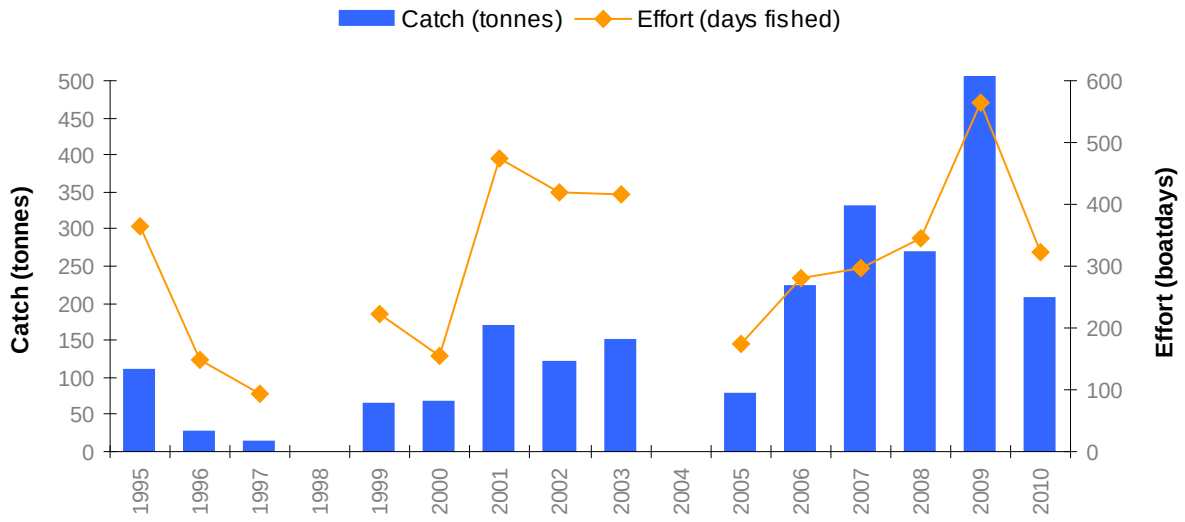

Figure 3. Commercial catch and effort for the Demersal Fishery, 1995 to 2010*

* Note: Due to confidentiality constraints (i.e. fewer than five operators working in a single fishery) data collected in 1998 and 2004 has not been published.

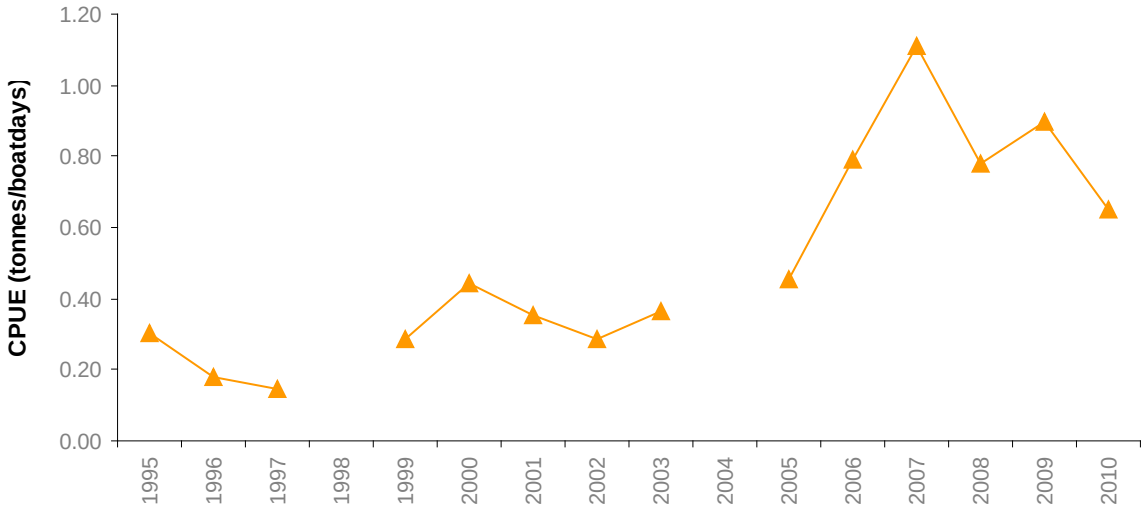

Figure 4. Total catch per unit effort (CPUE) for the commercial Demersal Fishery, 1995 to 2010*

* Note: Due to confidentiality constraints (i.e. fewer than five operators working in a single fishery) data collected in 1998 and 2004 has not been published.

Marketing

Currently, nearly all the fish landed within the line and trap fisheries are sold whole 'fresh on ice', with only a small amount sold as fillets. The small local Darwin market makes it necessary to send most of the product to interstate markets, principally Brisbane and Sydney. Increasingly, operators are developing marketing arrangements outside the wholesale central interstate marketing systems.

Recreational Sector

Recreational fishers operating predominantly in inshore waters catch some of the same species targeted by commercial operators working in the offshore fishery, particularly red snappers and red emperor. Although recreational fishers share the same resource as commercial fishers, their catches are currently considered negligible. Nonetheless, recreational fishers are considered in each review of the fisheries management arrangements to ensure their sector allocations are appropriately set.

Fishing Tour Operator Sector

Very few FTOs are active in the offshore areas typically fished by commercial operators. However, FTO activity is increasing each year. Whilst FTOs share the same resources as commercial operators, their catches are currently less than 1% of those of the commercial sector. FTOs are considered in all reviews of the fisheries management arrangements to ensure their sector allocations are appropriate.

Non-retained Species

No monitoring trips were conducted in the fishery during 2010. The monitoring trip conducted in 2009 confirmed that the fishing methods, gear, fishing grounds and catch composition in the fishery were similar to those of the Timor Reef Fishery. Non-retained species were reported to be less than 4% of the total catch and consisted mainly of trevally (Carangidae) with some sharks. Bycatch in this fishery is well below the 10% trigger value.

Threatened Species Interaction

In 2010, there were no recorded interactions with threatened, endangered or protected species in the fishery. The method of fishing and the location of the fishery generally prevent interaction with these species.

Ecosystem Impact

The management arrangements for the Demersal Fishery licensees allow operators to use passive vertical lines and traps. The effect of setting and hauling traps on substrate and bottom fauna is unknown, but to avoid excessive interaction with the substrate upon hauling, traps must be connected individually to an identifying float by a single line and not attached to one another. Anchoring is usually limited to overnight stand down of fishing activity.

The impact of 'ghost fishing' (i.e. the continued fishing of 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 entry and exit of fish from traps of the same design as used in the fishery.

Social Impact

The commercial sector of the fishery directly employs about 35 people as crew on boats and many others are employed by other related industries, such as transport and boat repairs. Recreational fishermen and FTOs target some of these demersal species. Product from the fishery supplies a healthy source of protein to consumers and ensures an economic return from natural resources to the community.

Economic Impact

The fishery was valued at $1.24 million in 2010. The gold-band snapper component was valued at $0.77 million and the red snapper component at $0.34 million.

STOCK ASSESSMENT

Monitoring

The fishery is monitored primarily through logbooks, which operators are required to fill out on a daily basis during fishing operations. The logs provide detailed catch and effort information, as well as information on the spatial distribution of the fishing operations. Logbooks are submitted with monthly marketing information by the 28th day of the following month.

A monitoring trip conducted during 2009 confirmed the similarity in methods, fishing

grounds and catch composition with the Timor Reef Fishery. With the present level of effort, monitoring information from the Timor Reef Fishery can be applied to the management of the Demersal Fishery.

Stock Assessment Methods and Reliability

An assessment of gold-band snapper stocks in 1994, using yield-per-recruit models and survey data, estimated an annual yield of 400 tonnes from the fishery in the Arafura Sea area of the fishery (Ramm 1994).

A further stock assessment of gold-band snappers was conducted in 2003. The assessment combined both the Demersal and Timor Reef fisheries, since a significant amount of fishing effort in the fishery occurs on grounds adjacent to the Timor Reef Fishery. The stock assessment indicated that an absence of key parameters precluded the estimation of an absolute figure for sustainable harvest. Such parameters include an understanding of the Indonesian catch and effort, the level and interchange of fish and recruits, and productivity parameters for gold-band snappers.

An assessment of red snappers, including both *Lutjanus malabaricus* and *L. erythropterus*, was conducted in 1996 by Professor Carl Walters at a workshop in Darwin. Data from an independent trawl survey was used to provide a red snapper biomass estimate of 24 000 tonnes and a conservative annual sustainable harvest of 1500 to 2500 tonnes from the Arafura Sea area of the fishery (Ramm 1997).

Genetic studies conducted as part of an Australian Centre for International Agricultural Research (ACIAR) project provided some evidence indicating that separate stocks of *L. malabaricus* exist between Australia and Indonesia, but that it was difficult to separate stocks of *L. erythropterus* genetically, especially in the eastern areas of the Arafura Sea (Salini et al. 2006). Future assessment will need to recognise that although there appears to be some separation of stocks, in some instances the same stocks are fished by Indonesia and Australia.

Additional age data is being collected for inclusion in stock assessment models to determine more refined sustainable yield estimates for both the gold-band and red snapper species groups (see Current Research, below).

Current Harvest Status

Harvest levels in Australian waters of the Arafura Sea are below current triggers set for a review of management arrangements. The combined harvest of red snappers, from both the Demersal Fishery and the Finfish Trawl Fishery, was less than 940 tonnes, which is well below the lowest limit for sustainable harvest.

Future Assessment Needs

Gold-band and red snapper (both *L. malabaricus* and *L. erythropterus*) assessment needs are being addressed at a national level through a collaborative project involving the Northern Territory (NT), Western Australia and Queensland (see Current Research below).

Although adult red snappers appear to have reasonably limited movement patterns, information on the movement of snappers prior to recruitment to the fishery (larval and juvenile stages) is lacking. Better information on juvenile habitats, movements and biological characteristics will extend our knowledge of poorly-understood life history parameters of all targeted species (gold-band and red snappers). This will provide a better understanding of combined harvest effects on shared stocks (particularly in the Gulf of Carpentaria).

Indonesian catch and effort information would also assist in stock assessment and in determining sustainable yields in the Australian fishery.

RESEARCH

Summary

Geographic information system spatial statistical methods have shown that there is a relationship between bathymetry and geomorphology, and high catches of gold-band snappers (Lloyd and Puig 2010). Although this work was undertaken in the Timor Reef Fishery, there are implications for the Demersal Fishery. The Demersal Fishery has a smaller catch than the Timor Reef Fishery; however, the results from this project have shown that there is an extensive area of potential high productivity in the fishery, which is largely unexploited at present.

The stock structure of gold-band snappers (*P. multidens*) has been determined through a number of externally-funded projects (Ovenden et al. 2000; Newman et al. 2000). Red snapper biology, life history and sustainability have been investigated by the ACIAR project FIS/1997/165 (Salini et al. 2006; Blaber et al. 2005), which is available on the ACIAR web site: www.aciar.gov.au.

Incorporation into Management

Research findings up to now suggest that the current harvest target levels are appropriate for the ecologically sustainable development of the fishery. Collaboration with Queensland, Western Australia and Indonesia will continue to provide information on the management of tropical stocks.

Current Research

Current research is focussed on obtaining more comprehensive age data for the targeted offshore snapper species. A collaborative project led by the Queensland Department of Employment, Economic Development and Innovation's Fisheries Division, is assessing the use of current monitoring and logbook datasets to identify critical indicators and develop a monitoring program to provide fishery-independent data for gold-band and red snapper stock assessment. The monitoring program that will result from this project is expected to provide annual spatially-referenced age data and an index of relative abundance for the offshore snapper species across northern Australia. The data will provide essential information for establishing annual harvest rates to ensure greater reliability of stock assessments.

A research project is being conducted to identify juvenile red snapper nursery grounds. Initially, this project is expected to provide information on seasonal settlement and movement patterns as well as age information from smaller fish for current stock assessment models.

MANAGEMENT/GOVERNANCE

Management

Objective

The overall management objective for the fishery is to maintain catches of gold-band snapper and red snappers by all sectors within acceptable ranges. Should landings of these species from the Timor and Arafura seas, and from the Gulf of Carpentaria, rise above sustainable yield estimates, a review of the management arrangements will commence. Similarly, a significant decline in catch rates would prompt a review of the management measures for this fishery (see Table 1).

History

The NT and Australian governments jointly manage the fishery through the NT Fisheries Joint Authority. Day-to-day management is the responsibility of the Department of Resources (DoR) in accordance with the NT *Fisheries Act 1988*.

Current Issues

The development of this fishery (particularly the red snapper component) and the encouragement of operators to fish in the entire fishery area in an ecologically sustainable manner continue to be the management focus for this fishery.

The impact of illegal, unreported and unregulated (IUU) fishing in northern Australian waters, primarily by foreign fishers, remains uncertain.

The NT Government continues to work with the Australian Government to ensure appropriate measures are applied to mitigate the impact of IUU fishing on the sustainability of red snapper stocks.

Catches in the fishery have slowly increased with operators committing more expertise and resources to the development of the fishery. As a result, the NT Government informed fishers in 2006 that it was exploring mechanisms to stimulate the less active licence effort in the fishery, to secure gold-band snapper grounds for non-trawl fishing methods and expand the Finfish Trawl Fishery (which also fishes in the area of the Demersal Fishery). An Offshore Snapper Advisory Group (OSAG), comprising members from the industry, recreational fisher and FTO representatives, compliance and departmental officers was established in 2010 to develop a comprehensive policy and management framework incorporating a mechanism to better utilise the offshore snapper resources, focussing primarily on red snappers as the resource is thought to have the greatest potential for growth.

OSAG considered public comments received from stakeholders and interested parties during 2008-09, which indicated support for the following alternative proposal to facilitate the development of the offshore snapper fisheries:

- An agreement for the Finfish Trawl and Demersal fisheries to be managed within a quota management framework.
- The allocation of units of entitlement (as individual transferable quota) to existing licences in the Finfish Trawl and Demersal fisheries.
- The exclusion of the gold-band habitat area from the Finfish Trawl Fishery and inclusion of a similar-sized new ground to the Finfish Trawl Fishery. This will require OSAG to liaise with other fisheries, including those managed by the Australian Government.
- Development of a management framework by OSAG incorporating a mechanism to better utilise the red snapper resources.

Future Plans

A draft management framework addressing the above points has been developed by OSAG and was out for an extended public comment, ending in late January 2011. Comments received from this process will facilitate the further development of the framework.

The NT and Australian governments continue to work closely with the Indonesian Government to develop a bilateral management guide for shared red snapper stocks in the Arafura Sea.

Compliance

The Water Police Section of the NT Police, Fire and Emergency Services, is responsible for fisheries compliance and enforcement in the NT under the NT *Fisheries Act 1988*.

Arriving and departing vessels are inspected at the Port of Darwin, which is the only catch landing point currently used by fishery operators. Logbook returns submitted by fishery operators are validated against market returns. All operators are required to specify in their market returns where they are selling their product. Where required, returns submitted by traders/processors are also analysed and used to validate fishery logbook returns.

In 2010, there were no recorded compliance issues.

Consultation, Communication and Education

Regular consultation occurs between DoR, the NT Demersal Fishermen's Association and the NT Seafood Council. In addition, DoR officers regularly visit the wharf to speak informally with fishers.

The low number of active participants in the fishery allows all stakeholders to be directly involved in discussions on any proposed management arrangements.

DoR also produces publications, such as Fishery Reports, Fishnotes and newsletters to inform and educate stakeholders.

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Aquatic Resource Manager – Mr David McKey

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Table 1. Management objectives and status against performance indicators for the Demersal Fishery

Species or group	Management objectives	Performance indicator	Trigger reference point	Current status review	Management response to be taken
Gold-band snapper	Ensure inter-generational equity by maintaining ecologically sustainable annual catches in all sectors.	Optimal sustainable yield estimates.	Catch levels increase to 90% of estimated sustainable annual yield.	Gold-band snapper catch in 2010 was 92 tonnes (279 tonnes in 2009). The trigger reference point was not reached.	Demersal Fishery Management Advisory Committee (DFMAC) to review fishery and make recommendations to the Executive Director of Fisheries (EDF) regarding appropriate measures to ensure annual catches do not exceed estimated sustainable yields and on-board monitoring if not already in place, to commence at earliest practical opportunity. Amended arrangements to be implemented within 12 months of trigger being released.
Red snappers	Optimal sustainable yield estimates met.	Optimal sustainable yield estimates.	Catch levels increase to 90% of estimated sustainable annual yield.	The combined red snapper catch in 2010 was 92 tonnes (181 tonnes in 2009). The trigger reference point was not reached.	
Byproduct species (including red emperor and cods)	Ensure sustainability of byproduct species taken in the Demersal Fishery.	Monitoring of commercial logbook returns. Significant change in catch composition on Demersal Fishery grounds.	Annual catch increase in proportion of the total catch by more than 10% above the five year average.	Combined byproduct species in 2010 was 25 tonnes. The trigger reference point was reached.	DFMAC to review fishery and make recommendations to the EDF and on-board monitoring to commence at the earliest practical opportunity. Amended arrangements to be implemented within 12 months of trigger being released.
Bycatch species	Ensure sustainability of bycatch species taken in the Demersal Fishery.	On-board monitoring of the adjacent Timor Reef Fishery.	Total bycatch within the Demersal Fishery increases to 10% of total catch or a decline in a species relative numbers without a corresponding change in fishing area or fishing technique.	Total bycatch in 2010 at 4%. The trigger reference point was not reached. On-board monitoring to continue annually.	DFMAC to make recommendations to the EDF regarding appropriate remedial action and on-board monitoring to commence at the earliest practical opportunity. Amended arrangements to be implemented within 12 months of trigger being released.
Threatened, endangered or protected species and/or communities.	Maintain the present level of interaction between demersal fishing operations and species and communities listed under the EPBC Act.	Threatened, endangered or protected species and/or communities are identified in Northern Territory waters.	Identifiable impacts observed by commercial fishers, fisheries observers or other agencies regarding the EPBC Act listed species or communities.	No identifiable impacts observed in 2010. The trigger reference point was not reached.	DFMAC to make recommendations to the EDF regarding appropriate threat abatement plan implemented and on-board monitoring to commence at the earliest practical opportunity. Amended arrangements to be implemented within 12 months of trigger being released.

Species or group	Management objectives	Performance indicator	Trigger reference point	Current status review	Management response to be taken
Ecosystem components.	Minimise the effects of fishing on ecosystem components.	Identification of threatening processes.	Identification of significant negative interaction with components of the natural ecosystem present on demersal fishing grounds.	No negative ecosystem interactions identified in 2010. The trigger reference point was not reached.	DFMAC to make recommendations to the EDF regarding appropriate remedial action. Amended arrangements to be implemented within 12 months of trigger being released.

DEVELOPMENT FISHERY STATUS REPORT 2010

INTRODUCTION

The commercial fishing industry is characterised by evolving technologies and changing market opportunities. To conduct trials of new fishing gear, or to encourage the sustainable harvest of aquatic resources currently not utilised by existing fisheries, commercial operators are required to apply for a development permit or licence.

Fishers who wish to conduct development trials are required to lodge written applications providing detailed information about their proposed activities. Each application is assessed on a case-by-case basis, with relevant input from fishery stakeholders.

Applicants that are approved by the Executive Director of Fisheries are issued a development permit valid within the licensing year commencing in July. Performance criteria are assigned to each permit so that the feasibility of the trials may be assessed. Permit holders who have satisfied all aspects of the performance criteria may re-apply for a development permit or, if appropriate, a development licence.

Development licences may be issued to approved applicants for up to one licensing year and may be renewed a maximum of four times. Where licence holders meet all performance criteria and remain able to demonstrate that the fishery and/or gear is both ecologically and economically sustainable, the fishery and/or gear in question may progress to a managed fishery.

DEVELOPMENT PERMITS

In 2010, one development permit was issued to trial the harvest of sea urchins. Confidentiality constraints prohibit the release of catch and effort information for this permit.

DEVELOPMENT LICENCES

In 2010, two development licences were issued to trial the harvest of squid and bait fish, using alternative gear types. One was for the use of lift net and drop net gear, whilst the other was for the use of a small purse-seine net.

The development of a local, ecologically sustainable bait fishing industry to supply bait for use by all fishery sectors would be advantageous to the Northern Territory (NT). Most of the bait currently sold in the NT is imported from interstate and overseas.

Fishing Method

A lift net is a small net that is opened alongside the vessel. Lights are used to encourage fish into the net before the net is closed and lifted aboard. A drop net operates similarly to a cast net. Fish are encouraged under the net by the use of lights, and then the net is dropped and then hauled on board. The purse seine method of fishing involves surrounding a school of fish with a net and then pulling the bottom of the net together to form a purse or pouch around the fish.

Catch

Confidentiality constraints prevent the publication of specific catch and effort data for the two development licences. However, the composition of catch harvested in the Developmental Bait Fishery during 2010 primarily consisted of herring, pilchards and sardines (Figure 1).

No sea urchin catch was recorded in 2010.

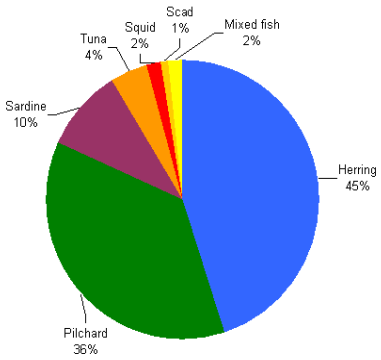

Figure 1. Catch composition in the Development Bait Fishery in 2010

Non-retained Species

A small number of mackerels (<1%) comprising Spanish mackerels, grey mackerels, spotted mackerels and unidentified mackerels were taken during trials in 2010.

Ecosystem Impact

The impact by a proposed development trial on the ecosystem is considered when assessing an application for a permit or licence. All applications are considered on the premise of the precautionary principle to provide the greatest care to the environment in which the trials are conducted. The Department of Resources (DoR) has encouraged fishing practices that cause minimal impact to the ecosystem. The harvest strategy for the fishery ensures that appropriate gear is used, that fishing occurs in appropriate locations and that conservative catch volumes are taken from the targeted stock.

Since sea urchins are collected by hand, there is no interaction with non-target species.

Monitoring

Permit and licence holders are required to provide records of the daily catch and annual activity reports as required by permit/licence conditions.

One monitoring trip was conducted by a DoR fisheries scientist on the vessel that operated the development licences for squid and bait fish. The purpose was to independently validate the catch and help with more accurate species identification. Monitoring trips will continue to be a requirement of new licences if granted in future years.

MANAGEMENT/GOVERNANCE

The appropriateness of the equipment and methods are governed by the conditions of the permit or licence. They may include restrictions on the type of gear permitted, the time and place in which trials may occur and limits on the target and bycatch species. Formal performance criteria are applied to all development permits and licences.

Aquatic Resource Management Officer – Mr Dan Firth
Research Scientist – Mr Grant Johnson

FINFISH TRAWL FISHERY STATUS REPORT 2010

INTRODUCTION

The principal species landed in the Finfish Trawl Fishery are red snappers (*Lutjanus malabaricus* and *L. erythropterus*). Products from this fishery are marketed primarily as whole fresh fish, mostly on the Australian domestic market.

The fishery is comprised of a single trawl operator fishing in offshore waters east of Darwin, including the northern region of the Gulf of Carpentaria.

The Northern Territory (NT) Fisheries Joint Authority (NTFJA), through the NT *Fisheries Act 1988*, manages all finfish taken in the fishery while the day-to-day management of the fishery is conducted by the Department of Resources (DoR).

The fishery was assessed in 2009 by the then Australian Government's Department of Environment, Water, Heritage and the Arts against the Guidelines for the Ecologically Sustainable Management of Fisheries. Full export exemption accreditation was subsequently issued under the Australian Government's *Environment Protection and Biodiversity Conservation Act 1999*. The assessment demonstrated that the fishery was managed in a manner that does not lead to over-fishing and that fishing operations have minimal impact on the structure, productivity, function and biological diversity of the ecosystem. The fishery is scheduled for re-assessment in May 2014.

PROFILE OF THE FISHERY

Commercial Sector

Area

The fishery operates in offshore waters east of Darwin to the outer limit of the Australian Fishing Zone (AFZ), excluding the area of the Timor Reef Fishery (Figure 1).

Within this overall area of approximately 202 000 km^2, only a relatively small portion is currently fished due to the single operator targeting the higher-yield red snapper fishing grounds. Although legally able, the Finfish Trawl Fishery operator does not presently fish the same grounds as the Demersal Fishery licensees.

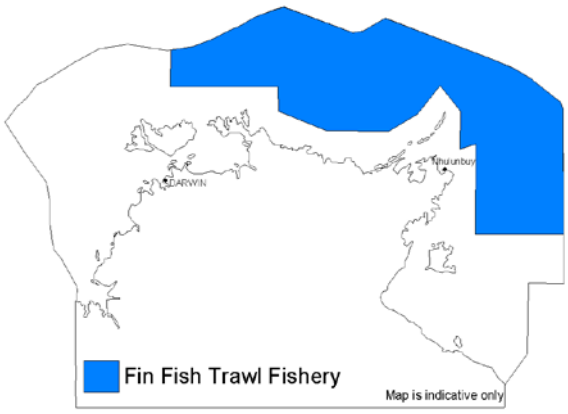

Figure 1. Fishing area available to the commercial Finfish Trawl Fishery

Fishing Method

Fishing operations are conducted using a semi-pelagic demersal trawl. The trawl net was developed cooperatively by the industry and DoR to minimise habitat disturbance whilst ensuring commercial catch rates were maintained. The quality of the retained catch was also improved by the reduction in the number of sponges and other unwanted species associated with the operations of traditional demersal trawls.

The operator is currently using bycatch reduction devices (BRDs) and a square mesh funnel in order to increase the value of the landed product, rather than increase his catch volume.

Catch

Saddle-tail snapper (*Lutjanus malabaricus*) and crimson snapper (*L. erythropterus*) are the target species of the fishery comprising 79% of the total catch (Figure 2).

Since 1995, catches have increased steadily (Figure 3). In 2010, the catch was 1072 tonnes. As there is only one operator in this fishery, care must be taken in interpreting catch trends as they may reflect business decisions rather than fish abundance.

In 2010, the byproduct harvested reached 228 tonnes, comprising mainly of painted sweetlip (*Diagramma labiosum*), red spot emperor (*Lethrinus lentjan*), and gold-band snappers (*Pristipomoides multidens* and *P. typus*).

Effort

Fishing effort has increased steadily from 158 boat-days in 1995 to 325 boat-days in 2010, a similar effort to the 323 boat-days in 2009 (Figure 3). However, as with interpreting catch, there are many reasons for changes to effort that are particularly evident in a single operator fishery.

Catch Rates

Since 1997, the catch per unit effort (CPUE) has shown little change, ranging from 3.0 to 3.9 tonnes per boat-day (Figure 4). CPUE for 2010 was 3.3 tonnes per boat-day.

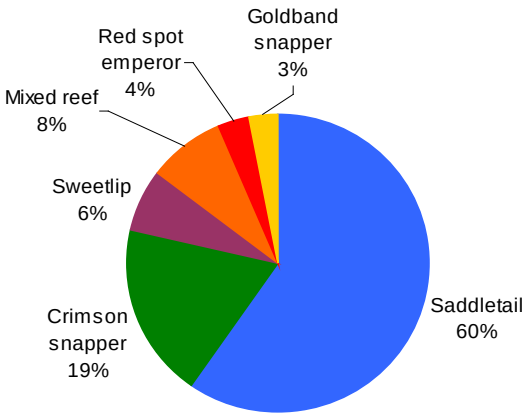

Figure 2. Catch composition for the Finfish Trawl Fishery in 2010

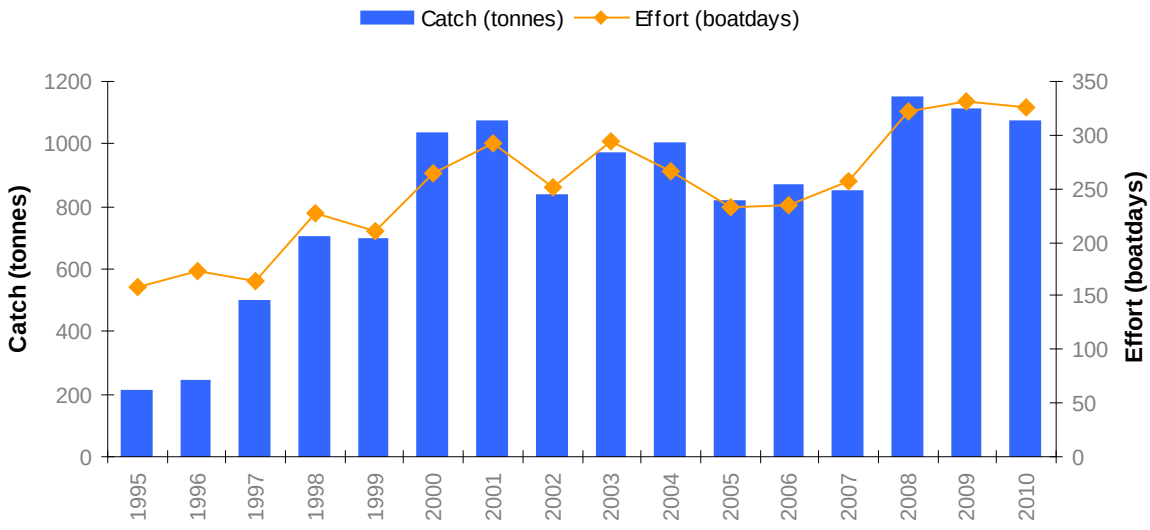

Figure 3. Total catch and effort within the commercial Finfish Trawl Fishery, 1995 to 2010

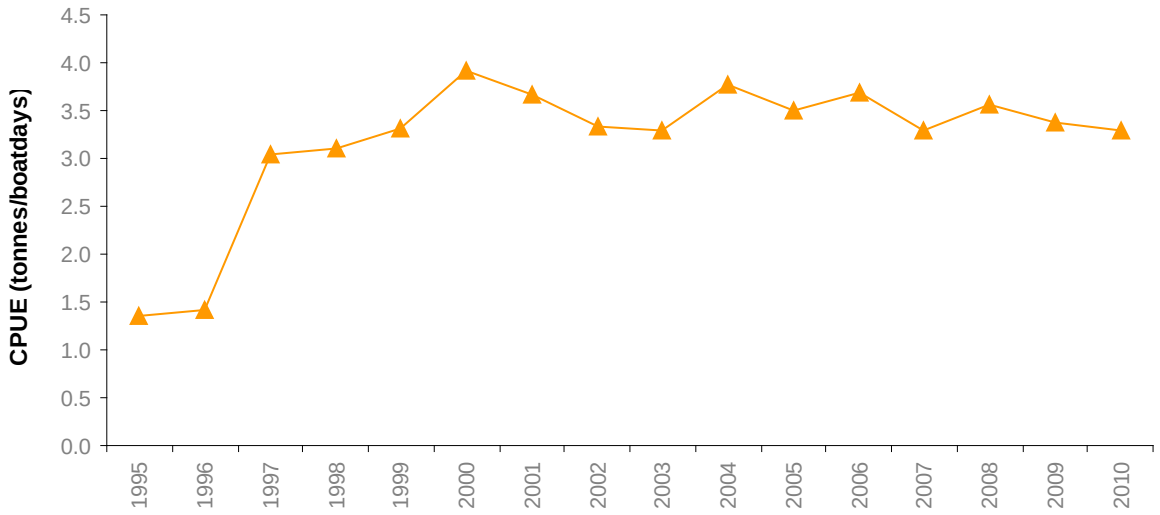

Figure 4. Commercial catch per unit effort (CPUE) for the Finfish Trawl Fishery, 1995-2010

Marketing

The product is transported from Darwin in refrigerated trucks to southern markets where 80% of it is sold as fresh fish. The remaining 20% is exported to Asia and North America.

Recreational Sector

Recreational fishers take some of these species from inshore waters, particularly saddle-tail snapper, crimson snapper and red emperor. The interaction between recreational fishers and the Finfish Trawl licensee is negligible.

Fishing Tour Operator Sector

The majority of Fishing Tour Operator (FTO) activity is in inshore waters where some of the same species are taken.

Non-retained Species

Logbook records reported that an average of 12% of the total catch in 2010 was discarded. Most of the discarded species (by weight) were sharks and rays as there is a 'no-take' regulation in place regarding these species.

To assist in reducing release mortality, the operator has developed a system comprising grids and rails on the fish hopper to enable sharks and rays to be returned alive to the water via a chute. The hopper system is being evaluated by other trawl fisheries interstate with the intention of incorporating its use as standard operating practice. Additionally, the operator is trialling a BRD designed to exclude large sharks and rays from the landed catch and assist in improving product quality.

During observer trips since 2008, there has been a noticeable decline in the numbers of larger animals seen on the hopper. This is likely to be due to design improvements of the BRD, which enable larger sharks and rays to escape from landing.

Threatened Species Interaction

In 2010, no interactions with threatened, protected or endangered species were recorded.

Ecosystem Impact

DoR has encouraged fishing practices that cause minimal impact to the ecosystem.

The development of a semi-pelagic demersal trawl net in conjunction with the industry minimises seabed disturbance and reduces the amount of bycatch and environmental impact in the fishery. The use of a BRD in conjunction with

the square-mesh funnel/codend is expected to further reduce broader ecosystem impacts.

Social Impact

This fishery directly employs fewer than 10 people. However, there are flow-on benefits from the fishery for other industries, such as freight haulage, gear storage and vessel repairs. Recreational fishers also target some of the same species (from inshore waters) and recreational fishing forms an important component of the lifestyles and culture of a large proportion of people residing in the NT.

Economic Impact

Confidentiality constraints prevent the publication of the economic value of this fishery.

STOCK ASSESSMENT

Monitoring

The fishery is monitored primarily through logbooks, which operators are required to fill out on a daily basis during fishing operations. The logs provide detailed catch and effort information, as well as information on the spatial distribution of fishing activity within the fishery. Daily logbooks are submitted along with marketing information by the 7th day following the end of the trip. In addition to logbooks, DoR observers conduct on-board monitoring of commercial fishing trips. While on-board, observers document vessel and gear information, location, depth, fishing practices, catch composition (including bycatch), and where possible, measure most landed species.

One on-board monitoring trip was undertaken in 2010. This level of monitoring is considered adequate given the single operator, relatively low levels of bycatch and the proactive actions taken to further reduce the level of bycatch.

Stock Assessment Methods and Reliability

Stock assessments for the fishery were conducted in 1996 and 2004. The initial assessment used a stock reduction analysis model developed by Professor Carl Walters (Ramm 1997). The more recent assessment used yield per recruit and biomass dynamics models, which incorporated updated biological parameters (Blaber et al. 2005).

Despite genetic studies showing some separation of saddle-tail snapper (*L. malabaricus*) stocks between Australia and Indonesia, separation of crimson snapper (*L. erythropterus*) stocks is less certain, especially in the eastern Arafura Sea.

Some stocks are currently fished by both countries (Blaber et al. 2005; Salini et al. 2006). An absolute figure cannot be placed on sustainable harvest for the fishery because key parameters (Indonesian catch and effort, level of interchange of fish and recruits and important productivity parameters for red snappers) are not well known.

For the Australian sector of the Arafura Sea, the biomass of red snappers was estimated by a fishery-independent survey in 1990 to be 24 000 tonnes. It has been agreed that a harvest level trigger of 10% of this estimate be implemented for management purposes. Additional age data is currently being collected for inclusion in stock assessment models to assist in determining more refined sustainable yield estimates for the red snapper species group (see Current Research).

Current Harvest Status

The high level of Indonesian trawl fishing in the Arafura Sea adjacent to the AFZ should not imply that the Australian sector is unsustainable. The question of sustainability of the Australian sector of this fishery depends on where recruitment occurs and the level of movement of fish between the two countries. Given the results of the genetic studies conducted as part of an Australian Centre for International Agricultural Research (ACIAR) project, which indicate that there is some genetic separation of stocks (see above), the effect of fishing in Indonesian waters may be small (Salini et al. 2006). However, there is a lack of information on recruitment and the movement of

snappers prior to recruitment (larval and juvenile stages). Better information on juvenile habitats, movements and biological characteristics will assist in determining the interaction between Australian and Indonesian fishing on red snapper populations.

Over the past 10 years, CPUE has remained relatively constant (Figure 4) and harvest levels in the Australian sector of the Arafura Sea are below current reference points.

Future Assessment Needs

The future assessment needs for red snapper research are being addressed at a national level through the Northern Australian Fisheries Management Forum.

There is consensus that the following areas are of high priority:

- Completing an updated red snapper stock assessment.
- Warehousing for historical data.
- Conducting fishery-independent surveys.
- Identifying juvenile habitats.
- Investigating the degree of movement of red snappers.
- Investigating the effect of illegal, unreported and unregulated fishing on red snapper stocks.

Several of these priorities are being addressed through a collaborative project led by Fisheries Queensland, which is a part of the Queensland Department of Employment, Economic Development and Innovation. The project will assess the utility of current monitoring and logbook datasets for stock assessment, conduct a risk analysis and develop a monitoring program to provide fishery-independent data for red snapper assessment.

RESEARCH

Summary

A joint project between DoR, CSIRO and Indonesia, funded by ACIAR (project FIS/1997/165), has investigated the biology, life history and sustainability of the target species (*Lutjanus malabaricus* and *L. erythropterus*) for this fishery, which account for 79% of the Finfish Trawl Fishery catch. Findings from this project are outlined in the final report to ACIAR, which is available on the ACIAR website: http://www.aciar.gov.au. As noted above, genetic studies conducted as part of this project provide some evidence that separate stocks of *L. malabaricus* exist between Australia and Indonesia, but that stocks of *L. erythropterus* are less able to be separated genetically, especially in the eastern areas of the Arafura Sea (Salini et al. 2006). Future research will need to consider that although there appears to be some separation of stocks, in some instances the same stocks are fished by both countries. In addition, information on the movement of snappers prior to recruitment to the fishery (larval and juvenile stages) is lacking. Better information on juvenile habitats, movements and biological characteristics will extend our knowledge of the poorly-understood life history parameters of red snapper species (Salini et al. 2006).

Incorporation into Management

Stock assessment findings have been incorporated into management plans, ensuring that trigger points are set within sustainable limits for the Australian sector of these stocks. Collaboration with Queensland, Western Australia and Indonesia will continue to provide information on the management of snapper stocks.

Current Research

Current research is focussed on obtaining more comprehensive age data for the red snapper species. The monitoring program that will result from the collaborative project with Queensland (noted above) is expected to provide annual, spatially-referenced age data and an index of relative abundance for the offshore snapper species across northern Australia. The data will provide essential information for establishing annual harvest rates and, in turn, ensure greater certainty in stock assessments.

A research project to identify juvenile red snapper nursery grounds is being conducted. Initially, this project is expected to provide information on seasonal settlement and movement patterns as well as provide age information from smaller fish for inclusion in current stock assessment models.

On-going research on the effectiveness of bycatch reduction devices is being conducted by the Finfish Trawl Fishery operator.

MANAGEMENT/GOVERNANCE

Management

Objective

The management of the fishery seeks to ensure the ecological sustainability of target, byproduct and bycatch species. Trigger points and management actions for the fishery are listed in Table 1. An appropriate management response would be made in consultation with stakeholder groups should a trigger point be reached. Amended arrangements are to be implemented within 12 months of a trigger being activated.

History

With the passage of the revised jurisdictional arrangements contained in the Offshore Constitutional Settlement of 1995, management of the trawl, shark and line fishing and trapping in waters adjacent to the NT passed to NTFJA.

NTFJA provides for the Australian and NT governments to jointly manage the fishery given the likelihood of shared resources with adjacent national and international jurisdictions. DoR conducts the day-to-day management of the fishery on behalf of NTFJA.

Current Issues

The impacts of illegal, unreported and unregulated (IUU) fishing in northern Australian waters, primarily by foreign fishers remain poorly understood. DoR continues to work with the Australian Government to ensure appropriate programs are implemented to mitigate IUU impacts on the sustainability of red snapper stocks. It is not yet possible to determine the potential effect IUU fishing is having on the tightly-regulated domestic fishery.

DoR, in consultation with the industry, has held a series of workshops to develop a sectoral development plan for offshore snappers. The Finfish Trawl Fishery shares the same area, and potentially the same stocks, as the Demersal Fishery. Discussions led the NT Government to inform fishers in the Demersal and Finfish Trawl fisheries in 2006 that it was exploring mechanisms to rationalise the latent licence effort in the Demersal Fishery, securing gold-band snapper grounds for non-trawl fishing methods and expanding Finfish Trawl effort.

An Offshore Snapper Advisory Group (OSAG), comprising members from industry, recreational fisher and FTO representatives, compliance and departmental officers was established in 2010 to develop a comprehensive policy and management framework incorporating a mechanism to better utilise the red snapper resources.

OSAG considered public comments received mainly from stakeholders and interested parties during 2008-09, which indicated support for the following alternative proposal to facilitate the development of the offshore snapper fisheries:

- An agreement for the Finfish Trawl and Demersal fisheries to be managed within a quota management framework.
- The allocation of units of entitlement (as individual transferable quota) to existing licences in the Finfish Trawl and Demersal fisheries.
- The exclusion of the gold-band snapper habitat area from the area available for fishing by finfish trawl gears and inclusion of a similar-sized new ground for use by finfish trawl gear. This will require OSAG to liaise with other fisheries, including those managed by the Australian Government.
- Development of a management framework by OSAG incorporating a

mechanism to better utilise the red snapper resources.

Future Plans

A draft management framework addressing the above points has been developed by OSAG and was out for extended public comment by late January 2011. The comments received from this process will facilitate the further development of the framework.

The NT and Australian Governments continue to work closely with the Indonesian Government to develop a bilateral management plan for shared red snapper stocks in the Arafura Sea.

Compliance

The Water Police Section of the NT Police, Fire and Emergency Services is responsible for all fisheries compliance and enforcement in the NT. This involves the inspection of vessel arrivals and departures through the port of Darwin as well as verification of catch returns against processor returns. If necessary, it has the power to investigate the records of wholesalers and licensees.

In 2010, there were no recorded compliance issues in this fishery.

A compliance risk assessment has been undertaken for the fishery. No major domestic fishery issues were identified.

Consultation, Communication and Education

Joint industry/government forums are used to consult with the single Finfish Trawl Fishery operator. DoR also puts out publications, such as Fishery Reports, Fishnotes and newsletters, to inform stakeholders.

Senior Research Scientist - Dr Julie Martin
Aquatic Resource Manager – Mr David McKey

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Table 1. Management objectives and harvest status against performance indicators for the Finfish Trawl Fishery

Species or group	Management objectives	Performance indicator	Trigger reference point	Current status review	Management response to be taken
Red snappers	Ensure intergenerational equity by maintaining ecologically sustainable annual catches in all sectors.	Sustainable yield estimates for nominated regions.	Combined Finfish Trawl and Demersal fisheries catch levels increase to 2500 t over the next calendar year. Catch levels decline by 30% over the next calendar year (Finfish Trawl only).	Combined red snapper catches in 2010: 844 t. Catch levels increased by 4% of 2009 catch levels. A trigger reference point was not reached.	Stakeholders are currently reviewing the fishery (refer 'Future Plans' section) and making recommendations to the Executive Director of Fisheries (EDF) regarding appropriate measures to ensure annual catches do not exceed estimated sustainable yields. Amended arrangements to be implemented within 12 months of trigger being released.
Byproduct species	Ensure ecological sustainability of by-product species taken in the Finfish Trawl Fishery.	Monitoring of commercial logbook returns.	Annual catch increase in proportion of the total catch by greater than 35%.	2010: 21%. A trigger reference point was not reached.	Stakeholders to review fishery and make recommendations to the EDF. Amended arrangements to be implemented within 12 months of trigger being released.
Bycatch species	Ensure ecological sustainability of bycatch species taken in the Finfish Trawl Fishery.	On-board monitoring of Finfish Trawl Fishery.	Total bycatch within the Finfish Trawl Fishery increases to 35% of total catch or a decline in a species relative numbers without a corresponding change in fishing area or fishing technique.	2010: 32% No identified decline in a species relative numbers. A trigger reference point was not reached.	Stakeholders to make recommendations to the EDF regarding appropriate remedial action. Amended arrangements to be implemented within 12 months of trigger being released.
Threatened, endangered or protected species and/or communities	Ensure the continued protection of species and communities listed under the EPBC Act and the Territory Wildlife and Conservation Act.	Threatened, endangered or protected species and or communities are identified in NT waters.	Identifiable impacts observed by commercial fishers, fisheries observers or other agencies regarding EPBC Act listed species or communities.	No identifiable impacts have been observed in 2010. A trigger reference point was not reached.	Stakeholders to make recommendations to EDF regarding the implementation of a threat-abatement plan, if required. Amended arrangements to be implemented within 12 months of trigger being released.
Ecosystem components	Minimise effects on ecosystem components.	Identification of threatening processes.	Identification of significant negative interaction with components of the natural ecosystem present on finfish trawl fishing grounds.	No negative ecosystem interactions were identified. A trigger reference point was not reached.	Stakeholders to make recommendations to EDF regarding appropriate remedial action. Amended arrangements to be implemented within 12 months of trigger being released.

MUD CRAB FISHERY STATUS REPORT 2010

INTRODUCTION

The Mud Crab Fishery is one of the key Northern Territory (NT) wild harvest fisheries. In 2010, the commercial wild harvest sector caught 395 tonnes of mud crabs valued at $7.9 million.

Parallel surveys in 2000-01 highlighted the importance of the mud crab resource to recreational and Indigenous fishers who harvested 82 000 and 86 500 crabs, respectively (with a combined weight of about 135 tonnes) in a 12-month period (Henry and Lyle 2003).

Four species of mud crabs have been identified in the Indo-West Pacific region, two of which are found in NT waters. The giant mud crab (*Scylla serrata*) accounts for 99% of the catch from all sectors, while the orange mud crab (*S. olivacea*) constitutes the remainder. There is little byproduct and bycatch in this fishery due to the highly selective gear used to target large mud crabs.

The fishery has been assessed by the Australian Government's Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) against the Guidelines for the Ecologically Sustainable Management of Fisheries. Full export exempt accreditation has subsequently been issued under the Australian *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The assessment demonstrated that the fishery is managed in a manner that does not lead to over-fishing, and that fishing operations have minimal impact on the structure, productivity, function and biological diversity of the ecosystem. The fishery is due for reassessment in 2012.

PROFILE OF THE FISHERY

Commercial Sector

Area

The fishery operates in tidal waters between the Queensland and Western Australian borders, with most activity concentrated in the Gulf of Carpentaria. Some fishers also operate along the north Arnhem coast, Van Diemen Gulf, Chambers Bay and the west coast down to the Victoria River region. Crabbing operations are confined to coastal and estuarine areas, predominantly on mud flats. Commercial crab fishing is not permitted in Darwin Harbour and in most creeks adjoining Shoal Bay, Leaders Creek and the waterways of Kakadu National Park.

Small mesh nets may be used under a restricted bait net entitlement to harvest fish for use as crab bait. The nets may only be set in the open sea within 3 nautical miles of the coast and the fisher must attend the net at all times. The use of bait nets is prohibited between Bing Bong and the Queensland border and in a number of other areas around the coast. Commercial fishers appear to be increasing the use of purchased bait and decreasing the amount of time spent netting for bait.

Fishing Method

Many commercial crab fishers work from remote, rudimentary land-based camps, although some access remote waters using mother-ships or permanently-moored pontoons. Crabbers may travel more than 100 km to set their pots and then stay in the same area for a number of days before returning to their base to unload the catch.

Crab pots are baited with fresh meat or fish and set in estuarine and coastal waters. Pots must have a float (with the unit number inscribed) attached and must not exceed 0.5 m^3 in volume or 1 m in any dimension. Pots are generally checked on each daylight high tide. However, if tides and other conditions are favourable, they may also be checked again at night.

Pots are manually hauled into dinghies and each crab is checked to ensure that it is above the minimum legal size, not berried (i.e. with eggs attached) and is commercially suitable. The last condition is an industry initiative to ensure that no empty (i.e. low meat content) mud crabs are

harvested. This condition helps maintain the reputation and high market value of NT mud crabs and reduces mortality during transport.

Catch

In 2010, 395 tonnes of mud crabs were harvested by the commercial fishery (Figure 1). Ten years earlier, the annual commercial mud crab catch exceeded 1000 tonnes. It is believed that those exceptional catches were due to high recruitment during favourable environmental conditions. The introduction of the commercially unsuitable crab or 'soft crab' in 2001 also explains some of the decline in catch and catch per unit effort (CPUE) since that time.

Both male and female mud crabs can be retained in the NT. The minimum legal size (MLS) - measured across the widest part of the carapace - for commercially harvested mud crabs was increased from 13 cm to 14 cm for males and from 14 cm to 15 cm for females in May 2006. This measure was taken in response to recommendations in the 2004 NT Mud Crab Stock Assessment Report (Haddon et al. 2004). The change resulted in a decline in the 2006 catch compared with that in 2005 (noting that the new MLS was in place for the last eight months of 2006). The 2010 catch was down on the 2009 figure (562 tonnes) but close to the 2008 harvest (412 tonnes). Much of this decline was due to a shorter than usual crabbing season in the Gulf of Carpentaria (see Effort Section).

Byproduct of commercial crabbing operations in 2010 accounted for 95 kg of bream, 17 kg of cod and 8 kg of catfish, the bulk of which was used to bait pots. No bycatch was reported in the 2010 logbook returns (refer to the Non-retained Species Section for further information on byproduct and bycatch).

Effort

The commercial sector of the fishery is restricted to 49 individual licences and each was allocated two units of entitlement valued at 30 pots each. All licences were fully utilised in 2010. Fishers can now lease any number of individual units (although four units appears the practical maximum) but can only fish once they have at least two units attached to a licence. This system is more cost-effective for crabbers wishing to use 90 pots as they no longer need to lease and/or purchase two licences to do so. There has been no additional effort introduced into the fishery.

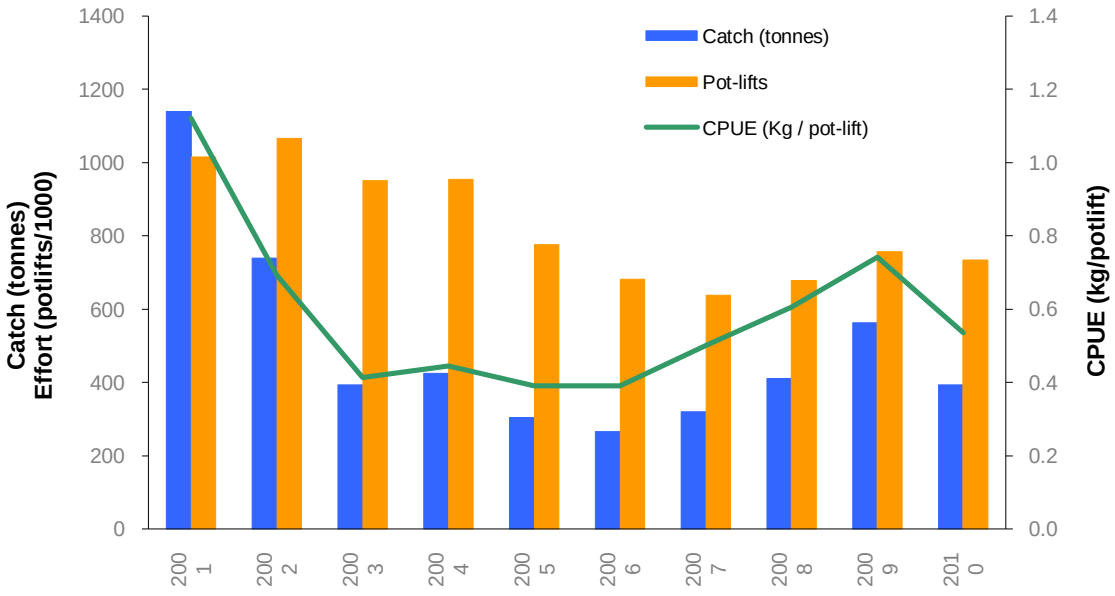

Figure 1. Catch and per unit effort (CPUE) for the NT commercial Mud Crab Fishery, 2001 to 2010

Total reported effort in 2010 was 734 396 pot-lifts (Figure 1), which represented a 3% decline on the 2009 figure. Crabbers sometimes check their pots twice a day, or more often; fishing effort is measured by the number of pot-lifts per day. The proportion of double pot-lift days ranged from 15% to 18% between 2000 and 2004, but has since dropped to about half that level, ranging between 4% and 9% for the period between 2005 and 2010.

Wet season flooding in the Gulf of Carpentaria (the main crabbing area in the NT) can restrict access to, and from, this region for several months. Flooding in March and April 2010 prevented access to some crabbing areas (e.g. Port Roper) until May, resulting in a shorter crabbing season in this very productive area.

Catch Rates

CPUE in 2010 equated to 0.54 kg per pot-lift (Figure 1), which represents a 28% decline on the 2009 figure. During the first decade of the fishery, catch rates remained relatively stable with an average of 0.35 kg per pot-lift (data not shown). CPUE increased to 0.65 kg per pot-lift in 1996, eventually peaking at over 1 kg per pot-lift in 2001. That peak was followed by a decline and then a plateau (at around 0.40 kg per pot-lift) from 2003 to 2006. CPUE has remained at or above 0.50 kg per pot-lift since 2007. The depressed catch rate in 2010 is possibly due to the impacts of low salinity and/or habitat damage caused by heavy rainfall earlier in the year.

Marketing

Mud crabs are premium seafood, with strong demand for live product from Sydney and Melbourne markets. Live mud crabs are transported to Darwin from around the NT coast (at least weekly, by truck), cleaned and sorted by size, sex and condition, then air-freighted to southern markets. NT mud crabs have previously been exported to Singapore, China and the USA.

Recreational Sector

Area

Recreational fishers may crab in all waters of tidal influence except in Kakadu National Park where pots are not permitted. Crabbing is often undertaken in conjunction with other fishing activities in coastal and estuarine regions.

Surveys of recreational anglers in 1995 and 2000 found that most of the crabbing activity occurred in the Darwin Harbour/Shoal Bay area, the McArthur River and the Roper River (Coleman 1998; Coleman 2004).

Fishing Method

Recreational mud crab fishers are subject to the same gear controls (in terms of markings and dimensions) as commercial fishers and most use collapsible mesh pots. Dillies, which consist of a panel of mesh on a steel frame that is baited and set on substrate, may also be used, but must not be constructed in such a way that would cause entanglement of mud crabs or other aquatic life. A gear restriction of five pots (or dillies) per person applies, with a maximum of 10 pots per vessel. Mud crabs may also be harvested by a hand spear, hand-held hook, hook and line, hand net, cast net or drag net.

Catch

The MLS for recreational mud crabbers is 13 cm for males and 14 cm for females. Berried female mud crabs are not permitted to be taken and must be released at the point of capture.

There are no restrictions on the take of ‘soft’ (or empty) mud crabs in the recreational sector; however, the Department of Resources (DoR) has produced extension material (*Fishnote* 28) that encourages the testing and release of such crabs.

The 2001 National Recreational and Indigenous Fishing Survey (Henry and Lyle 2003) indicated that recreational fishers harvested over 82 000 mud crabs (about 65 tonnes) from January to December 2000, with 74% (or about 61 000) of them caught in the Darwin Harbour/Shoal Bay area (Coleman 2004).

Effort

Recreational crabbing is often an adjunct to other recreational fishing or boating activities. A large number of recreational fishers set crab pots at

the start of the day's fishing trip and haul them at the end of the day, or at high tide.

In 2000, recreational fishing for 'non fish' species (e.g. shellfish, crabs and squid) totalled 303 033 hours and accounted for 17% of the total recreational fishing effort. However, targeted fishing for mud crabs was not quantified. Over 50% of the total fishing effort for 'non fish' species occurred in the Darwin Harbour area (Coleman 2004).

Catch Rates

The catch rate when fishing for species 'other than fish' (including mud crabs) was 0.4 individuals per hour in 2000 (Henry and Lyle 2003).

Fishing Tour Operator Sector

Area

Fishing Tour Operators (FTOs) must have a licence to operate in NT waters and their clients are subject to the same controls as recreational fishers. They are restricted to waters of tidal influence, excluding those in Kakadu National Park.

Fishing Method

FTO clients employ the same harvest methods and are subject to the same MLS, pot and possession limits as recreational fishers. Over 94% of all crabs caught by FTO clients are taken using pots.

Catch

In 2010, the FTO sector landed 1152 mud crabs, of which 410 (36%) were retained. This represents a decline from the 1285 mud crabs landed and 900 retained in 2009, which was consistent with the harvest rate over the last 13 years (since records began), which ranged between 62% and 79%.

Effort

In 2010, FTO clients spent 3379 hours of fishing effort targeting mud crabs. This represents a decline of 39% from the 5539 hours of mud crab effort in 2009. Such inter-annual variability in mud crab fishing effort is not uncommon in the FTO sector and is influenced by several factors, which may or may not include the abundance of mud crabs.

Catching mud crabs accounts for only a small part of the total FTO fishing effort. Since 1995, only 3% or less of all fishing trips reported annually have targeted mud crabs as part of their trip.

Catch Rates

The mean mud crab catch rate for FTO clients in 2010 was 0.34 crabs per hour, which was below the previous 13-year range of 0.4 to 0.8 crabs per hour.

Indigenous Sector

Area

Most fishing effort is localised and centred close to communities or outstations.

Fishing Method

Although Indigenous fishers are entitled to use the same fishing gear as recreational fishers, spearing and hand-harvesting are the most popular methods.

Catch

Mud crabs are a favourite food of coastal Indigenous Australians, who consume most of their catch. The Indigenous harvest over a 12-month period in 2000-01 was about 86 000 crabs or about 69 tonnes (Henry and Lyle 2003). Indigenous groups now own some commercial licences, thereby providing employment, income and fresh food for local communities.

Non-retained Species

Conventional crab pots, which are used to varying degrees by all sectors, are constructed from galvanised wire mesh and are highly selective towards adult mud crabs. Hence, the catch of non-target species is minimal. The aggressive nature of mud crabs may also deter other animals from entering the pots.

Apart from undersized (or unmarketable) mud crabs, which must be released, other bycatch species, such as blue swimmer crabs, cod and

catfish, may or may not be released. Blue swimmer crabs are often kept for consumption by all sectors, whereas cod and catfish, which are typically released by recreational fishers, are used as bait by commercial fishers.

Indigenous fishers target the same crab species as the other sectors, but their preferred harvest methods of hand collection or spear virtually eliminates bycatch.

Threatened Species Interaction

There were no reported interactions with threatened, endangered or protected species in the fishery in 2010.

Ecosystem Impact

The fishery has minimal impact on the benthic environment due to passive fishing methods that effectively target large mud crabs.

SEWPaC has reviewed the impacts of the fishery and considers that the current level of mud crab harvest is unlikely to significantly impact on the ecosystem.

A study by Hay et al. (2005) documented the relative abundance of mud crabs (*Scylla serrata*) in selected coastal habitats around northern Australia and serves as a comparative tool for similar areas if subjected to natural or anthropogenic disturbance.

Social Impact

Commercial mud crab fishing and processing operations provide direct employment and support a service industry, which supplies gear and consumables to crab fishers, repairs and services their equipment and provides freight services.

Crabbing operations may also benefit landholders, as operator camps may incur access fees, permit costs and camping fees.

Mud crabbing is also a popular recreational pastime as there is good access to the resource close to population centres. Whilst difficult to quantify, money spent by recreational fishers in the pursuit of mud crabs contributes to employment in the FTO, tackle and hospitality sectors.

Economic Impact

In 2010, the NT commercial mud crab catch was 395 tonnes, valued at $7.89 million.

The recreational mud crab sector also contributes to the NT economy, particularly through the service and fishing tackle industries.

STOCK ASSESSMENT

Monitoring

A mud crab monitoring program has been in place since the early 1990s. Between 100 and 200 crabs (contingent on availability) are sampled from several regions, such as the Roper River, the Adelaide River, Blue Mud Bay and the Borroloola area, on a monthly basis. Important information, such as carapace width, weight, sex, and mating success, is collected.

Time series analysis of carapace width data collected from the commercial fishery reveals a small decline in the mean size of both male and female crabs harvested in most regions. Such trends are often observed in harvested stocks, thereby necessitating the use of MLS to ensure that a sufficient proportion of the stock has the opportunity to reproduce.

Stock Assessment Methods and Reliability

Various stock assessment methods have been applied to the Mud Crab Fishery. Stock assessment workshops were held in 1996, 1999, 2000, 2004 and 2007.

The first assessment (Walters et al. 1997) revealed exploitation rates in fished areas were as high as 70% to 90% of the available stock, leading the authors to describe the fishery as fully developed from a management perspective.

The assessment by Haddon et al. (2004) revealed that catch rates in 2004 were similar to

those prior to 1996. However, the assessment concluded that effort had spread across a wider temporal and spatial scale, creating a greater dependence on new recruits to the fishery.

The most recent assessment (Ward et al. 2007) examined the effect of the 10-mm increase in MLS for the commercial sector (which came into effect on 1 May, 2006) using data to December 2006. The analyses suggested that a 10-mm increase was warranted and protected about four times as many small crabs as a 5-mm increase in MLS. The stock assessors also stressed, that at the time of the assessment, insufficient time had elapsed since the increase in MLS (just eight months) to enable the effect of the change to be fully expressed. A more appropriate interval would be 18 months to two years, in line with the reproductive biology of the species.

A further stock assessment will occur in 2011.

Current Harvest Status

Recent assessments indicate that the Mud Crab Fishery is fully developed.

Future Assessment

Professor Carl Walters of the Fisheries Centre, University of British Columbia, Canada was to visit Darwin in 2011 to lead a series of stock assessments on a number of local fisheries, including the Mud Crab Fishery.

RESEARCH

Summary

Mud crab research was commenced in the NT in 1990, collecting a large amount of information on the population dynamics of mud crabs (*Scylla serrata)*. That work has been published in various reports, the most recent being the stock assessment by Ward et al. (2007).

Incorporation into Management

DoR reviews results of all research programs annually. Any pertinent issues identified by research will be discussed by the Mud Crab Fishery Management Advisory Committee (MCFMAC). Pending discussions with key stakeholders, changes to the regulatory controls in the Mud Crab Fishery Management Plan (MCFMP) may be required for one or all fishing sectors.

Current Research

Two collaborative mud crab research projects (with DoR as a project partner) were completed in 2010. The first, 'Evaluating the environmental drivers of mud crab (*Scylla serrata*) catches in Australia' was conducted by Griffith University in order to:

- Consider links between selected environmental factors and mud crab (*Scylla serrata*) catches.
- Document possible time lags between environmental phenomena and mud crab catches.
- Develop predictive model(s) for Australian mud crab fisheries based on this information.

A major finding of this work was that 30 to 50% of the variation in commercial mud crab CPUE in the NT can be explained by rainfall and the Southern Oscillation Index. That is, more rain generally produces better mud crab catch rates (and vice versa), although the relationship breaks down during sustained flood events. The final report for this study (Meynecke et al. 2010) is available from DoR, the Fisheries Research and Development Corporation (FRDC) or Griffith University.

The second project, 'A collaborative recruitment forecasting program for the NT Mud Crab Fishery' was conducted by the NT Seafood Council (NTSC). The project considered ways to:

- Increase stakeholder engagement in the collection of data necessary to monitor and forecast recruitment to the fishery.
- Enhance the skills and understanding of fisheries research and sustainable management practices among stakeholders in the fishery.

This project was successful in capturing large numbers of juvenile mud crabs (< 80 mm carapace width), a feat that had not been achieved in northern Australia before. Most juveniles were caught in the first half of the year, particularly from March through to May. Whilst the project was successful in achieving its goals, it also highlighted the considerable time, effort and commitment needed to collect enough data to reliably forecast recruitment to the fishery (as would be required if the fishery were to move from input to effective output management controls). A summary of this work is available from DoR and NTSC.

DoR also received funding for a new project, "Improving gear selectivity in Australian mud crab fisheries" from the FRDC in 2010. This work will be completed in 2011. The objectives of the study are to:

- Describe the ratio and size distribution of "sized" and "undersized" mud crabs retained by different pot types used in Australian mud crab fisheries
- Quantify any change in the retention of undersized mud crabs (and other bycatch) by pots fitted with different mesh sizes or escape vents
- Provide advice to managers as to optimal mesh sizes, escape vent dimensions and the number of escape vents necessary to minimise the retention of undersized mud crabs relevant to the local size limits and species

Underwater videos of undersized mud crabs exiting pots can be viewed on the DoR YouTube: http://www.youtube.com/user/DoResources?feature=mhum.

A survey of recreational fishing in the NT began in April 2009. It will quantify resident and visitor catch, harvest, effort and expenditure. Results from this survey will be available in 2011 and will provide an understanding of the recreational harvest of mud crabs.

MANAGEMENT/GOVERNANCE

Management

Objective

A range of fishery objectives with performance indicators have been agreed by MCFMAC to ensure that the fishery remains sustainable. Trigger levels and status of the fishery against the performance indicators are presented in Table 1.

History

Conservative management, focusing on containing fishing effort and protection of breeding stocks through an MLS has been adopted in the fishery. Since 1991, the fishery has been controlled under MCFMP. Amendments were made to MCFMP in 1993 relating to non-retention of berried females and again in 1995 relating to a 10-mm increase in MLS for females to protect breeding stocks. An "in possession" limit of a maximum of 10 mud crabs per person applies in the recreational sector, with a vessel limit of 30 mud crabs if there are three or more people on board. MLS for both sexes of commercially-harvested mud crabs was increased by 10 mm on 1 May, 2006.

The main trigger points for this fishery relate to pronounced changes in catch, effort or mean size of crabs. Management arrangements will be reviewed under the following circumstances: the catch declines by 50% in any one year or by 10% per year over two consecutive years; total effort increases by 10% per year over two consecutive years; or median carapace width decreases by 5 mm per year over two consecutive years. Should any such changes occur, MCFMAC will assess the situation and provide advice to the Executive Director of Fisheries.

Current Issues

The fishery appears to have entered a recovery phase with catches around 400 to 500 tonnes and CPUE around 0.50 to 0.75 kg per pot-lift for the last three years. As such, the main issues in the fishery at present relate to non-compliance

and licensing arrangements, as opposed to the status of the stock.

On advice from MCFMAC, management arrangements were revised in 2010 to unitise entitlements in the fishery and strengthen penalties for non-compliance with MCFMP. Each of the existing licences was allocated two units of entitlement (currently valued at 30 pots each), which are transferable on a temporary basis to other licences in the fishery. The arrangement provides greater flexibility for operators to increase their individual pot entitlements, while the fishery overall continues to be managed within existing sustainability limits. A stronger penalty regime with respect to the take of undersized and commercially unsuitable crabs and for over-potting, was also introduced.

In late 2007, the fishery was re-assessed by SEWPaC against the Guidelines for the Ecologically Sustainable Management of Fisheries. As a result, the fishery received full export exempt accreditation under the EPBC Act. The assessment demonstrated that the fishery was managed in a manner that does not lead to over-fishing and that fishing operations have minimal impact on the structure, productivity, function and biological diversity of the ecosystem. SEWPaC has recommended that a range of additional tasks and measures be implemented before the next assessment in 2012. These include an ecological risk assessment and a review of the compliance risk assessment for the fishery.

Future Plans

MCFMAC will meet as necessary to discuss future research needs and management arrangements for the fishery.

Compliance

The Water Police Section of the NT Police, Fire and Emergency Services is responsible for all fisheries compliance and enforcement in the NT. Major compliance issues in the fishery include illegal use of excess or unmarked pots and the take of undersized and commercially unsuitable crabs.

Consultation, Communication and Education

MCFMAC, which consists of representatives from various stakeholder groups and government, provides advice on issues relevant to the fishery.

A series of regional Aboriginal Coastal Consultative Committees also provide advice on all aspects of fishing, including the Mud Crab Fishery.

The Mud Crab Licensee Committee and the Amateur Fishermen's Association of the NT also assist in formulating management policy for this fishery.

Prior to commencing fishing operations, all new entrants to the commercial fishery must attend an interview with the Aquatic Resource Management Officer responsible for the fishery. The interviews may utilise the services of an interpreter and are aimed at providing the fisher with an understanding of the legislation, status of the fishery, research, management and compliance issues.

Senior Research Scientist - Dr Mark Grubert
Aquatic Resource Management Officer – Ms Patti Kuhl

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Table 1. Management objectives and harvest status against performance indicators for the Mud Crab Fishery

Species	Management objectives	Performance indicator	Trigger reference point	Current status review	Management response to be taken
Mud crabs	Ensure the intergenerational equity by maintaining ecologically sustainable annual catches in all sectors.	Significant decline in the annual catch.	Commercial catch decreases by 10% per annum for two or more consecutive years or decreases by 50% in any one year.	Commercial catch decreased by 30% between 2009 and 2010. This was the first decrease in catch for four years. The trigger reference point was not reached.	MCFMAC to review fishery and make recommendations to the Executive Director of Fisheries (EDF) to ensure that the mud crab resource is harvested in an ecologically sustainable manner. Within three months of becoming aware of trigger being reached, a clear timetable for the implementation of appropriate management responses will be developed.
		Significant increase in fishing effort.	Commercial fishing effort increases by 10% per annum for two or more consecutive years.	Commercial fishing effort decreased 3% between 2009 and 2010. The trigger reference point was not reached.	
		Significant decrease in the median size of mud crabs.	Median size of mud crabs decreases by 5 mm per annum for two or more consecutive years.	Size frequency monitoring of commercially harvested mud crabs found no change in median size. The trigger reference point was not reached.	
Byproduct species	Ensure ecological sustainability of byproduct species.	Monitoring of commercial logbook returns.	Byproduct increases by more than 0.5 t in any one year period.	Total byproduct harvest was less than 0.2 t in 2010. The trigger reference point was not reached.	MCFMAC to review fishery and make recommendations to the EDF regarding appropriate remedial action. Within three months of becoming aware of trigger being reached, a clear timetable for the implementation of appropriate management responses will be developed.
Bycatch species	Ensure ecological sustainability of bycatch species.	Monitoring of commercial crabbing operations.	Bycatch abundance increases by more than 50% in any one year or more than 100% in any three year period.	No bycatch reported in 2010 (see notes in non-retained species). The trigger reference point was not reached.	MCFMAC to review fishery and make recommendations to the EDF regarding appropriate remedial action. Within three months of becoming aware of trigger being reached, a clear timetable for the implementation of appropriate management responses will be developed.

Species	Management objectives	Performance indicator	Trigger reference point	Current status review	Management response to be taken
Threatened, endangered or protected species and/or communities	Maintain present level of interaction between mud crab fishing operations and species and communities listed under the EPBC Act.	Threatened, endangered or protected species and/or communities are identified in NT waters.	Identifiable impacts observed by commercial fishers, fisheries observers or other agencies regarding EPBC Act listed species or communities.	No identifiable impacts reported or observed in 2010. The trigger reference point was not reached.	MCFMAC to make recommendations to the EDF regarding the implementation of a threat abatement plan, if required. Within three months of becoming aware of trigger being reached, a clear timetable for the implementation of appropriate management responses will be developed.
Ecosystem components	Minimise effects on ecosystem components.	Identification of threatening processes.	Identification of significant negative interaction with components of the natural ecosystem present on mud crab fishing grounds.	No significant negative interactions reported or observed in 2010. The trigger reference point was not reached.	MCFMAC to make recommendations to the EDF regarding appropriate remedial action. Within three months of becoming aware of trigger being reached, a clear timetable for the implementation of appropriate management responses will be developed.

OFFSHORE NET AND LINE FISHERY STATUS REPORT 2010

INTRODUCTION

The commercial Offshore Net and Line Fishery (ONLF) targets black-tip sharks (*Carcharhinus tilstoni, C. limbatus and C. sorrah*) and grey mackerels (*Scomberomorus semifasciatus*). A variety of other sharks and pelagic finfish are also caught as byproduct. Licensees are permitted to operate from the high water mark to the boundary of the Australian Fishing Zone (AFZ), although most of the effort occurs within 12 nautical miles (nm) of the coast and immediately offshore in the Gulf of Carpentaria.

The fishery is managed through individually transferable effort allocations. Strict gear specifications also apply, resulting in selective targeting of smaller, more productive sharks species, with a lesser impact on larger, less productive and biologically more vulnerable shark species.

The fishery has issued 17 licences, of which 12 were active in 2010.

The fishery is managed by the Northern Territory (NT) Fisheries Joint Authority (NTFJA), in accordance with the NT *Fisheries Act 1988*. Day-to-day management of the fishery is undertaken by the Department of Resources (DoR).

The fishery was assessed in late 2007 by the Australian Government's Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) based on the Guidelines for the Sustainable Management of Fisheries under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). An approved Wildlife Trade Operation (WTO) was subsequently issued. The assessment demonstrated that the fishery was managed in a manner that did not lead to over-fishing and that fishing operations had minimal impact on the structure, productivity, function and biological diversity of the ecosystem. SEWPaC has advised that the fishery will be reassessed in late 2011.

The NT actively supports the implementation of the National Plan of Action for Sharks (NPOA Sharks) and coordinates the northern response for the requirements of the Operational Plan for the Sustainable Use of Northern Australian Shark Resources. Cooperative research efforts are being conducted with Western Australia and Queensland. Information and samples collected from this fishery also support a number of universities and Government-sponsored research projects.

PROFILE OF THE FISHERY

Commercial Sector

Area

Licensees are authorised to fish in NT waters from the high water mark to the boundary of the AFZ, an area of more than 522 000 km^2, with spatial restrictions placed on the use of certain gear. Demersal long lines may be used from the coastline to the AFZ; pelagic long lines may be used from 3 nm from the coast to the boundary of the AFZ and pelagic nets from 2 nm from the low water mark to the boundary of the AFZ. Most of the fishing is undertaken within the coastal zone (within 12 nm of the coast or baseline) and immediately offshore in the Gulf of Carpentaria. As in previous years, little fishing was undertaken in the offshore area of the fishery during 2010.

Fishing Method

Operators may use demersal or pelagic long lines or pelagic nets. The use of bottom-set gillnets is prohibited and pelagic long lines are currently not used by any operator. Most of the fishing is undertaken by pelagic gillnets. Although the legal maximum length of nets is 2000 m, for operational reasons, they are generally 1000 to 2000 m long, with a mesh size of 160 mm to 185 mm. Most nets are made of monofilament nylon, with a drop of 50 to a maximum 100 meshes. The nets are weighted and have a buoyed headline. The total length of long lines must not exceed 15 nm at any time and must

have no more than 1000 snoods (hooks). Automated baiting gear is prohibited.

Catch

Operators in the fishery target black-tip sharks (*Carcharhinus tilstoni, C. limbatus* and *C. sorrah*) and grey mackerel. Logbook records indicated a total catch of 1239 tonnes in 2010, a 4% decline over the 2009 catch of 1286 tonnes.

In 2010, the *C. tilstoni* and *C. limbatus* catch of 342 tonnes represented 28% of total landings, an 8% decline over the 371 tonnes taken in 2009 (Figure 1). The *C. sorrah* catch of 127 tonnes, which represented 10% of the total catch, represented a 48% rise over the 86 tonnes taken in 2009 (Figure 1). While black-tip sharks were the principal target species in 2007 and 2008, grey mackerel were caught in substantially higher numbers during 2009 and 2010; the 2010 grey mackerel catch of 401 tonnes represented 32% of the total landings, a 12% decline over the 457 tonnes taken in 2009 (Figure 1). Operators reported that market forces and other operational considerations, such as weather conditions, were the main causes of variation in grey mackerel catches, thus indicating that variations in catch largely reflect variations in targeting.

A prohibition exists on the possession of sharks and shark products for the Timor Reef, Demersal, Finfish Trawl, and Spanish mackerel fisheries. Sharks are taken as a limited byproduct in a range of fisheries targeting other species. Such incidental catch of sharks in other NT fisheries is around 1% of the total combined fisheries shark catch.

Byproduct Species

The recorded catch of sharks other than black-tips declined by 1% from 336 tonnes in 2009 to 332 tonnes in 2010. Byproduct species principally consisted of bull sharks (*C. leucas)* - 135 tonnes, 11% of the total catch; hammerhead sharks (*Sphyrna* spp.) - 103 tonnes, 8% of total catch; lemon sharks (*Negaprion acutidens)* - 38 tonnes, 3% of the total catch; tiger sharks (*Galeocerdo cuvier)* - 30 tonnes, 2% of the total catch; and wing-head sharks (*Eusphyra bloc*hii) - 15 tonnes, 1% of the total catch.

A requirement to explicitly record catches of bull sharks in logbooks was first made in 2009. Until that time, fishers probably ascribed catches of bull sharks to the pig-eye shark or “other shark” categories. Changes to the logbook created an apparent increase in the catch of bull sharks and a corresponding decline in the catch of the similar looking pig-eye sharks. In 2010, there was only a small recorded catch of pig-eye sharks. Based on habitat distribution and observer data, it appears that pig-eye sharks are being misidentified and recorded as bull sharks. Other byproduct shark species included dusky sharks (*C. obscurus),* milk sharks (*Rhizoprionodon acutus*) and a variety of other carcharhinids (Figure 2).

Non-shark byproduct species landed in 2010 consisted of 15.1 tonnes of narrow-barred Spanish mackerel (*Scomberomorus commerson)* - 1% of the total fishery catch, which was over the 13.5 tonnes allocated for the fishery; 3.5 tonnes of queenfish (*Scomberoides* spp.); and a combined weight of 16.8 tonnes of other fish species, mainly tunas, black pomfret and blue salmon (Figure 2).

Effort

A total of 820 boat-days were spent fishing during 2010. This reflects a 13% decline compared with 2009; the effort was well below the peak of 1538 boat-days recorded in 2003, which precipitated the introduction of precautionary measures to contain domestic effort in the fishery in 2005 (Figure 1).

It is also important to note that in very remote areas, such as the Top End and the western Gulf of Carpentaria, operational considerations, such as weather and fuel availability, are important contributors to variation in effort.

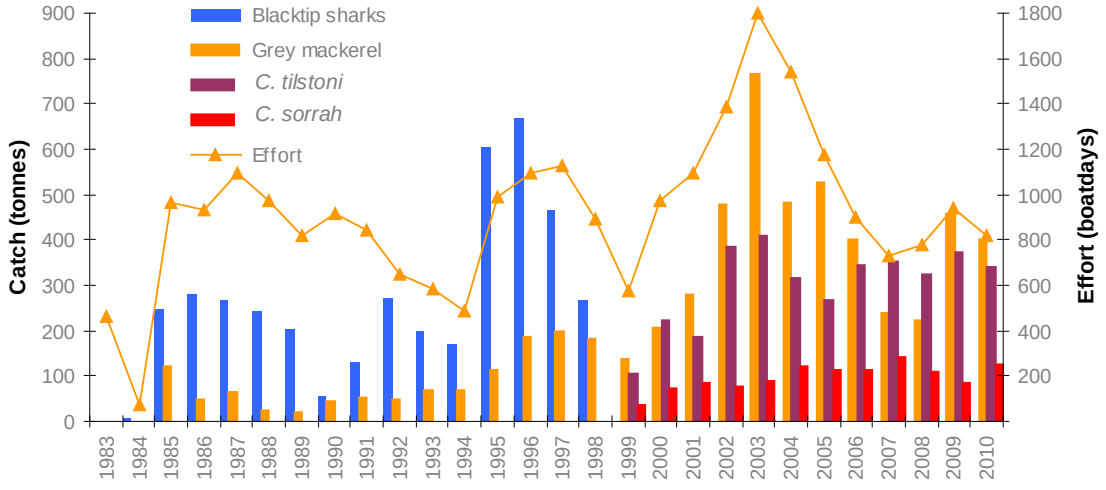

Figure 1. Catches and effort for the target species in the commercial Offshore Net and Line Fishery, 1983 to 2010*

*Note: Black-tip sharks were identified as separate species in commercial logbooks only from 1999. Catches reported for *C. tilstoni* are likely to include *C. limbatus*.

Catch Rates

Catch per unit effort (CPUE) in 2010 was 417 kg/boat-day for *C. tilstoni* and *C. limbatus*, and 155 kg/boat-day for *C. sorrah,* showing an increase over the previous year's figure (Figure 3).

Grey mackerel catch rates have generally followed a pattern of steady increase from the early 1990s, but experienced a decline in 2007 and 2008. However, CPUE for grey mackerel increased during 2009 to 485 kg/boat-day and remained relatively stable in 2010 at 479 kg/boat-day (Figure 3).

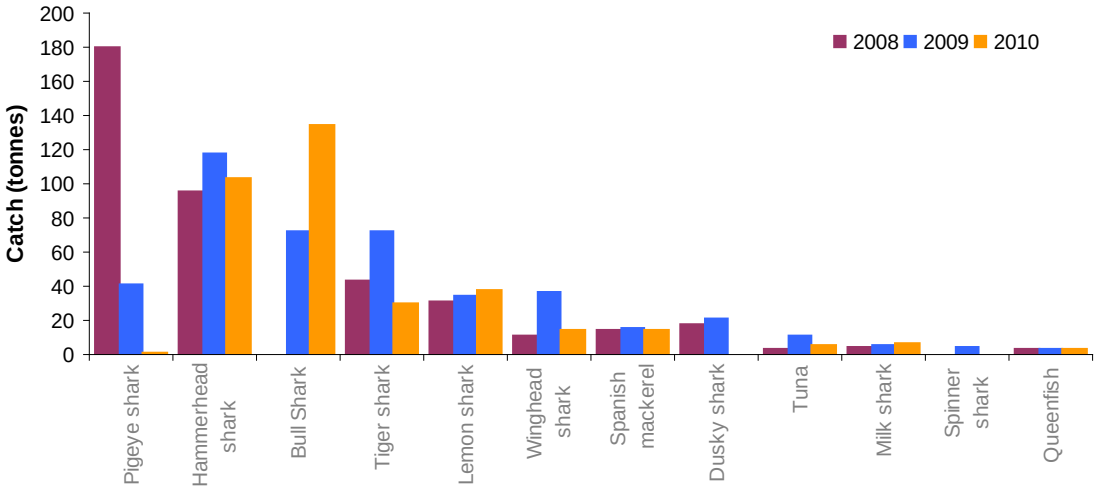

Figure 2. Composition of byproduct species in the Offshore Net and Line Fishery's commercial catch for 2008, 2009 and 2010

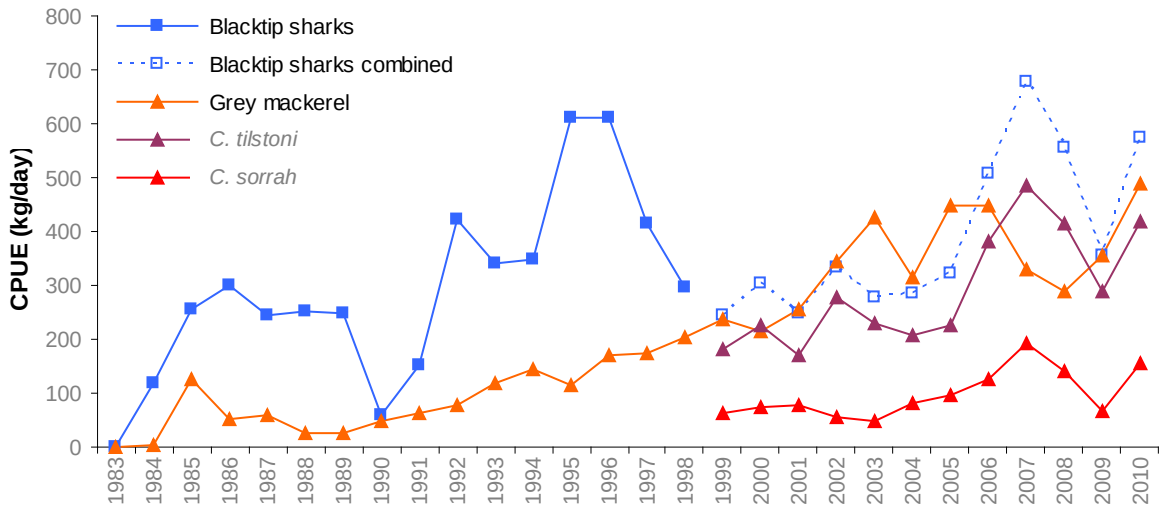

Figure 3. Commercial catch per unit effort (CPUE) for the Offshore Net and Line Fishery target species between 1983 and 2010*

*Note: Black-tip sharks were identified as separate species in commercial logbooks only from 1999.Catches reported for *C. tilstoni* are likely to include *C. limbatus.*

Marketing

Sharks are marketed in trunk, fillet and whole forms, both as fresh and frozen product. Fins are a valuable product but must be landed with a prescribed proportion of shark meat. This is designed to contain wasteful practices in which only the fins are retained and the shark body is returned to the water. While some shark product is retained for local processing and consumption, most is sent interstate, with over 20% of total shark catch reportedly earmarked for direct export to overseas markets.

Grey mackerel are marketed domestically as fillet, trunks and whole fish.

Recreational Sector

Area

The significant areas for recreational shark catches are Darwin Harbour, McArthur River and Cobourg Peninsula (Coleman 2004).

For grey mackerel, most of the recreational catch comes from the Vernon Islands, Dundee, Lorna Shoal and the Gove area (Coleman 2004).

Fishing Method

Most sharks are taken during reef fishing and general fishing (fishing with no specific target). These types of fishing generally use baited lines. Grey mackerel are fished by jigging or taken as an incidental catch by anglers trolling lures over reef targeting Spanish mackerel.

Catch

Sharks are generally not targeted by recreational fishers in the NT, but are caught during other targeted fishing activities.

In 2000-01, a survey of recreational fishers found that over 76 000 sharks were caught, with 8000 harvested and the remainder released (Coleman 2004). This indicates a 47% reduction in the proportion harvested compared with 1995. In 1995, over 80 000 individuals were caught; 18% were retained, resulting in a harvest of 15 000 (Coleman 1998).

The survey indicated that barramundi fishing, reef fishing and non-target fishing accounted for 14%, 26% and 52% of the total shark catch, respectively. In 1995, reef fishing and non-target fishing accounted for 74% and 18% of the total

shark catch, respectively. The proportion of sharks harvested depends on the type of fishing undertaken. During non-target fishing, 34% of sharks caught are harvested, whilst reef fishers only harvest 12% (Coleman 2004).

Grey mackerels were not identified as a specific catch in either the 2000 or 1995 recreational fishing surveys. All species of mackerel were reported as one group, including Spanish, grey and spotted mackerel. In 2000-01, the total mackerel catch was 25 233 individuals; 64% were released (Coleman 2004).

A comprehensive 12-month survey of recreational fishing in the NT commenced in 2009 and will provide current recreational catch estimates. The results are expected in late 2011.

Fishing Tour Operator Sector

Area

Sharks and grey mackerels are not specifically targeted by Fishing Tour Operators (FTOs), but are landed during other targeted fishing activities.

Catch

In 2010, 5274 sharks were caught by FTOs, representing a 21% decline from the 2009 catch. Of these, 5166 (98%) were released. The species of sharks caught and harvested were not recorded.

In 2010, 1446 mackerels (other than Spanish mackerel) were caught by FTOs. Observations from operators suggest that most of them were grey mackerel. Of these, 995 (69%) were released. The 2010 FTO mackerel catch (other than Spanish mackerel) increased by 14% from the 1269 caught in 2009.

Indigenous Sector

Area

Most Indigenous fishing activity occurs close to communities and outstations, inland or near coastal waters.

Catch

Sharks and rays are among the more important groups of fish caught by Indigenous people in the coastal areas of the NT. In 2000, a survey of Indigenous fishing activities found that over 12 000 sharks and rays were harvested, comprising just over 3% of the total finfish harvest (Henry and Lyle 2003). The species of sharks and rays caught and harvested were not identified.

As grey mackerels tend to exist on offshore reefs, they are rarely caught via traditional means by Indigenous people.

Non-retained Species

Although gillnets are often regarded as non-selective fishing gear, when used by a skilled operator, they are very effective at taking the targeted catch. The amount of bycatch depends strongly on location and season. Most shark species are now retained, apart from the tawny shark (*Nebrius ferrugineus)*, for which there is no market, and protected species. Rays are an uncommon bycatch in the surface-set nets and are usually released alive. Some finfish, for example trevally and queenfish, may be retained.

Threatened Species Interaction

There were three recorded interactions with turtles in 2010 in this fishery. All turtles were reportedly released alive. Data on interactions with threatened, endangered and protected (TEP) species in the fishery has been collected since 2003 as part of the commercial fishing logbook process. Gillnets are relatively selective in catching targeted species; however, in the past, incidental captures of some TEP species have been recorded in the fishery.

The NT Seafood Council has developed a Code of Conduct and Code of Practice to assist in minimising the incidental capture of TEP species.

Continued monitoring trips by DoR scientists will assist in providing more information on the distribution and status of sawfish populations, as well as obtain better information on TEP species interactions with fishing operations.

Ecosystem Impact

Controls on fishing gear have been introduced to minimise a possible physical impact on the seabed. A prohibition on the use of bottom-set gillnets was introduced to minimise interactions with turtles and to reduce the catch of rays.

Social Impact

In 2010, 12 licences were operating in the fishery. Most vessels employ a skipper and have two or three crew members.

Economic Impact

At the point of first sale in 2010, the overall catch value of the fishery was $3.76 million. The black-tip shark component was valued at $0.83 million, $1.27 million for other sharks and $1.38 million for grey mackerel.

STOCK ASSESSMENT

Monitoring

Routine monitoring information for the fishery comes from compulsory catch and effort logbooks. Monthly summary returns for the commercial fishery form a time-series from 1983 onwards. A transition from monthly summary returns to recording each gear set has been implemented since the late 1990s and, from July 2005, the target species have also been recorded. This reflects a policy of improving the quality and utility of collected logbook information.

Scientific monitoring trips provide additional information regarding species composition, and other biological and ecological data. Three monitoring trips totalling 21 days and 34 shots were conducted on-board commercial boats during 2010. While at sea, DoR observers routinely collect information on catch composition, interactions with TEP species, biological data, such fish length and sex, and collect vertebrae from sharks and otoliths (ear bones) from mackerel for aging.

During scientific monitoring trips in 2010, grey mackerels were the dominant species in the catch, comprising 63% of the catch in terms of the number of fish caught. *C. tilstoni* and *C. limbatus* comprised 8% of the catch with *C. sorrah* accounting for between 5% of the catch. The most common byproduct species recorded included black promfret (*Parastromateus niger)* - 6%, wing-head sharks (*E. blochii)* - 2% and milk sharks (*R. acutus)* - 2%. All other species caught comprised less than 2% of the catch.

Research has continued since 2006 to develop a tagging protocol for monitoring harvest rates for the target shark and indicator species. The project, jointly funded by the Australian Research Council Linkage Program and the NT Fishing Industry Research and Development Fund, is entitled 'Estimating fishing-related mortality and designing sustainable management protocols for shark fisheries in northern Australia'. It is led by Charles Darwin University (CDU) in collaboration with the fishing industry, DoR and the Australian Institute of Marine Science (AIMS). The project aims to estimate fishing-related fish mortality in the fishery and evaluate various combinations of monitoring and management regimes for the fishery.

Over the four years of this project, 3534 sharks of all species were tagged, mostly during scientific monitoring trips aboard commercial fishing vessels operating in the fishery. Most of the sharks tagged were the commercially important species *C. tilstoni* and *C. limbatus,* together accounting for 31% (1081 individuals) and *C. sorrah,* 22% (780 individuals). Ninety six sharks were re-captured, including 26 *C. tilstoni/ C. limbatus* and 11 *C. sorrah*. The results of the project, which will provide guidelines for establishing a tag-based monitoring program, will be released in 2011. Tissue was retained from most tagged and released sharks for confirmation of species identity and genetic analysis.

Stock Assessment Methods and Reliability

The fishery has a history of continual assessment. In the 1980s, a joint assessment was conducted by DoR, CSIRO and the Australian Fisheries Management Authority (AFMA). The Pelagic Fish Stock Assessment Program estimated that, in waters adjacent to the NT, the maximum sustainable yield for black-tip sharks (*C. limbatus*, *C. tilstoni* and *C. sorrah),* was 3400 tonnes annually: 1900 tonnes in the Arafura and Gulf of Carpentaria zones, and 1500 tonnes in the NT zone.

Assessment in the mid 1990s (Walters and Buckworth 1997) suggested a potential yield estimate for Western Australia, the NT and Queensland of at least 2000 tonnes per year. The optimum annual harvest rate is 6% to 7% of the component of the stock vulnerable to gillnet fishing. The age-structure modelling (Walters and Buckworth 1997) indicated that the overall stock should have been increasing at a rate of between 5% and 10% per year since the mid-1980s, when Taiwanese catches were greatly reduced.

However, CPUE data from the NT gillnet fishery to 1995 (on which the assessment was based) suggested a decline in relative abundance since the mid-1980s, for which several potential, unquantified sources were identified. Those sources included losses to other fisheries across the northern border - AFZ - or undeclared catches within other Australian fisheries (which, it was calculated, could account for up to 1500 tonnes of catch), as well as localised depletion effects. The unreliability of the assessment was emphasised.

A 2005 update of the age-structured model by the Northern Australia Science and Management Working Group noted that the declining trend shown to 1995 in the previous assessment was no longer a feature of the time series. Nevertheless, the status of the stock remained uncertain. The model incorporated the additional eight years of CPUE data available since Walters and Buckworth (1997). The dominant characteristic of the CPUE data is strong variation. It was recognised that CPUE statistics were a poor index of abundance, particularly given a high level of uncertainty in the catches of the Australia-Taiwan joint venture fishery.

The problem with CPUE, as an index of abundance, is that it may reflect other factors, such as the ways in which fishers respond to markets and cost structures, more so than to the abundance of the fish. This is illustrated by the targeted fishing apparent within the fishery. The very strongly increasing trend in the catch rate of grey mackerel during 2000-06 suggests that this species has been increasingly targeted, rather than the abundance of stocks increasing steadily. The subsequent downturn probably reflected a switch to targeting of sharks during recent years, in response to market pressures. The catch rate variations among black-tip sharks and grey mackerel (Figure 3) are substantially in counterpoint: those years in which catch rates of grey mackerel peaked, shark catch rates generally declined and vice versa. Although existing logbook effort data could not be allocated among the target groups, the inference from these observations is that catch rate trends presented for sharks and mackerels in this fishery are unlikely to match all but the strongest trends in abundance. The slight variations evident in black-tip shark catch rates in Figure 3 may simply reflect a diversion of effort by operators to generate the largest economic return at any time.

Current Harvest Status

Exploitation by the FTO and recreational sectors is considered to be quite low. The harvest by the commercial sector is below estimates of sustainable yield and is a small fraction of the catch taken by the Taiwanese-Australian joint venture fishery of the 1970s and 1980s, or current estimated landings by Indonesia (Blaber 2006).

In 2010, no trigger points for annual catch were exceeded. There were small declines in the catches of grey mackerel, and *C. tilstoni* and *C. limbatus.* The composition of byproduct

species was less than 10% of the total catch, except for bull sharks, which was 11%. As such, the trigger point for bycatch species has been exceeded. The Ministerial Advisory Committee will now review the trigger breach and provide advice to the Executive Director of Fisheries for appropriate action.

Recent work by the FRDC project 2005/010, 'Determination of Management Units for Grey Mackerel Fisheries in Queensland and the Northern Territory' has revealed that separate stocks of grey mackerel exist within the Gulf of Carpentaria compared with waters off the north-western NT. Consequently, the spatial distribution of catches of grey mackerel will be closely monitored in the future to assess the health of the two separate NT stocks.

Queenfish catches show substantial temporal variability and therefore variations in catch are more likely to reflect changes in abundance rather than a sustainability issue.

Given the high degree of uncertainty in stock estimates, the recovery of CPUE for black-tip sharks following a declining CPUE trend in the late 1990s and uncertainties about the status of grey mackerel, conservative management currently precludes any significant increase in harvest rates. The target species in the fishery are thus considered to be fully-fished.

Future Assessment Needs

A key recommendation from previous assessments has been to establish sources of information on harvest rates or abundance levels of NT shark stocks, independent of logbook data. Consequently, research to develop mark-recapture methods (tagging) to provide an on-going index of harvest levels for the NT shark fishery has been undertaken as described above.

There is little information available as yet on the magnitude and impact on northern Australian shark and finfish stocks of illegal, unregulated and unreported (IUU) fishing by foreign vessels operating in northern Australian waters. CSIRO and AFMA are completing projects considering the magnitude of IUU fishing, as well as ecosystem impacts. The consequences of this fishing on the Australian fishery are difficult to predict without this information.

In addition, a greater understanding is required of the ecological effects arising as a result of fishing down many of the top predatory fish from the offshore area of the fishery.

Movement rates and life history linkages between inshore (where most Australian fishery effort is directed) and offshore (most IUU fishing) are poorly understood for most species. A greater understanding of these factors for key species is required for future assessments.

An initial assessment for grey mackerels was undertaken in 2006. The main conclusion of the assessment was that the fishery was not currently over-fished, with variation in catch largely being effort-driven. However, the assessments were limited by their reliance on catch and effort data and the inability to determine whether sharks or grey mackerel were the principal target. Additionally, spatial dynamics of the species as described by the project 'Determination of Management Units for Grey Mackerel Fisheries in Queensland and the Northern Territory', (FRDC 2005/010) will need to be addressed in future assessment work.

Further assessment will occur in 2011.

RESEARCH

Summary to Date

In the mid-1980s, the NT Shark Fishery (now known as ONLF) was the subject of a major joint Commonwealth, NT, Queensland and WA 'Pelagic Fish Stock Assessment Program', sampling extensively around the NT coastline to establish species and size composition and provide basic biological information. Sharks were tagged to provide growth and movement information. The project provided substantial information, including extensive and long-term information on movements and growth from the mark-recapture work (Stevens et al. 2000). The

most recent tag recovery from this program occurred in 2011.

Research during the 1990s was mostly limited to monitoring trends in the commercial fishery data and stock assessment using all available data (Walters and Buckworth 1997). However, the recognised need for more information on the broad suite of shark species taken in northern Australia prompted a series of national projects on the sustainability of sharks and rays in northern Australia, and which were conducted since the late 1990s (Stobutzki et al. 2003; Rose et al. 2003; Salini et al. 2007). Those projects characterised catches, species composition and gear types across all northern Australian fisheries that take sharks. The projects developed observer programs and provided a substantial body of biological knowledge on sharks and rays in northern Australian fisheries. The principal outputs of this series of projects included risk analyses that indicated knowledge gaps yet to be addressed and the need for sustainable management.

The stock structure of shark species has been investigated in an Australian Centre for International Agricultural Research (ACIAR) - sponsored project (FIS/2003/037) led by CSIRO. The results indicated that Australian and Indonesian populations of *Carcharhinus sorrah* and *Rhizoprionodon acutus* were genetically separate, so that these stocks can be managed separately. However, populations of *Sphynra lewini* and *C. obscurus* were genetically not distinguishable across the geopolitical boundaries, and caution and cooperation in their management was suggested. Although this study indicated that black-tip sharks form a single large genetic stock throughout northern Australia, mark-recapture studies showed that movement rates both alongshore and offshore were relatively restricted between the northern Australian Arafura Sea, the Gulf of Carpentaria and the Joseph Bonaparte Gulf. Mixing is sufficient to ensure a genetically-homogeneous population but, at the same time, interactions were sufficiently restricted that segments of the population could be fished down without impacting on production throughout the population as a whole (Stevens et al. 2000).

The Natural Heritage Trust-funded research project, 'Pilot Study to develop Methodology to determine Indigenous Fishing Impacts on Sharks and Rays in the Northern Territory', was completed in 2009. This project developed a successful protocol for collecting information on the quantity and species composition of harvest of sharks and rays by the Indigenous sector.

Information on stock structure, movements and age structure of the grey mackerel population was provided by the FRDC project 2005/010, 'Determination of Management Units for Grey Mackerel Fisheries in Queensland and the Northern Territory' which was completed in 2009 (Welch et al. 2009). Results from this project have provided valuable direction in managing this multi-stock species. For assessment and management purposes, the project indicated that there were at least five stocks of grey mackerel across northern Australia: in Western Australia, the Timor Sea (NT), the Gulf of Carpentaria, and northern and southern coasts of Queensland. The project also provided valuable life history information on growth and reproduction.

Incorporation into Management

The NT hosted the Northern Australian Science and Management Working Group on Sharks in May 2008 to discuss shark research projects. Fisheries managers and researchers from across northern Australia discussed the implementation of research results into current management strategies and prioritised the research needs for northern Australian sharks. Results of the research have allowed informed and conservative management regimes to be implemented for the fishery. A follow up meeting will be held in 2011 to discuss joint management arrangements for both grey mackerel and shark stocks across northern Australia.

Current Research

A scientific monitoring program is in place to yield information on catch composition, an important

basis for monitoring biodiversity, as well as size and reproductive status of the catch species. Although the black-tip species are well-known biologically, this has not been true for many of the species that are less frequently caught.

A collaborative tagging program with commercial fishers, as described above, is also in place with the intention of delivering a protocol for monitoring harvest rates of the principal shark species. In 2010, 282 sharks were tagged and 14 were re-captured.

The participation of CDU and AIMS has expanded the scope of projects undertaken on sharks in the NT. The projects conducted in 2008 and 2009 included studies on the distribution and abundance of *Glyphis* species, and the genetics and biology of bull and pig-eye sharks (*C. leuca*s and *C. amboinensis*, respectively).

The identification of Carcharhinid sharks, particularly juvenile animals, at the species level is an on-going problem. DoR recently commenced research to provide a key with which to reliably identify and distinguish between *C. tilstoni* and *C. limbatus* based on field measurement. Although genetic analysis is currently the only reliable method to distinguish between the two species, *C. tilstoni* and *C. limbatus* have very different biological parameters as *C. tilstoni* grows faster and matures at a much smaller size than *C. limbatus*, with potential management implications. Consequently, SEWPaC identified the need to address this problem to maintain WTO accreditation.

Given the value of grey mackerel in the fishery, there is a need for more information on them. DoR continues to routinely collect information on length and sex composition of the catch and otoliths for age structure analysis.

MANAGEMENT/GOVERNANCE

Management

Management of the fishery seeks to maintain shark and grey mackerel catches within appropriate ranges, dictated by the scientific understanding of sustainable harvest levels and the underlying value of the fishery in providing food and income. This is achieved through a range of input and output controls and containment of fishing capacity.

This fishery is managed by individually transferable effort allocations. The total allowable effort (TAE) is set at 1599 days for pelagic net fishing gear and 234 days for longline fishing gear. Each licensee has been issued an allocation of TAE, which can be fished each year or transferred in full, or part, to another licensee. A licensee must cease fishing once the allocation for the licensing year has been used or transferred.

TAE may be revised up or down from year to year depending on the best available information on the sustainable catch and effort limits in the fishery.

A 'three-for-one' licence reduction program is in place. This program requires new entrants to acquire and transfer three restricted ONLF licences to DoR for the issue of an unrestricted licence. Of the17 licences currently in the fishery, six are restricted and 11 are unrestricted.

Fin ratio licence conditions apply in the fishery, which require a proportionate amount of fin and trunk to be landed. These arrangements are in place to deter the targeting of large sharks for their fins only. The current ratios are:

- 6.5% fresh or frozen fin as a proportion of trunk weight;
- 13% fresh or frozen fin as a proportion of fillet weight; and
- 3% fresh or frozen fin as a proportion of whole weight.

No shark product is allowed on board a vessel upon commencement of the next voyage.

A review was conducted of fin ratios in late 2008 resulting in changes to fishery logbooks and reporting procedures, which were introduced during the 2009 licensing year.

Catch restrictions apply to the harvest of Spanish mackerels in the fishery. Only 30 trunks/whole Spanish mackerels may be taken by fishers in the fishery per trip with no more than 10 additional trunks per tonne of grey mackerels. This limit is intended to link landings of Spanish mackerels to grey mackerel catches to address concerns by other sectors regarding pelagic net fishers targeting Spanish mackerels while recognising that incidental catches did occur when fishing for grey mackerels.

A prohibition on the possession of sharks and shark product is in place for the Demersal, Finfish Trawl, Spanish mackerel and Timor Reef fisheries. The Barramundi, Coastal Net and Coastal Line fisheries have allowances for incidental catches of sharks. The fin-to-meat ratios also apply to these fisheries in addition to trip limits.

In 2007, the fishery was subjected to an ecological assessment of management arrangements by SEWPaC against the Guidelines for Ecological Sustainable Fisheries under the EPBC Act. The fishery was found to be operating in an appropriately precautionary manner and was accredited with a WTO, which permitted it to export shark products until November 2010. SEWPaC has since granted an extension to ONLF until late 2011 with the intention of negotiating the recommendations for the fishery in conjunction with the Queensland fishery.

The NT is signatory to a multi-jurisdictional 'operational plan' for northern Australian shark fisheries to achieve the outcomes of NPOA Sharks. The Shark Implementation and Review Committee was established by the Natural Resource Management Marine and Coastal Committee to oversee the implementation and review of NPOA Sharks. In 2009 NPOA Sharks was under review with a revised plan to be developed and released for public comment in 2011.

History

A large commercial shark fishery commenced throughout northern Australia in the early 1970s. At that time, a Taiwanese gillnet fleet targeted a range of pelagic shark and fish species (as a Taiwan-Australia joint venture), with foreign fishing vessels working as close as 12 nm off the coast prior to 1978. Foreign fishing vessels were excluded from the Gulf of Carpentaria in 1979.

With the declaration of AFZ in 1979, the foreign fishing fleet's exclusion zone adjacent to Arnhem Land and the Wessel Islands increased to between 40 and 50 nm offshore. A bilateral agreement between Australia and Taiwan permitted continued access for 30 gillnet users to land up to 7000 tonnes of sharks from northern Australian waters. Further restrictions were introduced in 1986 due to declining catch rates and concerns about the incidental capture of dolphins. These restrictions limited the length of gillnets to not more than 2.5 km, thereby rendering foreign gillnetting uneconomic. Despite the permitted use of baited long lines, foreign fishing operations in northern Australian waters ceased in late 1986.

Direct involvement by dedicated domestic shark fishers in coastal waters began in the early 1980s. At that time, the NT actively encouraged the development of the inshore component of the fishery. Landings remained low with catches ranging from 100 to 500 tonnes, with shark fillets sold at established markets throughout southern Australia.

In 2004, the fishery was initially assessed against the Australian Government's Guidelines under the EPBC Act. The fishery was accredited with a WTO enabling shark products to continue to be exported.

In 2006, as part of the requirements of WTO, DoR reviewed the catch logbook program. Logbooks were amended to include the capacity to record bycatch by weight on a shot-by-shot basis.

In 2007, DoR conducted a review on the adequacy of management arrangements,

objectives, performance indicators and trigger points using the latest available verified data. The review determined that the current management objectives and performance indicators for the fishery were being met while trigger points were yet to be reached. In addition, management actions and responses to triggers were considered appropriate and in line with a conservative approach. The outcomes of the review were provided to SEWPaC as part of the fishery's WTO conditions.

The completion of the FRDC report 'Northern Australian Sharks and Rays: the Sustainability of Target and Bycatch Species, Phase II' in 2007 further supported the outcomes of the DoR review and provided additional information to assist in the identification of species of potentially higher risk and to guide the development of some species-specific measures (Table 1). Since 2004, a number of mitigation measures have been implemented based on a conservative regime.

The fishery was reassessed and received an approved WTO in November 2007. The management arrangements of the fishery were recognised by the Australian Government to be operating in an appropriately precautionary manner and the fishery is exempt from export regulations for a further three years. SEWPaC granted an extension to ONLF until late 2011 with the intention of negotiating the recommendations for the fishery in conjunction with the Queensland fishery.

To improve the identification and quantification of shark catches on a species-specific basis, DoR developed a shark identification guide booklet, which has been provided to each vessel in the fleet.

Current Issues

The changes in catch levels for grey mackerel may have been caused by a spatial shift due to the unavailability of fuel in certain regional areas and rising fuel prices. In addition, the increase in the catch of some of the shark species is believed to have been caused by changes in the nature of one licensee's activities. These matters will be considered by the ONLF Management Advisory Committee (ONLFMAC). In addition, DoR is undertaking more targeted research to obtain a better understanding of these species, specifically the commercial fishing sector's interaction with them.

An ecological risk assessment of the fishery involving stakeholders and scientific experts was conducted in 2009. The main outcomes of the workshop were that all shark species were considered to be fished well within sustainable limits due to the small catches taken by the small number of operators in the fishery. Grey mackerels were also considered to be fished within sustainable limits; however, increasing catches of this species by Queensland fishers in the Gulf of Carpentaria led the group to suggest that the species is being fished close to maximum limits within this area. Outcomes of the workshop were provided to SEWPaC.

Future Plans

A review of the shark fin ratios has resulted in the development of new information requirements in the logbooks and amendment to the existing reporting procedures to both tighten the process and ensure compliance checks are compatible. Changes to this process are being conducted in consultation with the industry and the Water Police Section of the NT Police, Fire and Emergency Services.

The NT will continue to play an active part in the revision of NPOA Sharks which was scheduled for development in 2010-11.

Compliance

The Water Police Section of the NT Police, Fire and Emergency Services is responsible for all fisheries compliance and enforcement in the NT. Water Police monitor and enforce management arrangements for the fishery through the inspection of vessels arriving and departing through the single Port of Darwin. This includes verification of catch returns against fish trader/processor returns. When necessary, Water Police have the power to investigate the records of wholesalers and licensees.

In 2010, no significant domestic compliance issues were recorded for this fishery.

Consultation, Communication and Education

Regular communication and consultation occurs between stakeholders to discuss matters of concern within the fishery. Stakeholders involved in such discussions include the NT Offshore Net and Line Licensee Committee, the NT Seafood Council, neighbouring jurisdictions, other fishing stakeholders and wider interest groups.

ONLFMAC membership is derived from a wide range of stakeholder interest groups to provide expert advice to the Executive Director of Fisheries. The committee meets to work through relevant issues to ensure the fishery continues to be sustainably managed in an open and transparent manner.

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Table 1. Management objectives and status against performance indicators for the Offshore Net and Line Fishery

Species or group	Management objective	Performance indicator	Performance measure	Harvest status for 2010	Management action
Black-tip sharks *C. tilstoni,* *C. limbatus* and *C. sorrah*	Ensure inter-generational equity by maintaining ecologically sustainable annual catches in all sectors.	Sustainable yield estimates.	Catch levels increase to 2000 t over the next calendar year.	*C. tilstoni*/*C. limbatus* 337 t; *C. sorrah* 127 t in 2010. The trigger reference point was not reached.	MACs to review fisheries annually and make recommendations to the Executive Director of Fisheries (EDF). Any amended arrangements will be implemented within 12 months of trigger being reached.
			Catch levels decline by 30% over the previous two calendar years.	*C. tilstoni*/*C. limbatus* 9% decrease from 2009 following a 14% increase in 2009 from 2008 catch; *C. sorrah* 28% increase from 2009 catch following a 22% decline from 2008. The trigger reference point was not reached.	
Grey mackerel			Catch levels decline by 30% over the previous two calendar years.	Grey mackerel catch decreased by 14% from 2009 following a 103% increase from 2008 catch. The trigger reference point was not reached.	

Species or group	Management objective	Performance indicator	Performance measure	Harvest status for 2010	Management action
C. amboinensis *S. mokarran* *S. lewini* *G. cuvier* *N. acutidens* *E. blochii* Spanish mackerel *C. obscurus* Tuna *Rhizoprionodon acutus* Queenfish *C. brevepinna*	Ensure ecological sustainability of these species in all fisheries.	Monitoring of commercial logbook returns. On-board monitoring of ONLF.	The proportion of the total catch increases by >35% in the calendar year. Catch of any byproduct species increases to >10%of the total catch in the calendar year.	All species, *except for C. leucas* within trigger reference points. *C. leucas* catch comprised 11% of the total catch. The trigger reference point was reached.	As for target species. MAC to review the trigger point and catch levels of *C. leucas*. Further investigate corresponding fluctuations in catch *between C. amboinensis* and *C. leucas*. Advice to be provided to the EDF for appropriate action.
Bycatch species	Ensure ecological sustainability of bycatch species in all fisheries.	Monitoring of commercial logbook returns. On-board monitoring of ONLF.	Total bycatch within the shark fishery increases to 10% of total catch in successive calendar years or a % decline in a species relative numbers without a corresponding change in fishing area or fishing technique.	Total bycatch in the fishery was <1% of the total catch in 2010. The trigger reference point was not reached.	
TEPs including: Sawfish, *Pristis clavata* *P. microdon* *P. zijsron* *Turtles,* *Caretta caretta,* *Chelonia mydas,* *Eretmochelys imbricata*	Ensure the continued protection of species and communities listed under the EPBC Act and the *Territory Wildlife and Conservation Act 2000*.	Threatened, endangered or protected (TEP) species and or communities are identified in NT waters.	Identifiable impacts observed by commercial fishers, DoR staff or other agencies regarding the EPBC Act listed species or communities.	There were three interactions with unidentified turtle species, and all were released alive. The trigger reference point was not reached.	MACs to review fisheries annually and make recommendations to the EDF. Fishery logbooks to be amended to include records of any interaction with endangered, threatened or protected species.
Ecosystem components	Minimise effects on ecosystem components	Identification of threatening processes	Identification of significant negative interaction with components of the natural ecosystem present on fishing grounds.	No negative interactions with environment reported. The trigger reference point was not reached.	MACs to review fisheries annually and make recommendations to the EDF.

SPANISH MACKEREL FISHERY STATUS REPORT 2010

INTRODUCTION

Spanish mackerels are found throughout tropical and subtropical coastal waters of the Indo-west Pacific, from Africa to Fiji. In Australian waters, they are found from the southern tip of Western Australia, throughout northern Australian waters and down the east coast to the south coast of New South Wales.

The Northern Territory (NT) Spanish Mackerel Fishery is based on the narrow-barred Spanish mackerel (*Scomberomorus commerson*), which is caught using trolled lures or baited lines. Spanish mackerels are also landed as an incidental catch in the Offshore Net and Line Fishery (ONLF) and the Finfish Trawl Fishery (FTF). Catch limits are set for all sectors, including commercial, Fishing Tour Operator (FTO) and recreational fishers. Spanish mackerels are also keenly sought by recreational anglers.

Historically, there were significant landings of Spanish mackerels by the Taiwanese gillnet fleet off northern Australia between 1974 and 1986, with annual catches perhaps as high as 1000 tonnes in the late 1970s. Annual catches by foreign fishing vessels were around 400 to 500 tonnes through the late 1970s and early 1980s. Since the mid-1990s, the fishery has stabilised as a small, tightly-controlled NT-based troll fishery that has since grown steadily.

The fishery has been assessed by the Australian Government's Department of Sustainability, Environment, Water, Population and Communities against the Guidelines for the Ecologically Sustainable Management of Fisheries. The fishery received the highest level of export accreditation under the Australian *Environment Protection and Biodiversity Conservation Act*. The assessment demonstrated that the fishery was managed in a manner that does not lead to over-fishing and that fishing operations have minimal impact on the structure, productivity, function and biological diversity of the ecosystem. The Export Exempt accredited fishery is due for re-assessment in 2013.

The Spanish Mackerel Fishery Management Advisory Committee (SMFMAC), in consultation with the industry, has identified management options to ensure environmental sustainability and profitability of the commercial fishery into the future. A discussion paper regarding possible management options was provided to industry licensees in 2008 and a subsequent paper, at the request of the industry, detailing different allocation models and administrative arrangements under an Individual Transferable Quota management regime, is currently being prepared by the Department of Resources (DoR) and will be available in 2011.

PROFILE OF THE FISHERY

Commercial Sector

Area

Spanish Mackerel Fishery licensees may fish in NT waters seaward off the coast and river mouths, to the outer limit of the Australian Fishing Zone (AFZ).

The principal fishing areas include waters near Bathurst Island, New Year Island, northern and western Groote Eylandt, the Gove Peninsula, the Wessel Islands, the Sir Edward Pellew Group and suitable fishing grounds on the western and eastern mainland coasts. Fishing generally takes place around reefs, headlands and shoals.

Fishing Method

Fishers in the fishery may operate from a mother boat with up to two dories. They may use any number or combination of troll lines, floating hand lines and rods. It is common for fishers to troll two to four lines behind a dory and up to eight lines from a mother boat. Using more than one licence, some operators use up to four dories with one mother boat.

Most commercial fishers purchase bait (usually southern Australian garfish) for their fishing operations. However, a small number of operators fish for bait under a restricted bait net entitlement. Bait fish, usually garfish, harvested under this entitlement, may only be used for the commercial fishing of Spanish mackerel.

Catch

The key target species in the fishery is the narrow-barred Spanish mackerel (*Scomberomorus commerson*). Small numbers of other *Scomberomorus* species are included in the catch in some years, as are various other species that might take a trolled lure or bait.

The commercial Spanish mackerel catch in 2010 was 254 tonnes, increasing from the 233 tonnes caught in 2009 and declining from the 270 tonnes in 2008 (Figure 1). The fluctuation in total annual catch largely reflects annual effort, which is influenced by prices and various operational factors. Operators have indicated that in 2010, prominent factors included fuel price and availability in remote ports, wind strength and crew availability. The low availability of skilled skippers and crew is a continuing issue for operators in this fishery, which, at times, prevents fishing.

The commercial catch in 2010 was almost all Spanish mackerel with 12 kg of grey mackerel and trevally being the only other species caught.

The capture method in this fishery (usually heavy troll lines) means that other species that are not retained for sale are usually returned to the water alive. Information from observer trips suggests that non-retained catch accounts for less than 1% of the total catch. The species typically discarded include trevallies (Family Carangidae), queenfish (Family Carangidae) and barracudas (*Sphyraena* spp.).

Landings of Spanish mackerels as bycatch in ONLF declined to 14.7 tonnes in 2010 from 20.7 tonnes in 2009. The FTF catch of Spanish mackerels was 3.0 tonnes, up from 1.6 tonnes in 2009.

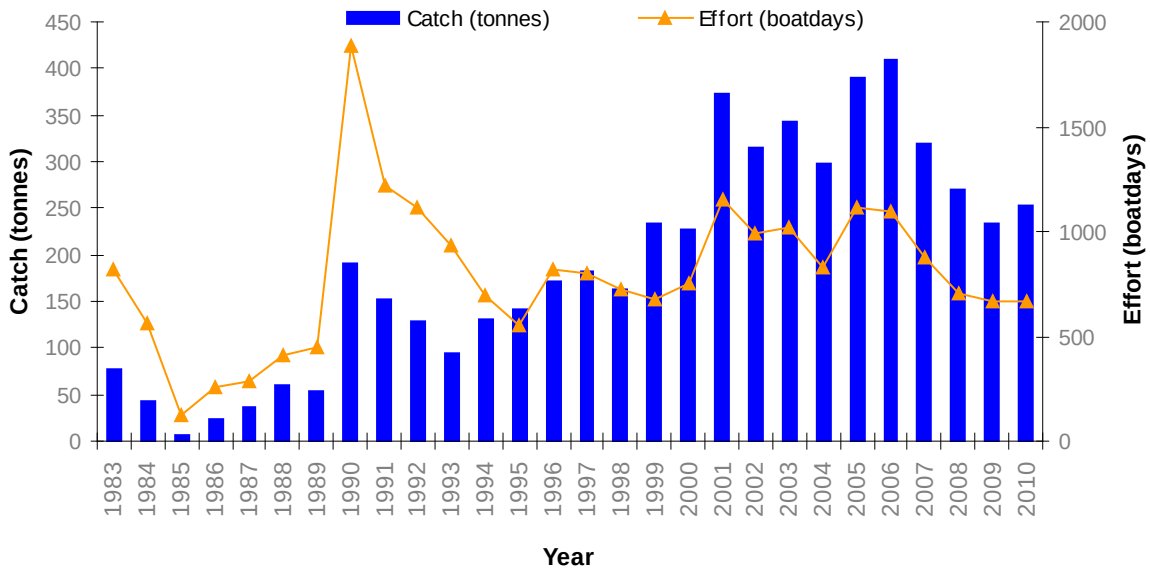

Figure 1. Annual catch (tonnes) and effort (boat-days) in the NT Spanish Mackerel Fishery, 1983 to 2010

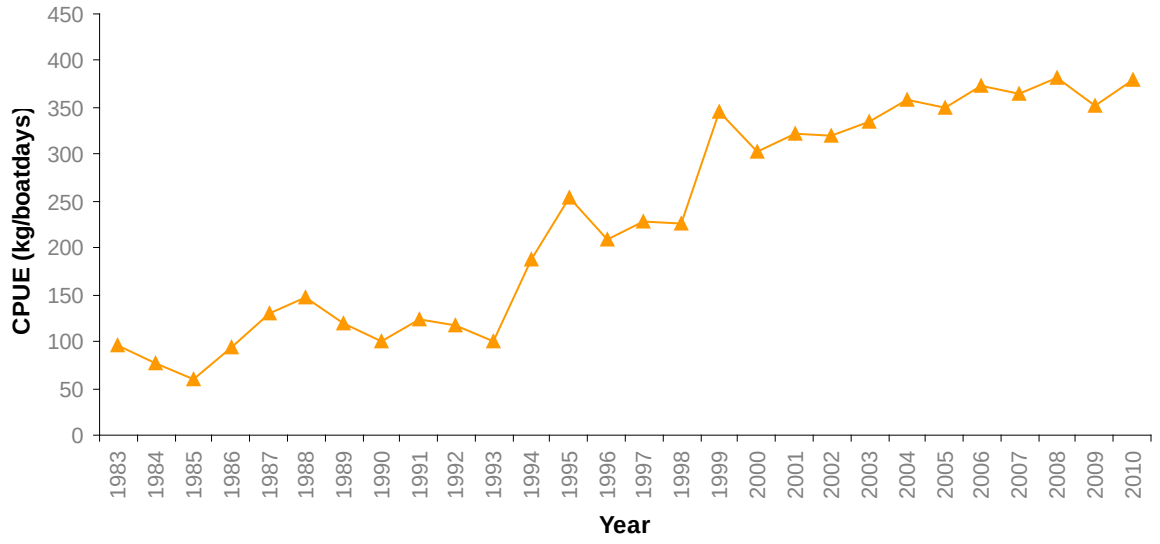

Figure 2. Catch per unit effort (CPUE) for the NT Spanish Mackerel Fishery, 1983 to 2010

Effort

In 2010, there were 16 Spanish Mackerel Fishery licences, of which 12 were actively operating.

Fishing effort in the fishery increased to 670 boat-days in 2010 from 662 boat-days in 2009, but declined from the 708 boat-days in 2008 (Figure 1), after being relatively elevated during the first part of the decade. A peak of 1155 boat-days in 2001 was still substantially below the fishery's maximum effort of 1887 boat-days recorded in 1990 (Figure 1).

Catch Rates

The catch per unit of effort (CPUE) for the commercial sector of the fishery has followed a strong increasing trend through the past two decades. CPUE since 1999 increased to at least twice that in the 1980s (Figure 2). A gross catch rate of 378.8 kg/boat-day was achieved during 2010, which was higher than the 351.5 kg/boat-day in 2009. The long-term trend may reflect improved efficiency in fishing operations and thus should be interpreted with care. However, part of the trend might include the recovery of the Spanish mackerel population from historical over-fishing by the licensed Taiwanese-Australia joint venture fishery of the 1970s and 1980s.

Marketing

Spanish mackerels are usually filleted on-board the mother vessel soon after capture. Some mackerels are processed as trunks. Trunks (whole fish from which the head, viscera and tail have been removed), are convenient for processing later into cutlets or fillets. The catch is usually frozen after processing and stored on-board; some operations land their fish fresh on ice. The catch may be unloaded to barges that service remote ports or delivered directly to the major ports of Darwin and Gove.

Recreational Sector

Area

Highly prized as a sport and table fish, most Spanish mackerels taken by recreational fishers are from waters within easy reach of the major coastal population centres of Darwin, Nhulunbuy and Borroloola. Surveys of recreational anglers in 1995 and 2000-01 found that most (47%) of the targeted effort for game fish, such as mackerel, occurred in the Nhulunbuy area.

Fishing Method

Fishing gear and methods employed by recreational fishers targeting Spanish mackerel are similar to those used in the commercial

sector. Lures and baits are trolled in the vicinity of reefs, headlands and shoals, or baited lines are used for casting or drifting into mackerel schools. Many recreational anglers use berley, which is diced and continuously tossed from the fishing vessel to entice mackerel. A proportion of the catch is also taken when fishing for other species, where fishing methods may vary.

Catch

A recreational fishing survey conducted in 1995, estimated the total recreational catch of all mackerel to be around 24 500 individuals (Coleman 1998). Almost all of these fish were harvested, weighing perhaps 170 tonnes. The proportion of Spanish mackerel within the recreational mackerel catch was not identified.

The National Indigenous and Recreational Fishing Survey conducted in 2000-01 found that the annual catch of all mackerels by the recreational sector in the NT numbered 25 233 fish (Coleman 2004), suggesting that the recreational catch was fairly stable between that survey and the FISHCOUNT survey conducted in 1995. Over half of the mackerel catch was not identified by species. However, during a recent survey with recreational fishers, 49% of the mackerel catch was thought to be Spanish mackerel. The survey also indicated that the average weight of individual Spanish mackerel was estimated to be about 5.9 kg, with an estimated release mortality of 54%. This information provided an estimated recreational sector harvest of 62.2 tonnes, including the FTO catch component of 15.1 tonnes.

A comprehensive 12-month survey of recreational fishing in the NT commenced in 2009 and will provide up-to-date recreational catch estimates. The results are expected in 2011.

Effort

In 1995, targeted game fishing accounted for only a small proportion (2%) of the total recreational fishing effort of over 37 000 hours (Coleman 1998). In 2000, targeted game fishing increased to nearly 8% of the total recreational fishing effort of over 139 313 hours (Coleman 2004).

Fishing Tour Operator Sector

Area

Fishing Tour Operators (FTOs) can fish in all areas of the fishery.

Fishing Method

Fishing gear and methods used by FTOs targeting Spanish mackerels are similar to those found in the recreational and commercial sectors. Lures and baits are trolled in the vicinity of reefs, headlands and shoals, or baited lines are used for casting or drifting into mackerel schools. Trolling accounts for most of the fishing effort, although casting has been used more frequently since 1998.

Catch

The catch of Spanish mackerels in this sector declined in 2010 when 3145 fish were caught (compared with 4054 in 2009) of which 46% were released.

Effort

FTOs catch Spanish mackerels predominantly while targeting game fish, but they also take them when fishing for barramundi and reef fish.

Targeted game fishing by FTOs is a small component of the industry. There were 874 trips undertaken in 2009, a decline from the 999 trips in 2008. The total game fishing line-hours fished in 2010 reached 8494, a decline from the 12 516 undertaken in 2009.

While effort fluctuates from year to year due to numerous factors, such as the weather and flight costs, there has, however, been a strong increasing trend in FTO effort over the last two decades, directed at game fishing. In 2010, it more than tripled that of 1995.

Indigenous Sector

Very few (1400) mackerels were captured by Indigenous fishers according to the National Recreational and Indigenous Fishing Survey of

2000-01 (Henry and Lyle 2003). Species identities were not recorded.

Non-retained Species

Monitoring of the commercial fishery identified very low levels of bycatch, illustrating the highly targeted nature of the fishery. Low value species that are not retained as byproduct are usually released alive.

Apart from various mackerel species, the majority of other species caught by the recreational sector during targeted game fishing are trevally and queenfish. Most (over 83%) of them are released.

Threatened Species Interaction

Due to the highly targeted nature of the troll fishing method, interactions with threatened, endangered and protected (TEP) species are highly unlikely. No TEP species interactions were reported in 2010.

Ecosystem Impact

The fishing gear and the targeted nature of fishing operations in the fishery are likely to have minimal impact on the ecosystem.

Social Impact

There are 17 Spanish Mackerel Fishery licences. A vessel typically operates with a skipper and two crew members, with most processing done on-board. Although some fish are processed for sale and consumption locally, most Spanish mackerel are sold interstate.

Spanish mackerels are highly regarded by the recreational and FTO sectors.

Economic Impact

At the point of first sale in 2010, the value of the catch from the commercial sector of the fishery was $1.96 million.

The recreational fishing sector contributed to the NT economy, especially the service and tackle industries, and provided high quality food.

STOCK ASSESSMENT

Monitoring

Monitoring of the fishery comprises two main elements:

- The collection of detailed information on catch and effort from the commercial and FTO sectors via fishery logbooks. Operators are required to report this information for each fishing session for every day that fishing occurs. Some fishers also routinely provide information for further monitoring of the fishery, such as length measurements of the fish taken.
- Information obtained from regular monitoring of catches on-board commercial vessels. The information collected includes length of the fish and biological information, such as sex and maturity.

Changes in fishing effort patterns and the typically small size of vessels in this fishery have meant that on-vessel monitoring has become increasingly difficult. One on-board monitoring trip was conducted in 2009. Observations from this trip reflected the extremely low byproduct and bycatch recorded in the logbook data of this fishery. In addition, monitoring trips were conducted in ONLF (five) and FTF (one), which take small numbers of Spanish mackerel. Observations from these trips indicate that Spanish mackerels are not targeted and in fact, make up less than 3% of the total catch.

Stock Assessment Methods and Reliability

Various stock assessment methods have been applied to the fishery. Equilibrium analyses (Buckworth 2004) indicate the underlying resilience of Spanish mackerel stocks in the NT fishery. This resilience is due to rapid growth and fish maturing before being harvested.

Age structured models developed using catch and effort time series data in combination with mean size and age composition data have

provided assessments of the impact of fishing. They have indicated that the fishery is sustainable at current levels but the data is considered to be only moderately reliable in defining further potential for the fishery.

Catch rates are poor indicators of abundance as the fish have a strong schooling habit.

In the absence of more information for alternative assessments, the management of the fishery has used the approximate equilibrium catch of the Taiwanese fleet (450 tonnes per year) as indicative of an optimum sustainable annual yield. Using this as a limit reference point, conservative management methods, which contain fishing effort, have been adopted to ensure the protection of the resource.

Current Harvest Status

The assessment workshops of 1997 and 2000 (Walters and Buckworth 1997, unpublished) underlined the need for better information on harvest rates or abundance, but pointed out that the NT stocks of Spanish mackerel may now be close to being fully utilised. Outputs of these workshops, as well as Buckworth (2004), indicated that the fishery is probably below or nearing sustainable catch levels. Analysis of data on catches taken during the Taiwanese fishery (1974-1986), in conjunction with NT domestic catches, suggested that the lack of older fish in the age structure information resulted from over-fishing by the Taiwanese fishery and that the recovering NT population of Spanish mackerel may be nearing optimum catch levels. Substantial uncertainty in this and subsequent assessments (Buckworth 2004) may reflect inaccuracies in the catch and effort time series from the Taiwanese fleet.

The real impact of fishing in any of the assessments cannot be ascertained without better information on current harvest rates or abundance. It is difficult to estimate Spanish mackerel abundance due to stocks being finely divided geographically and difficulties in sampling using common methods. In addition, Spanish mackerel are difficult to capture uninjured for tagging and in a cost-effective manner.

The 2000 assessment also cautioned that while there were strong management measures available to contain commercial fisheries, if the NT follows world trends, the room for growth may be taken up by recreational, guided and charter fishing sectors. These sectors have potential for rapid growth as there are no ceilings either on the number of participants or the resulting increase in their share of the catch.

Despite the unknown harvest rates in all of the sectors of this fishery, none of the trigger reference points were exceeded during 2010.

Future Assessment Needs

It has been recognised that assessment based on time series of CPUE as an index of abundance or biomass in schooling species, such as Spanish mackerel, is unreliable. Assessments based on monitoring of harvest rates through tagging would be much more informative (Buckworth 2004). The use of tag-based monitoring would overcome the lack of confidence in the accuracy of the early catch data time series.

RESEARCH

Summary

Recent research in the fishery has focussed on spatial stock structure and development of programs for the measurement of harvest rates. Cooperative research undertaken with the commercial and recreational sectors, as well as with other fisheries research and management agencies, contributes to the success of these projects.

A project funded by the Fisheries Research and Development Corporation (FRDC) in 1992-93 examined the age composition of the commercial Spanish mackerel catch, based on the examination of growth patterns from fish otoliths (ear bones) and length composition of the catch. The study found that Spanish mackerels in the

catch varied in age between one and 11 years. Most of the catch was about 100 cm (length to caudal fork) and three to six years old, with NT Spanish mackerels not fully subjected to commercial fishing until they are around five years old. Size at age was quite variable. Females were the largest fish in the catch and were usually larger than males for any given age.

A study to describe the geographic structure of the Spanish mackerel stocks across northern Australia was completed in 2002. DoR, the Queensland Primary Industries and Fisheries, the Western Australian Department of Fisheries and the University of Queensland collaborated to examine the spatial stock structure of northern and western Australia's Spanish mackerels (Buckworth et al. 2007). The study used three stock discrimination methods: genetics, parasite abundance and otolith isotope chemistry.

The FRDC-funded work showed that Spanish mackerels across northern Australia were not highly migratory but were actually divided into a mosaic of separate adult groups. Little interaction between groups was evident from both the parasite and otolith isotope analyses, which demonstrated that the fish do not mix much over distances as small as 100 km. Thus, very few fish from Cape Wessel, for example, would mix with fish from Groote Eylandt, or from the Darwin region. Similarly, recent tagging experiments in the Darwin area have shown very little movement by adult fish, with most recaptures occurring within 10 km of release positions. However, just three distinct genetic stocks were identified: one on the east coast, one across northern and western Australia and a distinct stock lying between the two in the Torres Strait area. This amount of gene flow could be maintained by larval or juvenile interchange, or straying by a small number of adults. Fish sampled from Kupang (Indonesia) were also found to be distinct from the three Australian stocks in this study; movement from Australia was not supported by either parasite or genetic analyses. Movement of fish in the other direction (that is from the vicinity of Kupang to Australian waters) was not discounted. There may be some mixing between these four genetic stock units, but they certainly have distinctive seasonal migration and historical fishing patterns. This means that analysis of catch information and management must take into account fine spatial scales. Several publications have been generated from this work (see Buckworth et al. 2007).

Incorporation into Management

Results of all research programs are reviewed annually and if they indicate significant change in any aspect of the fishery, a review of the management arrangements is undertaken.

Current Research

Current projects include:

- Conducting tag/recapture studies on Spanish mackerels to determine exploitation rates of this species.
- 'GENETAG: Genetic mark-recapture for real-time harvest rate monitoring'. This project is jointly conducted by DoR, the Molecular Fisheries Laboratory (Queensland Department of Employment Economic Development and Innovation), and commercial and recreational fishing groups; it is funded by FRDC. It aims to refine the tissue sampling method, develop efficient genetic screening methods and implement the genetic tagging approach at the fishery scale. The final report on the Genetag project is due for completion in 2011.

MANAGEMENT/GOVERNANCE

Management

Objective

The overall management objective of the fishery is to ensure its long-term sustainability by maintaining landings within acceptable ranges. This objective is achieved primarily through the strict limit controls in place in the fishery, the low level of commercial fishing activity allowed over a large fishing area, effort reduction programs, the

monitoring of catches and regular reviews of the fishery.

The fishery is managed under a catch-sharing arrangement with all user groups: commercial, recreational, FTOs and Indigenous stakeholders. The catch shares have been established to provide greater certainty for each fishing sector. The relative catch shares were based on historic harvest levels identified from the compulsory commercial logbook program and the National Recreational and Indigenous Fishing Survey (Table 1).

The management framework seeks to maintain all landings of Spanish mackerel by all sectors within the allowable catch of 450 tonnes per year. This is not a total allowable catch (i.e. it is not linked to a maximum sustainable yield) but rather it is a precautionary harvest level.

Table 1. Allocation of allowable catch of Spanish mackerel amongst sectors.

Sector	Sector allocation (%)	Weight (tonnes)
Commercial Spanish Mackerel licensees	76	342
Commercial Offshore Net and Line licensees	3	13.5
Commercial Finfish Trawl licensees	1	4.5
FTO licensees	3	13.5
Recreational fishers	16	72
Aboriginals	1	4.5
Total	100	450

In addition, management objectives, performance criteria and trigger points for the fishery have been developed and implemented (see Table 2). A review of management arrangements must commence should estimated aggregate landings by all sectors reach 405 tonnes (being 90% of the allowable catch) or total catch declines by 30% over 12 months. Should the estimated allocated catch share by stakeholder group(s) (either commercial or recreational) vary by more than 20% over 12 months, a review of the management regime will commence. Depending on the outcomes of the review, mitigation management measures may be implemented. Current arrangements also seek to ensure the sustainability of byproduct taken in the fishery by maintaining its contribution to less than 10% of the total catch.

History

Until the early 1970s, the holder of a general fishing licence could land and sell fish, including Spanish mackerels. Throughout the 1970s, management arrangements were refined, with the taking of Spanish mackerel restricted to the holder of Net and Line licences.

A Taiwanese gillnet fleet commenced fishing for pelagic species, including Spanish mackerels, in 1974. Recorded overall catches from the AFZ by this fleet peaked at 10 000 tonnes per year (processed weight), with shark, tuna and mackerel being the main species. The foreign fishing fleet was permitted to fish within 12 nm of the NT coast until 1978, at which time they were excluded from waters adjacent to Arnhem Land and the Wessel Islands. Foreign fishing vessels were excluded from the Gulf of Carpentaria in the following year. Net lengths were restricted in 1986 in response to declining shark catch rates and concerns about the incidental capture of dolphins. These controls resulted in the closure of foreign fishing operations in northern Australian waters late that year.

In 1980, commercial mackerel fishers were issued with a Reef and Mackerel Fishery licence, which superseded the previously issued Net and Line Fishery licence. In 1984, the licensing scheme was further refined, with pelagic, inshore reef fish or offshore reef fish fishery endorsements authorising trolling as a permitted fishing method to take Spanish mackerel. Fishers were encouraged to operate under a Pelagic Fishery endorsement when targeting Spanish mackerel.

The Australian Government managed all fish species in northern Australian waters beyond 3 nm of the coast until 1988. Subsequently, the NT Government assumed responsibility for the management of Spanish mackerels at this time for all waters adjacent to the NT coast to the outer boundary of the AFZ.

A ceiling on the number of licences in the Pelagic Fishery was introduced in 1990. A public announcement on 1 April, 1991 advised that the landing of Spanish mackerel by other than the holder of a pelagic endorsement might not be recognised in any future allocation of fishing entitlements.

With the formation of the fishery in 1991, only those licensees able to demonstrate a reliance on the fishery maintained access. Consequently, the number of licences was reduced to 28. An active licence reduction scheme was introduced in 1993 (and is still in place) with new entrants required to either surrender two pre-existing licences or acquire a licence previously issued on the surrender of two licences.

In 2004, a Byproduct Action Plan was developed and implemented for all the non-target Spanish mackerel fisheries. The plan introduced stringent restrictions on the incidental harvest of Spanish mackerels in ONLF and FTF and a 'no take' requirement for all other NT fisheries.

In recognition of the incidental catch of Spanish mackerel when targeting grey mackerel in ONLF, an ONLF licensee is restricted to only 30 whole trunks of Spanish mackerels during a voyage. In addition to the 30 fish for each tonne of grey mackerel harvested in ONLF, the licensee may take an additional 10 trunks or whole Spanish mackerels. In FTF, a licensee must not possess more than 50 Spanish mackerels on board.

On 1 January, 2005 amendments were made to the Spanish Mackerel Fishery Management Plan, which introduced catch share arrangements. The plan outlined the necessary input controls designed to limit overall harvest capacity and complement the catch sharing arrangement with other user groups, which include commercial, recreational, FTO and Indigenous stakeholders.

Current Issues

In 2005, the aggregate catch of all sectors exceeded 90% of the total allowable catch for the fishery, triggering a review of the management arrangements. A review of management arrangements in 2005 determined that catches were not sufficiently high to warrant any immediate concern or urgent management responses. The review concluded that continuous monitoring and a review of 2006 catches should be conducted. In 2006 the total commercial catch of Spanish mackerels once again exceeded the commercial allocation.

Due to these high catch levels, SMFMAC was asked to provide advice to the Executive Director of Fisheries on whether changes to current management arrangements were required to maintain catches within the allowable catch.

Following advice from DoR on the status of the Spanish mackerel stocks in 2008, a discussion paper, which considered future management options for the commercial take in the Spanish Mackerel Fishery, was released for comment.

In December 2008, the NT Seafood Council and the Spanish Mackerel Fishery Licensee Committee provided in principle support for the introduction of Individual Transferable Quotas (ITQs). However, there was no agreement on a preferred allocation method. As a result, DoR is developing a discussion paper to investigate a possible framework surrounding ITQs for the fishery. The paper will be released to the industry in 2011.

Future Plans

Following the release of the ITQ framework discussion paper to industry, SMFMAC will continue to work through issues associated with the potential introduction of ITQs in the fishery. Advice from SMFMAC in relation to this matter is expected in 2011.

After the review of the Spanish Mackerel Fishery has been completed and any new management

arrangements are implemented within the fishery, the industry will require some time to settle into the new operational requirements. It is anticipated that once any new management arrangements have begun to influence the fishing activity and thereby have potential impact on stocks, an Ecological Risk Assessment will be conducted.

DoR will continue to work with Spanish mackerel licensees and SMFMAC to ensure the conditions of export exemption accreditation are met. The fishery is scheduled for re-assessment in 2013.

Compliance

A risk assessment of compliance issues in the fishery was conducted in May 2006. The objective of the assessment was to identify and assess the severity of the compliance risks and formulate compliance strategies, policies and management to obviate the risks identified. The compliance risk assessment analysed several aspects within the fishery, with five out of the nine issues being ranked as 'moderate' and one - illegal unreported and unregulated (IUU) fishing - as 'extreme', primarily by foreign fishers. Management responses will continue to be developed and implemented for risks ranked as 'moderate' in the compliance risk assessment.

There is little information available on the magnitude and impact on northern Australian Spanish mackerel stocks of IUU fishing by foreign vessels operating in northern Australian waters. The consequences of IUU fishing for the fishery are difficult to predict as we do not know the magnitude and composition of the fishing over time, or the nature of the linkage between Australian and Indonesian Spanish mackerel stocks. While currently low, IUU fishing may have been sufficient in the past to have some impact on the status of NT Spanish mackerel stocks. Consultation with other relevant State and Australian Government agencies will be maintained to minimise the risk posed by illegal fishing. In addition, estimates of the level of take from illegal fishing parties will continue to be incorporated into stock assessments and management arrangements for the fishery.

The Water Police Section of the NT Police, Fire and Emergency Services is responsible for all fisheries compliance and enforcement activities under the NT *Fisheries Act 1988*.

In 2010, there were no significant compliance issues in this fishery.

Consultation, Communication and Education

SMFMAC provides advice to the Executive Director of Fisheries and the Minister on the management of the fishery.

Regular consultation occurs between DoR, the Spanish Mackerel Licensee Committee of the NT Seafood Council, the Amateur Fishermen's Association of the NT and other stakeholders to discuss matters of relevance to the management of the fishery.

Principal Research Scientist - Dr Thor Saunders
Aquatic Resource Management Officer - Mrs Tricia Beatty

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Table 2. Management objectives and status against performance indicators for the Spanish Mackerel Fishery

Species or group	Management objective	Performance indicator	Performance measure	Harvest status for 2010	Management action
Spanish mackerel	Ensure the sustainability of Spanish mackerel stocks.	Estimated catch by all sectors does not exceed the estimated sustainable yield of Spanish mackerel (450 t).	Aggregate landings by all sectors reach 90% of the sustainable yield (405 t) and/or total fishery catch declines by 30% over the calendar year (by whole weight)..	The total catch from the commercial, FTO and recreational sectors was only 78% of the estimated sustainable yield. Even if the Indigenous sector caught all of its allocation this figure is still only 79% of the estimated sustainable yield. Trigger reference point was not reached.	Within three months of becoming aware of a triggered performance measure, DoR will review and consider appropriate management responses if necessary, including a clear timetable for implementation of management action.
		Sustainable yield estimates are reviewed annually.	Annual review.		Continue existing research and review alternative yield estimate methodologies annually.
Spanish mackerel	Optimal utilisation of Spanish mackerels.	Estimated catch share (as a percentage of total aggregate landings, by whole weight) for all sectors remains unchanged.	Estimated catch share by a stakeholder group(s) (commercial or recreational) changes (increase or decrease) over the calendar year by more than 20% (by whole weight).		Within three months of becoming aware of the triggered performance measure, DoR will review and consider appropriate management responses if necessary, including a clear timetable for implementation of management action.

Species or group	Management objective	Performance indicator	Performance measure	Harvest status for 2010	Management action
Byproduct	Ensure the sustainability of by-product taken in the Spanish Mackerel Fishery.	Byproduct in the Spanish Mackerel Fishery increases significantly.	Byproduct in the Spanish Mackerel Fishery increases to 10% of the total catch over the calendar year (whole weight).	Byproduct in the fishery has a trigger value of 23.3 t in 2010. Total byproduct harvested in 2010 was <20 kg. The trigger reference point was not reached.	Within three months of becoming aware of the triggered performance measure, DoR will review and consider appropriate management responses if necessary, including a clear timetable for implementation of management action.
Bycatch	Ensure the sustainability of bycatch taken in the Spanish Mackerel Fishery.	Bycatch in the Spanish Mackerel Fishery increases significantly.	Bycatch in the Spanish Mackerel Fishery increases to 10% of the total catch over the calendar year (whole weight).	Less than 1% of the catch was discarded during the observer trip in 2010. The trigger reference point was not reached.	Within three months of becoming aware of the triggered performance measure, DoR will review and consider appropriate management responses if necessary, including a clear timetable for implementation of management action.
Threatened, endangered or protected species	Minimise effects of fishing operations on threatened, endangered or protected (TEP) species/communities.	TEP species/communities are identified in NT waters.	Impacts are observed by commercial fishers or fisheries observers.	No TEP species interaction in 2010. The trigger reference point was not reached.	Within three months of becoming aware of the triggered performance measure, DoR will review and consider appropriate management responses if necessary, including a clear timetable for implementation of management action.

TIMOR REEF FISHERY STATUS REPORT 2010

INTRODUCTION

Commercial fishing plays a dominant role in the remote Timor Reef Fishery, primarily targeting the higher-valued gold-band snapper (*Pristipomoides multidens)* and other *Pristipomoides* species. Significant quantities of red snappers (*Lutjanus malabaricus, L. erythropterus*), red emperors (*L. sebae*) and cods (Family Serranidae) are also harvested. Most of the catch from this fishery is marketed on the Australian domestic market as 'fresh on ice' whole fish.

With the passage of revised jurisdictional arrangements in 1995, the management of the fishery was passed on to the Northern Territory (NT) Fisheries Joint Authority (NTFJA). Through the NT *Fisheries Act 1988*, NTFJA manages all the finfish taken from the fishery, while the Department of Resources (DoR) conducts its day-to-day management. In 2010, there were only 12 licences in the fishery, compared with 22 in 1993.

There is little fishing by recreational fishers and Fishing Tour Operators in the fishery due to the remote offshore location of the fishery. For similar reasons, no Indigenous harvesting has been recorded from this fishery.

The fishery has been recently assessed by the Australian Government's Department of Sustainability, Environment, Water, Population and Communities against the Guidelines for the Ecologically Sustainable Management of Fisheries. The fishery received full Export Exempt accreditation under the Australian *Environment Protection and Biodiversity Conservation Act 1999*. The assessment demonstrated that the fishery was managed in a manner that does not lead to over-fishing, and that fishing operations have minimal impact on the structure, productivity, function and biological diversity of the ecosystem. The fishery is due for re-assessment in 2013.

PROFILE OF THE FISHERY

Commercial Sector

Area

The fishery operates well offshore in the Timor Sea, in a remote region extending north-west of Darwin to the Western Australia/NT border and to the outer limit of the Australian Fishing Zone. The fishery has an area of approximately 8400 square nautical miles (nm) (Figure 1).

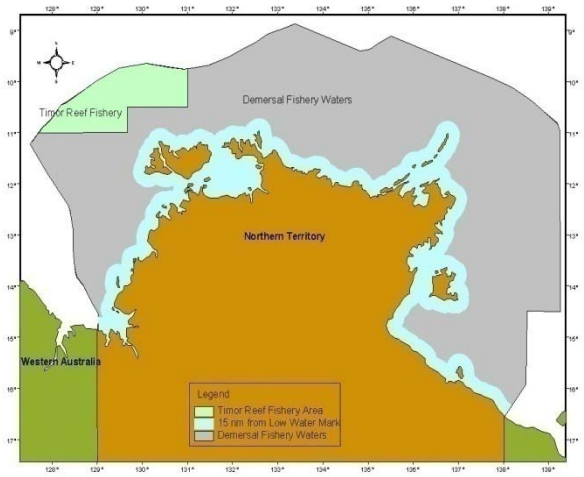

Figure 1. Area of the Timor Reef Fishery

Fishing Method

Commercial operators are authorised to use baited traps and vertical lines, including hand lines and drop lines. Prior to 1999, most operators in the fishery used drop lines. During 1999-2000, there was an industry-wide change to trap fishing, with only one operator using drop lines in 2002. In 2004, there was a reversal of this trend when many operators went back to drop lines; but by 2009, most operators were again using traps. In 2010, one vessel used drop lines and six vessels used traps, reflecting the developing nature of the wider fishery grounds.

Catch

Gold-band snappers are the principal target of the fishery, comprising the three species

Pristipomoides multidens, *P. typus* and *P. filamentosus*. Together, they comprise 52% of the total catch (Figure 2), with *P. multidens* being the most common. Other key species caught in the fishery are saddle-tail snapper (*Lutjanus malabaricus*), crimson snapper (*L. erythropterus*), red emperor (*L. sebae*) and cods (Family Serranidae) (Figure 2). There was very little change in 2010 in the species composition from 2009.

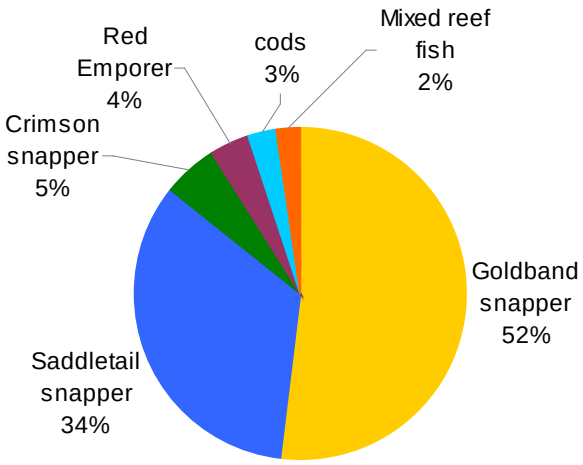

Figure 2. Catch composition of the commercial Timor Reef Fishery, 2010

The species composition of the catch has historically been gear-dependent. Drop liners generally catch a higher proportion of gold-band snappers, compared with trap boats. This year was no exception, with the dropline vessel catching a slightly higher proportion (57%) of gold-band snapper than the trap boats (51%).

In 2010, the total fishery catch was 912 tonnes, of which 475 tonnes were gold-band snappers. This represented an increase of 24% in total catch compared with 2009 (733 tonnes), with a commensurate increase of 16% in the gold-band snapper catch from 410 tonnes caught in 2009.

Byproduct species made up 9% of the overall catch in the fishery. As well as red emperor (*Lutjanus sebae*), byproduct species include small snappers (such as *L. russelli* and *L. lemniscatus*) rock cods (such as *Epinephelus areolatus*), emperors (such as red spot emperor, *Lethrinus lentjan*) and Robinson's sea bream (*Gymnocranius grandoculus*).

The 2010 byproduct level was below the 10% trigger value required to initiate a review of management arrangements for the protection of byproduct species.

Effort

During 2010, 11 licensees actively fished over a period of 1520 boat-days, an increase of 311 boat-days (or 26%) from the previous year (Figure 3).

Catch Rates

Catch per unit effort has steadily increased since 1999, which reflects the introduction of traps and increasing investment in the fishery by new operators (Figure 4).

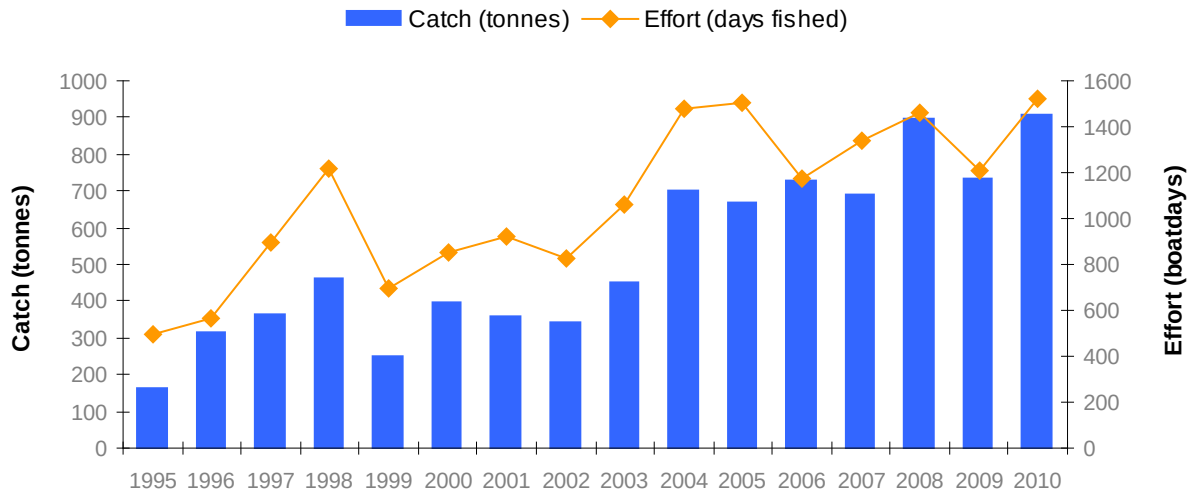

Figure 3. Commercial catch and effort for the Timor Reef Fishery, 1995 to 2010

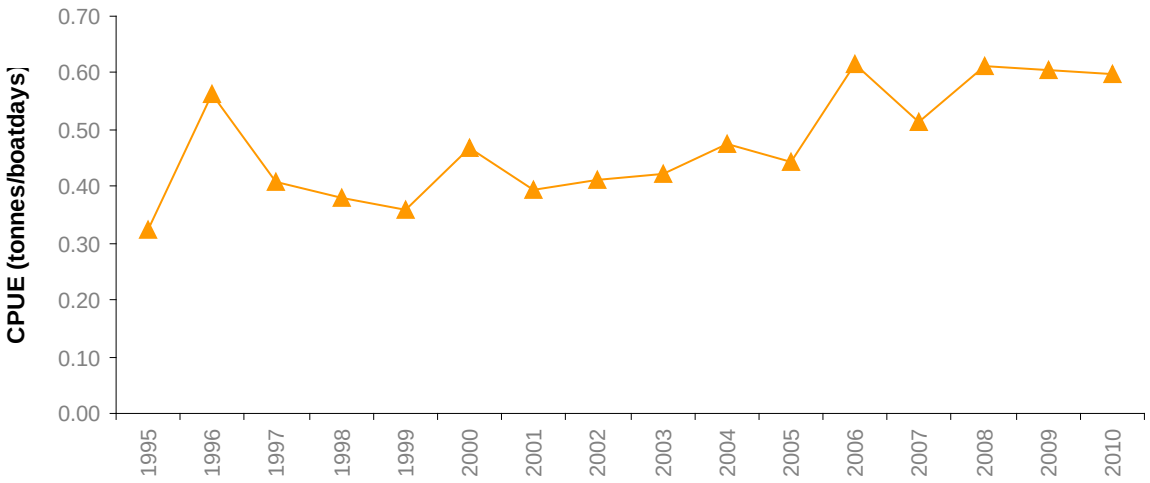

Figure 4. Commercial catch per unit effort for the Timor Reef Fishery, 1995 to 2010

Marketing

Currently, almost all snappers landed in the dropline and trap fisheries are sold as “fresh on ice” whole fish (including gills and stomach), with very small amounts sold as fillets. As the Darwin market is small, most of the product is forwarded to interstate markets, principally Brisbane and Sydney. Increasingly, operators are developing marketing arrangements outside the traditional central marketing systems, with a local representative of a major seafood wholesaler continuing to coordinate consignments to east coast markets. At least one operator independently markets catch from his two vessels.

Non-retained Species

Non-retained species include crabs, urchins, catfish (*Arius thalassinus*), Chinaman fish

(*Symphorus nematophorus*), trevally (Carangidae), and starry triggerfish (*Abalistes stellatus*).

The recorded level of bycatch (non-retained species) in the fishery is less than 7% of the total catch. Bycatch in this fishery is below the 10% trigger value.

Threatened Species Interaction

In 2010, no interaction between fishing gear and protected species was reported or observed in the fishery. Such interactions are not expected to occur in a deep-water dropline and trap fishery.

Ecosystem Impact

Operators are authorised to use drop lines and traps, which are passive fishing gear. Interaction with the habitat is limited to the effects of dropline weights and traps on the substrate, and the effect of anchors. To avoid excessive interaction with the substrate upon hauling, traps are required to be connected individually to an identifying float by a single line and not attached to one another. Anchoring is usually limited to overnight stand-down of fishing activity.

The impact of "ghost fishing", i.e. the continued fishing of 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 throughout northern Australia has shown the unimpeded entry and exit of fish from the traps used in the fishery.

Fish trawling within the area of the fishery was prohibited in the late 1980s. Such a declaration sought to provide greater protection to the then emerging fishery from the impacts of demersal fish trawling. The Northern Prawn Fishery, managed by the Australian Government, operates year round in offshore waters throughout northern Australia. Prawn and scampi (deep-water shellfish) trawling activity is generally limited to water more than 200 m deep in areas immediately north of current Timor Reef fishing grounds.

Social Impact

This fishery directly employs over 42 people as boat crew, packers and marketers, and in other support industries, including transport, ice manufacturing, packaging, boat repairs and electrical maintenance services.

Economic Impact

At the point of first sale in 2010, the overall catch value of the fishery was $5.72 million. The gold-band snapper component was valued at $4.03 million in 2010 and the combined red snapper component was valued at $1.23 million.

STOCK ASSESSMENT

Monitoring

This fishery is monitored primarily through logbooks, which operators are required to fill out on a daily basis during fishing operations. The logs provide detailed catch and effort information, as well as information on the spatial distribution of the fishery. Logbooks are required to be submitted with monthly marketing information by the 28th day of the following month.

During 2010, a DoR observer conducted one on-board monitoring trip. The observer documented vessel and gear information, location, depth, fishing practices, catch composition (including bycatch) and, where possible, measured landed species. Information gathered during monitoring trips is used to validate logbook returns, monitor bycatch, and provide biological data to assist in research and stock assessments.

Stock Assessment Methods and Reliability

A stock assessment of gold-band snappers for the fishery was undertaken in 2003. This analysis also included part of the Demersal Fishery from the boundary of the fishery to longitude 133º east because at that time 95% of the Demersal Fishery's catch of gold-band snapper was from that area. The Timor Reef and Demersal fisheries target the same gold-band snapper stocks.

The models used in this stock assessment were extensions of those developed by Professor Carl Walters at a workshop in Darwin in 1996. Details can be found in Ramm (1997). The gold-band snapper biomass was estimated to be between 3000 and 20 000 tonnes, with 9000 tonnes considered the more realistic estimate (Ramm 1997). It has been recommended that the harvest level of gold-band snappers should not exceed 10 to 15% of estimated biomass.

An assessment of red snapper stocks in 1994, using yield surplus production and yield per recruit models, estimated a conservative annual yield of 1300 tonnes from the fishery (Ramm 1994).

Additional age data is currently being collected for inclusion in stock assessment models to determine more refined sustainable yield estimates for both the gold-band and red snapper species groups. A full stock assessment will be conducted on gold-band snappers in 2011.

Current Status

Harvest levels in the Australian sector of the Timor Sea are below current reference points. Genetic studies have shown a significant difference in the Timor Sea between gold-band snapper in Kupang (West Timor) and the northwest Australian site (Ovenden et al. 2002). Otolith microchemistry also revealed distinct populations for all sites sampled across northern Australia and Indonesia (Newman et al. 2000). In the Indonesian-controlled area of the Timor Sea, gold-band snappers are targeted by Indonesian longline vessels.

Future Assessment Needs

Despite the results of the genetic studies on gold-band snappers, some key parameters are still required to enable a more accurate assessment of the fishery, including:

- Indonesian catch and effort information.
- The identification of gold-band juvenile habitats and movement patterns.
- More accurate growth parameters from the capture of juvenile gold-band snappers.

Given the proportion of red snappers in the catch, similar parameters are required for future assessment of those species.

RESEARCH

Summary

Fine scale spatial analysis of this fishery was conducted as part of a Fisheries Research and Development Corporation project, which commenced in October 2005 (Lloyd and Puig 2009). The project used GIS spatial statistical methods to investigate new ways to incorporate the very diverse forms of physical and environmental data, often on different scales, with fishery logbook data. This study showed that bathymetry and geomorphology strongly influenced catches of gold-band snappers.

The stock structure of gold-band snappers (*P. multidens*) has been determined by using both genetic methods and otolith microchemistry (Newman et al. 2000; Ovenden et al. 2002). These were collaborative projects between DoR, the Western Australian Department of Fisheries and Fisheries Queensland, which is a part of the Queensland Department of Employment, Economic Development and Innovation. Both studies used fish from the same sites.

The genetic study showed no differences between Australian sampling sites in the Timor and Arafura seas, but a significant difference in the Timor Sea between Kupang (West Timor) and the northwest Australian site. These sites were located less than 200 nm from each other on either side of the Timor Trench (Ovenden et al. 2002). Otolith microchemistry revealed distinct populations for all sites sampled, indicating that substantial movement of adults between sites is unlikely (Newman et al. 2000).

A project to ascertain if hearing damage occurred in gold-band snappers due to seismic survey exposure was conducted by Curtain University in

conjunction with DoR. The project was funded by Santos Ltd and was completed in December 2007. The results of the tests were deemed inconclusive and suggested more targeted work was required to isolate the causes of any noticeable effects.

Incorporation into Management

Recent research findings have confirmed the validity of present management arrangements for this fishery between the NT, Western Australia and Indonesia.

Current Research

Current research is focussed on obtaining more comprehensive age data for the targeted offshore snapper species. A collaborative project led by the Queensland Government commenced this year to assess the utility of current monitoring and logbook datasets, conduct a risk analysis and develop a monitoring program to provide fishery-independent data for gold-band and red snapper assessment. The monitoring program that will result from this project is expected to provide regular spatially-referenced age data and an index of relative abundance for the offshore snapper species across northern Australia. The data will provide essential information for establishing annual harvest rates and, in turn, ensure greater reliability of stock assessments.

A research project is being conducted to identify juvenile red snapper nursery grounds. Initially, the project is expected to provide information on seasonal settlement and movement patterns as well as provide age information from smaller fish for inclusion in current stock assessment models.

DoR is currently collaborating with Indonesia and Timor Leste in the Arafura and Timor Seas Ecosystem Action Program, which aims to characterise the socio-economic profile of the Arafura and Timor seas (ATS) region and identify cross boundary issues, including exploitation of fisheries. It is expected that this project will strengthen links between each of the countries bordering the ATS and improve the flow of information necessary to accurately assess offshore snapper fisheries.

MANAGEMENT/GOVERNANCE

Management

Objective

Management objectives for the fishery are achieved by maintaining target, incidental and non-retained catch levels within acceptable ranges. Should landings of gold-band snappers rise above sustainable yield estimates, a review of the management arrangements will commence. Similarly, a significant decline in catch rates would prompt a review of the management measures for the fishery (Table 1).

History

Separate management measures were implemented for the fishery in 1993 when it was annexed from the Demersal Fishery. Limits were implemented on the number of operators in response to concerns that fishers displaced from interstate fishing restructuring programs may lead to over exploitation of gold-band snapper stocks.

Jurisdictional arrangements were changed in 1995, at which time management responsibility for line fishing and trapping in waters adjacent to the NT passed to the NT Government.

At the request of the industry, a review was conducted throughout 2006-07 of the levels of permitted gear (drop lines and traps) and management arrangements in order to develop alternative management arrangements for the fishery.

The Timor Reef Fishery Assessment Group was established to provide advice to the Timor Reef Fishery Management Advisory Committee (TRFMAC) and DoR on the potential of introducing a catch quota management system into revised management arrangements for the fishery.

Current Issues

TRFMAC has developed a catch quota management framework for consideration by the Minister. Additional cost implications, as a result of moving to management by catch quota, are included in the advice to the Minister. Amended draft Timor Reef Fishery Regulations have been developed using the management framework as the basis for the proposed changes.

The effect of illegal, unreported and unregulated (IUU) fishing in northern Australian waters is not clearly understood. It is important that adequate resources are allocated by the Australian Government to mitigate IUU impacts on the sustainability of red snapper stocks.

The industry and DoR continue to liaise with oil and gas exploration companies in an effort to increase cooperation and reduce potential economic impacts on fishing operators by exploration surveys.

Future Plans

DoR will continue to work with TRFMAC and the industry on matters relating to the proposed introduction of catch quota management. The introduction of a vessel monitoring system is being explored to complement the planned move to quota management arrangements for the fishery.

Gold-band snappers landed adjacent to the boundary of the fishery are likely to form part of the same stock. Management triggers recognise this and management arrangements are under constant review.

Compliance

The Water Police Section of the NT Police, Fire and Emergency Services, is responsible for fisheries compliance and enforcement in the NT.

The Water Police Section effectively monitors compliance in the fishery through the inspection of vessels arriving in and departing from the single Port of Darwin. This may include verification of fishery logbook returns against processor returns (i.e. a requirement for all operators to specify where they are selling their product). If necessary, the Water Police Section has the power to investigate the records of wholesalers and licensees.

In 2010, no domestic compliance issues were recorded in this fishery.

Consultation, Communication and Education

Regular consultation occurs between DoR, the Timor Reef Fishermen's Association and the NT Seafood Council. In addition, DoR staff regularly visit the wharf to speak informally with fishers.

TRFMAC, consisting of representatives from all fishery stakeholder groups, and DoR provide advice to the Minister and the Executive Director of Fisheries on matters related to the management of the fishery.

DoR liaises with conservation groups and non-government organisations on matters of relevance to this fishery. DoR also produces publications in the form of Fishery Reports, Fishnotes and newsletters to inform and educate stakeholders.

Senior Research Scientist – Dr Julie Martin
Aquatic Resource Manager – Mr David McKey

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Table 1. Management objectives and status against performance indicators for the Timor Reef Fishery

Species or group	Management objectives	Performance indicator	Trigger reference point	Current status review	Management response to be taken
Gold-band snapper	Ensure inter-generational equity by maintaining ecologically sustainable annual catches in all sectors.	Optimal sustainable yield estimates.	Annual catch exceeds 900 t.	Gold-band snapper catches in 2010: 470 t. Catch levels increased from 410 t in 2009. The trigger reference point was not reached.	TRFMAC to review fishery and make recommendations to the Executive Director of Fisheries (EDF) regarding appropriate measures to ensure annual catches do not exceed estimated sustainable yields. Amended arrangements to be implemented within 12 months of trigger being released.
Red snapper (including saddle-tail snapper)	Ensure inter-generational equity by maintaining ecologically sustainable annual catches in all sectors.	Optimal sustainable yield estimates.	Annual combined catch exceeds 1300 t.	Combined red snapper catches in 2010: 357 t. Catch levels increased from 264 t in 2009. The trigger reference point was not reached.	TRFMAC to review fishery and make recommendations to the EDF. Amended arrangements to be implemented within 12 months of trigger being released.
Red emperor	Ensure inter-generational equity by maintaining ecologically sustainable annual catches in all sectors.	Significant change in catch composition on Timor Reef Fishery grounds.	Annual catch increase in proportion of the total catch by greater than 25% above the five-year average.	Red emperor as a proportion of total catch in 2010: 4%. An increase from 2% of total catch in 2009. The trigger reference point was not reached.	TRFMAC to review fishery and make recommendations to the EDF. Amended arrangements to be implemented within 12 months of trigger being released.
Byproduct species	Ensure sustainability of byproduct species taken in the Timor Reef fishery.	Monitoring of commercial logbook returns for a significant change in by-product catch composition on Timor Reef Fishery grounds.	Annual catch increase in proportion of the total catch by greater than 10 per cent above the five year average.	Combined byproduct species (includes cods) in 2010: 5%. The trigger reference point was not reached.	TRFMAC to review fishery and make recommendations to the EDF. Amended arrangements to be implemented within 12 months of trigger being released.

Species or group	Management objectives	Performance indicator	Trigger reference point	Current status review	Management response to be taken
Bycatch species	Ensure sustainability of bycatch species taken in the Timor Reef Fishery.	On-board monitoring of Timor Reef Fishery.	Total bycatch within the Timor Reef Fishery increases to 10% of total catch or a decline in a species relative numbers without a corresponding change in fishing area or fishing technique.	Total bycatch in 2010 was less than 2% – trigger reference point not reached. On-board monitoring to continue annually.	TRFMAC to make recommendations to the EDF regarding appropriate remedial action and on-board monitoring to commence at earliest practical opportunity. Amended arrangements to be implemented within 12 months of trigger being released.
Threatened, endangered or protected species and/or communities	Maintain present level of interaction between Timor Reef fishing operations and species and communities listed under the EPBC Act.	Threatened, endangered or protected species and or communities are identified in Northern Territory waters.	Identifiable impacts observed by commercial fishers, fisheries observers or other agencies regarding EPBC Act listed species or communities.	No identifiable impacts observed in 2010. The trigger reference point was not reached.	TRFMAC to make recommendations to the EDF regarding appropriate threat abatement plan implemented and on-board monitoring to commence at earliest practical opportunity. Amended arrangements to be implemented within 12 months of trigger being released.
Ecosystem components	Minimise effects on ecosystem components.	Identification of threatening processes.	Identification of significant negative interaction with components of the natural ecosystem present on Timor Reef fishing grounds.	No negative ecosystem interactions identified in 2010. The trigger reference point was not reached.	TRFMAC to make recommendations to the EDF regarding appropriate remedial action. Amended arrangements to be implemented within 12 months of trigger being released.

TREPANG FISHERY STATUS REPORT 2010

INTRODUCTION

Trepang fisheries in northern Australia date back to at least the 1700s, when Macassans from Celebes (Sulawesi Island group, Indonesia) visited northern Australia to fish for these species. The term trepang refers to the dried body wall of holothurian sea cucumbers, whereas the term bêche-de-mer refers to the cooked body wall.

Trepang fishing activity in the Northern Territory (NT) declined around 1880. By 1907, the South Australian Government ceased issuing licences to Macassans, possibly due to the emergence of a local industry. Landing reports, although scant, suggest the catch was many times higher than current levels.

A lower level of commercial exploitation continued until around 1945. Little fishing activity was observed until the early 1980s, with virtually no reported exports. Commercial fishers were generally European Australians assisted by Aboriginal people who inhabited the remote Arnhem Land coast.

Increasing interest in the late 1980s led to the re-opening of the NT Trepang Fishery.

Currently, there are six trepang licences, all owned by one licensee.

The principal target species in this fishery is sandfish (*Holothuria scabra*). It prefers coastal areas with soft sediment substrate and is often found in beds of seagrass, which plays an important role in triggering larval settlement.

In late 2007, the fishery was re-assessed against the Australian Government's Guidelines for the Ecologically Sustainable Management of Fisheries. As a result, the fishery received certification as an accredited Wildlife Trade Operation (WTO) under the Australian *Environment Protection and Biodiversity Conservation Act 1999*. The assessment demonstrated that the fishery was managed in a manner that does not lead to over-fishing, and that fishing operations have minimal impact on the structure, productivity, function and biological diversity of the ecosystem. The fishery is currently undergoing reassessment.

PROFILE OF THE FISHERY

Commercial

Area

The fishery operates in waters to 3 nautical miles (nm) seaward of baselines (i.e. the NT coastline and surrounding islands). Most of the effort occurs along the Arnhem Land coast, the major harvest areas being around Cobourg Peninsula and Groote Eylandt.

Fishing Method

Sandfish is the most important species for tropical sea cucumber fisheries. It is one of the few tropical sea cucumber species that prefer coastal areas to coral reefs. Harvesting of sandfish usually takes place by walking at low tide and diving in shallow coastal bays and foreshores. Snorkel, scuba and hookah may be used when diving for trepang. Collection is generally limited to neap tides and the dry season when visibility in water improves and cyclone activity is minimal.

Catch

The total harvest of trepang was low during most of the 1990s before peaking at 333 tonnes in 2000. Since 2000, the harvest has varied, largely in response to fishing effort (Figure 1). Total harvest reported for 2010 was 22.2 tonnes, which is a decline from the 64.6 tonnes harvested in 2009. The 2010 catch is less than a tenth of the annual average catch (235 tonnes) between 1998 and 2007.

No byproduct species were harvested in 2010 owing to the hand-collecting method of harvesting.

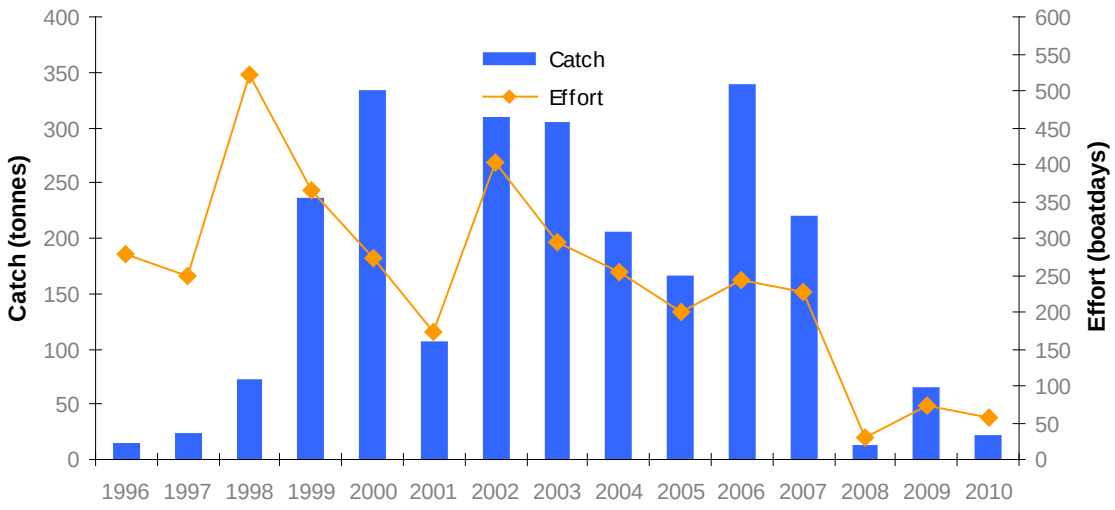

Figure 1. Annual total catch* and effort for the commercial Trepang Fishery, 1996 to 2010

*Catch weight indicates whole wet weight, which is double the reported gutted and blanched weight.

Effort

Between 1996 and 2010, fishing effort varied substantially (Figure 2). Catch and effort declined from 72 days in 2009 to 58 days in 2010, which is less than a fifth of the annual average effort (296 days) during the period 1998 to 2007.

Catch Rates

Until the mid-1990s, catch rates in the fishery were low, with 11 kg/hour and 20 kg/hour recorded in 1996 and 1997, respectively (Figure 2). In 2000, the catch rate for trepang peaked at 248 kg/hour. Catch rates declined in 2001, levelling out in subsequent years to between 115 kg/hour in 2005 and 198 kg/hour in 2006. However, since 2006, catch rates have declined substantially (apart from an increase in 2009). The 2010 catch rate of 72.2 kg/hour is the lowest recorded since 1998 (Figure 2).

The low catch and effort values recorded in 2008-2010 have been attributed to a business decision by the Trepang Fishery licensee to concentrate effort in other jurisdictions and to also focus resources on the ranching and aquaculture of trepang. The ongoing availability of skilled skippers and crew is also an operational issue for the NT Trepang Fishery and the skill of divers and visibility of the water greatly impacts catch rates.

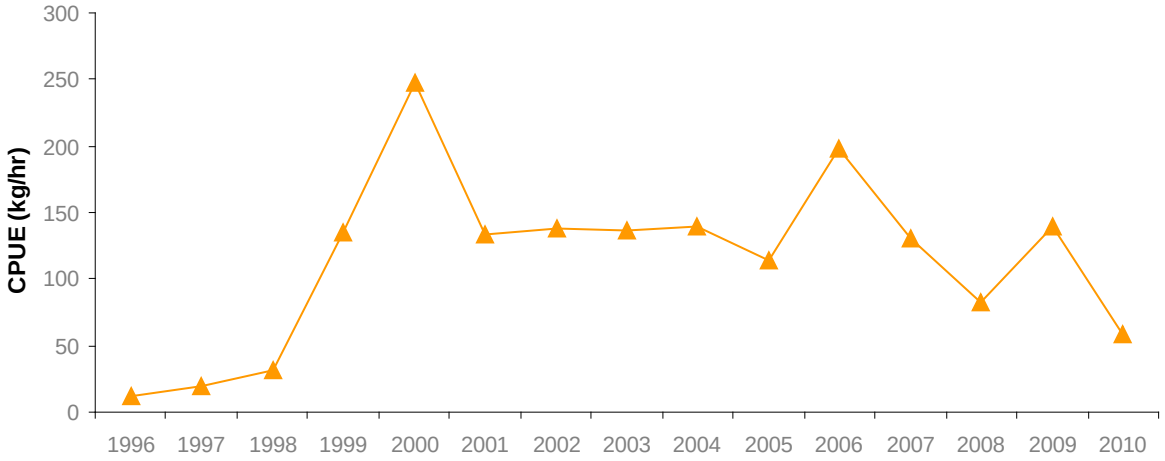

Figure 2. Catch per unit effort (CPUE) for the commercial Trepang Fishery, 1996 to 2010*

*Catch rates represented here are per hour of operation where a catch was declared in units of weight.

Marketing

With restricted land access to most of the NT coastline, all fishing operations are vessel-based. Initial processing includes washing, grading and freezing the harvested product, with most operators removing the stomach, and then boiling and freezing the trepang. The processed catch is generally unloaded in Darwin (the only NT port with all season access) and transported to domestic facilities for further processing, which typically is mechanical drying.

Due to limited domestic demand, most of the catch is exported.

Recreational Sector

The recreational harvest of trepang is not known, but is likely to be low. No trepang catch was reported by recreational fishers during either of the two recreational fishing surveys conducted in 2000 and 2010. The local Asian community may take limited amounts for personal consumption.

Fishing Tour Operator Sector

There were no reports of trepang in the catch of Fishing Tour Operator clients in 2010.

Indigenous 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 field trips suggested that trepang was never used as food.

Non-retained Species

The targeted hand-collecting method of fishing for trepang means that there are no non-retained (bycatch) species.

Ecosystem Impact

Hand-collecting of trepang is unlikely to have an impact on the sea floor. The effect of removing quantities of trepang from the ecosystem is unknown. However, with the current low participation rate and precautionary management, impacts are likely to be low.

Economic Impact

Confidentiality constraints prevent the publication of this information.

STOCK ASSESSMENT

Monitoring

Operators in the fishery are required to complete and submit catch (numbers and weight) and effort logbook information for each day of fishing. This information is used to assess the status of the fishery.

It is important to note that individual weights of trepang vary substantially as the animal may take in or release substantial volumes of water and has no hard parts that might be a reliable indicator of weight. By reporting total weight and number in the catch, fishers nevertheless provide useful information on trends.

Fishers also continue to report fishing locality and now also report the harvest area in latitude and longitude so that future assessment and management may address the spatial dynamic attributes of the fishery.

Stock Assessment Methods and Reliability

Studies in Queensland indicate limited genetic variability between shallow and deep-water populations of sandfish. This finding may be consistent with the view that juveniles settle in shallow seagrass beds and then migrate to areas of deeper water during their life span.

Sexual reproduction of sandfish is via broadcast spawning, which generally occurs in the warmer months from December to February. The planktonic larvae of this species spend 10 to 14 days in the water column before settlement. Consequently, there is potential for larval dispersal between populations.

Although there is no current stock assessment for the fishery, the Department of Resources (DoR) has adopted a precautionary management approach. This includes a limit on the number of licences (six) and the area of the fishery (i.e. within 3 nm of the NT baselines). This cautious management approach, together with natural inhibitors (visibility, accessibility, wet season and cyclonic events) limit the potential for over-fishing.

Current Exploitation Status

A change in average weight has triggered a reference point. An examination of the cause and implications of the trigger will be conducted and a report will be provided to the Executive Director of Fisheries. If necessary, DoR will consult with the industry and other stakeholders on the need for alternative management arrangements. No other performance measures for the fishery reached the limit reference points, including total catch and rolling three-year average CPUE.

Licensed commercial operators are permitted to harvest all trepang species. Discussions with fishers indicate that the fishery continues to target sandfish in preference to other lower-valued species found in tropical waters. A review of trepang fisheries elsewhere indicates that in the event of a population decline in the higher-value species, fishers seek to maintain profitability by targeting the lower value holothurian species.

Such a situation was observed in the Queensland Bêche-de-mer fishery, where commercial fishers targeted white teatfish (*Holothuria fuscogilvia*) and prickly redfish (*Thelenato ananas*), and in the Torres Strait fishery, where fishers targeted teatfish (*H. fuscogilvia, H. noblis*), prickly redfish and surf redfish (*Actinopyga mauritiana*). Such a trend has not been observed in the NT's trepang fishery.

Future Assessment Needs

A program to develop a series of cooperative industry-based projects is currently being investigated. It is expected that a program of management strategy evaluation will be initiated to identify research directions and monitor information that would be appropriate for various management options. Research will seek to assess the status of stocks both within and outside the fishery.

Incorporation into Management

Future monitoring will depend on the information needs identified above and future fishery performance.

RESEARCH

Current research primarily involves analysis of trends in fishery statistics and assessment, and assimilation of research from other areas and jurisdictions.

The industry is currently working on trial hatchery techniques for sandfish. The research is concentrating on improving hatchery techniques and rearing of juvenile sandfish. This work is providing a far greater understanding of biological parameters relevant to the NT, including growth rates.

In collaboration with the Flinders University of South Australia, DoR and the South Australian Research and Development Institute, the industry is conducting a genetic study of stocks along the entire NT coastline. The results of this project should assist in identifying any genetic evidence of geographically distinct trepang stocks in NT waters. It will also determine the geographic extent of the mixing of genetic information.

Work commenced in 2007 on an industry-funded pilot survey of NT coastal waters (inside 3 nm). The survey involved most of the NT coastline with the exception of waters from Groote Eylandt to the NT/Queensland border. The survey utilised a “stalled plate” trawl design; however, technical difficulties encountered during the survey may have limited the success of this approach. Further fine-scale surveys will be conducted to aid in spatial management and projection of trepang distributions in the NT.

MANAGEMENT/GOVERNANCE

Management

Objective

The fishery management arrangements seek to conserve, enhance, protect, utilise and manage trepang stocks in the NT. Key management strategies include:

- Limiting the number of commercial licensees to a maximum of six.
- Having two separate management zones, with no more than three licences authorised to operate in each zone.
- Limiting fishing to an area extending from the high water mark to an imaginary line 3 nm from baselines.
- Limiting the number of crew and collectors/divers.
- Permitting the harvesting of trepang by hand only.

Analysis and monitoring of catch and effort trends, average weight of trepang caught, the continuation of fishing on the same grounds, operational and logistic constraints, together with the continued focus on the principal target species, indicate that the current arrangements are appropriate.

In addition, fishing in the tropical inshore waters of the NT with their large tidal range (exceeding 8 m in some areas) and distinct wet/dry monsoon seasons with highly turbid water, place operational limitations on the fishery and the collection of trepang by hand. Highly turbid water impedes the effectiveness of hand-gathering, with commercial operators reporting their inability to harvest trepang during spring due to larger tides and heavy flooding, often associated with the monsoons. As a result of these factors, actual fishing time is limited. These natural inhibitors are taken into account by management and are acknowledged as providing further protection to trepang stocks.

The fishery is managed in accordance with the management objectives, performance indicators, triggers and management actions agreed by the industry, DoR and the Australian Government assessment process as part of WTO accreditation (Table 1).

History

In the 1980s, six licences were issued for the harvesting of trepang by hand. Initially, the

fishery was divided into three separate management areas, with two licences permitted to operate in each area. Once the fishery was operational, licensees in the far western area indicated that there was insufficient product for their operations to be economically viable, particularly given the more extreme tidal fluctuation in this management area. For this reason, the central and western zones were merged.

Currently, one management zone extends east of Cape Grey in the Gulf of Carpentaria to the Queensland border (including Groote Eylandt) and the other extends west of Cape Grey to the Western Australian border. Controls were introduced at that time to regulate the number of crew and permitted divers/collectors.

Current Issues

Reported catch levels for the target sandfish in 2010 were within acceptable levels.

There is little information available on the magnitude and impact on northern Australian trepang stocks of illegal, unreported and unregulated (IUU) fishing by foreign vessels operating in northern Australian waters. DoR continues to work with the Australian Government to ensure adequate resources are allocated to mitigate IUU impacts on the sustainability of trepang stocks.

Compliance

Fisheries compliance and enforcement in the NT is conducted by the Water Police Section of the NT Police, Fire and Emergency Services, under the NT *Fisheries Act 1988*. The Water Police Section monitors and enforces the fishery's management arrangements by inspecting vessels arriving in and departing from the single Port of Darwin. Compliance includes verification of fishery logbook returns against processor returns (i.e. requirement for all operators to specify where they are selling their product). If necessary, the Water Police Section has the power to investigate the records of wholesalers and licensees.

In 2010, no significant compliance issues were recorded for the fishery.

Consultation, Communication and Education

Periodic consultation occurs between DoR, the holder of the trepang licences and the Seafood Council of the NT on matters related to the continued long-term ecologically sustainable management of the fishery.

DoR also liaises with conservation groups and non-government organisations on relevant matters.

Fishery Reports, Fishnotes and newsletters are published to inform and educate stakeholders.

Senior Research Scientist - Dr Thor Saunders
Aquatic Resource Management Officer - Mr Steven Matthews

REFERENCES

Henry, G. W. and Lyle, J. M. (2003). The National Recreational and Indigenous Fishing Survey. FRDC Project 99/158. NSW Fisheries Final Report Series No 48.

Table 1. Management objectives and status against performance indicators for the NT Trepang Fishery

Species or group	Management objectives	Performance indicator	Performance measure	Harvest status for 2010	Management action
Target species	Ensure intergenerational equity by maintaining ecologically sustainable annual catches in all sectors.	Sustainable yield estimates developed. Change in total catch.	Total catch increases over 300 t/year.	Trepang catch in 2010 was 22.2 tonnes. The trigger reference point was not reached.	The Executive Director of Fisheries (EDF) to be notified within 60 days if trigger reached. An internal examination of cause and implication of reference point being triggered with report prepared within six months to the EDF. Consultation with industry and other stakeholders on need for alternate management strategy or action if necessary and agreement on line of action. If appropriate, any amended arrangements to be implemented within 12 months of trigger being reached.
		Change in CPUE.	The rolling three-year CPUE average varies by a factor of 30% from the current years catch.	The 2010 CPUE value was 26.2% lower than the rolling three-year average. The trigger reference point was not reached**.**	
		Change in average weight.	Average weight decreases by more than 20%.	The average individual weight decreased by 29% in 2010. The trigger reference point was reached.	
		Change in catch composition.	Catch of trepang species other than *H. scabra* increases to over 30% of total catch.	*H. scabra* were the only species harvested in 2010. Trigger reference point was not reached.	
		Change in licence ownership.	Any licences traded.	There were no licences traded in 2010. The trigger reference point was not reached.	
Byproduct and bycatch species	Ensure sustainability of byproduct and bycatch species taken in the NT Trepang Fishery.	Monitoring logbook. On-board monitoring.	NA - no byproduct or bycatch in the fishery.		NA

RECREATIONAL

FISHING TOUR OPERATOR STATUS REPORT 2010

INTRODUCTION

By the middle of the 1980s, a handful of barramundi guides and fishing lodges had begun operating in various locations throughout the Northern Territory (NT). By 1989 there were 24 guided fishing businesses and a well organised Fishing Tour Operators' Association.

This was the start of a boom period in guided fishing tourism that was triggered by the NT Government's decision to allocate barramundi resources to the recreational fishing sector in several key areas. The remarkably rapid growth of this industry necessitated more formal management, leading to the introduction of Fishing Tour Operator (FTO) licences in 1993. Licence numbers peaked at 218 in 1997.

FTOs operating in Kakadu National Park require an additional permit issued by the Australian Government's Department of Sustainability, Environment, Water, Population and Communities (SEWPaC).

Most FTOs target barramundi in coastal and inland areas, while others operate offshore targeting other species. Vessels range in size from small dinghies up to luxury mother ships.

FTOs and their clients observe the same fishing controls as recreational fishers and none of their catch may be sold or bartered.

PROFILE OF THE FISHERY

Area

The majority of FTOs operate in areas which are accessible to the general public. A large proportion of FTOs operate out of Darwin but the industry is well represented in the regional areas of Nhulunbuy and Katherine. While several FTOs are based on big tidal rivers, some are based on Aboriginal land and others operate from bush camps, lodges and commercial accommodations.

While FTO licence conditions do not generally restrict access to specific areas other than those not accessible to recreational fishers, there are restrictions on the number of commercial operations allowed in specific areas managed by SEWPaC and the NT's Parks and Wildlife Service. Some FTOs maintain financial agreements with landholders to operate exclusively from land of Aboriginal and other tenure.

Fishing Method

The methods and gear used by FTOs and their clients are the same as those that may be used by other recreational fishers. Most FTO fishing activity is conducted using lines (rod) with bait, or trolling or casting with an artificial lure. FTOs submit log returns to the Department of Resources (DoR) for each day spent fishing. The numbers of various species caught and released are recorded together with the number of line hours spent barramundi fishing, game fishing, reef fishing, crabbing or using other methods, such as cast netting or drag netting.

Catch and Effort

In 2010, the total FTO catch was 166 054 fish, representing a 12 222 (6.9%) decline from the 178 276 fish caught in 2009 and a 20% decline from the peak catch of 207 858 in 2006 (Figure 1).

Barramundi continued as the species most frequently caught with a catch of 54 104 in 2010, a 13% increase from the catch of 47 937 in 2009 (Figures 2 and 3) and an 8% decline from the 2006 peak. Most barramundi (86% average over a 17-year period) caught by FTOs are released. In 2010, 47 892 barramundi (88% of the catch) were released.

Other common species caught by FTOs in 2010 included golden snapper (15 382), stripey snapper, also known as Spanish flag, (12 427), grass emperor, also known as tricky snapper, (9091) and trevally (8063) (Figure 2). While

trevally has a high rate of release (93%), the other species average a 63% release rate.

In 2010, 169 661 line-hours were spent fishing, representing a decline of 12.6% from the peak of 194 085 hours spent fishing in 2008 (Figure 1). Barramundi fishing has traditionally accounted for the majority of the fishing effort; however, in 2008 and 2009, reef fishing was the most predominant method of fishing used (Figure 4). In 2010, barramundi fishing once again accounted for the majority of fishing effort with 85 442 line-hours, representing 50% of the total FTO effort, a 13% increase from the 73 599 line-hours in 2009 (Figure 4). In addition, 72 159 line hours were spent reef fishing in 2010, representing 42.5% of total FTO effort, a 12% decline from the 82 306 line-hours spent in 2009 (Figures 3 and 4).

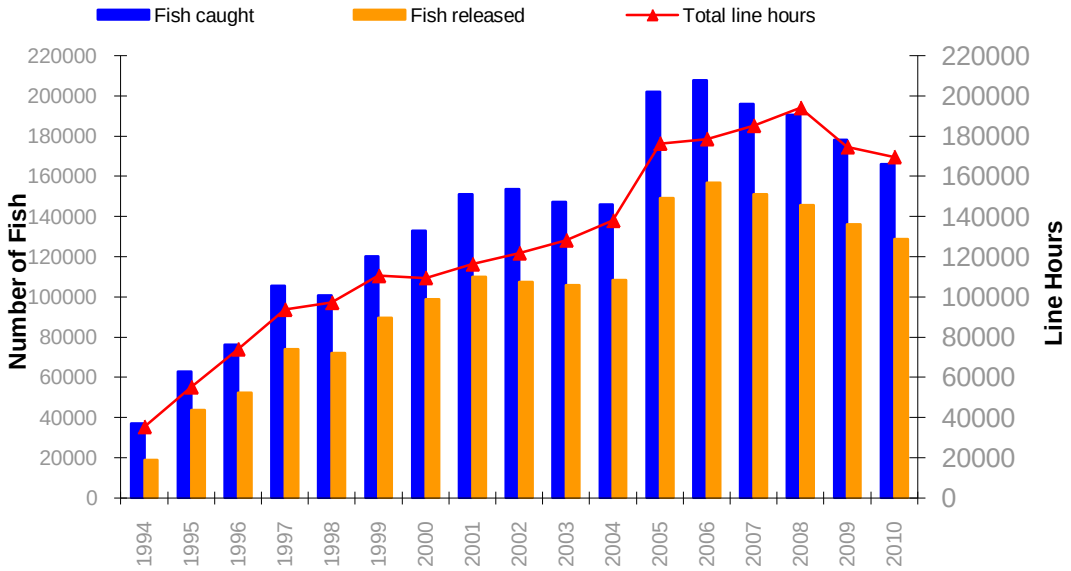

Figure 1. Catch, release and total line-hours fished by FTOs, 1994 to 2010

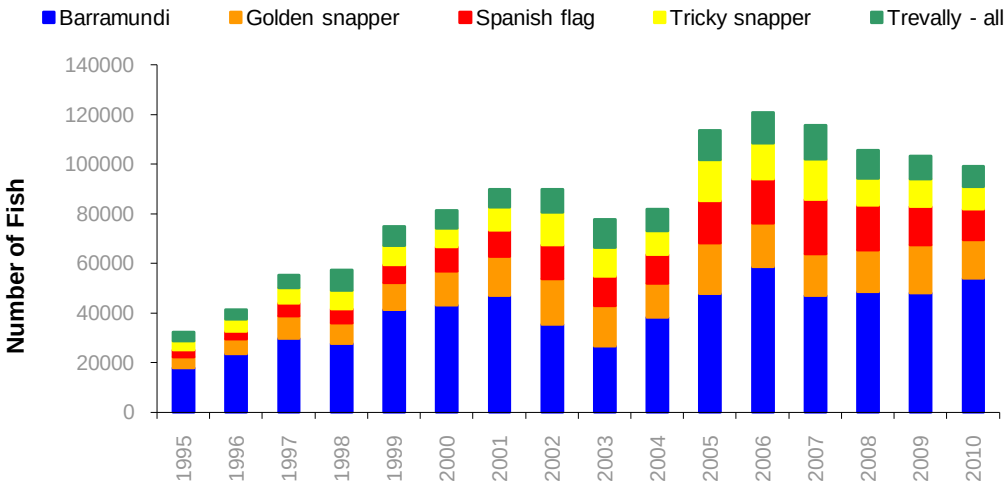

Figure 2. The five species most frequently caught by FTOs, 1994 to 2010

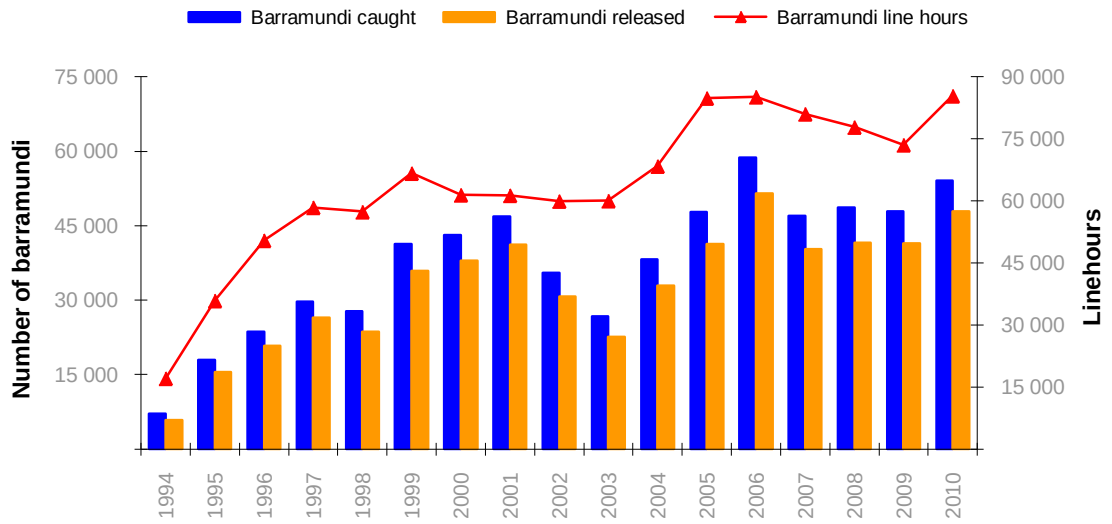

Figure 3. Total barramundi catch, release and line-hours fished by FTOs, 1994 to 2010

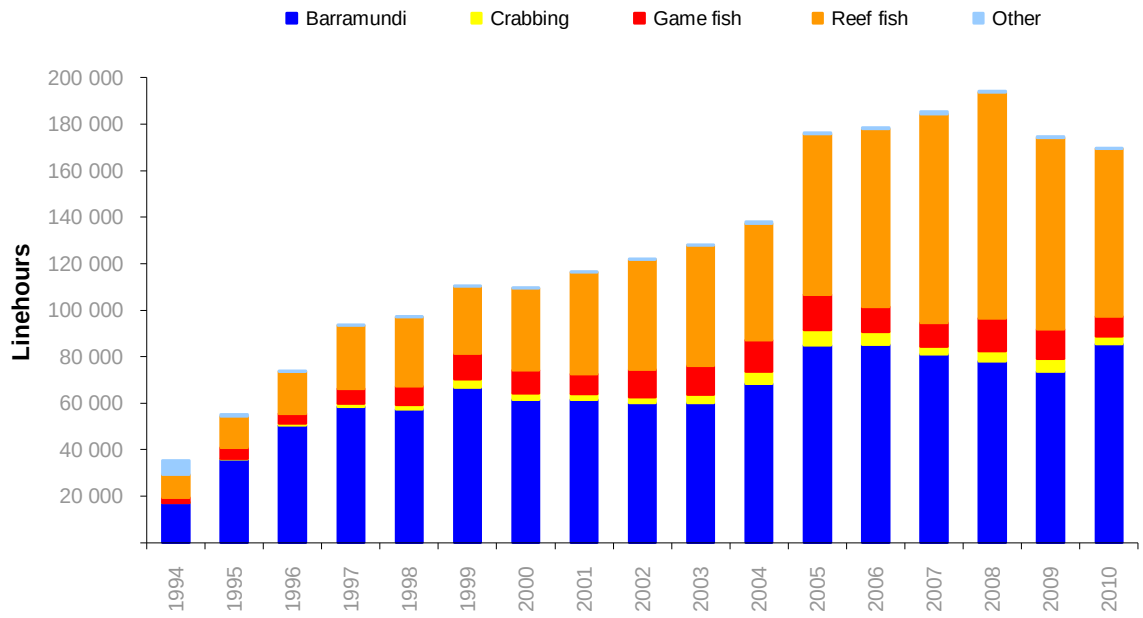

Figure 4. Line-hours spent by fishing FTOs using various fishing methods, 1994 to 2010

Non-retained Species

More than 75% of all fish caught by FTOs are released after capture. However, studies have shown that many species caught from water deeper than 10 m are susceptible to pressure-induced injuries (barotrauma) that greatly increase levels of post-release mortality. Jewfish and golden snapper are highly susceptible to the effects of barotrauma and are unsuitable for catch and release in water deeper than 10 m.

Ecosystem Impact

No detrimental effects on ecosystems have been linked to the guided fishing industry.

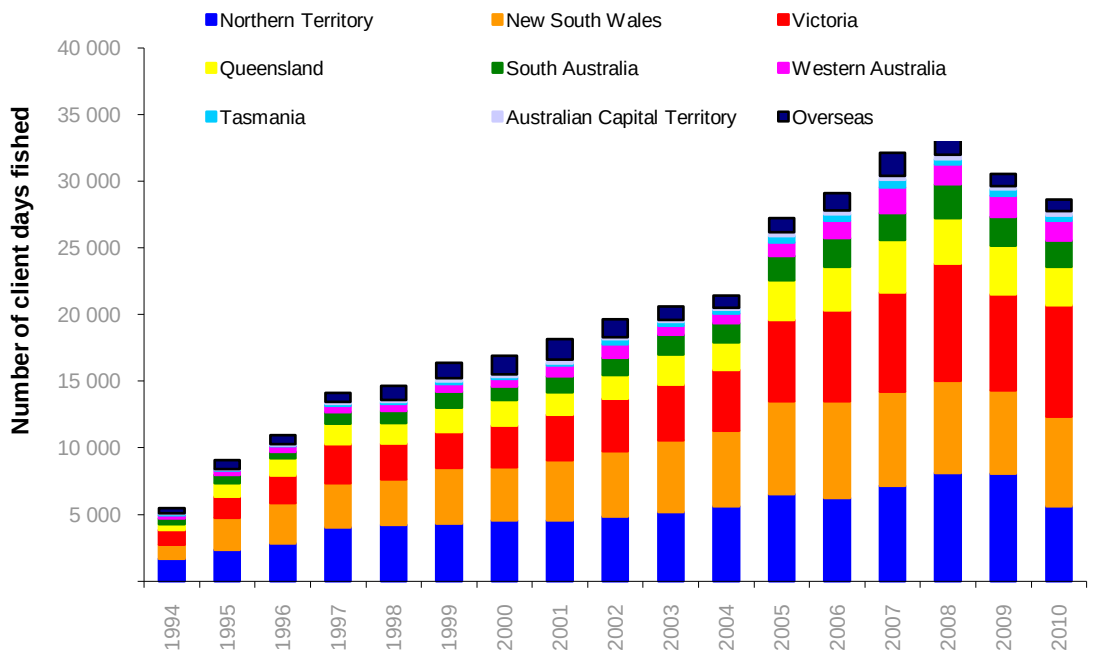

Figure 5. FTO client days fished and client origins, 1994 to 2010

Social Impact

There was a consistent increase in the number of 'client-days' fished between 1994 (5583 client days) and 2008 (34 370 client days). In 2009, there was an 11% decline in client-days followed by a further decline in 2010 (28 640 client-days), representing a 16.5% decline compared with 2008. Most client-days fished in 2010 were from Victoria (8364), New South Wales (6711) and NT residents (5641), In addition, 858 clients (3%) were from other countries.

Economic Impact

An evaluation of the guided fishing industry's annual contribution to the NT's economy commenced in 2010 and results are expected in 2011.

STOCK ASSESSMENT

Monitoring

The guided fishing tourism industry is monitored primarily through logbook returns information. Annual log data summaries are compiled to show the number of each species caught and released, fishing methods used, time and areas fished and client origins.

Stock Assessment Methods and Reliability

Data from FTO logbook returns and recreational fishing surveys are used for species-specific stock assessments. Details have been included in individual Fishery Status Reports elsewhere in this publication.

Current Exploitation Status

Although FTOs maintain a release rate of around 75% of their total catch, substantially increasing reef fishing effort is generating concern regarding the sustainability of several reef species with vulnerable life history characteristics (slow growth, late maturity) and a susceptibility to barotrauma. Releasing reef fish captured from water deeper than 10 m is no longer considered best practice and management strategies to most effectively conserve these fish stocks are being developed.

The total annual catches between 2006 and 2008 have declined despite increasing line-hours. In 2009 and 2010, the total catch declined further; however, this correlates more closely to diminished line-hours and client numbers in that year. Work has begun to assess the reasons for the recent trends.

Future Assessment Needs

The FTO log returns system provides essential data to fishery managers. These are combined with data from recreational fishing surveys to provide an overview of the NT's recreational fishing sector. Results from the most recent recreational fishing survey are expected in 2011.

RESEARCH

Summary

All fisheries research on recreationally significant species is important to FTOs. The current relevant research programs focus on golden and other snappers, barramundi, sharks, Spanish mackerels and mud crabs.

Incorporation into Management

Assessment of FTO and recreational fishing survey data, combined with outcomes from specific research programs, are considered when decisions are made regarding fishery area restrictions, regulation amendments, infrastructure developments, and land and native title claims.

Current Research

Although FTO clients release the majority of the fish they catch, they do have potential to impact on the sustainability of key species, particularly the more sedentary species and those affected by barotrauma. DoR is currently working with the sector to study barotrauma and to better understand catch composition (e.g. size classes of different reef fish caught).

Current research is focused on the sustainability of key species, including a range of tropical snappers, barramundi, Spanish mackerels, mud crabs and sharks. Details of these research programs can be found in the relevant Fishery Status Reports.

MANAGEMENT/GOVERNANCE

Management

Objective

The primary management objective for the guided fishing industry is to ensure its development is managed in a sustainable manner.

History

Guided fishing tourism began to increase in the mid 1980s. By 1989, there were 24 guided fishing businesses in the NT. FTO licences were introduced in 1993. They were issued free of charge until the 2007 licensing year. Licence numbers are not limited. Figure 6 illustrates the number of FTO licences issued each year since 1994 and those actively operated. Inactive licences account for around 35% of licences issued for any year.

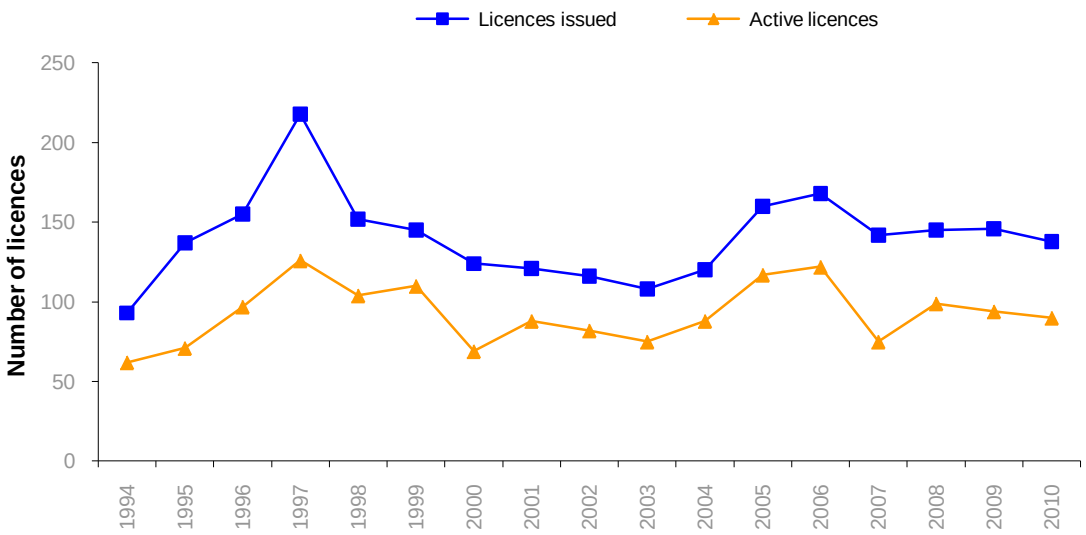

Figure 6. The annual number of FTO licences issued and those actively fished from 1994 to 2010

Future Plans

In 2010, DoR continued working with the NT Guided Fishing Industry Association (NTGFIA) to enhance industry standards and service. Consultation with the industry throughout 2010 focused primarily on operator qualifications, vessel survey requirements, the existing licensing framework and sustainability of key target species. A range of proposals regarding these and other matters will be made available for public comment in a discussion paper that will be released in 2011.

Compliance

The Water Police Section of the NT Police, Fire and Emergency Services is responsible for monitoring and enforcement of fishery regulations.

Consultation, Communication and Education

The establishment of NTGFIA enhanced consultation and communication between government agencies and the guided fishing industry.

The Guided Fishing Industry Steering Committee has been established consisting of representatives from both government and industry.

Aquatic Resource Management Officer, Recreational Fishing – Mr Phil Hall
Technical Officer, Recreational Fishing – Mr Kane Dysart

RECREATIONAL FISHING STATUS REPORT 2010

INTRODUCTION

Recreational fishing is an important part of the lifestyle of the people of the Northern Territory (NT), which has the highest level of recreational fishing participation per capita than any other part of Australia. Fishing tourism is also important for the NT economy. Its success and growth largely depend on the number and size of barramundi available in the NT. Approximately half of all barramundi caught recreationally in Australia come from NT waters (Henry and Lyle 2003).

There are many extensive inland tidal river systems that provide world class sport fishing for barramundi. Peak barramundi season occurs from March to June when wet season flood waters recede from the floodplains to the sea. However, barramundi are available throughout the year and can be caught in a range of fresh and saltwater habitats, including Manton Dam near Darwin. The months preceding the Top End's wet season are also highly productive and barramundi are caught during that time in coastal saltwater environments and freshwater billabongs.

Although barramundi are a famous table fish, nearly half (47%) of those caught by NT and visiting anglers are released. Fishing tour operators (FTOs) release nearly 90% of the barramundi they catch.

Part of the attraction to barramundi fishing is the diversity of fish species, habitats and fishing methods that anglers experience. Other species caught during targeted barramundi fishing include saratoga, sooty grunter, king threadfin, golden snapper and mangrove jack.

During the cooler dry season, many anglers target inshore migrations of mackerel and tuna. Sailfish and black marlin are also often caught. Mud crabs are best targeted in the dry season when they are more abundant and easily caught.

Reef fishing is the most popular targeted fishing method after barramundi fishing. This is largely due to the high eating quality of many of the reef species. Black jewfish, red emperor, coral trout and a range of tropical snappers are targeted more often each year. Increasing reef fishing effort and catch of key reef species requires close monitoring, especially in more populated areas. It is important that anglers become more aware of low post-release survival rates of fish taken from water deeper than 10 m.

Size and possession limits are the primary catch controls for recreational fishing in the NT. However, seasonal area closures also apply to the lower Mary and Daly rivers during barramundi spawning periods.

One of the most important requirements for successful fishing in the NT is a boat. Although some land-based fishing opportunities exist, large tidal movements and the presence of saltwater crocodiles make boat fishing a safer and more productive option.

Some areas around the NT are closed to commercial barramundi netting to benefit recreational fishing and tourism. All waters within Kakadu National Park are also closed to commercial fishing.

The NT Government continues to expand artificial reef sites close to Darwin and farther offshore at Fenton Patches. These structures are for the specific benefit of recreational anglers and divers. Commercial fishing near artificial reefs is not permitted.

There are several fishing clubs throughout the NT and various major annual fishing tournaments are conducted. Most tournaments are barramundi-specific with rules that promote catch and release fishing. There are also various saltwater fishing competitions that focus on other sport, game and reef fish.

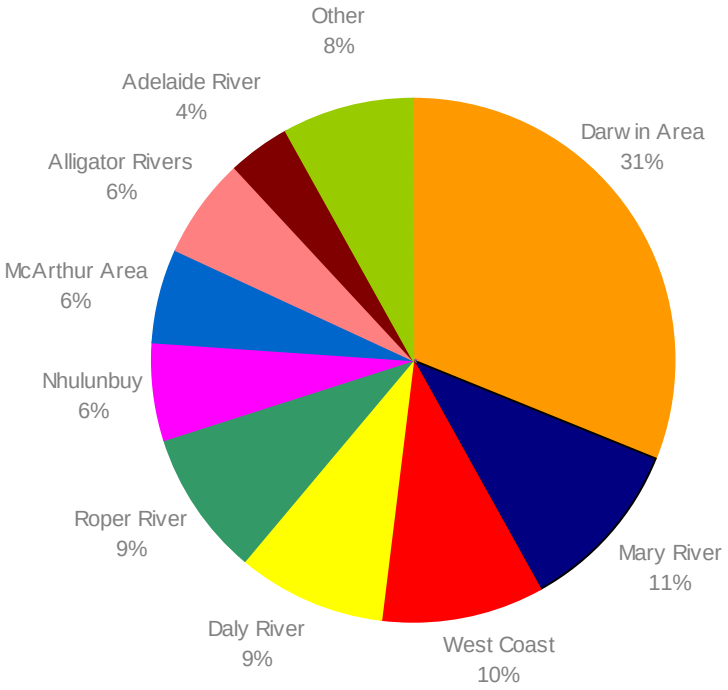

Figure 1. Recreational fishing line-hours (time spent with lines in the water) by residents and visitors by area from the 2000-01 National Recreational Fishing Survey of the NT

PROFILE OF THE FISHERY

Recreational fishing surveys conducted in 1995 and 2000-01 indicated that the recreational fishing participation rate among NT residents remained stable at around 32%. The National Recreational Fishing Survey: the Northern Territory (NRFSNT) provides a comprehensive overview of the recreational fishery in the NT. The survey report is available from DoR. A new recreational fishing survey was conducted in 2010 and a report will be available in 2011.

Area

NRFSNT found that over 25% of all recreational fishing in NT waters took place in Darwin Harbour, Shoal Bay and the offshore area adjacent to Darwin. About 40% of recreational fishing activity occurred in estuaries and 30% in rivers. A further 22% is focused within 5 km of the coast, 6% occurs farther from the coast and 2% took place in impounded waters. The Mary River accounted for 11% of all hours fished, while all other survey areas individually accounted for less than 10% of hours fished.

Fishing Method

More than 75% of all recreational fishing in NT waters is conducted from boats, with 84% of fishers using lines. Artificial lures are used during half of all the time spent line-fishing and bait is used during 41% of this time. A combination of lures and bait is used during 10% of all time spent line fishing. Fifteen percent of fishing effort involves the use of pots and traps. NRFSNT recorded very little use of cast nets, drag nets or other gear.

Catch

Of the 1.83 million aquatic organisms reported during the NRFSNT, 1.6 million (89%) were fish, while fewer than 0.2 million were crabs, molluscs and other types of aquatic life.

Barramundi is the most predominantly targeted species by recreational anglers in the NT. About half of the barramundi caught by recreational fishers are released. Saratoga, sooty grunters, king threadfins, golden snappers and mangrove jacks are often caught on the same lures, baits and flies used by anglers to target barramundi. Many other popular saltwater species can be caught throughout the year, including red emperor, coral trout, black jewfish, blue tusk fish, saddle-tail snapper, blue lined emperor, queenfish and trevally.

Effort

NRFSNT reported that people in the NT spent 314 272 days (or 1.9 million hours) recreational fishing in 2000-01. Residents fished an average of five days in that year, a decline from the average of eight days per year recorded during Fishcount 95. However, the number of hours spent fishing by visitors to the NT increased from 23% in 1995 to 37% in 2001.

Queensland visitors accounted for 33% of this increased effort, while New South Wales and Victorian visitors accounted for 26% and 16%, respectively. Recreational fishing visitor numbers are highest in the dry season, when they account for 40% of all fishing effort. Visitor numbers are lowest in the wet season when they account for 15% of the overall effort.

Non-retained Species

Of all the aquatic animals recorded during NRFSNT, 55% were released. This was an increase over the 43% released in 1995. An increasing number of anglers release some or all of their catch. There is a particularly strong trend toward releasing larger barramundi in recognition of their increased spawning potential.

DoR supports the Released Fish Survival Program, which advocates methods that enhance the survival of released line-caught fish. Recommended methods include the use of fish-friendly tackle such as enviro-nets and circle hooks.

Studies by DoR revealed that at least 90% of lure-caught barramundi survive after release. However, studies on the effects of barotrauma on released black jewfish indicate that almost half of the fish caught from depths of 10-15 m sustained life-threatening injuries and were considered unlikely to survive after release. Interim results from work with golden snappers indicate that they too are susceptible to barotrauma. Educational material has been produced to make recreational fishers aware of the effects of barotrauma on various fish species when fishing in water of this depth.

Ecosystem Impact

Although no significant studies have been conducted on the effects of recreational fishing on natural NT ecosystems, no major detriment has been identified. The National Policy for Recreational Fishing and The National Code of Practice for Recreational and Sport Fishing promote the importance of ecological awareness. The River Watch Program also promotes environmental awareness in the fishing community.

Social Impact

Each year about 40 000 (32%) non-Indigenous NT residents fish for recreation. NRFSNT found that 32% of anglers fish so as to be outdoors, 28% fish to relax and unwind and 11% fish to be with family. Other reasons to go fishing were to be with friends, to catch fish for the table, to participate in fishing competitions and for sport.

As mentioned earlier, recreational fishing is a significant lifestyle activity in the NT, where participation rates and boat ownership are proportionately higher than elsewhere in Australia and fishing for consumption is not always the primary motivator.

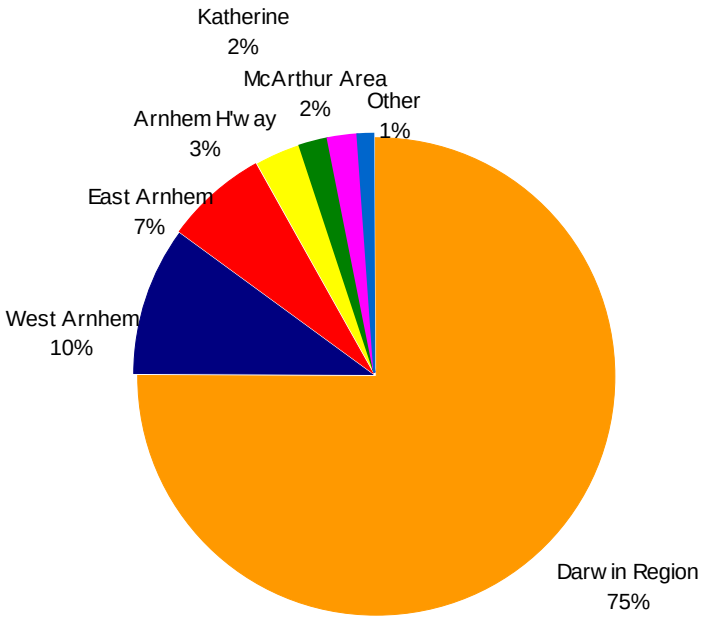

Figure 2. Annual expenditure by survey zones in the 2000-01 National Recreational Fishing Survey of the NT

Economic Impact

NRFSNT indicated that nearly $35 million is spent in the NT each year on recreational fishing. Most of this expenditure is for the purchase of boats, vehicles and associated running costs. The purchase of fishing gear is another significant expenditure. Visitors to the NT contribute 25% of this amount.

An assessment of the guided fishing tourism industry's annual contribution to the NT economy has recently been conducted. Results of this assessment should be available in 2011.

The guided fishing tourism industry's annual contribution to the NT economy has not been formally assessed but is considered significant.

STOCK ASSESSMENT

Monitoring

Broad-scale recreational fishing surveys were conducted in 1986, 1995 and 2000-01. A fourth recreational fishing survey was concluded in 2010, with a report expected in 2011.

Many research programs by DoR focus on the species that are important to recreational, commercial and Indigenous stakeholders. Current research on snappers, Spanish mackerels, sharks, barramundi and mud crabs is particularly important to recreational fishing. Outcomes of this research will influence future management decisions. More specific information on research programs relevant to recreational fishing is provided in individual Status Reports in this publication.

Some recreational fishing tournament organisers provide DoR with catch and effort information,

which enhances knowledge of barramundi populations in specific rivers. For example, all fish caught in the annual NT *Barra Classic* held on the Daly River are tagged and measured prior to release.

Data from recreational fishing surveys is used in conjunction with logbook returns data provided by FTOs. The combined results from research, surveys and FTO data are supplemented with catch, size and effort information from annual fishing tournaments.

Stock Assessment Methods and Reliability

Research, survey, FTO and commercial fishing data is used for fishery stock assessment purposes. Details are included in other Fishery Status Reports.

Current Exploitation Status

The same data is used to monitor current exploitation levels. Generally, the fish stocks targeted by recreational fishers are considered sustainable across the NT. However, in some heavily utilised areas, the total harvest of many reef species may be approaching the maximum sustainable yield.

Future Assessment Needs

Results from a new survey on recreational fishing activity will be available in 2011.

There is a need to obtain a better understanding of the relative impacts of catch and release fishing for reef fish in deep water.

RESEARCH

Summary

The first broad-scale survey of recreational fishing in the NT occurred in 1986. Later, Fishcount 95 provided a valuable database which was updated by NRFSNT in 2000-01.

Fisheries research is generally species or area-specific. Many species currently researched are important to recreational, commercial and traditional fishers. The current relevant research programs focus on golden and other snappers, black jewfish, barramundi, sharks, Spanish mackerels and mud crabs. Specific details on researched species are provided in individual Fishery Status Reports in this publication.

Incorporation into Management

Survey, monitoring and FTO data was considered before the closure of areas to commercial barramundi gillnetting, such as the McArthur and Adelaide rivers. This data provided background information for a decision to close the Finniss River to barramundi gillnetting in 2010 and reallocate barramundi resources in the area to the recreational, Indigenous and FTO sectors.

Current Research

Currently, the most significant research for recreational fishers relates to tropical snappers, black jewfish, barramundi, sharks, Spanish mackerels and mud crabs.

Research on the susceptibility of snapper and jewfish populations to over-fishing and barotrauma continued throughout 2010 and a golden snapper tagging program commenced to obtain information on the harvest rate of this species' as well as growth and movements throughout its lifecycle. In addition, tagging studies continued on barramundi, Spanish mackerel and sharks primarily to determine the harvest rates of these species. The study of barramundi numbers, size and recruitment continues annually on the Mary River. Monitoring of adult mud crab size frequency, sex ratio and mating success continued and a two-year collaborative juvenile mud crab monitoring program was concluded in 2010. A trial to determine the success of vents built into the mesh of pots to enable the escape of juvenile mud crabs commenced in 2010. Findings from the recreational fishing survey completed in 2010 will be incorporated into future fishery assessments.

MANAGEMENT/GOVERNANCE

Management

Recreational fishing in the NT is managed by DoR through the NT *Fisheries Act 1988* and supporting Regulations and various fishery management plans.

Management controls include species-specific personal possession limits and a general personal possession limit. Minimum size limits apply to barramundi (55 cm) and mud crabs (male 13 cm, female 14 cm) and a maximum size limit of 1.2 m applies to cod and groper. Seasonal area closures apply on the lower Daly and Mary rivers from 30 September to 1 February. These areas also have specific recreational fishing controls that are different to the rest of the NT. Specific fishing controls also apply at the East Point Aquatic Life Reserve and fishing restrictions apply at Stokes Hill Wharf. No fishing is allowed at the Doctors Gully Aquatic Life Reserve. In addition, a number of commercial fishing closures apply in popular areas to enhance the recreational fishing experience.

Permits are required by recreational fishers intending to fish waters within or abutting Aboriginal land. Information on permit requirements is available from the Northern Land Council and the Tiwi Land Council. The Amateur Fishermen's Association of the NT (AFANT) issues permits for access to specific camping sites on the Tiwi Islands.

More information in relation to recreational fishing controls in the NT can be found in the Recreational Fishing Controls booklet from DoR or from its website.

History

Prior to 1991, recreational fishers in the NT were required to observe a daily barramundi bag limit of five-per-person and a limit of ten for extended trips. In 1991, the concept of daily bag limits was abolished in favour of personal possession limits. A five-per-person barramundi possession limit was introduced in that year, together with limits of ten mud crabs per person and 30 mud crabs per vessel when three or more people are on board.

Possession limits of five Spanish mackerel and five black jewfish were introduced in 1993 and 1997, respectively. In 1997, the general possession limit of 30 fish per person was introduced, but this did not include the specific possession limits for managed finfish until 2002.

To enhance recreational fishing and tourism, the Mary River was closed to commercial barramundi gillnetting in 1988. This was followed by a similar closure of the Daly River in 1989, the Roper River in 1991, the partial closure of the Victoria River in 1993, the closure of Darwin Harbour and Shoal Bay in 1998, the closure of McArthur River in 2002, the Adelaide River in 2004 and the Finniss River and Bynoe Harbour in 2010. These closures have been implemented together with voluntary commercial fishing licence buy-backs.

Barramundi Stocking

To provide alternative recreational fishing opportunities, DoR continued stocking Manton Dam in 2010 with the release of approximately 70 000 barramundi fingerlings.

Current Issues

Access rights with respect to pastoral land and Aboriginal land and waters are the primary current issues for recreational fishers in the NT.

Future Plans

A draft development plan for recreational fishing was compiled in 2010, with a focus on future sustainable management and data collection, catch controls, access and infrastructure requirements, industry development, resource sharing issues and improving community stewardship of fishery resources. The draft development plan was compiled by a community-based working group and will be made available for public comment in 2011. One of its key objectives is to ensure that recreational fishers adopt greater responsibility for the management of aquatic resources and the development of recreational fishing as the NT's increasing population places greater pressure on fish

stocks, especially those near the major fishing ports.

In addition, the Daly River Fish Management Zone will be established in February 2011 with specific controls for barramundi and freshwater crustacean fishing.

A range of proposals to enhance standards and viability of the guided fishing industry were developed in 2010. These will be made available for public comment in a discussion paper that will be released in 2011.

Compliance

The Water PoliceSection of the NT Police Fire and Emergency Services is primarily responsible for fisheries compliance and enforcement in the NT.

Recreational fishing controls are displayed on signage at boat ramps, launching sites, tourist establishments and River Watch Centres throughout the Top End of the NT.

Consultation, Communication and Education

DoR consults primarily with AFANT and the NT Guided Fishing Industry Association (NTGFIA) on recreational fishing issues and future management and development. Public consultation is conducted when broader matters require community input.

AFANT is the peak representative association for recreational fishing in the NT. The guided fishing tourism industry is represented by NTGFIA. The NT Government provides annual funding to AFANT and NTGFIA to assist in their roles.

Signage is erected at boat ramps, launch sites and fishing tourism establishments throughout the NT, depicting fishery Regulations and other advice. Information on recreational fishing in the NT is also available from DoR. Literature on recreational fishing is also provided on the DoR website and at various shows and exhibits throughout the NT.

Aquatic Resource Management Officer, Recreational Fishing – Mr Phil Hall
Technical Officer, Recreational Fishing – Mr Kane Dysart

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AQUACULTURE

AQUACULTURE INDUSTRY SUPPORT AND DEVELOPMENT STATUS REPORT 2010

SUMMARY

The Northern Territory (NT) aquaculture industry's total value increased by 9.6% in 2010 ($27.08 million), compared with 2009 ($24.7 million). This increase was due to greater production levels in the pearling and barramundi farming industries.

A privately-run pilot sea cucumber hatchery continued to meet its research objectives and progress towards the goal of establishing a sea cucumber farming industry. The company has sea-cucumber ranching trials in conjunction with an Indigenous community on Groote Eylandt.

An additional sea-cucumber ranching trial commenced in 2010 on Goulburn Island in collaboration with the Department of Resources (DoR).

PROFILE OF AQUACULTURE

National Issues

DoR is a member on two national committees of importance to aquaculture, the Sub-Committee on Aquatic Animal Health and the Aquaculture Committee. These committees provide advice to the National Biosecurity Committee and the National Marine and Coastal Committees, respectively on current and emerging national issues related to the management and development of the aquaculture industry.

Currently, the Aquaculture Committee is working to establish best practice models for environmental assessment and regulatory arrangements, and benchmarking between jurisdictions of these administrative processes.

Aboriginal Liaison

Liaison and industry support continued during 2010 to assist Aboriginal communities to develop aquaculture-based projects.

Funding has been obtained from the Fisheries Research and Development Corporation for collaborative work with the University of the Sunshine Coast on social science research to identify successful engagement models for aquaculture enterprise development within Indigenous communities. The project is to commence in 2011.

Additional funding was obtained from the Australian Centre for International Agricultural Research for two research trials that commenced in 2010 to assess the viability of sea cucumber ranching by Indigenous communities.

Environmental Management

DoR continued to maintain a close contact with the NT Department of Natural Resources, Environment, the Arts and Sport to maintain the currency and percentage of operators working under an approved Environmental Management Plan. A water quality monitoring protocol was developed in 2010 for barramundi farms.

New Investment

A pilot sea cucumber hatchery continued to be operated by the private industry at Darwin Aquaculture Centre (DAC). Commercialisation trials for this species began in 2009. The operator of the pilot hatchery has obtained access to earthen ponds and sea areas to conduct pilot grow-out trials to begin to assess the viability of sea cucumber farming from hatchery production. The pilot trials began in 2010.

The private pearl oyster research hatchery and nursery facility established at DAC continued to operate with a number of successful trials in 2010.

RESEARCH

Research to support the barramundi farming industry continues at DAC. This has resulted in

further improvements in larval rearing and nursery production procedures.

In collaboration with the University of Sydney, DoR conducted a three-year, Australian Research Council-funded project to improve the detection and management of the serious fish pathogen nodavirus. A new test for nodavirus was developed and validated in 2009. This test is now routinely used by the Australian barramundi industry and its associated veterinary laboratories.

DAC continued to work in association with a Nhulunbuy-based business to produce several thousand juvenile giant clams (*Tridacna squamosa)*. These were grown to market size and sold via the Nhulunbuy business to the aquarium trade. Further trials to refine the juvenile rearing process were carried out at DAC in 2010. Sea-based grow-out trials were planned with Indigenous communities in 2010.

DAC is working with elders on the Tiwi Islands to trial the farming of the black-lipped edible oyster (*Striostrea mytiloides*), which is a part of the traditional diet of Tiwi Islanders. The elders hope to grow enough black-lipped oysters to boost seafood supplies to the community. Brood-stock were collected in 2009 and then hatchery techniques were researched and trialled. Work is continuing to improve hatchery and grow-out techniques.

Aquatic Animal Health

DoR's Berrimah Veterinary Laboratories continued to provide a valuable health service throughout 2010, diagnosing aquatic animal health problems as well as maintaining monitoring programs and certifying stock suitable for translocation for the aquatic industries.

Industry Liaison

Secretarial and logistical support for the Pearling Industry Advisory Committee (PIAC) and the Ministerial Advisory Committee on Aquaculture in the NT (MACANT) continued to be provided in 2010. PIAC is a statutory committee that provides advice to the Director of Fisheries on pearling matters, whereas MACANT is a non-statutory committee that provides advice to the Minister on issues affecting the aquaculture industry. The terms of reference for MACANT allow for a greater focus on the existing industry, whilst still accounting for the needs of the developmental sectors. To address the industry's need for long-term stability, the tenure for aquaculture licences has been increased from one year to 20 years.

DAC also maintains a farm-based extension program, which ensures regular visits to farms to address technical issues.

Manager, Aquaculture – Dr Ann Fleming

AQUATIC ANIMAL HEALTH STATUS REPORT 2010

INTRODUCTION

One of the conditions for successful aquaculture is the absence of disease. The maintenance of healthy farmed populations of fish and shellfish depends on disease prevention through quarantine and health certification as well as on the early detection of disease as a basis for control and treatment.

SIGNIFICANT DISEASE EVENTS AND ISSUES

Finfish

Aquarium Fish

Various aquarium species were submitted to the laboratory for disease diagnosis during 2010. The following diseases were diagnosed:

- The most significant aquatic animal health issue occurred in March, 2010. Enteric septicaemia of catfish, caused by the bacterium *Edwardsiella ictaluri,* which is a national reportable disease, was confirmed to have caused deaths of a few hundred black catfish held in an aquarium. This is the first detection of the bacterium in native fish species in Australia, although it has been detected in several imported exotic ornamental fish species in the past. In this case, which occurred in Darwin, juvenile black catfish (*Neosilurus ater),* which had been collected from the Manton River area died in significant numbers from about a week after stocking. The affected catfish exhibited a slow and erratic swimming behaviour and a reddening of the ventral pale abdominal skin, and eventually died. The disease was confirmed by histopathology and bacterial culture. Several bacterial isolates were sent to the Australian Animal Health Laboratory to confirm the diagnosis. Immediate measures to control the disease include antibiotic treatment, disinfection, and quarantine and movement restriction. Following the confirmation of the disease, tests were conducted on new samples of catfish from Manton River as well as on a range of healthy native and exotic fish species from the aquarium facility. However, the source of the infection could not be established. It was suspected that the infection might have come from exotic fish species present in the aquarium facility. Stress caused by catching, transporting and holding catfish probably increased their susceptibility to the accidental introduction of the disease.
- Two captive adult barramundi from Howard Springs were diagnosed with Granulomatous pansteatitis. The cause was thought to be related to nutrition.
- An exquisite rainbow fish died from piscine mycobacteriosis.
- A group of fly-specked hardy-heads developed eye problems after capture from the wild. The owner described the symptoms as “started off with the eyes exploding and then death”. Intraocular haemorrhage and eye rupturing were the only laboratory findings. Suboptimal water alkalinity and hardness were suspected to be the major contributing factors.
- Starvation caused emaciation and death in a group of wild caught Tarpon in captivity.

Barramundi Aquaculture

Atypical bacterial gill disease, which caused significant mortality, was diagnosed in May in 13-month-old grow-out barramundi. The problem was resolved after improving water quality.

Non-suppurative retinitis was diagnosed in September in a small group of nine-month-old grow-out fish in a pond. Few died but the affected fish turned dark and did not feed well. The cause could not be established.

Gastroenteritis caused a few deaths in December in 14-month-old grow-out fish during high water temperature. The problem was resolved after withholding feed for a few days.

A Fish Kill Investigation

A fish kill was reported in June in a billabong in Oenpelli. Although the cause was not established, epizootic ulcerative syndrome was diagnosed histologically in a spangled perch, and mixed parasitic cysts of *diagenean metacercariae* and *myxozoan* parasites were noted in bony bream, Rendhl's catfish, spangled perch and chequered rainbow fish.

Health Certification, Monitoring and Testing

The Northern Territory Zoning Strategy for health certification and laboratory testing prior to movement of animals continued to be implemented. Pre-translocation histopathological examination of pearl oysters (*Pinctada maxima)* continues to be a major aspect of maintaining the health of translocated stocks. Barramundi, which are the main seed-stock held, are tested for freedom from nodavirus, *Streptococcus iniae* and parasitism. Testing is designed to provide specific pathogen-free stock to support the NT industry as well as to meet the importing requirements of other jurisdictions.

Aquatic Animal Health Pathologist – Dr Kitman Dyrting

BARRAMUNDI FARMING STATUS REPORT 2010

INTRODUCTION

Farmed barramundi (*Lates calcarifer*) production (tonnes whole fish) increased by 13% in 2010. The combined production from three pond-based farms was 698 tonnes in 2010, compared with 616 tonnes in 2009. The total value increased from $4.9 million in 2009 to $5.75 million in 2010.

PROFILE OF THE FARMING SECTOR

Hatchery/Nursery Production

The commercial annual fingerling number produced by the Northern Territory (NT) Government's Darwin Aquaculture Centre (DAC) declined from 814 800 in 2009 to 764 400 in 2010. One local farm produced its own fingerlings. Only DAC sold fingerlings during the year. Approximately 52% of the fingerlings (400 750) were sold locally and 34% (263 500) were sold interstate. The size of fingerlings supplied to local farmers ranged between 50 mm and 130 mm, whereas those sold interstate ranged between 25 mm and 35 mm.

Farm Production

Six aquaculture licences were endorsed to produce barramundi. Only the following three pond-based farms marketed fish in 2010: Australian Barramundi Culture Pty Ltd (Humpty Doo), Arda-Tek (Berry Springs) and Wild River Farmed Seafood (Berry Springs). Pond-produced fish increased from 616 tonnes in 2009 to 698 tonnes in 2010, continuing the trend of increased pond-based production over the last three years.

Impoundment Stocking

Over 100 000 of approximately 40 mm long excess fingerlings from DAC were stocked into Manton Dam in 2010.

Translocation

A zoning strategy covers health and biosecurity issues related to the importation of barramundi larvae or fingerlings and their movement within the NT. The strategy identifies disease control regions within the NT. Fish may be moved between, or within, zones of equivalent health status, but movement into zones of a higher health status requires health certification and quarantine measures to ensure that diseases are not transmitted along with the stock.

Marketing

In 2010, most of the fish produced on farms were sold either directly or indirectly to interstate markets. The majority of fish were sold whole, each weighing over 1.0 kg. A small proportion (6%) was sold either as whole fish weighing less than1.0 kg, or as fillets.

Employment

Permanent labour employed in the grow-out and hatchery/nursery sectors of the industry averaged 11 in 2010 compared with 17.5 in 2009; casual employment remained steady at eight.

Ecologically Sustainable Development/Environmental Management

The NT Department of Natural Resources, Environment, the Arts and Sport supervises environmental assessments and approvals. As part of aquaculture licence conditions, all farms must have an approved Environmental Management Plan, which stipulates the environmental parameters under which the farm must be constructed and operated. Pond-based farms discharging into waters with declared beneficial uses are required to have discharge licences. All farms are subject to environmental and aquaculture licence compliance audits.

RESEARCH

In 2002, Marine Harvest P/L funded research to develop a bacterin against two pathogenic marine bacteria (*Vibrio harveyi* and *Photo bacterium damselae*), which affect barramundi fingerlings. The bacteria caused significant

fingerling mortality at the DAC hatchery/nursery and at the Marine Harvest cage farm. The bacterin was used in bath immersions of all fish prior to transfer to Port Hurd. The use of the bacterin, together with improved on-farm management of the fish, was considered to have successfully reduced mortality due to the bacteria.

In 2006, an autogenous vaccine against one strain of *Streptococcus iniae* found in the NT, which causes streptococcosis, which is the most devastating bacterial disease affecting farmed barramundi in Australia, was developed and produced commercially by Intervet Norbio, in collaboration with Marine Harvest and Berrimah Veterinary Laboratories (BVL). The vaccine was approved by the Australian Pesticides and Veterinary Medicine Authority for use in fingerlings destined for Marine Harvest's barramundi sea-cage farm.

From 2005 to 2007, DAC improved hatchery culture protocols to reduce the rate of fingerling deformity to less than 5%. Following further improvements, the deformity rate declined to around 1%.

In 2007, another autogenous vaccine was developed in collaboration with the barramundi pond-based farming industry. This time the vaccine included a second NT strain of *Streptococcus iniae* and was produced commercially by Allied Diagnostics.

Recent Research

Together with BVL, DAC maintains an aquatic animal health program to assist the industry. In 2008-09, DAC helped the industry to investigate and develop controls for a number of disease problems, such as the protozoan parasite *Amyloodinium*, and the potentially toxic microalga *Prymnesium* sp.

In 2005, funds were obtained from the Australian Research Council to study the causative agent of VER (viral encephalopathy and retinopathy), the most significant viral disease affecting barramundi hatchery and nursery production. Two PhD students, in collaboration with DAC, BVL, the University of Sydney and Marine Harvest, commenced research in May 2006. A new brood-stock screening test (polymerase chain reaction) was developed and validated, which will help improve the understanding of the epidemiology of the disease.

The Fisheries Research and Development Corporation funded a project to establish a method to improve the rapid diagnosis of *Streptococcus iniae* strains, which could assist in the further development of appropriate vaccines against *S. iniae* for use on all barramundi farms. The project was completed in 2009.

DAC has improved the efficiency of barramundi production in the hatchery and nursery by continuously refining and reviewing culture techniques.

INDUSTRY DEVELOPMENT

Commercial barramundi farming commenced in the NT in the early 1990s with support from the NT Government. Since then, the level of barramundi production has varied, with some farmers turning to marine prawns in the mid to late 1990s and changing back from prawns to barramundi in recent years.

Australian Barramundi Culture Pty Ltd established a pond-based farm in 1993 and commenced full commercial operation in 1998. Marine Harvest established a sea-cage farming operation at Bathurst Island in 2000. The NT Government has supported industry development through the expansion of its commercial barramundi hatchery and nursery at DAC.

The NT Government also provides a disease investigation and certification service through BVL, which has assisted the industry to develop and ensured that aquatic animal health issues are effectively managed.

Current Issues

The barramundi industry is going through a period of significant challenge. Competition from

cheaper imports and rising production costs mean that the industry will need to focus on improving efficiencies and maintain its program of innovation to remain competitive.

Future Plans

DAC will continue to work on improving disease control systems and continually improve hatchery and nursery production techniques to enhance the efficiency of barramundi production in the NT. DAC is also negotiating to join an industry-wide program for genetic improvement of farmed barramundi. It is anticipated that genetic improvement could lead to gains in fish growth rates and feed utilisation efficiency, which will greatly assist the economic sustainability of the industry.

The projected local and interstate demand for fingerlings during 2011 is approximately 500 000.

Industry Liaison

DAC regularly facilitates contact with all active aquaculture licence holders and encourages open channels of communication with the industry. In addition, an Extension Officer is available to advise farmers and who regularly visits the farms.

Aquaculture licensees were represented by the NT Seafood Council through the Aquaculture Licensee Committee.

Manager, Aquaculture – Dr Ann Fleming

PEARLING INDUSTRY STATUS REPORT 2010

INTRODUCTION

The Northern Territory (NT) pearling industry produced 177.3 Kan* of pearls in 2010 from farmed pearl oysters (*Pinctada maxima)*. Production increased by 29%, from the 137.8 Kan produced in 2009. The value of produced pearls, however, increased by only 10%, from $18.98 million in 2009, to $20.93 million in 2010.

The recent global economic crisis continues to have a major impact on the pearling industry as there is still a reduced demand, leading to reduced prices for pearls in international markets. Pearl production and value are expected to decrease slightly next year.

*Kan and momme are old Japanese units of weight (1000 momme = 1 Kan). A momme equals 3.75 g. A 13-mm round pearl weighs about 1 momme.

PROFILE OF THE FARMING SECTOR

Commercial Production

Active pearl oyster farms are distributed along the northern coast of the NT in three main areas: Bynoe Harbour, Cobourg Peninsula/Croker Island and English Company Islands/Truant Island areas. Other lease sites are owned by licensees, but are not currently used for the cultivation of pearls.

Hatchery/Nursery Production

Most pearl oysters used in the production of Australian South Sea pearls in the NT are hatchery-reared. Only one company operates a commercial hatchery in the NT at present. It uses oysters produced in its hatchery for grow-out on its leases and also has the option to sell them to other licensees. Pearl oysters farmed by other licensees are sourced from hatcheries or are wild-harvested oysters from Western Australia (WA).

Farm Production

Pearl oyster farms are usually located in sheltered embayments that facilitate continual access. Pearl oysters are placed in panels that are suspended from floated long-lines and are watched regularly to ensure that fouling does not impede the viability of the pearl oyster or the production of the pearl.

Pearl oysters are seeded by artificially placing a nucleus derived from the shell of the Mississippi mud mussel together with a piece of donor mantle tissue into the oyster. Pearl nacre forms around the nucleus, creating the pearl. A series of turning actions occur after the nucleus is implanted to assist in the development of a well-shaped pearl sac to ensure even coating of the nacre. It takes two years to produce a pearl.

If an oyster produces a good quality round pearl, it may be re-seeded with another nucleus and maintained for another full grow-out cycle. However, only a small proportion of oysters are seeded a second time and even less a third time. Re-seeded pearl oysters generate larger pearls, as a space has already been created in the oyster by the production of the first pearl.

Farmed pearls vary in size, shape and quality, and are priced accordingly. There are also several other products from pearl oyster culture, namely half pearls or Mabe, Keshi (natural pearls of various shapes and sizes), Mother of Pearl (MOP), which is a pearl oyster shell used for buttons, jewellery and decorative inlays, and pearl meat (the adductor muscle of the pearl oyster).

Translocation

A protocol is in place that addresses health and security issues related to the importation of adult and juvenile pearl oysters into the NT and their translocation within the NT.

Marketing

The marketing of Australian South Sea pearls is conducted individually by licensees. Most of the

pearls produced each year are sold either via private treaty, at auctions in either Japan or Hong Kong, or through retail outlets operated by the companies in Australia and overseas. MOP is sold in many countries; Italy and Korea are the major customers. Pearl meat, which is valued at around $85/kg, is currently only sold in the Australian market.

Employment

About 90 people were directly employed in pearl farming or farm-related activities in the NT during 2010, down from 98 in 2009. The effects of the global economic crisis have resulted in further rationalisation of employment. The closure of several pearling companies in WA along with reduced staffing requirements by the mining industry has eased recruitment difficulties previously experienced by the local pearling industry.

Indigenous Development

Aboriginal people play an important role in the operation of pearl farms. The land-based infrastructure of most farms is located on Indigenous-owned land and is controlled through access agreements with traditional owners and land councils. Employment opportunities exist for local Aboriginal people to assist in the operation of the farms.

Ecologically Sustainable Development/Environmental Management

Pearling farms operate under Environmental Management Plans (EMPs) to ensure that best practices are employed to minimise the impact of pearling operations on the environment. In cooperation with the NT Government, the industry has developed EMPs for each farm.

RESEARCH

Summary

The renewed interest in pearling in the mid-1980s highlighted a lack of knowledge regarding pearl stocks in the NT. This led to a survey of diving for pearl oysters by the Bureau of Rural Resources in 1989. This was followed by a Fisheries Research and Development Corporation (FRDC)-funded project which commenced in 1991 to describe the current status of the fishery, determine the size-frequency and morphometric characteristics of harvested NT pearl oysters, and monitor the period and abundance of pearl oyster settlement.

Work on improving the feeding of pearl oyster spat and brood-stock was undertaken in the mid-1990s using funds from the Cooperative Research Centre for Aquaculture.

An FRDC-funded report on a survey of pearl oyster health across northern Australia in 1998 provided valuable information to assist the industry and the government to improve disease management protocols. A book titled 'The pearl oyster *Pinctada maxima*: An atlas of functional anatomy, pathology and histopathology' was published in 2005, based on samples collected during the pearl oyster health survey and pathology cases submitted to the Veterinary Pathology Laboratories in WA, Queensland and the NT.

Much of the research by the pearling industry is conducted in-house and its outcome is contributing to the competitive advantage of individual companies.

INDUSTRY DEVELOPMENT

History

Several species of pearl oysters are found in Australian waters. The gold or silver-lipped pearl oyster (*Pinctada maxima)* forms the basis of Australia's pearl oyster fishery and the pearl oyster culture industry. The distribution of this species extends across the central Indo-Pacific region from India to New Guinea and the Philippines; in Australia, it extends from Carnarvon on the west coast, to south of Cairns on the east coast.

Pearl oysters have been fished commercially in NT waters since 1884 when 50 tonnes of pearl shell were harvested from Darwin Harbour. Historically, most pearl oysters were collected for their shell, which was sold for its MOP value – the lustrous nacre of the shells was used for the production of buttons, ornaments and as an additive in paints and cosmetics. Between 1884 and 1887, oysters were collected from the harbour until they were fished out.

As pearlers spread around the coast from Darwin, new pearling grounds were discovered as the old were progressively fished out. This resulted in large yield fluctuations of MOP over the next 80 years. By 1899, 51 luggers were working the grounds harvesting about 200 tonnes of MOP a year. This slowly fell to 60 tonnes by 1910, ceased during WWI and did not start again until 1923. Production increased again until 1930 when 32 luggers yielded about 700 tonnes per year. Production remained around this level until 1939 when WWII halted production until 1948. After the war, production slowly increased until 1953. In 1953, the Australian Government permitted 35 Japanese divers into Australia in an attempt to rebuild the industry. The MOP industry flourished again and production peaked at 1100 tonnes a year and remained at that level for three years. As the new areas were fished out, production again declined slowly.

The arrival of plastics made shell harvesting uneconomic and MOP harvesting virtually ceased by 1964 when only two luggers remained in the industry, harvesting only 5 tonnes that year. The Japanese fleet's last harvest was in 1961.

Meanwhile, pearl culture techniques were proving commercially viable and pearl oysters were being collected for this purpose. In 1964, Paspaley Pearls established a pearl oyster farm for the culture of pearls at Knocker Bay, Port Essington. From 1966 until 1987, Paspaley Pearls was the only company farming and conducting diving for NT pearl oysters. Unlike the shallow and productive grounds in WA, the NT grounds are deeper, more isolated and patchier and have a higher proportion of oysters not suitable for round pearl culture. Consequently, in the early 1970s, Paspaley Pearls started to obtain culture stock from WA and as techniques improved in the transport of oysters to the NT, the reliance on sourcing local oysters declined.

The success of Paspaley Pearls' pearling activities in the NT and WA, along with an expanding WA industry, prompted the NT Government to promote the expansion of a local pearling industry. Five additional companies met the government's selection criteria and were given restricted licences in 1988. Companies that met the development covenants over the following three years had their licences converted to unrestricted licences. From 1987 to 1993, there was renewed interest in harvesting pearl oysters from NT waters, with average yields during this period reaching 40 tonnes per year. Since 1994, there has been very limited harvesting of pearl oysters due to a reliable supply of hatchery-reared oysters and poor yields of good culture stock from the local pearling grounds.

In 1998, to assist with the development of the industry, both the Pearl Oyster Culture Industry Management Plan and Fisheries Regulations were changed to allow trade in fishing and hatchery units. Further changes occurred in 2006 that included changing licensing from a financial to a calendar year, the provision of additional pearl oysters to assist in training technicians in the art of pearl oyster seeding and allowing additional shell to account for pearl oysters that fail to retain their seeded nuclei. This was achieved by increasing the unit value by 15%, from 1000 to 1150 oysters.

Current Management Arrangements

The NT pearling industry is managed under a quota-based system and operates using two types of licences: a licence to fish for wild pearl oysters and a licence to culture pearls (either from fished or hatchery-propagated pearl oysters). There are 120 wild-harvest fishery units and 300 hatchery units. A licensee may substitute part or all of their annual pearl oyster fishing allocation for hatchery-reared pearl

oysters. Although a limited allocation of MOP fishing occurs in most years, no licensee currently fishes for pearl oysters suitable for pearl culture.

Each fishery or hatchery unit is allowed 1150 oysters. Therefore, with the available 420 units, the total number of new pearl oysters that may be seeded each year under the NT allocation system is 483 000. Only 30% of the seeding entitlement was used in 2010.

After successful negotiations with the WA Department of Fisheries and the WA pearling industry, NT licensees now have the option of seeding their NT allocation in WA and afterwards moving it to the NT.

A Memorandum of Understanding (MoU) has been developed between the NT and WA Governments to ensure that the Australian South Sea pearl industry is managed in a consistent manner since the industry is highly susceptible to market pressures and any change in management arrangements in one jurisdiction could impact on the other. The MoU was signed by the respective Fisheries Ministers in June 2006 to ensure that complementary management measures are put in place and that both jurisdictions consult on any matter affecting the industry.

A compliance program based around farm audits, developed in conjunction with the industry, was implemented in 2007.

Current Issues

The on-going depressed world market for pearls is continuing to affect the viability of pearl oyster farming.

The WA Government is reviewing its pearling legislation, which may result in changes in the way the seeding quota is administered. Discussions with the WA Government on this topic are continuing.

Future Plans

The NT pearling legislation will be reviewed as part of the full review of the NT *Fisheries Act 1988.*

Industry Liaison

The Department of Resources (DoR) provides a dedicated management officer for the pearling industry to assist with its issues and strategic development of the industry. The Pearl Industry Advisory Committee (PIAC) meets once a year to address issues of specific importance to the pearling industry and is composed of each pearling licensee and DoR officers. PIAC is chaired by the Executive Director of Fisheries.

The industry can also raise any issues of concern and contribute to aquaculture development in the NT through membership of the NT Seafood Council and its representation on the Ministerial Advisory Committee on Aquaculture in the NT.

Pearling Industry Manager – Mr Murray Barton

INDIGENOUS

INDIGENOUS FISHING AND ECONOMIC DEVELOPMENT STATUS REPORT 2010

INTRODUCTION

Aboriginal and Torres Strait Islander people have lived in Australia for over 40 000 years. In the Northern Territory (NT), many Indigenous groups live on the coast, nearly half of them in remote or rural areas, making up approximately 32% of the NT's population (ABS 2006).

Subsistence fishing is an important part of Aboriginal culture in the NT as it is a traditional source of protein and economic benefit. In addition, many of the freshwater and marine species found in billabongs, rivers and coastal waters of northern Australia are totemic to Aboriginal people and are therefore of great cultural significance.

The NT *Fisheries Act 1988* makes provision for Aboriginal people to continue traditional use of fish and aquatic life.

Most Indigenous fishing activities, which occur close to communities and out-stations, are widespread across the northern part of the NT. Such activity occurs in inshore waters (61%), estuarine waters (11%) and on rivers (17%) (Henry and Lyle 2003).

Most coastal Aboriginal groups continue to practise customary management, education and law relating to the sea. These customary laws have been passed down over generations in the form of stories, dance, song, art and ceremony. Customary management styles vary across the NT, with each group respecting others' boundaries for hunting and fishing. This usually means that Aboriginal people will prefer to fish and hunt within their own country and seek permission before fishing in someone else's. Aboriginal customary fishing and hunting are undertaken according to the season which allows species to be targeted when in abundance and when in prime condition (Davis 1983).

Some areas of significance, such as sacred sites, may exclude Indigenous as well as non-Indigenous people, depending on the level of cultural significance. These exclusions may be according to age or gender. In addition, some species have totemic value and cannot be harvested by particular people. These restrictions also act as traditional management tools that help protect species and habitats. Many Indigenous groups continue to manage their resources through the leadership of community sea rangers. The challenge is to ensure that Aboriginal people in the NT are engaged at all levels of fisheries management and to identify some of the traditional management practices that may be incorporated into customary management.

PLANNING AND CONSULTATION

The NT Government has identified a need for greater Indigenous participation in various economic development activities, including aquaculture, fishing tourism and wild harvest fishing ventures to create long-term employment and produce positive economic and social outcomes. Such outcomes can only be achieved by establishing new partnerships with Indigenous communities while maintaining old alliances and by fostering a constructive working environment with Land Councils, other Indigenous organisations and the fishing industry to identify, negotiate and implement Indigenous economic development opportunities in the fishing industry.

A number of initiatives to increase the involvement of Indigenous people in the NT in the seafood industry and in aquatic resource management have been successfully implemented over time, including:

- Establishing and maintaining recreational fishing campsites on Aboriginal land.

- Establishing agreements between Aboriginal landowners and commercial fishermen.
- Implementing a dugong code of practice for the commercial fishing sector.
- Donating vessels to coastal ranger groups to carry out coastal surveillance.
- Establishing an Indigenous apprenticeship program in the Department of Resources (DoR).
- Establishing the Indigenous Community Marine Ranger Program (ICMRP).
- Developing and delivering Certificate II Fisheries Compliance (Seafood Industry) training to Indigenous rangers.
- Using funds from the Natural Heritage Trust for conducting a pilot trial survey on the impact of Indigenous people on sharks and rays.
- Researching new and innovative aquaculture farming models suitable for remote Indigenous communities.

Consultative Committees

Many Indigenous groups have been included in the management of fish and aquatic life in the NT through the establishment of Aboriginal Fisheries Consultative Committees (AFCCs) by DoR. One of the principal roles of AFCCs is to provide a mechanism that allows information flow between Aboriginal people engaged in customary fishery management practices and the NT Government. Information obtained from AFCCs has been incorporated into contemporary fisheries management decision-making processes. In addition, AFCCs provide Aboriginal communities with an avenue to voice their concerns to Government about matters relating to fisheries.

The information provided to Indigenous communities through AFCC meetings increases their understanding of potential opportunities for involvement in commercial fishing, aquaculture, tourism, resource management and research.

There are seven established committees in the NT; however, most have not convened for several years. One AFCC met during 2010. The composition of Aboriginal members on each committee is determined by the relevant community. AFCCs also have representatives from the Water Police, DoR, the Amateur Fishermen's Association of the NT, the NT Seafood Council and other government agencies as required.

AFCCs are being reviewed to improve Indigenous engagement in the fishing industry. DoR is developing an efficient fisheries management framework to include Indigenous input more effectively.

Government Liaison and Community Involvement

The maintenance of an open communication process with Aboriginal communities has enabled DoR to build a capacity among Indigenous people to participate in the long-term sustainable management of aquatic resources in the NT.

Through the AFCC consultative process, DoR conducts discussions, and plans and implements new fisheries initiatives relevant to coastal Aboriginal communities. This may include exploring commercial development opportunities for remote coastal communities, which may help resolve social and economic problems that many communities face. The AFCC process is currently under review to improve Indigenous engagement in fisheries management and businesses whilst maximising recreational and commercial fishing interest.

Indigenous people are also represented on individual Fishery Ministerial Advisory Committees, which provide advice to the Director of Fisheries and the Minister on sustainable fisheries management.

To further enhance the capability and knowledge sharing between Government and Aboriginal people, DoR has employed a manager, a marine ranger coordinator and a support officer to carry out community engagement activities, including on-going consultation, economic development and resource management. This also includes the employment of Indigenous apprentices. Since the employment of the first four Indigenous

apprentices in 2003, 18 more have been employed to work in DoR. The apprentices develop skills in a wide range of areas in fisheries management and have completed qualifications in Certificates II and III Business Administration, Certificate III Laboratory Skills and Certificate III Seafood Industry (Aquaculture).

The Indigenous Development unit (IDU) in DoR employed one Indigenous apprentice in 2010 who is undertaking a Certificate IV in conservation land and sea management.

During 2010, IDU officers spent 125 days in the field in remote communities working with marine rangers, meeting with traditional owners discussing fisheries management issues and assisting interested people with economic development activities.

MARINE RANGER PROGRAM

The NT Government commenced funding for Indigenous ranger groups through ICMRP in 2002 and continues to allocate annual grants of $60 000 to each ranger group. The program currently involves eight marine ranger groups that are strategically based along the NT coastline and include the Tiwi Islands, Borroloola, Port Keats, Maningrida, Goulburn Island, Elcho Island, Groote Eylandt and Ngukurr.

ICMRP facilitates and provides fisheries monitoring and surveillance support in local coastal waters. It also promotes a culture of environmental responsibility and continues to strengthen community leadership. Increasingly, the marine ranger groups are playing an important role in educating both Indigenous and non-Indigenous fishers, as well as providing a visual presence on water to help deter illegal fishing activities.

The marine ranger groups provide regular reports of their coastal activities to DoR. Information contained in these reports is forwarded to other relevant agencies, such as the Water Police and the Australian Customs Service. Funded marine ranger groups conducted 293 patrols in 2010.

A nationally accredited Certificate II Fisheries Compliance (Seafood Industry) course was delivered in conjunction with Charles Darwin University at the Department of Education and Training facility in Jabiru in 2010. The course provided an opportunity for marine rangers across the NT to meet and develop their skills. Twenty five rangers attended and completed the course, including two Kakadu National Park Rangers. The Water Police and senior Kakadu National Park Rangers provided essential support in the delivery of the training course that included:

- Intelligence, surveillance and evidence gathering.
- Presenting evidence in court.
- Communicating in cross cultural environments.
- Promoting the sustainable use of aquatic resources.
- Working effectively in the seafood industry.

ECONOMIC DEVELOPMENT

Indigenous people make up about 32% of the NT population, 80% of whom live in remote or rural areas. Aboriginal-identified land covers 84% of the NT coastline.

Many coastal community groups live in remote geographical locations where they own land, which makes them potentially eligible for joining existing activities in the fishing industry and also developing new fishing enterprises. The NT Government is committed to facilitate and enhance partnerships with Aboriginal groups to increase their economic development and employment opportunities.

A number of Aboriginal communities are actively involved in the commercial fishing industry with several groups or individuals owning licences, including Aboriginal Coastal, Coastal Net, Barramundi, Mud Crab and Aquarium fish/display licences. IDU officers visited 10 remote communities throughout 2010 to conduct a range of activities, including training and the provision

of advice on economic development opportunities.

Some Aboriginal groups and individuals have joined Fishing Tour Operators to facilitate the use of land-based facilities established on Aboriginal land.

SOCIAL BENEFITS

Fishing is an important lifestyle activity for Indigenous people in northern Australia. It not only contributes to a healthy diet, it provides cultural stimulation. In part, fishing also allows communities and families to retain their independence and connection to their country.

Many studies have documented the importance of wildlife catch in the diet of Indigenous people. Seafood has also been shown to contribute a large proportion of caloric intake for those living in coastal outstations.

The value of food collecting, hunting and fishing is important in maintaining the social cohesion of communities. Social networks are reinforced through the customary sharing of gathered food. Hunting is also used as an important educational tool for teaching younger people to adhere to Aboriginal law through the expression of knowledge and strengthening spiritual beliefs. This traditional management knowledge has been extrapolated over thousands of years of fishing and management of aquatic resources and now needs to be harnessed and utilised to strengthen contemporary management. Such a management structure can assist in making informed fisheries management decisions across the NT as well as recognise and empower Aboriginal people as natural resource managers.

Indigenous subsistence fishing does not value individual species in a similar way to the commercial and recreational fishing sectors, but rather as a valuable source of protein. The Indigenous fishing sector targets species when they are most abundant and in prime condition. Other fishing is done opportunistically with virtually no waste or bycatch. Most Indigenous fishing takes place as a family event or for the purpose of education, cultural maintenance and ceremony. It is a cultural obligation to provide food for everyone and as such, there is very little discarded catch.

A range of issues relate to Indigenous engagement in resource management and economic development. The cost of entry into the fishing industry is too high for most Aboriginal people. There is also a shortage of fishing industry-related skills in remote areas. Coastal Aboriginal people know where the fish hide and how to catch them; however, this alone does not guarantee a sustainable business. Fishing industry training and capacity-building are needed in remote communities. However, there is also a need for employment opportunities to complement any training. Fishing industry training that can also be applied to other jobs is necessary, thereby providing Indigenous people with a range of career options.

RESEARCH

Through ICMRP, many Indigenous groups are becoming more active in monitoring community fishing activities.

Marine rangers commenced work in 2008 on collaborative research projects with the NT Seafood Council and DoR. The research projects aim to identify juvenile red snapper nursery grounds and the location, distribution and abundance of juvenile mud crabs. The research projects continued through early 2009 with the assistance IDU. Further information on these projects can be found in the Timor Reef Fishery Status Report 2009 and the Mud Crab Fishery Status Report 2009. In 2010, Indigenous Marine Ranger groups were engaged in four fisheries research projects: a sawfish survey, juvenile mud crabs, mud crab escape vent trials and monitoring of snapper and barramundi stocks.

In 2008, the Anindilyakwa Sea Rangers, in collaboration with DoR, conducted research to develop appropriate methodology to monitor Indigenous fishing impacts on sharks and

stingrays. The final report was released in 2010 (Saunders and Carne 2010).

Manager, Indigenous Development – Mr Bo Carne

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AQUATIC BIOSECURITY

AQUATIC BIOSECURITY STATUS REPORT 2010

INTRODUCTION

The Aquatic Biosecurity program performs an important role in helping to protect the valuable aquatic resources, habitats, and fishing and aquaculture industries of the Northern Territory (NT) from introduced aquatic pests.

The Aquatic Biosecurity unit (ABU) was established following recognition of the vulnerability of NT waterways to invasion by exotic species, as highlighted by the incursion of the black-striped mussel (*Mytilopsis sallei*) in Darwin Harbour in April 1999.

The role of Aquatic Biosecurity is to:

- Maintain a surveillance program to detect introduced aquatic pests.
- Coordinate the inspection and treatment of high-risk vessels.
- Conduct emergency responses to detected exotic species.
- Provide a contact point for reporting potential pest species seen in the local environment.
- Raise public awareness of the threat of aquatic pests through educational activities.
- Represent the NT on national forums that address the prevention of entry and the management of introduced aquatic species.
- Assist in coordinating the implementation of strategies that will provide Australia with a nationally-coordinated approach to aquatic pest issues.

Ecosystem Impact

The introduction and subsequent establishment of an aquatic pest species in fresh, estuarine or marine waters of the NT has the potential to seriously impact on the biological diversity and productivity of our aquatic resources.

Aquatic pests tend to share a number of characteristics – they have high reproduction and growth rates, broad environmental tolerances and are highly invasive. These characteristics allow them to colonise a wide variety of habitats in large numbers to the exclusion of native plants and animals. They may out-compete or prey on native species, affect community dynamics and food webs, or alter the physical structure of habitats.

Social Impact

Aquatic resources have intrinsic social values as a basis for food, income and recreation. The negative impact of exotic species on the aesthetics of our waterways and on the variety of species of fauna and flora has the potential to dramatically damage them.

Economic Impact

The introduction and establishment of aquatic pests have the potential to significantly damage the economy of the NT. The establishment of aquatic pests may reduce the productivity of fisheries resources and increase the maintenance and amelioration costs associated with eradication. Such costs may also be associated with increased fouling of infrastructure (such as nets, pipes and vessels) and increases in aquaculture losses, resulting from reduced water quality, competition with fouling aquatic pest species and increased risk of disease.

Trade may also be affected. The establishment of marine pest species has the potential to limit interstate trade, as destination ports wishing to remain free of aquatic pests may restrict the entry of vessels from infested ports.

ENVIRONMENTAL ASSESSMENT

The monitoring of water quality and of species diversity in Darwin Harbour and marinas commenced following the eradication of the black-striped mussel from Cullen Bay, Frances

Bay and Tipperary Waters marinas in April 1999. Similar monitoring has been conducted at Bayview Marina since it was first filled with water in November 2000. The monitoring documents variations in water quality and species diversity.

No known marine pests were detected in 2010 in Darwin Harbour and marinas, or at Milner Bay (Groote Eylandt), Garden Point (Melville Island) or at Gove Harbour.

Biological Monitoring

The monitoring of marine bio-fouling organisms continued during 2010 with assistance from the local industry. Monitoring is conducted by ABU at sites within each of Darwin's lock-accessed marinas and at open-water locations in Darwin Harbour. Monitoring at locations along the NT coastline is conducted in cooperation with the industry and with Indigenous Marine Rangers at Gove Harbour (Rio Tinto Alcan Pty Ltd), Milner Bay (Groote Eylandt, GEMCO) and Garden Point (Tiwi Marine Rangers).

Results

No recognised marine pest species were detected during 2010 at any of the locations monitored.

Differences in the species colonising artificial settlement surfaces are most apparent when enclosed marina sites are compared with open-water sites. Although the species present in bio-fouling assemblages vary from one location to another, open-water sites, including those in Darwin Harbour and across the NT coastline, generally have a greater diversity of bio-fouling taxa and number of individual species present within the fouling community. It is very rare for a single taxon or species to dominate the fouling community to the exclusion of other taxa or species.

Marinas, however, are an artificial environment and are not exposed to tidal regimes and water exchanges that characterise open-water environments. Furthermore, marinas are subject to heavy vessel movements, which expose them to a higher likelihood of marine pest incursions. The four Darwin marinas tended to be dominated by blooms of one or two species, with the dominant species (and often taxonomic group), varying both between marinas and over time. The most common of such organisms were barnacles and polychaete tubeworms. Both have a calcareous structure and are able to form large quantities of hard fouling matter in short timeframes and colonise hard substrates, including boat hulls.

Marinas tend to act as a sink for freshwater run-off, resulting in the stratification of marina waters with a cool layer of less saline water forming over the top of warmer, more saline water. This environment potentially contributes to the booms and busts of the aforementioned species. Given that these seasonal fluctuations result in a lack of competition from established populations of native species, opportunities may exist for the establishment of invasive species in Darwin marinas. Seasonal stratification can be minimised by marina management by implementing practices that promote adequate flushing and mixing of marina waters so as to support the establishment of a more diverse and resilient fouling community.

Pest Monitoring by Indigenous Marine Rangers

In 2007-08, ABU conducted a Natural Heritage Trust-funded project to engage remote Indigenous communities in coordinated marine pest monitoring activities.

The processes established through this project now form part of the on-going Aquatic Biosecurity monitoring program. Training in marine pest awareness and surveillance has been incorporated in the Certificate II in Fisheries Compliance, in cooperation with the Indigenous Fisheries Development unit of the Department of Resources (DoR). Through this training, marine rangers are encouraged to be involved in regular monitoring activities.

As part of a Certificate II in Fisheries Compliance course held in Jabiru in May 2010, Aquatic Biosecurity staff trained marine rangers to identify

marine pests as well as monitor marine pests in their communities. Some of these ranger groups have since set up their own marine pest monitoring sites. In 2010, rangers from across the NT submitted four reports of suspect marine fouling organisms. All of the organisms were found to be native species.

Marine Pest Survey of Darwin Harbour

During 2010, Darwin Harbour was the focus of a large-scale survey targeting marine pests as part of the National System for the Prevention and Management of Marine Pest Incursions (NSPMMPI). The survey was conducted by Golder Associates, a consultancy experienced in port surveys of this kind. Sampling took place in April and August/September 2010 to determine any variation between the wet and dry seasons in Darwin.

A number of locations around Darwin Harbour were selected for monitoring due to their potential as sites for the establishment of marine pests. These locations generally experience high volumes of vessel traffic and have infrastructure, such as wharves, boat ramps, moorings, marinas and jetties as well as natural habitats, such as reefs, mangroves and foreshore areas. Twenty eight species with the potential to establish in the NT were targeted.

No targeted species were detected during sampling. One species of algae, *Caulerpa racemosa* var*. lamourouxii*, was found at two sites in Darwin Harbour. Some species of *Caulerpa* have been shown to be invasive in other regions of Australia and around the world. However, *C. racemosa* var. *lamourouxii* is native to, and widely distributed across, northern Australia. It has previously been recorded during studies of Darwin Harbour and no instances of invasive tendencies are known for this variant. Thus, this detection was not considered to be of a significant concern. A single, non-viable Pacific oyster (*Crassostrea gigas*) shell was also found in a shipping yard. This species was one of the 28 targeted species; however, it is more likely that this was a discarded shell from oysters imported for human consumption. There are no indications that this species is living in Darwin Harbour.

Water Quality Monitoring

Water quality in the marinas varies seasonally and is largely driven by freshwater runoff as a result of wet season rainfall. Stratification (layers of water possessing different temperature and salinity characteristics) of marina waters is most notable in Cullen Bay and Tipperary Waters marinas between November and May.

Incorporation into Management

The change in environmental conditions that results from a cooler, freshwater layer developing above warmer, denser water is hostile to many native species. In contrast, the same environment can provide opportunities for the establishment of aquatic pests, which are generally more tolerant of extreme variations in environmental conditions. Information from environmental monitoring has highlighted water quality as an important factor influencing seasonal variation in fouling communities.

Changes in water quality between the dry and wet seasons generally correspond to changes observed in the fouling communities in the lock-accessed marinas.

A reduction in the degree of wet season stratification may reduce the potential for the establishment of aquatic pest species. Seasonal stratification can be minimised by marina management by implementing practices that promote the mixing and flushing of marina waters.

Aquatic Pest Control

History

Prior to 1999, no record of noxious marine species had been reported from the waters of Darwin Harbour. Darwin marinas were quarantined on 1 April 1999 due to an extensive invasion by the exotic black-striped mussel.

This bivalve had the potential to seriously damage the local marine biodiversity and

threaten the social and economic benefits derived from the marine environment. Following its discovery, a rapid response by the NT Government successfully eradicated the species at a cost exceeding $2.2 million. This is believed to be the first documented successful eradication of an established marine pest population.

ABU was established following the recognition of the vulnerability of Darwin Harbour to invasion by exotic organisms and its status as a primary port and popular tourist destination. The issue of freshwater exotics also came under the scope of Aquatic Biosecurity.

Since 1999, the black-striped mussel and two other bivalve marine pest species, the Asian green mussel (*Perna viridis*) and the Asian bag mussel (*Musculista senhousia*), have been detected on a number of occasions as fouling either on the hulls or in the on-board plumbing of vessels arriving in Darwin from international locations, usually South-East Asia. These vessels have included apprehended illegal foreign fishing vessels (IFFVs), suspected illegal entry vessels (SIEVs), recreational cruising yachts and commercial vessels, such as rig tenders and tug boats. In such instances, the vessels were treated appropriately in cooperation with other relevant Australian and local government departments to mitigate the risk of the pest.

On numerous occasions, ABU has also controlled populations of non-native fish and invertebrates. Feral fish in NT waterways are usually common ornamental species, such as guppies, platies or swordtails, which generally appear to have either been released deliberately or escaped from backyard ponds during wet season rainfall. Invertebrate snail species are often inadvertently spread through trade in aquarium plants.

Current

Fifteen reports were received of suspected marine pests during 2010. Following investigations, eight were found to be native or cosmopolitan species and three were identified as known marine pest species. In all three instances, the Asian green mussel was detected, as well as one case where the black-striped mussel *was* also found.

The identity of the species was confirmed by the Curator of Molluscs at the Museum and Art Gallery of the NT. Two detections were from SIEVs that had been towed to Darwin for destruction and one from a navy vessel. The vessels were treated to remove pest populations from both the hulls and the internal seawater systems.

Six freshwater pest reports were received and investigated during 2010. The investigations highlighted the ease with which common ornamental fish, such as guppies (*Poecilia reticulata*), can be released (intentionally or unintentionally) from tanks and ponds and establish populations in drainage creeks and streams. Guppies and other exotic fish can compete with native species and impact negatively on the ecosystem. Known populations of exotic aquarium fish in NT waterways are currently being monitored to ensure that they are not adversely affecting native species where they have established.

Marine rangers submitted four samples of marine fouling organisms. In all cases, the samples were found to be native species. Many samples collected by marine rangers have been lodged with the Museum and Art Gallery of the NT, contributing to the knowledge of species distribution in these remote areas of the NT coastline.

Future Assessment Needs

With the expansion of port industries and the associated increase in shipping movements, as well as the transient nature of the NT population, the opportunities for exotic species to be introduced to the NT will increase. In addition, the continuing spread of the noxious fish tilapia throughout Queensland waterways is of serious concern. Tilapia is an extremely aggressive and successful competitor; its spread into the NT will

impact on native fish, including iconic species, such as barramundi.

It is, therefore, important to continue to collect environmental information on NT aquatic habitats and find ways to expand aquatic pest monitoring and surveillance activities, particularly in freshwater environments.

VECTOR MANAGEMENT

History

Two high-risk categories of vessels frequenting NT waters were identified through a risk assessment based on voyage history, stopovers in international ports and vessel maintenance regimes. They were vessels that had been in international waters and which entered Darwin marinas or were apprehended.

Vessels that transit international waters can transport exotic species as fouling, either on the hull or in the internal pipe works. Marinas are recognised to be at a greater risk of marine pest establishment because they are disturbed, artificial habitats frequented by high-risk vessels and which experience extremes in environmental conditions. Although the vast majority of vessels entering marinas are recreational cruising yachts, they also include such commercial vessels as fishing vessels and tug boats.

Vessels that have been apprehended for illegal activities originated from, or transited through, areas known to be inhabited by potential aquatic pest species. Some vessels from this class (iceboats from the Province of Probolinggo in East Java and all SIEVs) are considered to pose an extreme risk as a high proportion of them have had hulls infested with either black-striped or Asian green mussels.

Current Issues

The vessel categories mentioned above continue to be of concern. The inspection and treatment of high-risk vessels entering Darwin marinas are continuing in cooperation with marina management. Similarly, high-risk IFFVs and SIEVs are managed in cooperation with the Australian Quarantine and Inspection Service (AQIS) and the Australian Fisheries Management Authority (AFMA).

COMPLIANCE

Vessels intending to enter Darwin marinas are required to undergo an inspection and/or treatment of their internal seawater systems prior to being permitted entry. With the assistance of lockmasters, compliance has been excellent.

In 2010, 143 vessels were inspected and/or treated compared with 133, 173 and 141 in 2009, 2008 and 2007, respectively (Figure 1). The number of recreational vessels inspected each month clearly highlights Darwin's dry season tourism peak.

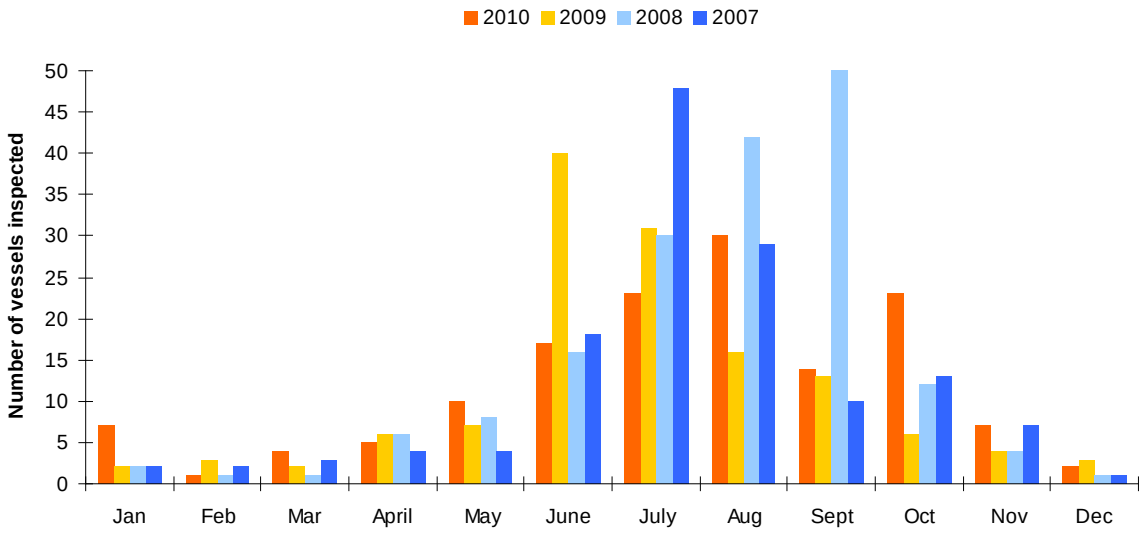

Figure 1. The number of vessels inspected prior to marina entry each month, 2007 to 2010

In addition to recreational vessel inspections, vessels apprehended off the northern Australian coastline destined for the ports of Darwin and Gove are examined for the presence of aquatic pest species.

FUTURE PLANS

NSPMMPI was developed by the National Introduced Marine Pest Coordination Group. As a result of increased industrial development around Darwin, an increase in international shipping is predicted, which will increase the risk of the introduction of marine pest species via such vectors as hull fouling and ballast water. NSPMMPI will address such pathways by implementing both regulatory and non-regulatory components. The national marine pest website provides details of NSPMMPI and contains resources for various industry sectors: http://www.marinepests.gov.au.

A design for a marine pest survey of Darwin Harbour was completed in 2009, according to the requirements of NSPMMPI. The survey was conducted in 2010 and now provides up-to-date information on the presence or absence of a number of marine pest species. No populations of the 28 targeted species were detected during the survey of Darwin Harbour.

The aquarium trade in marine species is also included in NSPMMPI. However, freshwater species fall outside the terms of reference. The management of feral freshwater fish is incorporated in the Australian Pest Animal Strategy.

CONSULTATION, COMMUNICATION AND EDUCATION

Vessel inspection and treatment protocols were developed in consultation with members of the fishing industry, marina owner/operators, ship repair and maintenance facilities, the Australian Customs Service, the Australian Defence Force, AQIS and AFMA. Information from on-going environmental monitoring is regularly reported to stakeholders and is available on DoR's website and on request. Brochures outlining general marine pest information and vessel inspection protocols are distributed to stakeholders. Publications are available from the Aquatic Biosecurity pages of the Fisheries website.

The general issue of aquatic pests has been presented in seminars and through articles in the

popular media. Such presentations have targeted the general public and stakeholder groups, such as commercial and recreational fishers, yachtsmen, port operators, ship repair and maintenance facilities and Indigenous groups. Presentations and field trips have also been conducted at high schools and at tertiary environmental science classes. Two public seminars were held prior to the Darwin Harbour Port Survey of 2010 to garner interest for community involvement.

Contact numbers to facilitate the reporting of aquatic pest sightings have been widely publicised through brochures, posters and the website.

There is a need to conduct further public education initiatives in relation to aquatic pests in freshwater systems. The use of native species in aquaria and ponds, as opposed to non-native species, will continue to be promoted and encouraged. Programs are also required to educate the public about the threats posed by the spread of tilapia from Queensland. Early detection of new populations and prompt action will be the key to prevent the establishment of this invasive fish in the NT. Early detection will largely depend on a well-informed and alert local community.

Manager, Aquatic Biosecurity – Ms Helen Cribb

Research Officer, Aquatic Biosecurity – Mr Jimmy Maher

FISHERIES LICENSING AND COMPLIANCE

FISHERIES COMPLIANCE STATUS REPORT 2010

INTRODUCTION

The Water Police Section of the Northern Territory (NT) Police, Fire and Emergency Services (NTPFES) is responsible for fisheries compliance and enforcement in the NT.

The Roles of the Water Police Section

The vision of NTPFES is 'a safe and secure NT' by 'working in partnership to reduce crime and enhance community confidence'. The Water Police Section is responsible for achieving this objective in inland, coastal and offshore environments. It is also responsible for:

- Search and rescue in aquatic environments.
- Marine safety education, compliance and enforcement.
- Investigation of marine incidents and accidents.
- Education, training and support for the Marine Ranger Program.
- Marine tactical insertion and extraction support for the Tactical Response Section.
- Specialist diver response capability for NTPFES.
- Counter-terrorism protection of visiting foreign warships.
- Counter-disaster (e.g. Katherine flood, cyclones) operational response.
- Management of the vessel replacement program for NTPFES.

Working in Partnership

The Water Police Section works with the Department of Resources (DoR) to develop advice, educational material and programs to increase compliance with NT fisheries legislation as well as the development and provision of training to Indigenous marine ranger groups.

The Water Police Section is a member on all Fishery Management Advisory Committees and attends Aboriginal Consultative Committees as required.

Current Status

During 2010, short, medium and long-range patrols were conducted across the NT. Fisheries compliance patrols were conducted in the following regions:

- Darwin Harbour and Shoal Bay.
- Bynoe Harbour, Finniss River and Dundee Beach.
- Tiwi Islands.
- Daly River region.
- Mary River (including Management Zone/Shady Camp).
- Kakadu, including East Alligator, South Alligator and Wildman Rivers, including Pocock's Beach.
- Victoria and Adelaide Rivers.
- Blue Mud Bay and Bennett Bay.
- Gulf of Carpentaria, from Port Roper to Calvert River, including the Roper and MacArthur river systems.
- Northern Arnhem Land region.

In 2010, 3393 contacts were made with commercial and recreational fishers, and Fishing Tour Operators, compared with 4456 contacts in 2009. Random checks were conducted on catch, gear and licences (where applicable), as well as general compliance with other relevant fisheries legislation. Twenty four people were summonsed to appear in court on fisheries-related matters; sixty seven summonses were issued in 2009. Also nine Infringement Notices (compared with 15 in 2009) and 39 cautions (compared with 153 in 2009) were issued.

The Water Police Section must balance other policing priorities (such as search and rescue, counter-terrorism protection of visiting foreign warships, marine safety) with fisheries compliance priorities. As such, the number of fisheries patrols and contacts made with fishers will vary from year to year.

Fisheries Compliance

The Water Police Section, in conjunction with DoR, conducted a fisheries compliance training of marine rangers resulting in 22 obtaining Certificate II in Fisheries Compliance. Support and advice were also provided to a number of marine ranger groups involved in the detection and surveillance of alleged illegal fishing practices.

Future Plans

The Water Police Section will continue to focus on increasing the level of compliance by commercial, recreational and Fishing Tour Operators using relevant fisheries legislation. Training, support and advice for marine rangers will continue throughout the NT.

FISHERIES LICENSING STATUS REPORT 2010

LICENSING

The Fisheries Licensing Section of the Department of Resources grants and renews licences and permits under Sections 11 and 15 of the *Fisheries Act 1988*. In 2010, 1000 licences and 236 permits were issued. A breakdown of the numbers of licences and permits issued per type and the numbers of parties in receipt of these licences and permits, is provided in Table 1.

It should be noted that the holders of a specific licence type may have exercised an option (e.g. two-for-one licence surrender) in order to obtain a single unrestricted licence for a particular fishery. In such instances, the number of licences issued may not reflect the number of licences available and/or operating in a particular fishery.

With the upgrade of the licensing database, the Licensing Section is progressing towards electronic processing of application forms, which will enable the applicant to apply or renew a licence online.

DATA

The Logbook Section records fishery logbook data that is collected from logbook returns which are required to be submitted by licence and permit holders. This information is vital in assisting the sustainable management of fisheries, in stock assessments and to enable the compilation of accurate gross value of product figures. In order to have reliable data, it is essential for all licence holders to submit accurate and timely logbook returns.

In 2009, a review was undertaken, which noted that approximately 100 returns per month were either late, or were not submitted at all. As of 1 July 2011, a tougher stand is being taken against those who do not submit logbook returns on time.

Table 1. The number of licences and permits issued in 2010

Licence type	Number of licences 2010	Number of licences 2009
A1 – Coastal Line Fishery licence	54	54
A2 – Coastal Net Fishery licence	5	5
A3 – Bait Net Fishery licence	2	2
A4 – Spanish Mackerel licence	16	16
A5 – Shark Fishery licence	17	17
A6 – Demersal Fishery licence	60	60
A7 – Barramundi Fishery licence	20	20
A8 – Mud Crab Fishery licence	49	49
A9 – Mollusc Fishery licence	1	1
A10 – Pearl Oyster Fishery licence	7	7
A12 – Aquarium Fish/Display licence	11	11
A13 – Trepang Fishery licence	6	6

Licence type	Number of licences 2010	Number of licences 2009
A14 – Development Fishery licence	2	2
A15 – Restricted Bait Entitlement	125	125
A16 – Finfish Trawl Fishery licence	1	1
A17 – Jigging Fishery licence	1	1
A18 – Timor Reef Fishery licence	15	12
A50 – Development Fishery – Coast Net	1	1
B1 – Fish Trader/Processor licence	38	35
B2 – Fish Retailer licence	376	388
C1 – Aquaculture licence	12	11
C2 – Pearl Oyster Culture licence	8	8
D1 – Aboriginal Coastal licence	2	5
D2 – Fishing Tour Operator licence	158	146
D3 – Aquarium Trader licence	10	10
D4 – Net licence	12	12
D5 – Public Aquarium licence	3	3
D14 – Development permit	1	1
S16 – Permit	38	24
S17 – Special permit	198	142
Total number of licences and permits issued	1249	1175

APPENDIX 1: GLOSSARY OF ABBREVIATIONS

ACIAR	Australian Centre for International Agricultural Research
ACS	Australian Customs Service
AFANT	Amateur Fishermen's Association of the NT
AFCC	Aboriginal Fisheries Consultative Committees
AFMA	Australian Fisheries Management Authority
AFZ	Australian Fishing Zone
AIMS	Australian Institute of Marine Science
AQIS	Australian Quarantine and Inspection Service
BFMAC	Barramundi Fishery Management Advisory Committee
BVL	Berrimah Veterinary Laboratories
CITES	Convention on International Trade in Endangered Species
CLFMAC	Coastal Line Fishery Management Advisory Committee
CPUE	Catch per unit effort
CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific Industrial and Research Organisation
DAC	Darwin Aquaculture Centre
DEEDI	Department of Employment, Economic Development and Innovation, Queensland, previously QDPI&F
DEWHA	Department of Environment, Water, Heritage and the Arts (Australian)
DFMAC	Demersal Fishery Management Advisory Committee
DoR	Department of Resources
EMP	Environmental Management Plan
EPA	Environment Protection Agency
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Australian)
ESD	Ecologically sustainable development
FRDC	Fisheries Research and Development Corporation
FTF	Finfish Trawl Fishery
FTO	Fishing Tour Operator
FFV	Foreign Fishing Vessel
FRDC	Fisheries Research and Development Corporation
GIS	Geographic Information System
ITQ	Individual Transferable Quota
IUU	Illegal, Unreported and Unregulated (fishing)
MACANT	Ministerial Advisory Committee on Aquaculture in the NT
MCFMAC	Mud Crab Fishery Management Advisory Committee
MCFMP	Mud Crab Fishery Management Plan
MLS	Minimum Legal Size
MOP	Mother of Pearl
NPOA	National Plan of Action (for Sharks)
NRETAS	Department of Natural Resources, Environment, The Arts and Sport, NT
NRFSNT	National Recreational Fishing Survey: Northern Territory
NRIFS	National Recreational and Indigenous Fishing Survey
NSPMMPI	National System for the Prevention and Management of Marine Pest Incursions
NT	Northern Territory
NTAC	NT Aquarium Committee
NTFDOC	NT Fisheries Development Opportunities Committee
NTFJA	NT Fisheries Joint Authority
NTGFIA	NT Guided Fishing Industry Association
NTPFES	Northern Territory Police, Fire and Emergency Services
NTSC	NT Seafood Council
OCS	Offshore Constitutional Settlement

OFMIG	Ornamental Fish Management Implementation Group
ONLF	Offshore Net and Line Fishery
OSAG	Offshore Snapper Advisory Group
PIAC	Pearling Industry Advisory Committee
POCIMP	Pearl Oyster Culture Industry Management Plan
QDPI&F	Queensland Department of Primary Industries and Fisheries - now DEEDI
SEWPaC	Department of Sustainability, Environment, Water, Population and Communities
SIRC	Shark Implementation and Review Committee
SMFMAC	Spanish Mackerel Fishery Management Advisory Committee
TAE	Total allowable effort
TL	Total length
TEP	Threatened, endangered and protected (species)
TRF	Timor Reef Fishery
TRFAG	Timor Reef Fishery Advisory Group
TRFMAC	Timor Reef Fishery Management Advisory Committee
WTO	Wildlife Trade Operation

APPENDIX 2: GENERIC FISHERIES DIVISION DETAILS

General Enquiries

Fisheries Division
Department of Resources
GPO Box 3000, Darwin NT, 0801
AUSTRALIA

Tel: +61 8 8999 2144
Fax: +61 8 8999 2065
Email: fisheries@nt.gov.au
Web site: www.fisheries.nt.gov.au

Please visit the website to obtain contacts for fisheries specific and aquaculture information.

Structure of Fisheries Division

Executive Director Fisheries

Aquatic Resources Branch

Director, Aquatic Resources

Fisheries Research

Aquatic Resource Management

Recreational Fishing and Fishing Tour Operators

Fisheries Development Branch

Director, Economic Development

Licensing and Data Services

Logbook Returns

Aquatic Biosecurity

Darwin Aquaculture Centre

Pearling

Fisheries Indigenous Development