Fishery Report No. 101

Fishery Status Reports 2008

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Department of Resources
GPO Box 3000
Darwin NT 0801
AUSTRALIA
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INTRODUCTION

The lifestyle enjoyed by many Territorians is reliant on the diverse abundance of fish and aquatic life resources of the Northern Territory (NT). The continued ecologically sustainable management of these fish and aquatic life resources is critical to ensuring future generations can also enjoy this lifestyle.

The Department of Resources (DoR) is responsible for administering the NT’s Fisheries Act 1988, which provides for the regulation, conservation and sustainable management of fish and aquatic life resources. DoR works closely with other NT and Australian Government departments, key stakeholder groups (including commercial, recreational and indigenous fishing sectors) to develop and implement key management objectives and strategies.

A number of key management initiatives commenced during 2008, including:

- Buy-back of commercial barramundi fishery licences.
- Development of a discussion paper on future management of Fishing Tour Operators.
- Seafood labelling requirements for fish retailers.
- A cooperative Fisheries Research and Development Corporation (FRDC) project between QPI&F and DoR on sustaining productivity of tropical red snappers.
- A pilot scale aquaculture production of juvenile giant clams for the aquarium industry.

Work in these initiatives will continue during 2009.

In addition, the High Court of Australia handed down its decision in 2008 on the matter known as the Blue Mud Bay Case. Whilst the NT Fisheries Act 1988 still applies, the Court found that permission must be obtained from the relevant Land Trust to legally enter waters over Aboriginal land in order to fish.

The High Court decision presents opportunities and challenges. During 2008, the NT Government worked with stakeholders to commence work on the development of a practical, negotiated outcome for the benefit of all Territorians. This work will continue in 2009.

The following report provides an overview of the NT’s wild harvest fisheries, recreational and fishing tourism industries, as well as the aquaculture and indigenous fishing sectors and aquatic biosecurity. Future research and management directions are also highlighted. I trust you will find the information provided in the Fishery Status Reports 2008 useful.

Ian Curnow
Executive Director, Fisheries
The gross value of production (GVP) of fisheries and aquaculture at first point of sale in the NT in 2008 was approximately $32.84 million and $21.0 million respectively. This represents an increase of $0.94 million over the estimated GVP in 2007. It should be noted that the value of the Northern Prawn Fishery has not been included in the calculation of the GVP.

The three highest catch value wild harvest fisheries in 2008 were the Mud Crab Fishery ($8.24 million), the Barramundi Fishery ($6.24 million) and the Timor Reef Fishery ($5.76 million). Other high value fisheries in 2008 included the Finfish Trawl, Shark and Spanish Mackerel Fisheries.

Pearling activities in the NT were valued at $16.3 million in 2008, with barramundi aquaculture production accounting for $4.3 million of the GVP. There was no prawn aquaculture activity in 2008.

Key highlights in 2008 included:

COMMERCIAL FISHING

- Completing the buy-back of Coastal Net Fishery licences with the surrender of nine licences.
- Establishing a buy-back scheme for the Barramundi Fishery.
- Conducting an Ecological Risk Assessment for the Mud Crab Fishery to assist in determining future management needs.

RECREATIONAL FISHING

- Developing an NT-wide recreational fishing survey.
- Developing and implementing an agreed works program for recreational fishing infrastructure.
- Continuing to expand the artificial reef network to improve fishing opportunities in NT waters.
- Stocking of Manton Dam with approximately 32,000 barramundi fingerlings.

INDIGENOUS FISHING

- Funding eight marine ranger programs.
- Holding two capacity-building workshops with marine rangers focusing on fisheries monitoring and compliance.
- Collaborating with marine rangers in two fisheries research programs that are examining juvenile snapper and mud crab distribution and abundance.
- Developing and implementing standardised reporting processes to enhance the contribution of marine rangers to fisheries monitoring and compliance.
- Granting five licences to Aboriginal coastal communities authorising the harvest and sale of fish within their communities.
AQUACULTURE

- Producing 970 000 barramundi fingerlings.
- Submitting the final report to FRDC on the three-year collaborative mud crab larval rearing project.
- Assisting industry and the NT Seafood Council to market key aquaculture sectors.
- Facilitating small-scale land-based grow-out trials for sea cucumbers.

AQUATIC RESEARCH

- Submitting the final report on ‘Utilisation of GIS spatial statistical methods to assist in the development of ecosystem-based fishery management strategies using the NT Demersal and Timor Reef Fisheries as case studies’.

AQUATIC BIOSECURITY

- Completing the NHT-funded project ‘Coordinated marine pest monitoring by remote coastal communities’.
- Inspecting and treating 173 vessels prior to their entry into local marinas.
- Intercepting three known marine pests on vessels that had recently arrived from South-East Asia.
AQUARIUM FISHERY STATUS REPORT 2008

INTRODUCTION

The Northern Territory (NT) Aquarium Fishery is a small-scale, multi-species fishery operating in fresh water, coastal waters 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 to date has been small by national and international standards, both in numbers and value. The demand for aquarium species, however, continues to increase. Harvesting techniques, transport and packaging have improved significantly over the past 10 to 15 years, which have enabled the industry to provide a quality product to a growing interstate market and potential export markets.

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

In 2008, a report was submitted to the Commonwealth Department of the Environment, Water, Heritage and the Arts (DEWHA) to re-assess the management arrangements of the fishery against the Guidelines for the Ecologically Sustainable Management of Fisheries. The fishery was subsequently accredited with a Wildlife Trade Operation (WTO) under the Commonwealth’s Environment Protection and Biodiversity Conservation Act (EPBC Act). The WTO declaration endorses the export of product from the sustainable fishery for a period of three years. 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
- Aquarium Trader licence (D3), which permits the sale and trade of aquarium species but does not permit the harvesting of aquarium species.
- Public Aquarium licence (D5), which allows the display of live fish and aquatic life for profit.

The number of Aquarium Fishing/Display licences permitted in the fishery is currently limited to 12. In 2008, only six operators recorded any fishing activity. There is no limit on the number of Aquarium Trader licences, which can be issued. In 2008, nine of these licences were issued. Two Public Aquarium licences were issued in 2008.

Following a review of the fishery in 2004-05, all Aquarium Fishing/Display Fishery licence holders were permitted to collect strictly limited quantities of coral and associated benthic species. Coral and associated benthic species cannot be collected from Darwin or Gove Harbours.

The management objectives, performance indicators, performance measures, triggers and management actions used in the fishery are shown in Table 3 along with harvest status for 2008.
**Area**

Licensees in the fishery may harvest from all inland, estuarine and marine waters to the outer boundary of AFZ. However, harvesting is not permitted in a number of designated protected areas, such as Doctor’s Gully and East Point Aquatic Life Reserves in the Darwin Harbour area, Aboriginal sacred sites, aquaculture farm leases and sanctuary zones.

Most freshwater and estuarine aquatic species are collected in streams and creeks close to Darwin, and the Adelaide and Daly River systems.

Commercial harvesting of marine species is concentrated in coastal waters near Nhulunbuy, although 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. Tables 1 and 2 show the quantities harvested in 2008.

Hermit crabs and corals comprised much of the invertebrate harvest in 2008. Approximately 1930 kg of live rock (mostly pieces of dead hard coral that had detached from the reef and colonised by other organisms) was taken. Over 1000 kg of small shrimp (Acetes spp.), which occur in massive numbers at certain times of the year, were also collected. In 2008, 256 giant clams (Tridacna squamosa) were collected. The number of giant clams harvested each year is highly dependent on market demand.

Gudgeons were the most popular group of fish taken, followed by scats, rainbow fish and sole (Table 2). All the fish harvested in the fishery are widespread and abundant in the NT.

A total of 5598 Group A finfish (silver and spotted scats, common archerfish, chequered and black banded rainbow fish, sailfin perchlet and clack catfish) were harvested in 2008. The estimated harvest of coral and associated benthic species was approximately 3.3 tonnes, well below the trigger point of 60 tonnes.

**Effort**

It is difficult to quantify effort within the fishery because of the wide range of species targeted, each with its own specific harvest technique, as well as differences in reporting of effort by licensees.

The fishery operates on a small scale, using highly selective harvest methods. Harvesting is restricted by weather conditions for much of the year and the majority of the species harvested have a wide distribution. These factors, in conjunction with strict controls and low participant numbers, indicate that effort in the fishery is minimal. In 2008, 174 days were expended in the fishery, which is an increase from the 157 days fished in 2007.

**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 rocks, 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. Invertebrates taken during 2008 in the Aquarium Fishing/Display Fishery

<table>
<thead>
<tr>
<th>Invertebrate</th>
<th>Harvest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetes shrimp</td>
<td>1350 kg</td>
</tr>
<tr>
<td>Anemones</td>
<td>563 individuals</td>
</tr>
<tr>
<td>Cherabin</td>
<td>1012 individuals</td>
</tr>
<tr>
<td>Coral morphs</td>
<td>3477 individuals</td>
</tr>
<tr>
<td>Coral other</td>
<td>1415 individuals</td>
</tr>
<tr>
<td>Giant clams</td>
<td>256 individuals</td>
</tr>
<tr>
<td>Land hermit crabs</td>
<td>33,760 individuals</td>
</tr>
<tr>
<td>Live rock</td>
<td>1930 kg</td>
</tr>
<tr>
<td>Red claw crayfish</td>
<td>465 individuals</td>
</tr>
<tr>
<td>Shrimp</td>
<td>1014 individuals</td>
</tr>
</tbody>
</table>

Table 2. Fish taken during 2008 in the Aquarium Fishing/Display Fishery

<table>
<thead>
<tr>
<th>Fish</th>
<th>Harvest (Individuals)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gudgeons (all)</td>
<td>11,571</td>
</tr>
<tr>
<td>Anemone fish (all)</td>
<td>294</td>
</tr>
<tr>
<td>Archerfish (all)</td>
<td>1941</td>
</tr>
<tr>
<td>Catfish (other)</td>
<td>1222</td>
</tr>
<tr>
<td>Eel-tailed catfish (all)</td>
<td>2180</td>
</tr>
<tr>
<td>Hardy heads (all)</td>
<td>240</td>
</tr>
<tr>
<td>Mouth almighty</td>
<td>238</td>
</tr>
<tr>
<td>Mullet (all)</td>
<td>537</td>
</tr>
<tr>
<td>Puffer fish (all)</td>
<td>1530</td>
</tr>
<tr>
<td>Rainbow fish (all)</td>
<td>3385</td>
</tr>
<tr>
<td>Saratoga</td>
<td>800</td>
</tr>
<tr>
<td>Scats (all)</td>
<td>4462</td>
</tr>
<tr>
<td>Sole (all)</td>
<td>3100</td>
</tr>
<tr>
<td>Other</td>
<td>853</td>
</tr>
</tbody>
</table>

Recreational Sector

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 possess 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 recreational harvest 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).

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 all non-target species are immediately returned to the water as soon as practicable with as little damage as possible. In previous years, observers from DoR accompanying licensees during their harvesting activities verified the extremely low bycatch and mortality rate for all species caught within this fishery.

Threatened Species Interaction

The Commonwealth Government’s *EPBC Act* requires fishers to report to DEWHA 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 considered to be 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 to these two groups, including the extensive area of the fishery, seasonal closures and the wide distribution of the species. No TEP species were harvested in 2008.

**Ecosystem Impact**

The potential impact on the environment from this fishery is limited due to the small scale nature of the industry and the unique climatic and regional characteristics of the NT. Monsoonal weather conditions render large portions of both inland and coastal waters of the NT inaccessible or unsafe for a significant period of each year. Furthermore, the biology of many species limits the frequency at which they can be caught in commercially-viable numbers.

The distance of collection sites from population centres imposes economic constraints on aquarium collectors and has led to effort being concentrated around Darwin and Nhulunbuy. The combination of these factors provides extensive “protection zones” that are not readily available for commercial or recreational exploitation.

**Social Impact**

The harvesting of coral in areas adjacent to major population centres is an issue for DoR largely due 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 collecting of coral and associated benthic species.

**Economic Impact**

The catch value of the fishery in 2008, based on market sales, was estimated at over $400 000.

**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 the capture methods used. Common aquarium species targeted by licensees at a particular point in time are also identified.

No observer trips were undertaken during 2008. Licensees have shown a willingness to participate in increased monitoring in this fishery to meet the requirements of the Commonwealth Government’s export accreditation process. Observer monitoring (focussing on coral collection) may resume in 2009 if required following a revision of the harvest trigger levels for coral and associated benthic species.

**Current Harvest Status**

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

Most species were well within their trigger points in 2008. Several trigger points were reached for species within Group A finfish. Catches of banded rainbow fish, chequered rainbow fish, common archerfish, sail-fin perchlet and black catfish all declined by more than 70% in 2008 compared with the previous three-year average (Table 3). These declines in catch are likely to be market-driven. Changes to logbooks for the Aquarium Fishing/Display Fishery will provide more information to assist with monitoring catches of these species in the future.
Future Assessment Needs

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

There is a need for finer-scale spatial reporting to improve the ability of monitoring programs to detect any localised impacts of the Aquarium Fishing/Display Fishery. This is important to ensure that an analysis of catch and ecosystem impacts can be undertaken at a scale that is appropriate to the fishery. Logbooks will be revised during 2009 to ensure a more accurate and consistent reporting of coral and associated benthic species. The current harvest trigger level for corals and associated benthic species is also to be revised during 2009.

RESEARCH

Summary

The Department of Natural Resources, Environment, The Arts and Sport (NRETAS) 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 (Townsville) and Kansas State University (USA) are currently clarifying the taxonomy and identification of anemones, corallimorphs and hard corals in the Nhulunbuy area, using morphology and genetic techniques.

Current Research

Two large freshwater research projects of relevance commenced in 2006 and are continuing with considerable involvement of DoR. The first, ‘Water Regime Dependence of Fish in the Wet-Dry Tropics’, is managed by the Charles Darwin and Griffith Universities with the objective to sample the fish communities of the middle and upper-reaches of the Daly River basin. The second project, ‘A Comprehensive Analysis of the Freshwater Fish Faunas and their Key Management Issues across Northern Australia’, is being coordinated by James Cook and Griffith Universities and aims to sample all catchments where comprehensive studies have yet to be undertaken. These two projects will ultimately map the geographic distribution, biodiversity and habitat requirements of freshwater fish in all major catchments across the NT. This will provide a wealth of information on which to base future decisions regarding the harvest of freshwater fish species.

A pilot study on the biology and potential sustainable yield of the land hermit crab (Coenobitat variabilis) was conducted by DoR at Coconut Grove and Lee Point in the Darwin area during 2008. Tagged, empty shells were distributed over hermit crab habitat to determine whether 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 their fecundity. Results from this study 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 movements averaging less than 11 m/day with the greatest movement being 70 m/day. Gravid females found during this work typically contained more than 200 eggs. Separate to the project, researchers have found gravid hermit crabs in the Darwin area during February, suggesting that the crabs probably have a protracted spawning period of at least five months’ duration.
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 to 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 large area of habitat available to these species, and the selective nature of the fishery. The fishery is also subject to natural seasonal closures.

Recreational capture of marine and freshwater fish and benthic species by hobby aquarists is managed by the same regulations 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 1990, the harvest of red claw crayfish by aquarium collectors was prohibited. Red claw is only permitted to be harvested for recreational or aquaculture purposes.

In 1993, the 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 importers of aquarium species; and 3) Aquaculture.

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 the 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 collection 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 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 by DEWHA against the Guidelines for the Ecologically Sustainable Management of Fisheries, in 2006. A WTO approval was granted for two years subject to conditions associated with ongoing sustainability of the fishery. Performance indicators were developed for the fishery as a result of those recommendations (Table 3).

Current Issues
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 aquaria 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 against the Guidelines for the Ecologically Sustainable Management of Fisheries. A WTO was granted for three years enabling the continued export of product harvested in the fishery. Re-assessment of the fishery is due in June 2011.

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 other associated benthic species. DoR will continue to work with NTAC to meet DEWHA recommendations to retain, if not improve, on the WTO approval.

In alignment 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 Reference Working Group 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.

Future Plans
As part of the review of the Aquarium fishery, the NT Government agreed to modify the fishing gear permitted in the Aquarium Fishing/Display Fishery. These modifications will be introduced in conjunction with the agreed review of the trigger levels for coral and associated benthic species. It is expected that the new arrangements will be implemented in 2009.

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 ESD of the resource with a view to maintaining the export status of the fishery under the EPBC Act.

Compliance
The Police, Marine and Fisheries Enforcement 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 within the fishery in 2008.
Consultation, Communication and Education

DoR works with stakeholders in the fishery individually and through NTAC, as well as 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 Scientists – Dr Thor Saunders and Dr Julie Martin

Aquatic Resource Management Officer – Mrs Tricia Beatty

REFERENCES


### Table 3. Management objectives, performance indicators, performance measures, triggers and management actions for the Aquarium Fishing/Display Fishery in 2008

<table>
<thead>
<tr>
<th>Species or group</th>
<th>Management objective</th>
<th>Performance indicator</th>
<th>Performance measure</th>
<th>Harvest status for 2008</th>
<th>Management response to be taken</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A Finfish (silver and spotted scat, common archerfish, chequered and black banded rainbow fish, sail-fin perchlet, black catfish)</td>
<td>Ensure intergenerational equity by maintaining ecologically sustainable annual catches in all sectors.</td>
<td>Significant increase or decline in the annual catch.</td>
<td>The harvest of any Group A Finfish species has a trigger point of 30,000 individuals per species.</td>
<td>Only 5,598 Group A Finfish were harvested in 2008 — trigger reference point not reached. The harvest of common archerfish decreased by 89% in 2008 — trigger reference point reached. The harvest of chequered rainbow fish in 2008 decreased by 89% — trigger reference point reached. The harvest of banded rainbow fish declined by 100% — trigger reference point reached. The harvest of sail-fin perchlet declined by 97% in 2008 — trigger reference point reached. The harvest of black catfish declined by 100% in 2008 — trigger reference point reached.</td>
<td>DoR to review Fishery, after consultation with industry stakeholders, and makes recommendations on appropriate management responses to the Director of Fisheries. Advice provided to the Director within three months of being made aware of trigger being reached.</td>
</tr>
<tr>
<td>Coral and associated benthic species</td>
<td>Ensure intergenerational equity by maintaining ecologically sustainable annual catches in all sectors.</td>
<td>Significant increase or decline in the annual catch.</td>
<td>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 to the mean of the previous 3 years.</td>
<td>Total harvest of coral and associated benthic species for 2008 was estimated to be 3.3 tonnes — trigger reference point not reached. Harvest of corals and associated benthic species in 2008 within limits of the three-year mean — trigger reference point not reached.</td>
<td>DoR to review fishery, after consultation with industry stakeholders, and make recommendations on appropriate management responses to the Director of Fisheries. Advice provided to the Director within three months of being made aware of trigger being reached.</td>
</tr>
<tr>
<td>Species or group</td>
<td>Management objective</td>
<td>Performance indicator</td>
<td>Performance measure</td>
<td>Harvest status for 2008</td>
<td>Management response to be taken</td>
</tr>
<tr>
<td>------------------</td>
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<td>-----------------------</td>
<td>---------------------</td>
<td>------------------------</td>
<td>--------------------------------</td>
</tr>
<tr>
<td>Giant fluted clams</td>
<td>Ensure intergenerational equity by maintaining ecologically sustainable annual catches in all sectors.</td>
<td>Significant increase or decline in the annual catch.</td>
<td>Giant fluted clams are harvested within a trigger value of 2000 individuals. The harvest of giant fluted clams increases or decreases by 50% when compared to the mean of the previous three years.</td>
<td>A total of 256 giant clams were harvested in 2008 - trigger reference point not reached. The harvest of giant fluted clams increased by 17% of the three years mean in 2008 – trigger reference point not reached.</td>
<td>DoR to review fishery, after consultation with industry stakeholders and make recommendations on appropriate management responses to the Director of Fisheries. Advice provided to the Director within three months of being made aware of trigger being reached.</td>
</tr>
<tr>
<td>Narrow sawfish (Anoxypristis cuspidate) and dwarf sawfish (Pristis clavata)</td>
<td>Ensure intergenerational equity by maintaining ecologically sustainable annual catches in all sectors.</td>
<td>Significant increase or decline in the annual catch.</td>
<td>Pristis species are harvested within a trigger value of 20 individuals. The harvest of any Pristis species increases or decreases by 50% when compared to the mean of the previous 3 years.</td>
<td>There were no Pristis species harvested in 2008 - trigger reference point not reached. n/a – none harvested in 2008.</td>
<td>DoR to review fishery, after consultation with industry stakeholders, and make recommendations on appropriate management responses to the Director of Fisheries. Advice provided to the Director within three months of being made aware of trigger being reached.</td>
</tr>
<tr>
<td>Syngnathid species, other than Hippocampus (seahorses) – NT waters only</td>
<td>Ensure intergenerational equity by maintaining ecologically sustainable annual catches in all sectors.</td>
<td>Significant increase or decline in the annual catch.</td>
<td>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% when compared to the mean of the previous 3 years.</td>
<td>There were no syngnathid species harvested in 2008 - trigger reference point not reached. n/a – none harvested in 2008.</td>
<td>DoR to review fishery, after consultation with industry stakeholders, and make recommendations on appropriate management responses to the Director of Fisheries. Advice provided to the Director within three months of being made aware of trigger being reached.</td>
</tr>
<tr>
<td>Hippocampus (seahorses) NT waters only</td>
<td>Ensure intergenerational equity by maintaining ecologically sustainable annual catches in all sectors.</td>
<td>Significant increase or decline in the annual catch.</td>
<td>Hippocampus are harvested within a trigger value of 50 individuals. The harvest of any Hippocampus increases or decreases by 50% when compared to the mean of the previous 3 years.</td>
<td>There were no Hippocampus individuals harvested in 2008 - trigger reference point not reached. n/a – none harvest in 2008.</td>
<td>DoR to review fishery, after consultation with industry stakeholders, and make recommendations on appropriate management responses to the Director of Fisheries. Advice provided to the Director within three months of being made aware of trigger being reached.</td>
</tr>
<tr>
<td>Species or group</td>
<td>Management objective</td>
<td>Performance indicator</td>
<td>Performance measure</td>
<td>Harvest status for 2008</td>
<td>Management response to be taken</td>
</tr>
<tr>
<td>-----------------</td>
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</tr>
<tr>
<td>Hermit crabs</td>
<td>Ensure intergenerational equity by maintaining ecologically sustainable annual catches in all sectors.</td>
<td>Significant increase or decline in the annual catch.</td>
<td>A precautionary trigger is set at 120 000 hermit crabs per year. The harvest of hermit crabs increases or decreases by 70% when compared to the mean of the previous 3 years.</td>
<td>Only 33 760 hermit crabs were harvested in 2008 - trigger reference point not reached. The harvest in 2008 of hermit crabs increased by 66% over the previous three years’ mean.</td>
<td>DoR to review fishery, after consultation with industry stakeholders, and make recommendations on appropriate management responses to the Director of Fisheries. Advice provided to the Director within three months of being made aware of trigger being reached.</td>
</tr>
<tr>
<td>EPBC Act listed species (excluding Syngnathids) in Territory waters</td>
<td>Ensure the continued protection of species and communities listed under the EPBC Act.</td>
<td>Endangered, threatened or protected species and/or communities are identified in Northern Territory waters.</td>
<td>Identifiable impacts observed by DoR, commercial fishers, or other agencies regarding EPBC Act listed species or communities.</td>
<td>There were no identifiable impacts on EPBC species or communities observed in 2008 - trigger reference point not reached.</td>
<td>DoR to review fishery, after consultation with industry stakeholders, and make recommendations on appropriate management responses to the Director of Fisheries. Advice provided to the Director within three months of being made aware of trigger being reached.</td>
</tr>
<tr>
<td>EPBC Act listed species in Commonwealth waters</td>
<td>Ensure the continued protection of TEP species.</td>
<td>No EPBC Act listed species may be taken in Commonwealth waters.</td>
<td>There were no EPBC Act listed species taken during 2008 - trigger reference point not reached.</td>
<td>Advice provided to Director of Fisheries and DEWHA regarding any interactions in Commonwealth waters.</td>
<td></td>
</tr>
<tr>
<td>Ecosystem components</td>
<td>Minimise effects on ecosystem components.</td>
<td>Identification of threatening processes.</td>
<td>Identification of significant negative ecosystem impacts on aquarium fishing grounds.</td>
<td>There were no negative ecosystem impacts observed in 2008 - trigger reference point not reached.</td>
<td>DoR to make recommendations, after consultation with industry stakeholders, to the Director of Fisheries regarding appropriate remedial action. Advice provided to the Director within three months of being made aware of trigger being reached.</td>
</tr>
<tr>
<td>Harvest of TEP species intended for trade to public aquariums (except coral and associated benthic species)</td>
<td>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.</td>
<td>Significant increase or decline in the annual catch.</td>
<td>The harvest of any TEP species increases or decreases by 50% when compared to the mean of the previous 3 years.</td>
<td>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 2008 - trigger reference point not reached.</td>
<td>DoR to make recommendations, after consultation with industry stakeholders, to the Director of Fisheries regarding appropriate remedial action. Advice provided to the Director within three months of being made aware of trigger being reached.</td>
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</tbody>
</table>
INTRODUCTION

Barramundi (*Lates calcarifer*) is widely distributed in the Indo-Pacific region and northern Australia. It is valued for its flesh quality, fighting ability, size and readiness to take artificial lures. These qualities have made barramundi an iconic species that supports important commercial and recreational fishing industries. Barramundi are also harvested by Aboriginal people in coastal and some inland areas of the NT, and have significant economic, health and cultural value to this sector.

The Barramundi Fishery is currently fished within sustainable limits after recovering from a period of over-fishing in the 1970s. Since management intervention in the 1980s, catch rates in both the commercial and recreational sectors have increased. However, in certain accessible and heavily-fished areas, recreational fishing pressure, in conjunction with commercial fishing, may increase the total harvest to levels approaching full utilisation. Management of these specific areas is currently under review with a view to ensuring catches remain sustainable in the longer term.

In July 2008, the NT Government announced a voluntary buy-back of Barramundi Fishery licences, with the aim of removing three licences from the fishery and investigating possible closures 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 of the coast, river mouth or legislated closure lines. Fishing is not permitted within the confines of Kakadu National Park, the Mary River Fish Management Zone, Darwin Harbour, Shoal Bay, or 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. Most of the commercial fishing currently takes place in Van Diemen Gulf, Anson Bay, Arnhem Bay and Buckingham Bay.

Commercial operators in the NT fish in 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 onboard 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 to get caught in a 150 mm gillnet by the end of their fourth year. Commercial operators target barramundi that are usually three to eight years old. However, in recent years, there has been increased targeting of larger fish as a result of fishers’ perception that these size classes (> 80 cm) were quite abundant. Using the larger mesh nets has also increased the catches of black jewfish (*Protonibea diacanthus*).

The commercial catch in 2008 was 641 tonnes of barramundi and 331 tonnes of king threadfin. This represents an increase in barramundi from 492 tonnes and a decline in king threadfin from 356 tonnes, harvested in 2007 (Figure 1).

A number of byproduct species are also taken in the commercial fishery, depending on their marketability. The most commonly retained byproduct species are black jewfish (*P. diacanthus*), assorted reef fish and sand bass (*Psammoperca waigiensis*). Sharks are also a byproduct (Figure 2), although the amount that can be taken is restricted to 500 kg of converted whole shark weight on board each vessel at any time.

In 2008, the total amount of retained byproduct was 58 tonnes, which is 6% of the total harvest, representing a decline of 3 tonnes from 61 tonnes retained in 2007.

![Figure 1. Catch and effort for the commercial Barramundi Fishery from 1973 to 2008](image-url)
Effort
There were 24 fully transferable licences in 2008 in the commercial fishery, all of which were fully utilised. Most of these licences were a ‘full 10 unit’ licence (1 unit = 100 m net) and equated to a total of 19 100 m of net. Effort is measured in ‘100 m net days’ (hmnd), where one hmnd equals 100 m of gillnet set for one day.

Current fluctuations in effort are primarily due to weather patterns. For example, a decline in effort was observed in 2005 (25 328 hmnd) when cyclonic activity delayed licensees from commencing operations at the start of the commercial barramundi season.

The distribution of commercial effort has changed significantly over the past 15 years with effort moving away from those areas where commercial activity has been constrained or excluded (e.g. the Mary River Fish Management Zone, Kakadu National Park and the McArthur and Adelaide rivers) to more remote areas, such as Arnhem Land. Rising fuel costs have contributed to a recent increase in the number of operators working the western coast of the Top End in areas such as Anson and Fog bays.

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 excessive commercial fishing effort. Following management changes, the CPUE has steadily increased, reaching 20.8 kg/hmnd in 1998. The 2008 barramundi CPUE was 23.4 kg/hmnd (Figure 3).

In recent years, the 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, where CPUE was as low as 5.0 kg/hmnd. In 2008, CPUE of king threadfin was 12.1 kg/hmnd (Figure 3). Fluctuations in CPUE most likely reflect annual variation in environmental conditions, rather than the level of exploitation.

Marketing
Historically, barramundi and king threadfin have been sold as frozen fillets to local and interstate markets. However, some fishers are now providing barramundi wings and swim bladders, and selling whole barramundi and king threadfin fresh on ice to southern markets.
Figure 3. Catch per unit effort (CPUE) for barramundi and king threadfin in the Barramundi Fishery from 1973 to 2008

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.

The Mary and Daly Rivers, as well as the rivers in Kakadu, are important fishing locations due to their proximity to Darwin. Further south, the Victoria, Roper and McArthur rivers are also well utilised by NT anglers from outside of Darwin and by 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 or live baits. Mullet are the most popular live bait species used in estuaries, while freshwater prawns (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 also 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 58% recorded in the 1995 survey.

Another recreational fishing survey of the NT is scheduled for 2009-10. The results are expected in late 2010.

A specific possession limit of two barramundi applies in the Mary River Fish Management Zone with a limit of five is 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. Fishing for barramundi 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 had declined from 1995 levels to 788,726 hours.

**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 (1995) 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 target barramundi in both salt and freshwater areas, often changing their fishing location according to the season. 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 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 2008, FTO clients caught 48,635 barramundi, representing an increase of 3% on the 2007 FTO catch. According to FTO logbook information, 85% (41,534) of barramundi caught in 2008 were released and 15% (7,101) were retained. Assuming a post-release mortality rate of 10% (de Lestang et al. 2004), the FTO sector would therefore have removed around 11,254 barramundi in 2008.

The proportion of fish released by FTO clients has remained relatively consistent since 1995. FTO clients generally retain a smaller proportion of caught barramundi than do non-guided recreational fishers.

The barramundi catch effort of FTOs has progressively expanded into more areas of the NT since 2000. The most productive areas where barramundi were caught in 2008 were
Arnhem Land, the Mary River system and the Tiwi Islands.

In 2008, FTO clients caught 1877 king threadfin, representing a decline of 11% on the 2007 FTO catch of 3368. According to FTO logbook information, 59% (1106) of king threadfin caught in 2008 were released and 41% (771) were retained. The most productive areas for king threadfin include the Tiwi Islands, the Mary River and Darwin/Bynoe/Dundee area.

**Effort**

In 2008, there was a decline in the number of line hours targeting barramundi from 81 085 in 2007 to 77 893 hours in 2008.

**Catch Rates**

The catch rate for barramundi remained stable from 1995 to 1998 at 0.5 barramundi per hour. From 1998, it gradually increased to 0.8 fish per hour by 2001, but declined to 0.4 fish per hour in 2003. In 2008, the catch rate improved to 0.6 barramundi per hour. These 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 and have significant economic, health and cultural value for this sector. In addition, barramundi also have a high totemic value for some Aboriginal groups.

**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 and 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 quite 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 may be discarded includes catfish, blue threadfin, queenfish, trevally, tripletail and sharks. Bycatch has been noted to increase when nets are set in deep channels rather than in 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.

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, e.g. most of the threadfins were retained, while most catfish were released.

**Threatened Species Interaction**

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

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. In 2008, there were a total of 98 TEP species recorded in the commercial logbooks. Of these, 57 species (58%) were released alive.
Crocodiles were the most common TEP species with 43 (68%) being released alive. There were also 18 recorded interactions with green sawfish. Other TEP species caught in 2008 included eight turtles, four Glyphis species, three freshwater sawfish and two dugongs. Most of these were released alive. No TEP species interactions were recorded by onboard observers during 2008.

The NT Seafood Council has developed an Environmental Management System and associated Code of Practice to assist in minimising the incidental capture of TEP species. In addition, 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 commercial sector of the fishery is restricted to tidal waters, while historically recreational fishers have targeted the freshwater stocks. With improved access and larger boats, recreational fishers are increasingly targeting the same stocks as commercial operators in the tidal reaches of rivers and mudflats.

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 are employed 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, as well as servicing equipment and freighting 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 of equipment from local businesses.

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 food source of some coastal communities but as an important component of indigenous wellbeing.

Economical Impact

At the point of first sale in 2008, the overall catch value for the commercial Barramundi Fishery was $6.24 million. In 2008, the barramundi component was just over $4.77 million with the king threadfin component being approximately $1.27. The value of byproduct sold in 2008 was approximately $0.18 million.

The recreational sector also contributes to the NT’s economy, especially in the service and fishing tackle industries. In 2000, it was estimated that over $26 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. Information provided by recreational fishers is also used.

An observer was present on commercial barramundi boats for nine days in 2008. Of the 224 fish caught during these trips, 23% were barramundi, 16% were queenfish, 10% were sharks, 5% were blue threadfin and 4% were king threadfin. Overall, 20% of the catch was discarded mainly comprising catfish, snub-nose dart and black pomfret. Only three narrow sawfish were caught and all were released alive. The current monitoring program will be modified from 2009 so that it includes annual monitoring trips in all of the major river systems. This will increase the level of information on size structure of target species and catch composition of byproduct and bycatch species to provide more detailed information for stock assessment models.

Stock Assessment Methods and Reliability

The fishery was first assessed using catch and effort data in 1978 and 1979 and has been assessed a number of times since then. The early assessments were not completely successful. Improved knowledge of barramundi genetic stock structure and improved modelling techniques have allowed subsequent models of the fishery to improve their reliability.

Stock assessment models since 2000 have used age structured and biomass dynamic models and the Deriso delay-difference model to assess the barramundi populations of the NT. The Deriso delay-difference model was then enhanced by including a parameter that approximates the total area of suitable habitat for each of the regions assessed, which allows the many different stocks to be modelled independently. The National Barramundi Workshop in 2005, and a follow-up meeting, created a more complex model that allowed the inclusion of a range of variables and enabled predictions of population patterns across many different catchments (Grace et al. 2008). This model is now nearing completion. Given the long and informative time series of catch and effort data available for this fishery, along with a long-term fishery-independent monitoring program and the extensive knowledge of barramundi biology, the stock assessment is considered reliable although the model requires some refinement.

The barramundi population of the NT has largely recovered from the overexploitation of the 1970s and overall the current level of exploitation in all targeted stocks is considered to be sustainable. There is concern about the pressure being placed on particular stocks in the easily-accessible and heavily-fished areas.

Current Harvest Status

No direct estimates of total harvest rate are available for the fishery, but output from the stock assessment model indicates that the overall commercial harvest rate is currently around 10%. This estimate could be verified with increased reporting of tag returns by commercial fishers. The model output also indicates that the total biomass of barramundi is currently at around 85% of un-fished levels. The precision of these estimates is likely to increase with increasing activity in commercial catch monitoring.

None of the trigger reference points were reached during 2008 (See Table 1 for details) 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 fishery Management Plan. These trigger points will then 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 embayments hold separate populations of barramundi within the NT (Shaklee and Salini 1985; Keenan 1994; Pender and Griffin 1996; Chenoweth et al. 1998). Consequently, the current monitoring program needs to be expanded into as many of the major river systems in the NT as possible so that the health of each population can be assessed separately.

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 into the physiological effects and survival of released juvenile barramundi. However, there needs to be research conducted on the lethal and sub-lethal effects of catching and releasing the larger size classes (>90 cm) of barramundi, given that most of them are likely to be females. Specifically, identifying the effects catch and release has on fecundity of large females is important to determine the effects of recreational fishing on barramundi egg production.

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 understood.

Future assessment of the commercial sector of the fishery is needed to meet the NT Government’s 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 any barramundi research between 1974 and 1977. Research recommenced in late 1978 with an assessment of the fishery and 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 a substantial reduction in the numbers of mature fish. The results of this study caused a seasonal closure to be put in place to protect spawning fish accompanied by a reduced recreational bag limit (Griffin 2006).

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

An estimated 823 barramundi were in the 660 m study site in 2008. This was above the long-term average of 767 fish and substantially higher than the 220 fish caught in 2007. Most fish (46%) were less than one year old and were 26 to 40 cm long. The 2008 data continues the alternating trend of year class strength where 2006 had high numbers of new recruits, which in turn resulted in high numbers of one-year-old fish in 2007. These fish
appeared to depress the new recruits in 2007 through either competition or predation. The one-year-old fish from the 2007 recruitment were in low enough numbers not to depress the 2008 recruits.

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 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 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 nets caused less damage to fish skin and fins than more traditional knotted mesh nets (de Lestang et al. in press). Knotless nets are recommended to minimise injuries and increase the chance of post-release survival.

Incorporation into Management

Monitoring of barramundi stocks in the Mary River during 1986 and 1987 provided vital information supporting 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 banning the use of live bait and treble hooks at the Shady Camp Barrage.

The long-term monitoring of the barramundi population at Corroboree Billabong has led to a greatly improved understanding of 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.
- Further development of stock assessment models for barramundi and king threadfin.
- On-board monitoring of the commercial Barramundi Fishery.
- Investigations into how different river flow patterns affect barramundi and king threadfin populations.
- Determining the stock structure of king and blue threadfins – do separate populations exist across northern Australia, or can the species be managed as one continuous stock?
• Post-release survival of line-caught fish.
• Observer trips to quantify interactions with threatened, endangered and protected species.

**MANAGEMENT/GOVERNANCE**

**Management**

**Objective**
Objectives, performance criteria and trigger points for the fishery will be defined as a result of the 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 commercial 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 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 further 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, Finnis River, Daly River and Roper River.

In July 2008, the NT Government announced a voluntary buy-back of Barramundi Fishery licences, with the aim of removing three licences from the fishery and investigating more area closures to commercial barramundi fishing. This should increase the profitability of the remaining commercial licences in the fishery and provide certainty for the sustainability of the industry as well as allow for the future expansion of the recreational fishery.

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 (e.g. saltwater intrusion in the Mary River catchment) and minimising interactions with TEP species.

**Future Plans**
There are future plans to buy-back more commercial licences from the fishery.

It is also proposed that a Fishery Management Advisory Committee for the fishery be re-established to provide ongoing advice with respect to barramundi management. This will include advice on strategic direction and management objectives for the fishery, future directions for recreational and commercial fisheries management and amendments to the Barramundi Fishery Management Plan. Any Management Advisory Committee for the fishery will be made up of representatives from key stakeholder groups and government representatives.

The results of the proposed recreational fishing survey of the NT 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 Police, Marine and Fisheries Enforcement Section of the NT Police, Fire and Emergency Services, under the NT Fisheries Act 1988. Major issues of concern during 2008 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, the Amateur Fishermen’s Association of the NT and the Guided Fishing Industry Association of the NT, are consulted on matters relating to the sustainable management of the fishery.

A series of Aboriginal Consultative Committees have been formed to enable DoR 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 undergo 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.

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

**REFERENCES**


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**Table 1.** Management objectives, performance indicators, trigger points and management actions used in the Barramundi Fishery

<table>
<thead>
<tr>
<th>Species or Group</th>
<th>Management Objective</th>
<th>Performance Indicator</th>
<th>Performance measure</th>
<th>Harvest Status for 2008</th>
<th>Management action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target species barramundi, king threadfin</td>
<td>To maintain the sustainability of the barramundi resource.</td>
<td>Significant decline in the annual catch or a significant increase in fishing effort.</td>
<td>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.</td>
<td>Barramundi catch decreased by 24% in 2007 then increased by 30% in 2008 - trigger reference point not reached. King threadfin catch increased by 6% in 2007 then decreased by 7% in 2008 – trigger reference point not reached.</td>
<td>Stakeholders to make recommendations to the Director of Fisheries regarding appropriate remedial action. Amended arrangements to be implemented within 12 months of trigger being reached.</td>
</tr>
</tbody>
</table>

<p>| 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. | Stakeholders to make recommendations to the Director of Fisheries regarding appropriate remedial action. Amended arrangements to be implemented within 12 months of trigger being reached. |</p>
<table>
<thead>
<tr>
<th>Species or Group</th>
<th>Management Objective</th>
<th>Performance Indicator</th>
<th>Performance measure</th>
<th>Harvest Status for 2008</th>
<th>Management action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target species barramundi</td>
<td>Maintain and enhance quality fishing experiences for recreational fishers into the future.</td>
<td>A significant number of recreational fishers or FTO clients do not enjoy their barramundi fishing experience.</td>
<td>If more than 20% of participants in stakeholder fishing surveys or FTO clients state that they are unsatisfied with their barramundi fishing experience.</td>
<td>Stakeholders to make recommendations to the Director of Fisheries regarding appropriate remedial action. Amended arrangements to be implemented within 12 months of trigger being reached.</td>
<td></td>
</tr>
<tr>
<td>Byproduct species jewelfish, shark (all), reef fish, sand bass, snappers, queenfish, blue threadfin, grunt</td>
<td>Ensure ecological sustainability of byproduct species.</td>
<td>Monitoring of commercial logbook returns and onboard monitoring of commercial vessels.</td>
<td>If any byproduct species increases or decreases by 50% for each year for two consecutive years.</td>
<td>Catches for all byproduct species remained within trigger point limits—trigger reference point not reached. Stakeholders to make recommendations to the Director of Fisheries regarding appropriate remedial action. Amended arrangements to be implemented within 12 months of trigger being reached.</td>
<td></td>
</tr>
<tr>
<td>Bycatch species</td>
<td>Ensure ecological sustainability of bycatch species.</td>
<td>Monitoring of commercial logbook returns and onboard monitoring of commercial vessels.</td>
<td>If bycatch species increase by more than 50% in any year for two consecutive years.</td>
<td>Bycatch remained within trigger point limits—trigger reference point not reached. Stakeholders to make recommendations to the Director of Fisheries regarding appropriate remedial action. Amended arrangements to be implemented within 12 months of trigger being reached.</td>
<td></td>
</tr>
<tr>
<td>Endangered, threatened or protected species and/or communities</td>
<td>Ensure the continued protection of species and communities listed under EPBC Act and as listed under the Territory Parks and Wildlife Conservation Act 2001.</td>
<td>Identifiable impacts observed by commercial fishers, fisheries observers or other agencies regarding EPBC Act listed species or communities.</td>
<td>There were no identifiable impacts observed on EPBC Act listed species or communities – trigger reference point not reached.</td>
<td>Stakeholders to make recommendations to the Director of Fisheries regarding the implementation of a threat abatement plan, if required. Amended arrangements to be implemented within 12 months of trigger being reached.</td>
<td></td>
</tr>
<tr>
<td>Ecosystem components</td>
<td>Minimise effects on ecosystem components.</td>
<td>Identification of threatening processes.</td>
<td>Identification of significant negative interaction with components of the natural ecosystem.</td>
<td>There were no significant negative interactions within the ecosystem where the barramundi fishery occurs—trigger reference point not reached. Stakeholders to make recommendations to the Director of Fisheries regarding appropriate remedial action. Amended arrangements to be implemented within 12 months of trigger being reached.</td>
<td></td>
</tr>
</tbody>
</table>
**INTRODUCTION**

The Coastal Line Fishery operates in the near shore waters of the NT and harvests a wide range of species using a variety of gear. The commercial sector began as a lifestyle fishery, but has now developed into a professional industry. Commercial operators primarily target black jewfish (*Protonibea diacanthus*) as well as a range of other reef fish, such as snapper, emperor and cod.

There is considerable overlap in the range of species harvested by commercial, recreational and indigenous fishers as well as Fishing Tour Operators (FTOs). Conservative estimates suggest that the recreational harvest of jewfish, snapper and emperor alone surpasses the total commercial take. The indigenous and FTO harvest is also significant. This being the case, the primary management objective of the fishery is to ensure 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.

The use of different fishing gear was reported for the first time in 2002, with drop lines and traps adopted by a small number of operators. Vertical lines and drop lines were both used in the fishery in 2008, with vertical lines being the preferred method.

**Catch**

The total reported catch for the fishery in 2008 was 205 tonnes (214 tonnes in 2007), a decline from the peak catch of 311 tonnes in 2004. Historical data shows 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, ranging between 85 and 87% of the total catch for the fishery over the last three years. Over the same period, the catch of golden snapper as a proportion of the total catch declined from an average of around 16%, to 3% in 2008.

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

**Effort**

The number of active licences varies each year. In 2008, there were 23 licences active in the fishery, compared with 24 active licences in 2007 and 22 in 2006.

The 2008 Coastal Line Fishery Status Report differs from previous years in that fishing effort (for the hand line only component of the fishery) is reported as ‘hook hours’ (rather than ‘hook days’). This is the product of the number of lines used by the number of hooks per line by grid hours fished (per trip) summed for the entire year. Hook hours is a more accurate measure of effort for this fishery.
Figure 2 shows the catch and effort totals for the hand line-only component of the coastal line catch. Note that due to confidentiality constraints (i.e. less than five active licensees) the drop line and trap components of the fishery are not displayed. Fishing effort (for the hand line-only component of this fishery) has fluctuated between ~ 6 000 hook hours and ~11 000 hook hours over the last decade, the 2008 figure being 10 113 hook hours.

**Figure 1.** Catch composition (tonnes) for the hand line-only component of the Coastal Line Fishery, 1999-2008

**Figure 2.** Catch (tonnes), effort (hook hours) and CPUE (kg/hook hr) for the hand line-only component of the Coastal Line Fishery, 1999-2008
**Catch Rates**

The catch per unit effort (CPUE) for the hand line-only component of the fishery steadily increased from 18.0 kg/hook hour in 2003 to 39 kg/hook hour in 2006 (Figure 2). It has since declined to 20.2 kg/hook hour in 2008. This decline may indicate some level of stock depletion.

CPUE should not be used as an estimate of abundance for aggregating species such as black jewfish (which constitutes the bulk of the commercial harvest) as catch rates for this species can remain high until the last fish is caught. That is, once catch decreases at one site, an operator is likely to move to another site to maintain high catches.

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 ensure annual catches for all sectors remain sustainable.

**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 the 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. The Darwin area supported 31% of the total NT recreational fishing catch in 2000-01.

**Fishing Method**

A variety of fishing gear is used by the recreational sector of the fishery. Most fishing is by line (84%), with the use of lures and bait equally popular. Over 75% of the time spent fishing in the NT takes place from a boat.

**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 snapper and Spanish flag (stripeys) accounted for the largest portion of the harvest, estimated at 68 000 and 22 000, respectively (Henry and Lyle 2003; Coleman 2004). 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.

In 1995, most of the fishing effort for reef fish and ‘non-specific target’ fishing 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 FTOs operate around Darwin, Fenton Patches, Bynoe Harbour, Fog Bay to Point Blaze and 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 for 95% of their time spent reef fishing.

**Catch**

Logbook data for 2008 reveals that the FTO sector catch and release large numbers of coastal fish, most notably: Spanish flag (18,041 landed; 71% released), golden snapper (16,793 landed; 57% released), trevally (11,513 landed; 93% released), saddletail snapper (10,926 landed; 67% released), tricky snapper (10,728 landed; 62% released), and cod (10,482 landed; 83% released). These numbers were exceeded only by the number of barramundi landed.

**Effort**

For the past two years, FTOs have spent more time targeting reef fish than barramundi (whereas the opposite is usually the case). This type of fishing activity accounted for 97,313 hours fished by FTO clients in 2008, an increase of about 8% over 2007. The growth in activity may be attributed to a slight increase in client numbers since 2007. Reef fishing effort has steadily increased since 1995, with total reef fishing line hours in 2008 over seven times those recorded in 1995.

**Indigenous Sector**

**Area**

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

**Fishing Method**

NRIFS of 2001 revealed that over 90% of all indigenous fishing in the NT was shore-based, with half 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 harvest species included catfish (60,000), snapper (27,500), shark and rays (12,000), salmon (8,500) and trevally (8,000).

**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 licensees have, at the request of the Offshore Net and Line Fishery Licensee Committee, accepted shark limits being introduced 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 essentially a subsistence activity.

**Threatened Species Interaction**

In 2008, there were no reported interactions with threatened, endangered or protected (TEP) species. 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 this type of fishing combined with negligible physical damage to the benthos means that this fishery has minimal impact on the ecosystem.
Social Impact

In 2008, there were 23 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 2008, the catch value of the commercial sector of the fishery was $0.5 million ($0.6 million in 2007). The jewfish component was $0.43 million (in 2007, $0.52 million) and golden snapper was $31,610 (in 2007, $31,000).

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

STOCK ASSESSMENT

Monitoring

Catch and effort trends in the commercial sector and fishing tour sector are monitored through analysis of logbook data submitted by fishers on a monthly basis as a condition of the licence.

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 not heavily utilised, there were signs of sequential, localised depletion of coastal fish stocks, particularly around major population centres.

Using the limited data available (commercial coastal line catch and effort data and preliminary biological information), an annual catch estimate of 100 to 1000 tonnes was made. Since then, estimates of recreational catch have been released. The total harvest from the fishery by all sectors, including the indigenous fishing component, is moving toward the upper estimate of the original stock assessment.

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 broader 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. In addition to monthly catch returns and targeted research, a fin size monitoring program (where fish size is estimated from pectoral fin length – see Research Section) involving commercial fishers (and other sectors if the technique is found practical) would offer a valuable and cost-effective means of describing the size structure of fish stocks harvested by the fishery. Such a program may be trialled in future.

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 percent of females reach sexual maturity at 63 cm (eight to ten years
Coastal Line Fishery

old). Males reach maturity at a smaller size, with 50% maturing at 47 cm. The oldest golden snapper sampled was 23 years old with a fork length of 82 cm.

Tricky snappers 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 the black jewfish. The key findings of these 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 percent 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 of 44 black jewfish at aggregation sites at Chambers Bay and Channel Point in 2006. These 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 black jewfish are highly susceptible to barotrauma, showing a range of conditions. These include haemorrhage and exophthalmos of eyes, hyperinflation or rupturing of the swim bladder (as a consequence of hyperinflation), displacement and damage to visceral organs and damage to the circulatory system.

Black jewfish landed from less than 10 m water depth showed few signs of barotrauma and were likely to survive if released. Forty six percent and 100% of black jewfish landed from 10-15 m and 15-20 m, 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.

Morphometric Study
Comparisons of 108 black jewfish total length and fin length data showed that there was a positive correlation between fish length and the length of several fins, especially the pectoral fin. This enables researchers to estimate the length of a black jewfish from its fins.

The findings of the abovementioned research are presented in greater detail in an FRDC final report (Phelan 2008).
Incorporation into Management

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

Current Research

A survey of recreational fishing in the NT will commence in 2009. It will quantify resident and visitor catch, harvest, effort and expenditure. Size distribution data of key recreational species (such as black jewfish) will also be collected. Applications to external funding bodies to support research on the impacts of fishing by all sectors of the fishery will continue to be submitted.

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, and which optimises the benefit to the NT community now and in the future.

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. Those Demersal Fishery licensees who did not already hold a Coastal Line licence were issued one, leading to the creation of 26 additional licences. This measure was accompanied by a two-for-one licence reduction scheme that allowed for the transfer of Coastal Line licences but also removed excess fishing capacity. At present, there are 54 Coastal Line licences. At the completion of the licence reduction scheme (in its current form), there will be a maximum of 45 fully transferable licences and one restricted licence.

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

Black jewfish form large spatially and temporally-predictable aggregations and as such, are vulnerable to over-fishing. Both interstate and overseas research shows that target fishing aggregations of this species can rapidly deplete stocks. Although recent research indicates that NT jewfish stocks are generally in good condition, there are concerns about particular aggregation sites. The Coastal Line Fishery Management Advisory Committee (CLFMAC) was re-established in 2008 to examine such issues and develop a long-term management strategy for the fishery.

Whilst the total catch of the recreational fishery probably exceeds the commercial catch, personal possession limits are in place to help regulate the impact of this sector. At present, recreational fishers may take no more than five black jewfish and five golden snapper (as part of the general possession limit of 30 fish per
person). As a precautionary measure, a reduction in the recreational possession limit for jewfish is proposed.

**Future Plans**
Ensuring that the harvest of coastal fish by all sectors is sustainable remains a primary management objective. A review of existing management arrangements will be undertaken in 2009.

**Compliance**
The Police, Marine and Fisheries Enforcement Section of the NT Police, Fire and Emergency Services is responsible for all fisheries compliance and enforcement in the NT. The Fishwatch toll-free number has become an increasingly popular mechanism for the public to provide information on suspicious fishing activity.

There have been few reported problems with compliance in the fishery. The major 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 the Amateur Fishermen’s Association of the NT 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 was re-established in 2008 and is a forum for key stakeholder groups to provide advice to government on management strategies and research for the fishery.

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

**REFERENCES**


INTRODUCTION

The Coastal Net Fishery operates within the inshore ≤ 3 nautical miles (nm) coastal waters of the Northern Territory (NT) and harvests over 40 species. Of these, mullet, blue salmon, shark and queenfish form the bulk of the catch. Commercial operators are not permitted to retain barramundi, king threadfin, Spanish mackerel or mud crabs. They are also required to clear their nets in not less than 30 cm of water to facilitate the release of bycatch.

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

In the past, a number of Development Fishery - Coastal Net Fishery licences were issued to allow for the development of commercial fishing in remote areas outside of the designated fishery area. Currently, there are two of these licences. No further licences will be issued whilst the management arrangements governing the fishery are finalised.

Recreational and indigenous fishers are permitted to use drag nets to take fish for subsistence purposes without the need for a licence. These fishers often target the same species and operate in the same areas as commercial licensees.

The removal of current and potential commercial effort in the fishery through the voluntary licence buy-back scheme, in conjunction with associated area closures, has reduced the potential for sectoral conflict between commercial and recreational fishers.

PROFILE OF THE FISHERY

Commercial Sector

Area

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

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

Development Fishery - Coastal Net Fishery licences have been issued for areas near Numayanga and Galiwinku. 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. Licensees are also permitted to use a cast net with a diameter not more than 6 m and mesh size not exceeding 25 mm. On the grounds of 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 2008 was 14.1 tonnes, a decline from 34.4 tonnes in 2007 and 47.7 tonnes in 2006 (Figure 1). The fishery averaged around 34 tonnes per year between 1998 and 2007, typically fluctuating between 25 and 35 tonnes per annum. Landings peaked in 2001 to 53.9 tonnes.
Much of the inter-annual variation in catch, effort and catch rate is likely due to the fact that the small number of Coastal Net licensees hold multiple licences, often for other fisheries. As such, fishers tend to alternate between different fisheries depending on factors such as catch rates and market demand. The recent reduction in licence numbers in the fishery has also contributed to the decrease in reported catch and effort.

Over 40 species are retained by the commercial fishery, with mullet, blue salmon, shark and queen fish accounting for the majority of the catch. Other common species include garfish, snappers, and whiting. Commercial licence holders are not permitted to retain barramundi, king threadfin, Spanish mackerel or mud crab.

**Effort**

All five licences were active in 2008.

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 2008 was 287 hmnd, a significant decline from 601 hmnd (previously reported as 533 hmnd) recorded in 2007 and 1464 hmnd in 2006.

**Catch Rates**

The catch per unit effort (CPUE) for the fishery has averaged 42.8 kg/hmnd since 1998. The CPUE in 2008 was 44.0 kg/hmnd, a decline from the 56.4 kg/hmnd reported in 2007 but an increase on the 2006 figure of 32.5 kg/hmnd.

**Marketing**

Most of the fish is sold fresh on ice as fillets, whole, or gilled and gutted. 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 human consumption.

The use of such 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 National Recreational Fishing Survey: the Northern Territory (NRFSNT) conducted in 2000-01, estimated that the total soak time for recreational nets set in NT waters was close to 10 000 hours.

Catch
Many of the key species harvested by the commercial fishery also form an important component of the recreational fishery of the NT. Results from NRFSNT indicated that mullet and salmon are 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 for human consumption or is utilised as bait. However, the survey indicated that almost half of the recreational line fishing effort in the NT uses bait.

Fishing Tour Operator Sector
Area
In 2008, Fishing Tour Operators (FTOs) operated throughout the coastal waters of the NT but most were concentrated in and around the Darwin area.

Fishing Method
Although FTO clients are permitted to use amateur drag nets (as per 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 scattered 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 the results of National Recreational and Indigenous Fishing Survey of 2000-01 and logbook return information from the fishery suggests a significant overlap of the harvest of primary species by both sectors.

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), snapper (27 500), shark (12 000), salmon (8500) and trevally (8000).

Non-retained Species
Licensees are prohibited from retaining barramundi, king threadfin, Spanish mackerel or mud crabs. Operators are required to clear their nets in not less than 30 cm of water to facilitate the release of any bycatch of these or other species.

Threatened Species Interaction
Fisheries regulations prohibit the take of aquatic life listed as protected under the Territory Parks and Wildlife Conservation Act 1976. Species vulnerable to capture by the fishery include dugong, turtles and crocodiles. However, the risk of interaction with these species is managed through the requirement for all
licensees to attend their nets whilst set in the water. Nets may only use such gear as a haul or surrounding net, and gillnet operators are required to remain within 500 m of a net when set. In 2008, there were no reported interactions with threatened, endangered and protected (TEP) species.

**Ecosystem Impact**

There is a lack of information regarding the direct impact of the fishery on the marine environment. However, the relatively low level of fishing effort combined with negligible physical damage to the benthos means that this fishery is considered to have a minimal impact on the ecosystem.

**Social Impact**

Five licences were active in 2008 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 2008, the commercial sector of the fishery was valued at $69,962. This is a decline from $134,294 in 2007. The mullet component was $41,265.

**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 on this fishery, primarily because of its small size and wide range of species harvested.

**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 desk-top 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**

Research being undertaken in Queensland and Western Australia on tropical coastal species may be of relevance to this fishery.
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 and 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 upon the implementation of the NT Fisheries Regulations. At this transition point, licences were offered to only those persons who held an existing Special Purpose (Haul Net) Fishery licence, or a Bait Fishery licence. At that time, there were four Special Purpose (Haul Net) Fishery licences (one remains current as a Coastal Net Fishery licence), and almost 60 Bait Net Fishery licences (four remain current as Coastal Net Fishery licences and two as Bait Net Fishery licences).

Following an announcement by the then NT Government in mid 2000 that Darwin Harbour and Shoal Bay would be closed to the fishery, a review of the management arrangements for the fishery along with the Bait Net, Development Bait Net and Aboriginal Coastal Net Fisheries was undertaken. Future management options were developed aimed at minimising conflict between these fisheries and the recreational fishing sector, as well as to reduce commercial fishing pressure on coastal fish stocks by inshore net fisheries adjacent to Darwin.

In February 2006, the NT Government announced a voluntary buy-back of licences from the Coastal Net Fishery.

Current Issues
Nine out of a total of 14 licences were bought back and removed from the fishery.

Darwin Harbour and Shoal Bay were closed to Coastal Net Fishery licensees in early 2008.

Future Plans
Following completion of the voluntary licence buy-back process and associated area closures, further consideration is being given to future management options for the fishery.

Compliance
The Police, Marine and Fisheries Enforcement Section of the NT Police, Fire and Emergency Service 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 an ongoing 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 regular, ongoing 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
REFERENCES


INTRODUCTION

The Demersal Fishery extends between 15 nautical miles (nm) to the outer edge of the Australian Fishing Zone (AFZ), excluding the waters of the Timor Reef Fishery. The catch is comprised mainly of goldband snappers (*Pristipomoides multidens*) and red snappers (*Lutjanus malabaricus, L. erythropterus*). Red emperors (*Lutjanus 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 increased in 2008 as many Timor Reef fishers (who also hold Demersal licences) continued fishing grounds immediately adjacent to the Timor Reef Fishery area for goldband and red snapper species.

Most fish taken by the Demersal Fishery licensees were marketed as ‘fresh on ice’ product with most sold as whole fish on the Australian domestic market.

Red snappers and red emperors were also caught by the recreational and fishing tour operator sectors, primarily by hook and line. However, there was limited overlap with commercial operators given the offshore nature of the fishery.

The fishery has been assessed by the Department of Environment, Water, Heritage and the Arts (DEWHA) against the Guidelines for the Ecologically Sustainable Management of Fisheries to receive full Export Exempt accreditation under the *Environment Protection and Biodiversity Conservation Act* (the EPBC Act). The fishery was due for reassessment in May 2009.

PROFILE OF THE FISHERY

Commercial Sector

**Area**

The fishery operates in waters from 15 nm from the coastal baseline to the outer limit of 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](image)

**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 to be used in the Timor Reef Fishery.
**Catch**

There are two principal target groups in the fishery: goldband snappers and red snappers. There are three goldband snapper species, *Pristipomoides multidens*, *P. typus* and *P. filamentosus*. Together they made up 52% of the total catch in 2008, with *P. multidens* being the most common.

The other major target group, red snappers, are made up of saddletail snappers (*Lutjanus malabaricus*) and red snapper (*L. erythropterus*), and constituted 40% of the catch in 2008.

Byproduct species are red emperor (*L. sebae*), and to a lesser extent, cod (Family Serranidae) (Figure 2).

The species composition of the catch is gear-dependent. That is, operators using drop lines tend to catch a higher proportion of goldband snapper. Comparatively, those operators using baited traps tend to catch almost equal proportions of red snappers (*L. malabaricus*, *L. erythropterus*) and goldband snapper (*P. multidens*). In 2008, more operators in the fishery used traps than drop lines.

The total commercial catch from the fishery in 2008 was 268 tonnes, representing a decline of 62 tonnes from 330 tonnes in 2007. The goldband snapper component was 140 tonnes compared with 153 tonnes in 2007 and red snapper 106 tonnes compared with 155 tonnes in 2007.

![Figure 2. Overall catch composition of the Demersal Fishery for 2008](image)

**Byproduct Species**

Byproduct catch (comprising mixed reef fish, cod and red emperor) accounts for 8% of the total catch, which is below the 10% trigger value required for a review of management arrangements for the protection of byproduct species.

**Effort**

There were eight active licences which fished 344 boat days in the fishery in 2008. In comparison, there were eight active licences in 2007, which fished a total of 297 boat days (Figure 3). This increase in effort could be a result of business decisions by operators to search for new grounds in this developing fishery.

**Catch Rates**

Catch per unit effort (CPUE) has fluctuated considerably over the history of this fishery (Figure 4). This is probably a reflection of the small number of operators and small amount of fishing activity rather than changes in fish abundance. The recent increase in catch rate (since 2006) is most likely due to the greater understanding by operators of the nature of the fishing grounds.
Figure 3. Catch and effort for the Demersal Fishery, 1995 to 2008*

* 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 CPUE for the commercial Demersal Fishery, 1995 to 2008*

* 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 all fish landed within the line and trap fisheries are sold “fresh on ice” as whole fish, 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 catch some of the same species targeted by commercial operators, particularly red snapper and red emperor, from inshore waters. The overlap is considered negligible.

**Fishing Tour Operator Sector**

Very few Fishing Tour Operators (FTOs) are active in the offshore areas typically fished by commercial operators.

**Non-retained Species**

One monitoring trip was conducted in the fishery during 2008. The fishing methods, gear, fishing grounds and catch composition in the fishery were found to be similar to those of the Timor Reef Fishery. Non-retained species were less than 4% of the total catch and consisted mainly of catfish (*Arius thalassinus*), which made up more than 64% of the bycatch. The remainder of the non-retained catch included eight elasmobranchs (4% of the bycatch), eels and various invertebrates (crabs and urchins). Bycatch in this fishery is well below the 10% trigger value.

**Threatened Species Interaction**

In 2008, 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 the 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. 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 25 people as crew on boats and numerous people through other industries, such as transport and boat repairs. Recreational fishermen and FTOs target some of these demersal species.

**Economic Impact**

The fishery was valued at $1.69 million, a slight decline from $1.94 million in 2007. This is likely to be a reflection of the decline in catch in 2008 compared with 2007.

**STOCK ASSESSMENT**

**Monitoring**

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

One monitoring trip was conducted in the fishery during 2008. This trip confirmed the similarity in methods, fishing grounds and catch
composition with the Timor Reef Fishery. This enables observer data from the Timor Reef Fishery to also be applied to the management of the Demersal Fishery.

**Stock Assessment Methods and Reliability**

An assessment of goldband 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).

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 for the fishery (Ramm 1997).

A further stock assessment of goldband snapper was undertaken 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. This stock assessment indicated that a lack 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 goldband snapper.

Genetic studies conducted as part of an Australian Centre for International Agricultural Research (ACIAR) project provide some evidence that separate stocks of *L. malabaricus* exist between Australia and Indonesia, but that it is 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.

**Current Harvest Status**

The most recent stock assessments of tropical snappers indicate that current catch levels in Australian waters of the Arafura Sea are below triggers set for a review of management arrangements. The combined harvest of red snappers, from both the Demersal Fishery and Finfish Trawl Fishery, was just less than 950 tonnes, which is well below the lowest limit for sustainable harvest.

**Future Assessment Needs**

Future assessment will concentrate on updating stock assessments for both goldband snapper and red snapper in the Arafura Sea. Red snapper (both *L. malabaricus* and *L. erythropterus*) assessment needs are being addressed at a national level through the Northern Australian Fisheries Management forum and the Northern Management and Science Working Group.

A collaborative project led by Queensland’s Primary Industries and Fisheries will commence in 2009 to assess the capability of using current monitoring and logbook datasets, identify critical indicators and develop a monitoring program to provide fishery-independent data for red snapper stock assessment.

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 target species (goldband and red snapper).
**RESEARCH**

**Summary**

Geographic Information System (GIS) spatial statistical methods have shown that there is a relationship between bathymetry and geomorphology and high catches of goldband snapper. Although this work (FRDC project 2005/047), was undertaken in the Timor Reef Fishery, there are implications for the fishery. Although the fishery has a smaller catch than the Timor Reef Fishery, 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 goldband snapper (*P. multidens*) has been determined through a number of externally-funded projects (Ovenden et al. 2000; Newman et al. 2000) and red snapper biology, life history and sustainability has been investigated in an ACIAR project FIS/1997/165 (Salini et al. 2006; Blaber et al. 2005 and also available on the ACIAR web site: www.aciar.gov.au).

**Incorporation into Management**

Research findings to date suggest that the current harvest levels are appropriate for the ecologically sustainable development of the fishery. Collaboration with Queensland, Western Australia and Indonesia will continue over the management of tropical stocks.

**Current Research**

Current research is focused on developing a holistic approach to fisheries management using geospatial statistics and fuzzy logic rule-based modelling (FRDC project 2005/047). This work explores new ways of incorporating the very diverse forms of physical and environmental data (often on different spatial scales), with catch and effort data. The project has enabled an analysis of the many components that may affect fish abundance and catchability in a geo-referenced framework. The fuzzy rule-based modelling allows the uncertainties of human knowledge to be captured as hard data. The final report on this work is expected to be available in 2009.

A research project to identify juvenile red snapper nursery grounds is being conducted. At present, a pilot project is being conducted in collaboration with the Groote Eylandt Marine Rangers.

Some operators in the fishery are currently undertaking gear trials to ascertain the feasibility and viability of long lines and trotlines in this fishery. Bait collection methods are also being trialled.

**MANAGEMENT/GOVERNANCE**

**Management**

**Objective**

The overall management objective for the fishery is to maintain catches of goldband snapper and red snapper by all sectors within acceptable ranges. Should landings of these species from the Timor and Arafura Seas, and 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 Commonwealth Governments jointly manage the fishery through the NT Fisheries Joint Authority (NTJFA). 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 and encouraging operators to fish in the entire fishery area in an ecologically sustainable manner continues 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 poorly understood. The NT Government continues to work with the Commonwealth Government to ensure appropriate measures are applied to mitigate the IUU impact 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. This led to government informing fishers in 2006 that it was exploring mechanisms to rationalise the latent licence effort in the fishery, securing goldband snapper grounds for non-trawl fishing methods and expand the Finfish Trawl Fishery.

**Future Plans**

During 2008, stakeholders and interested parties were asked to comment on the following alternative proposal to facilitate the development of the offshore snapper fisheries. This proposal incorporated:

- An agreement for the Trawl and Demersal Fisheries to be managed within a quota management framework
- The allocation of units of entitlement (individually transferable quota) to existing licences in the Finfish, Trawl and Demersal Fisheries.
- The excision of the goldband habitat area from the Finfish Trawl Fishery and inclusion of similar-sized new grounds into the Finfish Trawl Fishery. This will require liaison with other fisheries including those managed by the Commonwealth Government.
- An expression of interest process for the issue of a second Finfish Trawl licence. This would be conducted on the basis that the successful applicant (as assessed against a range of environmental, economic and technical criteria) would need to acquire a specified minimum holding of quota to enable them to operate in the Finfish Trawl Fishery.

The closing period for comments ends in early 2009.

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

**Compliance**

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

Vessel arrivals and departures are inspected at the Port of Darwin, which is the only catch landing point 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 2008, 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 staff 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 puts out publications in the form of Fishery Reports, Fishnotes and newsletters to inform and educate stakeholders.

Senior Research Scientist – Dr Julie Martin
Aquatic Resource Management Officer – Mr David McKey

REFERENCES


### Table 1. Management objectives, performance indicators, trigger points and management actions used in the Demersal Fishery

<table>
<thead>
<tr>
<th>Species or Group</th>
<th>Management objectives</th>
<th>Performance indicator</th>
<th>Trigger reference point</th>
<th>Current status review</th>
<th>Management response to be taken</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goldband snappers</td>
<td>Ensure inter-generational equity by maintaining ecologically sustainable annual catches in all sectors.</td>
<td>Optimal sustainable yield estimates.</td>
<td>Catch levels increase to 90% of estimated sustainable annual yield.</td>
<td>Goldband snapper catches in 2008 were 140 tonnes (153 tonnes in 2007). Trigger reference point not exceeded.</td>
<td>DFMAC to review fishery and make recommendations to the Director of Fisheries regarding appropriate measures to ensure annual catches do not exceed estimated sustainable yields and onboard monitoring if not already in place, to commence at earliest practical opportunity. Amended arrangements to be implemented within 12 months of trigger being released.</td>
</tr>
<tr>
<td>Red snappers</td>
<td>Optimal sustainable yield estimates met.</td>
<td>Monitoring of commercial logbook returns. Significant change in catch composition on Demersal Fishery grounds.</td>
<td>Annual catch increase in proportion of the total catch by greater than 10% above the 5 year average.</td>
<td>Combined red snapper catches in 2008 was 106 tonnes (55 tonnes in 2007). Trigger reference point not exceeded.</td>
<td>DFMAC to review fishery and make recommendations to the Director of Fisheries and onboard monitoring to commence at earliest practical opportunity. Amended arrangements to be implemented within 12 months of trigger being released.</td>
</tr>
<tr>
<td>Byproduct species (including red emperor and cods).</td>
<td>Ensure sustainability of by-product species taken in the Demersal Fishery.</td>
<td>Monitoring of commercial logbook returns. Significant change in catch composition on Demersal Fishery grounds.</td>
<td>Annual catch increase in proportion of the total catch by greater than 10% above the 5 year average.</td>
<td>Combined by-product species in 2008 was 22 tonnes. Trigger reference point not exceeded.</td>
<td>DFMAC to review fishery and make recommendations to the Director of Fisheries and onboard monitoring to commence at earliest practical opportunity. Amended arrangements to be implemented within 12 months of trigger being released.</td>
</tr>
<tr>
<td>Bycatch species</td>
<td>Ensure sustainability of bycatch species taken in the Demersal Fishery.</td>
<td>Onboard monitoring of the adjacent Timor Reef Fishery.</td>
<td>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.</td>
<td>2008: 3% on-board monitoring to continue annually. Trigger reference point not exceeded.</td>
<td>DFMAC to make recommendations to the Director of Fisheries regarding appropriate remedial action and onboard monitoring to commence at earliest practical opportunity. Amended arrangements to be implemented within 12 months of trigger being released.</td>
</tr>
<tr>
<td>Endangered, threatened or protected species and/or communities.</td>
<td>Maintain present level of interaction between demersal fishing operations and species and communities listed under the EPBC Act 1999.</td>
<td>Endangered, threatened or protected species and/or communities are identified in Northern Territory waters.</td>
<td>Identifiable impacts observed by commercial fishers, fisheries observers or other agencies regarding EPBC listed species or communities.</td>
<td>No identifiable impacts observed in 2008. Trigger reference point not exceeded.</td>
<td>DFMAC to make recommendations to the Director of Fisheries regarding appropriate threat abatement plan implemented and onboard monitoring to commence at earliest practical opportunity. Amended arrangements to be implemented within 12 months of trigger being released.</td>
</tr>
<tr>
<td>Species or Group</td>
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<tr>
<td>Ecosystem components.</td>
<td>Minimise the effects of fishing on ecosystem components.</td>
<td>Identification of threatening processes.</td>
<td>Identification of significant negative interaction with components of the natural ecosystem present on demersal fishing grounds.</td>
<td>No negative ecosystem interactions identified in 2008. Trigger reference point not exceeded.</td>
<td>DFMAC to make recommendations to the Director of Fisheries regarding appropriate remedial action. Amended arrangements to be implemented within 12 months of trigger being released.</td>
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**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 2008. Trigger reference point not exceeded.**
- **DFMAC to make recommendations to the Director of Fisheries regarding appropriate remedial action. Amended arrangements to be implemented within 12 months of trigger being released.**
**INTRODUCTION**

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

The administration of Development Fisheries was previously guided by the Policy for the Appraisal and Administration of Northern Territory (NT) Development Fishery Applications. The process for assessing applications for the Development Fishery is currently under review.

**DEVELOPMENT PERMITS**

In 2008, six development permits were issued. One permit was issued to trial the use of crab pots to harvest blue swimmer crabs, two permits were issued to trial the harvest of jellyfish using scoop nets and three permits were issued to trial the use of long line and trotline fishing gear in the Demersal Fishery.

Due to the low number of operators in the fisheries, confidentiality constraints prohibit the release of catch information. In general, activity under the development permits issued in 2008 was minimal.

**DEVELOPMENT LICENCES**

In 2008, two Development Fishery licences were issued, one to trial the harvest of squid and bait fish using a lift net and another issued to trial the use of a small purse-seine net also for harvesting bait fish.

The development of a local, ecologically-sustainable bait fishing industry, which could supply bait for use by all fishery sectors, would be advantageous to the NT. Most of the bait products currently sold in the NT are imported from interstate and overseas.

**Fishing Method**

A lift net is a horizontal net that is lowered to the bottom, left in place, and then lifted rapidly to the surface. The purse seine method of fishing involves surrounding a school of fish with a wall of net and then pulling the bottom together to form a purse or pouch around the fish.

**Catch**

Confidentiality constraints preclude specific catch data for the two development licences issued in 2008 to be published. However, the composition of catch harvested by Development Fishery licensees is shown in Figure 1. The catch was made up primarily of pilchard, herring and sardines (86%). Other byproduct species (large mouth mackerel, mixed fish and squid) represented 19% of the total catch taken in 2008.

![Figure 1. Species composition harvested by the squid and bait development fishery licensee](image-url)
Non-retained Species

A small number of mackerel comprising Spanish mackerel, grey mackerel, spotted mackerel and unidentified mackerel were taken during 2008. A small number of blacktip sharks and cod were also taken.

There was one reported interaction with a small turtle, which was returned to the water alive.

The impact on the ecosystem by the proposed development trials is considered when assessing an application for a licence.

Ecosystem Impact

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.

MANAGEMENT/GOVERNANCE

The appropriateness of the equipment and methods are governed by the conditions of the permit or licence. These 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 – Ms Rachael Davies
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 NT Fisheries Joint Authority, through the NT Fisheries Act 1988, manages all finfish taken in the fishery while the day to day management of the fishery is undertaken by the Department of Resources (DoR).

The fishery has been assessed by the 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 Environment Protection and Biodiversity Conservation Act (the EPBC Act). The fishery is scheduled for re-assessment in May 2009.

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 km², 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 operator does not presently fish the same grounds as the Demersal Fishery licensees.

![Figure 1. Fishing area available to the commercial Finfish Trawl Fishery](image-url)

Fishing Method

Fishing operations are conducted using a semi-pelagic demersal trawl. The trawl net was developed cooperatively by 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 trialling bycatch reduction devices (BRDs) and square mesh codends in order to increase the value of the landed product, rather than increase his catch volume.
**Catch**
Saddletail snapper (*Lutjanus malabaricus*) and red snapper (*Lutjanus erythropterus*) are the target species of the fishery, comprising 74% of the total catch (Figure 2).

Since 1995, catches have increased steadily (Figure 3). In 2008, the catch was 1150 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 trends.

In 2008, byproduct harvest was 307 tonnes. These species include primarily painted sweetlip (*Diagramma pictum*), red spot emperor (*L. lentjan*), and goldband snappers (*Pristipomoides multidens* and *P. typus*).

**Effort**
Fishing effort has increased steadily from 158 boat days in 1995 to 323 boat days in 2008. This is an increase from the 257 days in 2007 (Figure 3). However, as with interpreting catch, there are many reasons for changes to effort that are particularly emphasised by a single operator.

**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 2008 was 3.6 tonnes/boat day.
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 saddletail snapper, red 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 activity is in inshore waters where some of the same species are taken.

Non-retained Species
Eighteen percent of the total catch is discarded in the fishery. Most of the discarded species (by weight) are sharks and rays as there is a ‘no-take’ regulation in place regarding these species.

To assist in reducing release mortality substantially, the operator has developed a system comprising grids and rails on the fish hopper to enable sharks and rays to be returned to the water via a chute, alive and in a timely manner. 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 an observer trip in 2008, there was 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 landing.

Threatened Species Interaction
In 2008, no threatened, protected or endangered species were recorded.

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**Figure 4.** Catch per unit effort (CPUE) for the Finfish Trawl Fishery, 1995-2008

[Graph showing CPUE (tonnes/days fished) from 1995 to 2008]
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 industry minimises seabed disturbance and reduces the amount of bycatch and environmental impact in the fishery. Trialling of the BRD and square mesh codends 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 and vessel repairs. Recreational fishers also target some of these species (within coastal 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 preclude 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 the fishery. Logbooks are submitted with monthly marketing information by the 28th day of the following month. In addition to logbooks, DoR officers conduct onboard monitoring of commercial fishing trips. While onboard, observers document vessel and gear information, location, depth, fishing practices, catch composition (including bycatch), and where possible, measure most landed species.

One onboard monitoring trip was undertaken in 2008. 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 undertaken in 1996 and 2004. The initial assessment used a stock reduction analysis model developed by Professor Carl Walters (Ramm 1997). The more recent assessment, yield per recruit and biomass dynamics models, incorporated updated biological parameters (Blaber et al. 2005).

Despite genetic studies showing some separation of saddletail snapper (*L. malabaricus*) stocks between Australia and Indonesia, separation of red 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, and level of interchange of fish and recruits and important productivity parameters for red snapper) are not well known.

For the Australian sector of the Arafura Sea, the biomass of red snappers has been 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.

Current Harvest Status

The high level of Indonesian trawl fishing in the Arafura Sea adjacent to the AFZ does not necessarily 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 undertaken as part of an Australian Centre for International Agricultural Research (ACIAR) project, indicating 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.

In the past five 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

Identification of the future assessment needs for red snapper research is being addressed at a national level through the Northern Australian Fisheries Management Forum and the Northern Management and Science Working Group.

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 will be addressed through a collaborative project, led by Queensland’s Primary Industries and Fisheries, which will commence in 2009. 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 for this fishery, (*Lutjanus malabaricus*, *L. erythropterus*), which account for 74% of the Finfish Trawl Fishery catch. Findings from this project are outlined in the final report of 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 appear 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 poorly understood life history parameters primarily of red snapper (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.
Current Research

A research project aimed at identifying juvenile red snapper nursery grounds is being conducted. At present, this is a pilot project in collaboration with the Groote Eylandt Marine Rangers.

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

MANAGEMENT/GOVERNANCE

Management

Objective

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 the NT Fisheries Joint Authority (NTFJA).

NTFJA provides for the Commonwealth and the NT to jointly manage the fishery given the likelihood of shared resources with adjacent national and international jurisdictions. DoR undertakes 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 Commonwealth 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 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 to government in 2006 informing fishers in the Demersal and Finfish Trawl Fisheries that it was exploring mechanisms to rationalise the latent licence effort in the Demersal Fishery, securing goldband snapper grounds for non-trawl fishing methods and expanding the Finfish Trawl Fishery.

Future Plans

During 2008 stakeholders and interested parties were asked to comment on the following alternative proposal to facilitate the development of the offshore snapper fisheries:

- Agreement for the trawl and Demersal Line Fishery to be managed within a quota management framework.
- Allocation of units of entitlement (individually transferable quota) to existing licences in the Finfish Trawl and Demersal Fisheries.
- Excision of the goldband habitat area from the Trawl Fishery and inclusion of similar-sized new grounds into the fishery (this will require liaison with other NT and Commonwealth fisheries).
- Expressions of interest process for the issue of a second trawl licence. This would be conducted on the basis that the successful applicant (as assessed against a range of environmental, economic and technical criteria) would need to acquire a specified minimum holding of quota in the market to enable him/her to operate in the fishery.

The period for comments ends in early 2009.
The NT and Commonwealth Governments continue to work closely with the Indonesian Government to develop a bilateral management plan for red snapper shared stocks in the Arafura Sea.

**Compliance**

The Police, Marine and Fisheries Enforcement Section (PMFES) 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 arrival and departures through the port of Darwin as well as verification of catch returns against processor returns. If necessary, PMFES has the power to investigate the records of wholesalers and licensees.

In 2008 there were no recorded compliance issues with 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 operator. DoR also puts out publications such as Fishery Reports, Fishnotes and newsletters to inform and educate stakeholders.

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

**REFERENCES**


Table 1. Management objectives, performance indicators, trigger points and management actions used in the Finfish Trawl Fishery

<table>
<thead>
<tr>
<th>Species/Group</th>
<th>Management objectives</th>
<th>Performance indicator</th>
<th>Trigger reference point</th>
<th>Current status review</th>
<th>Management response to be taken</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red snappers</td>
<td>Ensure intergenerational equity by maintaining ecologically sustainable annual catches in all sectors.</td>
<td>Sustainable yield estimates for nominated regions.</td>
<td>Combined Finfish Trawl and Demersal Fishery catch levels increase to 2500 t over the next calendar year. Catch levels decline by 30% over the next calendar year (Finfish Trawl only).</td>
<td>Combined red snapper catches in 2008 - 949 tonnes. Catch levels increased by 24% over 2007 catch levels. Trigger reference point not exceeded.</td>
<td>Stakeholders are currently reviewing the fishery (refer ‘future plans’ section) and making recommendations to the Executive Director of Fisheries 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.</td>
</tr>
<tr>
<td>Byproduct species</td>
<td>Ensure ecological sustainability of by-product species taken in the Finfish Trawl Fishery.</td>
<td>Monitoring of commercial logbook returns.</td>
<td>Annual catch increase in proportion of the total catch by greater than 35%.</td>
<td>2008 – 26% Trigger reference point not exceeded.</td>
<td>Stakeholders to review fishery and make recommendations to the Executive Director of Fisheries. Amended arrangements to be implemented within 12 months of trigger being released.</td>
</tr>
<tr>
<td>Bycatch species</td>
<td>Ensure ecological sustainability of bycatch species taken in the Finfish Trawl Fishery.</td>
<td>Onboard monitoring of Finfish Trawl Fishery.</td>
<td>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.</td>
<td>2008 – 18% No identified decline in a species relative numbers. Trigger reference point not exceeded.</td>
<td>Stakeholders to make recommendations to Executive Director of Fisheries regarding appropriate remedial action. Amended arrangements to be implemented within 12 months of trigger being released.</td>
</tr>
<tr>
<td>Endangered, threatened or protected species and/or communities</td>
<td>Ensure the continued protection of species and communities listed under the EPBC Act and the Territory Wildlife and Conservation Act 2000.</td>
<td>Endangered, threatened or protected species and or communities are identified in NT waters.</td>
<td>Identifiable impacts observed by commercial fishers, fisheries observers or other agencies regarding EPBC listed species or communities.</td>
<td>No identifiable impacts have been observed in 2008. Trigger reference point not exceeded.</td>
<td>Stakeholders to make recommendations to Executive Director of Fisheries regarding the implementation of a threat-abatement plan, if required. Amended arrangements to be implemented within 12 months of trigger being released.</td>
</tr>
<tr>
<td>Ecosystem components</td>
<td>Minimise effects on ecosystem components.</td>
<td>Identification of threatening processes.</td>
<td>Identification of significant negative interaction with components of the natural ecosystem present on finfish trawl fishing grounds.</td>
<td>No negative ecosystem interactions identified. Trigger reference point not exceeded.</td>
<td>Stakeholders to make recommendations to Executive Director of Fisheries regarding appropriate remedial action. Amended arrangements to be implemented within 12 months of trigger being released.</td>
</tr>
</tbody>
</table>
INTRODUCTION

The Mud Crab Fishery is one of the key Northern Territory (NT)-managed wild harvest fisheries. In 2008, the commercial wild-harvest sector caught 412 tonnes of mud crabs, valued at more than $8.24 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 (with a combined weight of about 135 tonnes) in a 12-month period, respectively (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. *Scylla serrata* accounts for 99% of the catch from all sectors, while *S. olivacea* constitutes the remainder. There is little byproduct and bycatch in this fishery due to the highly selective gear utilised to target large mud crabs.

The fishery was assessed by the Commonwealth Department of the Environment, Water, Heritage and the Arts (DEWHA) against the Guidelines for the Ecologically Sustainable Management of Fisheries. Full export exempt accreditation was subsequently issued under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

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 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

Most commercial crab fishers work from remote, rudimentary land-based camps, although a small proportion now 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. Each commercial Mud Crab licence holder can use up to 60 pots, which must have a float (with the licence number inscribed) attached and must not exceed 0.5 m³ 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 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 2008, 412 tonnes of mud crabs were harvested by the commercial fishery (Figure 1). Seven 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 ‘soft crab’ rule in 2001 explains some of the decline in catches 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 to 14 cm for males and from 14 to 15 cm for females on 1 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). However, the commercial harvest in 2008 was 29% higher than in 2007 and 55% higher than in 2006.

Byproduct of commercial crabbing operations in 2008 accounted for 96 kg of cod, 28 kg of catfish, 140 kg of bream and 5 kg of shark, the bulk of which was used to bait pots. No bycatch was reported in the 2008 logbook returns.

**Effort**

The commercial sector of the fishery is restricted to 49 transferable licences. Generally, each operator utilises the maximum entitlement of 60 pots per licence.

Total reported effort in 2008 was 678 794 pot-lifts (Figure 1), a 6% increase on the 2007 figure. Crabbers sometimes check their pots two (or more) times a day; so 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 from 9% in 2005 to 4% in 2008.

Wet season flooding in the Gulf of Carpentaria (the main crabbing area in the NT) restricts access to, and from, this region for several months. Hence, most commercial crabbing takes place from May to November. Mature female mud crabs are less common in the catch.
during December through to April, when they stop feeding and/or have moved offshore to spawn.

**Catch Rates**
The CPUE in 2008 equated to 0.61 kg per pot-lift (Figure 1), which represents a 22% increase on the 2007 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). The CPUE increased to 0.65 kg per pot-lift in 1996, eventually peaking at over 1 kg per pot-lift in 2001. This peak was followed by a decline, then a plateau (at around 0.40 kg per pot-lift) from 2003 to 2006 and a gradual increase thereafter.

**Marketing**
Mud crabs are premium seafood, with strong demand for live product from the 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, handheld hook, hook and line, hand net, cast net or drag net.

**Catch**
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 commercially-unsuitable mud crabs in the recreational sector, or those that are not full of meat. However, the Department of Resources (DoR) has produced extension material (Fishnote 28) that encourages the testing and release of soft (or empty) crabs.

Recreational fishers harvested over 82 000 mud crabs (about 65 tonnes) from January to December 2000 (Henry and Lyle 2003), 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 in 2000, whilst fishing for species 'other than fish' (including mud crabs), was 0.4 individuals per hour (Henry and Lyle 2003).

Another recreational fishing survey of the NT is scheduled to commence in 2009. The results are expected in 2011.

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 2008, the FTO sector landed 1313 mud crabs, of which 909 (or 69%) were retained. This is a increase from the 1156 mud crabs landed and 794 retained in 2007, and is consistent with the harvest rate over the last 13 years (since records began), which has ranged from 62% to 79%.

Effort
In 2008, FTO clients spent 4428 hours of fishing effort targeting mud crabs. This represents an increase of 38% from the 3204 hours of mud crab effort in 2007. 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. Catching mud crabs accounts for less than 4% of all FTO fishing activities.

Catch Rates
The mean mud crab catch rate for FTO clients in 2008 was 0.3 crabs per hour, just below the previous 13-year range of 0.4 to 0.8 crabs per hour. The mean harvest rate for FTO clients in 2008 was 0.2 mud crabs per hour, again slightly below the previous 13-year range of 0.3 to 0.4 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 favoured 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 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 the fishery in 2008.

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

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

Crabbing operations may also benefit landholders, as crabber’ 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 2008, the NT commercial mud crab catch was 412 tonnes, valued at about $8.24 million.

The recreational mud crab sector also contributes to the NT economy, particularly to the service and 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, Adelaide River, Blue Mud Bay and the Borroloola area, on a monthly basis and 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 for 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 conclude the fishery may be described 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.

Current Harvest Status

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

Future Assessment

Provided no trigger points are reached in the
coming years, it is anticipated that the next
stock assessment of the fishery will take place
in three to four years time.

RESEARCH

Summary

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

Incorporation into Management

The Department of Resources (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

In 2008, DoR completed its evaluation of
durometers as a means of quantitatively
assessing shell hardness in mud crabs. The
results will be published in 2009.

In another study, microscopic examination of
brain and eyestalk tissue from known age mud
crabs found that the fluorescent age pigment
lipofuscin is unsuitable for ageing Scylla
serrata.

Two mud crab research projects obtained
funding in 2008. The first, ‘Evaluating the
environmental drivers of mud crab (Scylla
serrata) catches in Australia’ will be undertaken
by Griffith University. The project will:

- consider links between selected
  environmental factors and mud crab
  (Scylla serrata) catches;

- document possible time lags between
  environmental phenomena and mud
  crab catches; and

- develop predictive model(s) for
  Australian mud crab fisheries based on
  this information.

The second project, ‘A collaborative recruitment
forecasting program for the NT Mud Crab
Fishery’ will be undertaken by the NT Seafood
Council (NTSC). The project will consider ways
to:

- increase stakeholder engagement in the
  collection of data necessary to monitor
  and forecast recruitment to the fishery;
  and

- enhance the skills and understanding of
  fisheries research and sustainable
  management practices among
  stakeholders in the fishery.
DoR will work in collaboration with Griffith University and NTSC on these projects.

A survey of recreational fishing in the NT will commence in 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 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. Triggers 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 decreases 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 Director of Fisheries.

**Current Issues**

The fishery appears to have entered a recovery phase with catch and CPUE being at their highest levels for four and six years, respectively. 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.

In late 2007, the fishery was re-assessed by DEWHA 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 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. DEWHA also recommended that a range of additional tasks and measures be undertaken or 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 has recommended that the fishery be managed by way of unitised entitlements, which can be transferred units between licensees.

The objectives of the proposal are to:

- provide greater flexibility for operators to increase their individual pot entitlements, while the fishery overall continues to be managed within existing sustainability limits; and
- aid in the control of illegal over-potting in the fishery.

In combination with this, MCFMAC has also recommended amending a number of clauses in MCFMP to further strengthen penalties for non-compliance, thus providing a more
significant deterrent to breaching of the regulatory arrangements.

The concept of unitisation is being explored and may be incorporated into future management arrangements if considered appropriate.

MCFMAC will meet again in 2009 to discuss future research needs and management arrangements for the fishery.

Compliance
The Police, Marine and Fisheries Enforcement Section of the NT Police, Fire and Emergency Services is responsible for all fisheries compliance and enforcement in the NT. In 2008, major compliance issues in the fishery included illegal use of excess or unmarked pots and the failure to tie mud crabs as soon as practicable after capture.

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. These 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, and management and compliance issues.

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

REFERENCES


Grubert, M. A. and Phelan M. J. (2007). Mud Crab - running on empty? How to Ensure Your Mud Crab is Full! Department of Primary Industry, Fisheries and Mines Fishnote 28


<table>
<thead>
<tr>
<th>Species</th>
<th>Management Objectives</th>
<th>Performance Indicator</th>
<th>Trigger Reference Point</th>
<th>Current status review</th>
<th>Management response to be taken</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mud crabs</td>
<td>Ensure the intergenerational equity by maintaining ecologically sustainable annual catches in all sectors.</td>
<td>Significant decline in the annual catch.</td>
<td>Commercial catch decreases by 10% per annum for two or more consecutive years or decreases by 50% in any one year.</td>
<td>Commercial catch rose from 320 t in 2007 to 412 t in 2008 (i.e. a 29% increase). Trigger reference point not exceeded.</td>
<td>MCFAC to review fishery and make recommendations to the Director of Fisheries 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.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Significant increase in fishing effort.</td>
<td>Commercial fishing effort increases by 10% per annum for two or more consecutive years.</td>
<td>Commercial fishing effort rose from 637,863 pot-lifts in 2007 to 678,794 pot-lifts in 2008 (i.e. a 6% increase). Trigger reference point not exceeded.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Significant decrease in the median size of mud crabs.</td>
<td>Median size of mud crabs decreases by 5 mm per annum for two or more consecutive years.</td>
<td>Size frequency monitoring of commercially harvested mud crabs found no change in median size. Trigger reference point not exceeded.</td>
<td></td>
</tr>
<tr>
<td>Byproduct species</td>
<td>Ensure ecological sustainability of byproduct species.</td>
<td>Monitoring of commercial logbook returns.</td>
<td>Byproduct increases by more than 0.5 t in any one year period.</td>
<td>Total byproduct harvest less than 0.3 t in 2008. Trigger reference point not exceeded.</td>
<td>MCFAC to review fishery and make recommendations to the Director of Fisheries 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.</td>
</tr>
<tr>
<td>Bycatch species</td>
<td>Ensure ecological sustainability of bycatch species.</td>
<td>Monitoring of commercial crabbing operations.</td>
<td>Bycatch abundance increases by more than 50% in any one year or more than 100% in any three year period.</td>
<td>No bycatch reported in 2008. Trigger reference point not exceeded.</td>
<td>MCFAC to review fishery and make recommendations to the Director of Fisheries 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.</td>
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<tr>
<td>Endangered, threatened or protected species and/or communities</td>
<td>Maintain present level of interaction between mud crab fishing operations and species and communities listed under the EPBC Act.</td>
<td>Endangered, threatened or protected species and/or communities are identified in Northern Territory waters.</td>
<td>Identifiable impacts observed by commercial fishers, fisheries observers or other agencies regarding EPBC Act listed species or communities.</td>
<td>No identifiable impacts reported or observed in 2008. Trigger reference point not exceeded.</td>
<td>MCFAC to make recommendations to the Director of Fisheries 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.</td>
</tr>
<tr>
<td>Ecosystem components</td>
<td>Minimise effects on ecosystem components.</td>
<td>Identification of threatening processes.</td>
<td>Identification of significant negative interaction with components of the natural ecosystem present on mud crab fishing grounds.</td>
<td>No significant negative interactions reported or observed in 2008. Trigger reference point not exceeded.</td>
<td>MCFAC to make recommendations to the Director of Fisheries 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.</td>
</tr>
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INTRODUCTION

The commercial Offshore Net and Line Fishery targets blacktip sharks (*Carcharhinus tilstoni*, *C.*limbatus and *C.* sorrah) and grey mackerel (*Scomberomorus semifasciatus*). A variety of other sharks and pelagic finfish are also landed as byproduct. Licensees are permitted to operate from the high water mark to 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 by way of individually transferable effort allocations. The main gear used in this fishery is the pelagic gillnet although long lines are also permitted for use. Strict gear specifications apply, resulting in selective targeting of smaller, more productive sharks species, with little impact on larger, susceptible shark species.

The fishery allows 17 licences to operate, of which 13 were active in 2008.

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

Cooperative research efforts are being conducted with Western Australia and Queensland. The NT is also actively contributing to the implementation of the National Plan of Action for Sharks (NPOA Sharks). The NT also coordinates the northern response to the requirements of the Operational Plan for the Sustainable Use of Northern Australian Shark Resources.

The fishery was assessed in 2007 by the Commonwealth Department of Environment, Water Heritage and the Arts (DEWHA) against the Guidelines for the Sustainable Management of Fisheries under the Environment Protection and Biodiversity Conservation Act (the EPBC Act). An approved Wildlife Trade Operation (WTO) was subsequently issued for three years. The fishery will be reassessed by DEWHA in late 2010.

The NT hosted the Northern Australian Science and Management Working Group on Sharks (NASMWGS) meeting in May 2008. The meeting discussed shark research projects and prioritised the research needs for northern Australian sharks.

PROFILE OF THE FISHERY

Commercial Sector

Area

Licensees are authorised to fish in NT waters from the high water mark to the boundary of AFZ, an area of approximately 522 632 km², with spatial restrictions placed on the use of certain gear. However, 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 2008.

Fishing Method

Operators may use either long lines or pelagic nets. The use of bottom-set gillnets is prohibited. 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 constructed 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 anytime and must have no more than 1000 snoods (hooks). Automated baiting gear is prohibited.

Catch

Operators in the fishery target grey mackerel and blacktip sharks (*C.* tilstoni and *C.* sorrah). Logbook records indicated a total catch of 1070
tonnes in 2008 of all the species of the fishery, which was a slight decline of 6% from the 2007 catch of 1139 tonnes.

In 2008, the *C. tilstoni* catch of 323 tonnes represented 30% of total landings, an 8% decline from the 353 tonnes taken in 2007. The grey mackerel catch of 224 tonnes represented 21% of the total landings, a 7% decline from the 240 tonnes taken in 2007 (Figure 1). While grey mackerel were the principal target species caught during 2000-06, *C. tilstoni* were caught in greater numbers in 2007 and 2008. Operators reported that market forces and other operational considerations, such as weather conditions, may be among the main causes of variation in grey mackerel catches. Catch variations largely result from variations in targeting. However, it is not possible to deduce from recorded catches and effort whether, in any fishing operation, the target was any particular species or species group, or just the suite of species typical of the fishery. The *C. sorrah* catch of 111 tonnes represented 10% of the total catch, which was a 20% decline from the 140 tonnes taken in 2007 (Figure 1).

A prohibition on the possession of sharks and shark product exists for the Timor Reef, Demersal, Finfish Trawl, and Spanish Mackerel Fisheries. Sharks are taken as limited byproduct in a range of fisheries targeting other species. The incidental take of sharks in other NT fisheries remains around 5% of the total combined fisheries shark catch, indicating that the dedicated fishery accounts for 95% of the total shark catch.

**Byproduct Species**

The catches of sharks other than blacktips increased from 377 tonnes in 2007, to 390 tonnes in 2008, an increase of 3%. Byproduct species were principally pig eye shark (*C. amboinensis*) (180 tonnes, 17% of the total catch), hammerhead sharks (*Sphyrna* species) (95 tonnes, 9% of the total catch), tiger shark (*Galeocerdo curvier*) (44 tonnes, 4% of the total catch) and lemon shark (*Negprion acutidens*) (31 tonnes, 3% of the total catch). Other byproduct shark species included winghead shark (*Eusphyra blochii*) and a variety of other Carcharinids (Figure 2).

Also 14.1 tonnes of narrow-barred Spanish mackerel (*Scomberomorus commerson*) were caught (1.3% of the total catch). Small quantities of other fish species landed included tunas, mainly *Thunnus tonggol*, (a combined total of 3.8 tonnes) and 3.6 tonnes of queenfish (*Scomberoides* spp.) (Figure 2). Sharks were landed as an incidental catch in a range of commercial fisheries targeting other species. However, a strict limit of 500 kg of shark per trip as byproduct applies for the Barramundi, Coastal Line and Coastal Net Fisheries. The Barramundi Fishery harvested 13.4 tonnes, the Coastal Line Fishery landed 3.4 tonnes and the Coastal Net Fishery landed less than 1 tonne.

Almost no grey mackerel are harvested in other NT commercial fisheries apart from this fishery.

**Effort**

Effort fluctuations have largely driven the high variability in catches of sharks and mackerel in the fishery. Fishers indicate that effort reflects both operational and market conditions. Recorded effort prior to 1 July 2005 (when the fishery was known as the Shark Fishery) did not indicate target species. As a result, only effort directed at the fishery as a whole can be reported. This constraint has been addressed through recently-introduced logbook amendments.

After an initial low effort in the fishery in the early 1980s, effort stabilised at around 900-1000 boat-days through the late 1980s and early 1990s (Figure 1). The mean for 1985-1991 was 932.6 boat days. The 1990s was a period of particular variability. After a low point of 490 boat-days in 1994, effort generally increased, deviating from this pattern with a sharp increase in 1997 to 1127 boat days, but declining again over the next two years to 892 boat-days and 573 boat-days in 1998 and 1999, respectively. Effort then steadily increased in following years to the series peak of 1800 boat-
days in 2003. Precautionary measures introduced to contain effort in the fishery in 2005 successfully reduced domestic effort from 1538 boat-days in 2004 to 780 boat-days in 2008. Despite the decline in catch shown above, the effort in 2008 increased from the 729 days fished in 2007 (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 effort variation.

![Figure 1. Catches and effort for the target species in the commercial Offshore Net and Line Fishery, 1983 -2008](image)

Blacktip sharks were only identified as separate species in commercial logbooks from 1999 to 2008.

**Catch Rates**

Blacktip shark CPUE increased from 61 kg/day in 1990 to a peak of 613 kg/day in 1995. Thereafter, it dropped to 298 kg/hour in 1998 before separate species of blacktips were identified in commercial logbooks (Figure 3). Catch rates of *C. tilstoni* and *C. sorrah* have shown a similar pattern with lows being recorded in 1999 (*C. tilstoni*: 181 kg/hour, *C. sorrah*: 63 kg/hour) subsequently rising to a peak in 2007 (*C. tilstoni*: 484 kg/hour, *C. sorrah*: 192 kg/hour) before dropping in 2008 (Figure 3).

Grey mackerel catch rates have generally followed a pattern of steady increase from the early 1990s, but experienced a decline in the last two years to reach 287 kg/hour in 2008 (Figure 3).
Figure 2. Byproduct species composition of the Offshore Net and Line Fishery catch for 2007 and 2008

Figure 3. CPUE for the Offshore Net and Line Fishery target species between 1983 and 2008. Blacktip sharks were only identified as separate species in commercial logbooks from 1999 to 2008.

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

**Area**
The significant areas for recreational shark catches are Darwin Harbour, McArthur River and Cobourg Peninsula. For grey mackerel, most of the recreational catch comes from the Vernon Islands, Dundee, Lorna Shoal and Gove.

**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 tend to be taken as an incidental catch by anglers trolling lures over reef targeting Spanish mackerel.

**Catch**
Sharks are not targeted by recreational fishers, 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. This indicates a 47% reduction in harvest rate since 1995. In 1995, over 80 000 individuals were caught; only 18% were retained, giving a harvest of 15 000.

The survey indicated that barramundi fishing, reef fishing and non-target fishing accounted for 14%, 26% and 52% of the total shark catch, respectively. The mortality rate of released sharks is not known. 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%.

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.

Fishing Tour Operator Sector

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

**Catch**
In 2008, 7494 sharks were caught by FTOs. Of these, 7317 (98%) were released, representing a 16% increase in sharks caught by FTO clients in 2007. The species of sharks caught and harvested were not recorded and the mortality rate of released sharks is not known.

The number of sharks caught by FTOs has more than doubled since 1995, when fewer than 3000 were caught.

In 2008, 1237 mackerel, other than Spanish mackerel, were caught by FTOs. Observations from operators suggest that most of these were grey mackerel. Of these, 726 (59%) were released. The 2008 FTO mackerel catch declined by 10% from the 1367 caught in 2007.

Indigenous Sector

**Area**
Most indigenous fishing activity occurs in the close vicinity of communities and outstations, inland or near coastal waters.

**Catch**
Sharks and rays are one of 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 12000 sharks and rays were harvested, comprising just over 3% of the total finfish harvest. The species of sharks and rays caught and harvested were not identified.

As grey mackerel tend to exist on offshore reefs, they are rarely caught 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. Nevertheless, the amount of bycatch depends strongly on location and season. Most shark species are now retained, apart from the tawny shark (*Nebrius ferrugineus*) and species subject to the ‘no take’ policy, such as sawfishes and *Glyphis* species. Rays are an uncommon bycatch in the surface-set nets and are usually released alive. Some finfish, for example some trevally and queenfish, are also retained.

**Threatened Species Interaction**

In 2008, the fishery interacted with 28 threatened, endangered and protected (TEP) species which was an increase from the 15 captured in nets during 2007. All TEP species caught in 2008 were released alive except four speartooth sharks (*Glyphis glyphis*). Species interactions included seven green sawfish (*Pristis zijsron*), four speartooth sharks and 17 turtles.

In 2008, 61 days of onboard observer monitoring were conducted in the fishery and recorded seven TEP species interactions. This was an increase from the four interactions observed in 2007. Four *Glyphis glyphis* were found dead in nets while two hawksbill turtles and one olive Ridley turtle were released alive.

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

Ecosystem Impact

Controls on fishing gear have been introduced to minimise 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 2008, 13 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 2008, the overall catch value of the fishery was just over $2.00 million ($3.29 million 2007). The blacktip shark component was valued at $0.70 million (in 2007, $0.76 million), $0.38 million for other sharks (in 2007, $1.51 million) and $0.78 million for grey mackerel (in 2007, $0.84 million).

**STOCK ASSESSMENT**

Monitoring

The basic 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 managed since the late 1990s and, from July 2005, the target species have been additionally recorded. This reflects a policy of improving the quality and utility of logbook information collected.

Observer trips add information on species composition and provide other biological and ecological data. Five observer trips totalling 61 days were conducted on commercial fishery boats during 2008. Of the 4611 fish caught during these trips, 23% were *C. tilstoni*, 19% were grey mackerel, 16% were *C. sorrah*, 7% were milk sharks and 4% were pigeye sharks.

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

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 blacktip sharks (C. tilstoni and C. sorrah), was 3400 tonnes annually. This consisted of 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% per year 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. These sources included losses to other fisheries across the northern border or undeclared within other Australian fisheries which, it was calculated, could account for up to 1500 tonnes of catches, as well as localised depletion effects.

The unreliability of the assessment was emphasised. It was recognised that the CPUE statistics, on which the assessment relied, were a poor index of abundance. 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 assessment 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, particularly the large peaks of 1995 and 1996.

The basic 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, much more than the abundance of the fish. This is illustrated by apparent targeted fishing within the fishery. The very strong 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 general targeting of sharks during recent years, in response to market pressures. The catch rate variations among blacktip 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. Existing logbook effort data could not be allocated among the target groups, but the inference from these observations is that catch rate trends presented for sharks and mackerel in this fishery are unlikely to capture all but the strongest trends in abundance. The slight variations evident for blacktip shark catch rates
in Figure 3 may simply reflect diversion of effort by operators to whichever fishing target they predicted would have the greatest net value 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 most 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 for Indonesia (Blaber 2006).

For most of the species that interact with the fishery, trigger points were not exceeded. However, catches of grey mackerel have declined by 45% since 2006. As discussed above, this decline may be a result of preferential targeting of shark species in the last two years. Nevertheless, there have been substantial changes in the spatial distribution of the grey mackerel catch since 2000.

Catches from Arnhem Land comprised 47% of the total for this species in 2003 when catches were at their peak, but has dropped to only 16% in 2008. In contrast, grey mackerel catches have increased in the Darwin and Cape Ford/Anson Bay areas comprising ~6% of the catch in 2003 and rising to ~25% of the catch in 2008. It is likely that these spatial changes in catch reflect increases in fuel prices in recent years as the latter two areas are much closer to Darwin than Arnhem Land. In addition, this has been compounded by the lack of available fuel from Gove Harbour.

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 stocks in the NT.

Pigeye shark catch in 2008 exceeded the “10% of the total catch” trigger point for byproduct species while tiger shark catches increased by over 240% in 2008 compared with 2007. For pigeye sharks, the 180 tonnes taken in 2008 is the highest recorded catch for this species. Close monitoring of future catches of this species will determine the reason for this reported increase in catch for both these species. It should be noted that the tiger shark catch also appears to be well within historic maxima; so while future catches should be closely monitored, it is likely that the large increase from 2007 to 2008 reflects the inherent variability of this species catch within this fishery. Furthermore, there is only one operator in the line sector of the fishery that is able to catch pigeye and tiger sharks and therefore catches are normally reflective of changes in the activities of this licensee such as new skippers, changes to gear etc.

Trigger points were also reached for dusky sharks and queenfish as their proportion of the total catch increased by more than 35%. Catches of dusky sharks have risen substantially from the first recorded catch of 3.3 tonnes in 2006. Given that this species has vulnerable life history characteristics, future increases in catches should be carefully monitored to ensure they remain within sustainable limits (Simpfendorfer 2002; McAuley 2007). Again, only one operator from the line sector of the fishery is able to catch this species and changes in catch often reflect changes in the licensee’s activities.

In contrast, queenfish catches have rarely exceeded 3 tonnes and have shown substantial temporal variability. Consequently, it is unlikely that the current increase is impacting on sustainability of this species but reflects temporal variability in the interaction with this species within the fishery.

Given the high degree of uncertainty in stock estimates, a declining CPUE trend in blacktip shark 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

It is planned that target species in the fishery will be re-assessed at least every three years. 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, unreported and unregistered (IUU) fishing by foreign vessels operating in northern Australian waters. CSIRO and Australian Fisheries Management Authority are currently undertaking 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 of the ecological effects arising as a result of fishing down many of the top predatory fish from the offshore area of the fishery is required.

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 mackerel was undertaken during 2006. The main conclusion of this assessment was that the fishery is not currently over-fished. 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.

RESEARCH

Summary to Date

In the mid 1980s, the NT Shark Fishery (now known as the Offshore Net and Line Fishery) 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 2004.

Research during the 1990s was mostly limited to monitoring of 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, which have been conducted since the late 1990s (Stobutzki et al. 2003; Rose et al. 2003; Salini et al. 2007). These 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 project series included risk analyses that indicated knowledge gaps to be addressed and the need for sustainable management.
The stock structure of shark species has been investigated in an ACIAR-sponsored project FIS/2003/037 led by CSIRO. 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*, *Prionace glauca*, *C. falciformis*, *C. obscurus* and *Rhynchobatus* spp. were genetically not distinguishable across the geopolitical boundaries, and caution and cooperation in their management was suggested. Although this study indicated that blacktip sharks form a single large genetic stock throughout northern Australia, mark-recapture studies showed that movement rates both alongshore and offshore are relatively restricted between the northern Australia 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 are 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).

**Incorporation into Management**

NASMWGS met in Darwin 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 research have allowed informed and conservative management regimes to be implemented for the fishery.

**Current Research**

An ongoing observer 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 blacktip species are well-known biologically, this has not been true of many of the species that are less frequent catch components. Thus the biological information accumulated and communicated (e.g. Beatty and Crofts 2004) from previous and ongoing projects are valuable for the future management of the fishery.

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 2008, 1215 sharks were tagged and 15 were recaptured bringing the total for the project to 2816 tagged and 54 recaptured. In addition, the participation of CDU and AIMS has expanded the scope of projects undertaken on sharks in the NT. The projects for 2008 included studies on the distribution and abundance of *Glyphis* species, and the genetics and biology of bull and pigeye sharks (*C. leucas* and *C. amboinensis*), respectively.

Given the value of the grey mackerel in the fishery, there is also a need for further information on this species. A Fishnote was prepared to provide information to stakeholders on grey mackerel (Crofts and de Lestang 2004). Information on stock structure, movements and age structure of the population will be provided by current research in FRDC project 2005/010, ‘Determination of Management Units for Grey Mackerel Fisheries in Queensland and the Northern Territory’, which was recently completed. Results from this project will provide valuable direction in managing this multi-stock species.

**Management/Governance**

**Management**

Management of the fishery seeks to maintain shark and grey mackerel catches within appropriate ranges, dictated by 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. In 2008, the
total allowable effort (TAE) was set at 1599 days for pelagic net fishing gear and 234 days for long line fishing gear. Each licensee has been issued an allocation of TAE, which he/she can fish each year or transfer it in full or part to another licensee. A licensee must cease fishing once his/her allocation for the licensing year has been used or he/she has transferred all available allocation.

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 licence reduction program requires new entrants to acquire and transfer three restricted Offshore Net and Line Fishery licences to DoR for the issue of an unrestricted licence. Of the 17 licences currently in the fishery, six are restricted and 11 are non-restricted.

Fin ratio licence conditions apply in the fishery, which require a proportionate amount of fins to trunks to be landed. These arrangements are in place to deter the targeting of large sharks for their fins. 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 of the fin ratios was conducted in late 2008 resulting in significant changes to fishery logbooks and reporting procedures. These changes will be introduced for the 2009 licensing year.

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

A prohibition on the possession of sharks and shark product is in place for the Timor Reef, Demersal, Finfish Trawl and Spanish Mackerel 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 DEWHA 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 permits it to export shark products until November 2010.

The NT is signatory to a multi-jurisdictional “Operational Plan” for northern Australian shark fisheries to achieve the outcomes of the National Plan of Action for Sharks (NPOA). 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. A revised plan of implementation is scheduled for development in 2009-10.

**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, with foreign fishing vessels working as close as 12 nm (approximately 22 km) 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 gillnetters to land up to 7000 tonnes of shark 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 until November 2007.

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 DEWHA 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 Commonwealth Government to be operating in an appropriately precautionary manner and the fishery is exempt from export regulations for a further three years. The fishery is due for reassessment in 2010.

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. DoR is also participating in a National Heritage Trust-funded research project ‘Pilot Study to Develop Methodology to Determine Indigenous Fishing Impacts on Sharks and Rays in the Northern Territory’, to gain an understanding of the harvest of sharks by the indigenous sector.

**Current Issues**

Catches of grey mackerel have declined substantially in recent years from an historic high of 766 tonnes in 2003 to 224 tonnes in 2008. This decline has resulted in the ‘decline in catch’ trigger point being reached. In addition, catches of several byproduct shark species increased substantially in 2008 with pigeye sharks comprising more than 10% of the
The total catch in 2008, while the proportion of the total catch for tiger and dusky shark increased by more than 35%.

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 for 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 Offshore Net and Line Fishery Management Advisory Committee for consideration and advice in 2009. In addition, DoR is undertaking more targeted research to obtain a better understanding of these species and specifically, the commercial fishing sector’s interaction with them.

Future Plans
An ecological risk assessment of the fishery is planned in 2009 with outcomes to be provided to DEWHA. This is consistent with the commitments of the WTO approval.

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 Police, Marine and Fisheries Enforcement Section (PMFES) of the NT Police, Fire and Emergency Services.

The NT will play an active part in the revision of the National Plan of Action for Sharks which is scheduled for development in 2009-10.

Compliance
A review of the impacts of IUU fishing in northern Australian waters, primarily by foreign fishers, is currently being undertaken by the Commonwealth Government.

The collaborative research project to develop mark-recapture (tagging) protocols to provide on-going monitoring for the fishery will also assist in determining movement rates and life history linkages between inshore (where most domestic fishing occurs) and offshore (mostly IUU activity) stocks.

PMFES carries out all fisheries compliance and enforcement in the NT.

PMFES effectively monitors and enforces management arrangements for the fishery through the inspection of vessel arrivals and departures through the single port of Darwin. This includes verification of catch returns against fish trader/processor returns. When necessary, PMFES has the power to investigate the records of wholesalers and licensees.

In 2008, 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 extractive stakeholders and wider interest groups.

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

Senior Research Scientist - Dr Rik Buckworth
Aquatic Resource Management Officer – Mrs Tricia Beatty

REFERENCES

Page 90
Some interesting facts about a strange looking shark. Department of Business Industry and Resource Development *Fishnote* 34


Table 1. Management objectives, performance indicators, trigger points and management actions used in the Offshore Net and Line Fishery Management Plan

<table>
<thead>
<tr>
<th>Species or group</th>
<th>Management objective</th>
<th>Performance indicator</th>
<th>Performance measure</th>
<th>Harvest status for 2008</th>
<th>Management action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blacktip sharks C. tistiona &amp; C. sorrah</td>
<td>Ensure inter-generational equity by maintaining ecologically sustainable annual catches in all sectors.</td>
<td>Sustainable yield estimates.</td>
<td>Catch levels increase to 2000 t over the next calendar year. Catch levels decline by 30% over the previous two calendar years.</td>
<td>C. tistiona 324 t; C. sorrah 111 t in 2008 - trigger reference point not reached. C. tistiona 6% decline; C. sorrah 2% decline in 2008 catch compared to 2006 - trigger reference point not reached.</td>
<td>MACs to review fisheries annually and make recommendations to the Director of Fisheries. Any amended arrangements will be implemented within 12 months of trigger being reached.</td>
</tr>
<tr>
<td>Grey mackerel C. amboinensis S. mokarran S. Lewini G. cuvier N. acutidens E. blochii</td>
<td>Ensure ecological sustainability of these species in all fisheries.</td>
<td>Monitoring of commercial logbook returns. Onboard monitoring of Offshore Net and Line Fishery.</td>
<td>The proportion of the total catch increases by &gt;35% in the calendar year. Catch of any by-product species increases to &gt; 10% of the total catch in the calendar year.</td>
<td>G. cuvier increased by 240% in 2008 from 2007 - trigger reference point reached. C. amboinensis catch increased to 17% of the catch in 2008 - trigger reference point reached. C. obscurus Increased by 40% in 2008 - trigger reference point reached. Queenfish catch increased by 93% in 2008 - trigger reference point reached.</td>
<td>MAC to review the trigger point and grey mackerel catches. Advice to be provided to the Director of Fisheries for appropriate action.</td>
</tr>
<tr>
<td>Spanish mackerel C. obscurus Tuna Rhizoprionodon acutus Queenfish C. brevepinna</td>
<td>Ensure ecological sustainability of bycatch species in all fisheries.</td>
<td>Monitoring of commercial logbook returns. Onboard monitoring of Offshore Net and Line Fishery.</td>
<td>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.</td>
<td>Total bycatch in the fishery was &lt;1% of the total catch in 2008 - trigger reference point not reached.</td>
<td>As for target species. MAC to review the trigger point and G. cuvier, C. amboinensis, C. obscurus, and queenfish catches. Advice to be provided to the Director of Fisheries for appropriate action. Targeted research project is being currently conducted for C. amboinensis</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Species or group</th>
<th>Management objective</th>
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<th>Performance measure</th>
<th>Harvest status for 2008</th>
<th>Management action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Including: P. clavata P. microdon P. zijsron</td>
<td>Ensure the continued protection of species and communities listed under the EPBC Act and the Territory Wildlife and Conservation Act 2000.</td>
<td>Endangered, threatened or protected species and or communities are identified in NT waters.</td>
<td>Identifiable impacts observed by commercial fishers, fisheries observers or other agencies regarding the EPBC Act listed species or communities.</td>
<td>Number of TEPS interactions reduced by 45% in 2008, no increase in species interactions - trigger reference point not reached.</td>
<td>MACs to review fisheries annually and make recommendations to the Director of Fisheries. Fishery logbooks to be amended to include records of any interaction with endangered, threatened or protected species.</td>
</tr>
<tr>
<td>Ecosystem components</td>
<td>Minimise effects on ecosystem components</td>
<td>Identification of threatening processes</td>
<td>Identification of significant negative interaction with components of the natural ecosystem present on fishing grounds.</td>
<td>No negative interactions with environment reported - trigger reference point not reached.</td>
<td>MACs to review fisheries annually and make recommendations to the Director of Fisheries.</td>
</tr>
</tbody>
</table>
INTRODUCTION

Spanish mackerel 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 mackerel are also landed as an incidental catch in the Offshore Net and Line Fishery (ONLF) and the Finfish Trawl Fishery. Strict catch limits are set for these sectors. In 2008, there were 17 Spanish Mackerel Fishery licences, of which 14 were actively operating. Spanish mackerel are also keenly sought after by recreational fishers.

Historically, there were significant landings of Spanish mackerel 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. Possession limits have been set for the recreational sector.

In 2007, the fishery received the highest level of export accreditation against the Commonwealth Government’s Guidelines for the Ecologically Sustainable Management of Fisheries under the Environment Protection and Biodiversity Conservation Act (EPBC Act). The management arrangements for the fishery are recognised by the Commonwealth Government, which facilitates its operation in a sustainable manner. The fishery was subsequently issued export exemption accreditation until 2011, when it will again be reviewed against the guidelines.

At the request of the Director of Fisheries, the Spanish Mackerel Fishery Management Advisory Committee (SMFMAC), in consultation with industry, is compiling advice on preferred management actions to ensure that the commercial harvest of Spanish mackerel is maintained within the allocated commercial catch share.

PROFILE OF THE FISHERY

Commercial Sector

Area

Spanish Mackerel Fishery licensees may fish in NT waters seaward of 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.

Most commercial fishers purchase bait (usually southern Australian garfish) for their fishing operations. However, a small number of operators (less than five) 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.
Additionally, a small quantity of Spanish mackerel is taken by pelagic gillnet in ONLF, Demersal Trawl and Finfish Trawl Fisheries.

**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 2008 was 270 tonnes, declining from 320 tonnes caught in 2007 and 409 tonnes in 2006 (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 2008, prominent factors included fuel price and availability at remote ports, wind strength and crew availability. The low availability of skilled skippers and crew is a continuing issue for operators in this and several other fisheries, which, at times, prevents fishing.

The commercial catch in 2008 was predominantly *Scomberomorus commerson* with 188 kg of mangrove jack (*Lutjanus argentimaculatus*) and 25 kg of coral trout (*Plectropomus* spp.).

There is a small amount of byproduct in most years. Typically, this might include a very small catch of other mackerel species, such as Australian spotted mackerel (*S. munroi*), Queensland school mackerel (*S. queenslandicus*) and grey mackerel (*S. semifasciatus*). Other byproduct species may include wahoo (*Acanthocybium solandri*), goldband snappers (*Pristipomoides* spp.), trevallies (Family Carangidae) and cods (Family Serranidae, including coral trout, *Plectropomus* spp.).

The capture method in this fishery (usually heavy troll lines) means that other species that are not retained for sale can usually be returned to the water alive. Information from observer trips suggests that non-retained catch equals to approximately 3% of the total catch. The species typically discarded include trevallies, queenfish (Family Carangidae) and barracudas (*Sphyraena* spp.).

Landings of Spanish mackerel as bycatch in ONLF declined to 14.1 tonnes in 2008 from 16.86 tonnes in 2007 and 26.5 tonnes in 2006. The Finfish Trawl Fishery catch of Spanish mackerel was 2.78 tonnes, up from 1.6 tonnes in 2007. An additional 160 kg of mackerel of unspecified species was also landed in 2008.
**Effort**

Fishing effort in the fishery declined to 708 boat days from 876 boat days in 2007 and 1098 boat days in 2006 (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 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, with CPUE since 1999 at a level around twice or more of that seen in the 1980s (Figure 2). A gross catch rate of 381.2 kg/day was achieved during 2008, increasing slightly compared with previous years’ rates. 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.

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**Figure 1.** Annual catch (tonnes) and effort (boat days) in the NT Spanish Mackerel Fishery, 1983 – 2008

**Figure 2.** Catch per unit effort (CPUE) for the NT Spanish Mackerel Fishery, 1983 – 2008
Marketing
Spanish mackerel are usually filleted onboard the mother vessel soon after capture. Some mackerel 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 onboard; 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 sport and table fish, most Spanish mackerel 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 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
FISHCOUNT, a recreational fishing survey conducted in 1995, estimated the total recreational catch of all mackerel to be around 24 500 individuals. Almost all of these fish were harvested, weighing about 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 mackerel by the recreational sector in the NT numbered 25 233 fish, slightly higher than 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 Fishing Tour Operator (FTO) catch component of 15.1 tonnes.

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

FTO Sector
Area
FTOs can fish in all areas of the fishery.

Fishing Method
Fishing gear and methods used by FTOs targeting Spanish mackerel 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 mackerel in this sector again increased in 2008. A total of 3557 fish were caught, compared with 3162 in 2007. Of these, 52% were released. The total harvest of Spanish mackerel by FTOs in 2008 was 1,850 fish.

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

Targeted game fishing by FTOs is a small component of the industry. There were 999 trips undertaken in 2008, an increase from 780 trips in 2007 and 876 trips in 2006. A total of 13,987 game fishing line hours were spent by FTOs in 2008, which is an increase on those in 2006 and 2007.

Effort fluctuates from year to year due to numerous factors such as the weather and flight costs. For example, operators reported that their fishing for pelagic species was restricted during 2007 due to prevailing strong winds. There has, however, been a strong increasing trend in FTO effort over the last two decades, with effort directed at game fishing more than doubling in 2008 compared with 1995.

**Indigenous Sector**
Only a very few (1400) mackerel were captured according to the National Recreation and Indigenous Fishing Survey undertaken in 2000-01. 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, most of the other species caught by the recreational sector during targeted game fishing are trevally and queenfish. Most (over 83%) of these fish are retained. Other minor species caught also have a high retention rate of 78%.

**Threatened Species Interaction**
Due to the highly targeted nature of the troll fishing method, interactions with threatened species are highly unlikely. No threatened, endangered or protected species interactions were reported in 2008.

**Ecosystem Impact**
The fishing gear and targeted nature of fishing operations observed in the fishery 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 undertaken onboard. 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 2008, the value of the catch from the commercial sector of the fishery was $2.07 million ($2.59 million in 2007).

The recreational fishing sector also contributed to the NT’s economy, especially to the service and tackle industries.
STOCK ASSESSMENT

Monitoring

Monitoring of the fishery comprised two main elements: fishery-dependent and fishery-independent information.

Fishery-dependent information includes 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.

Fishery-independent information is obtained from regularly monitoring of catches onboard commercial vessels. The information collected includes length of the fish and biological information, such as sex and maturity.

Some fishers also routinely provide length measurements of the fish taken.

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. Consequently, no onboard monitoring trips were undertaken in 2008. However, five monitoring trips were undertaken in ONLF and one in the Finfish Trawl Fishery, which also take some Spanish mackerel.

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. This resilience is conferred by first maturity being within the first two years of life, at an age well below that for full recruitment to the fishery, and rapid growth.

Age structured models using the available time series of catch and effort as well as mean size and age composition data have provided assessments of the impacts of fishing but are considered to be only moderately reliable.

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

In the absence of more information for alternative assessments, initial management of the fishery 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 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 workshop 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 harvest rates or abundance. It is difficult to estimate Spanish mackerel abundance largely due to stocks being finely divided geographically and fish not amenable to survey by trawling or gillnet or even by air. 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 explosive growth as there are no ceilings either on the number of participants or the resulting increase in their share of the catch.

**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). Use of tag-based monitoring would overcome the lack of confidence in the accuracy of the early catch data time series.

**RESEARCH**

**Summary**

Research programs seek to improve knowledge required for fishery assessment and management. 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 mackerel in the catch varied in age between one and eleven years. Most of the catch was about 100 cm (length to caudal fork) and three to six years of age, with NT Spanish mackerel 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, for any given age, females were usually larger than males.

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

This FRDC-funded work showed that Spanish mackerel in the Top End of the NT are not highly migratory but are 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 these 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, in that 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, or be robust to, the 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 research indicates significant change in any aspect of the fishery, a review of the management arrangements is undertaken.

**Current Research**

A project to develop a new approach for tagging an aggressive, predatory fish like Spanish mackerel commenced in 2001, with funding from the NT Research and Development Trust Fund. This pilot study developed methods to “tag” Spanish mackerel using DNA fingerprinting techniques without the need to actually catch the fish. The “Genetag hook”, was developed to remove a very small piece of tissue, causing minimal damage to the fish. Subsequent DNA screening of these tissue samples from the catch will reveal those which have been previously “tagged”. Using this technique, it will be possible to determine harvest rates for monitoring the state of the fishery.

Following the success of the pilot work described above, the project ‘GENETAG: Genetic mark-recapture for real-time harvest rate monitoring’ commenced. The pilot studies in northern Australian Spanish mackerel fisheries were supported by FRDC. This project is jointly conducted by DoR, QPI&F and commercial and recreational fishing groups. It aims to refine the tissue sampling method, develop efficient genetic screening methods and implement the genetic tagging approach at the fishery scale. The project has deployed more than a thousand Genetag lures to collect tissue, developed protocols for preservation and storage of samples, and conducted DNA extraction, identification and matching protocols. The project has been expanded to include combined conventional/genetic tagging, with a panel of expert anglers tagging over a thousand fish between 2004 and 2008. More than 2% of these conventionally-tagged fish have subsequently been recaptured. This aspect of the project demonstrates that a recreational fishery monitoring program based around carefully-coordinated angler-tagging of Spanish mackerel can be feasible.

The project has identified several short-term recaptures from Genetag activities. In some cases fish were Genetagged more than once within a few days of each tagging, or were detected in the landed catch after having been Genetagged at the same location within the previous few days. While these recaptures do not as yet provide a good estimate of harvest rates, they form “proof of concept” for the Genetag approach.

**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. In addition, management objectives, performance criteria and trigger points for the fishery have been developed and implemented (see Table 2).

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 historical harvest levels identified from the compulsory commercial logbook.
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**

<table>
<thead>
<tr>
<th>Sector</th>
<th>Sector allocation</th>
<th>Tonnes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial Spanish Mackerel licensees</td>
<td>76%</td>
<td>342</td>
</tr>
<tr>
<td>Commercial Offshore Net and Line licensees</td>
<td>3%</td>
<td>13.5</td>
</tr>
<tr>
<td>Commercial Finfish Trawl licensees</td>
<td>1%</td>
<td>4.5</td>
</tr>
<tr>
<td>FTO licensees</td>
<td>3%</td>
<td>13.5</td>
</tr>
<tr>
<td>Recreational fishers</td>
<td>16%</td>
<td>72</td>
</tr>
<tr>
<td>Aboriginals</td>
<td>1%</td>
<td>4.5</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>450</td>
</tr>
</tbody>
</table>

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 mackerel. 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 mackerel, 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 during 1986 in response to declining shark catch rates and concerns about the incidental capture of dolphins. These controls resulted in the conclusion of foreign fishing operations in northern Australian waters late in 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 Commonwealth Government managed all fish species in northern Australian waters beyond 3 nm of the coast, until 1988. The NT Government assumed responsibility for the management of Spanish mackerel at this time for all waters adjacent to the NT coast to the outer boundary of 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 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 for the incidental harvest of Spanish mackerel in the ONLF and Trawl Fisheries 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 mackerel 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 mackerel. In the Finfish Trawl Fishery, a licensee must not possess more than 50 Spanish mackerel 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 mackerel once again exceeded the commercial allocation.

Due to these high catch levels, SMFMAC was asked to provide advice to the Director of Fisheries on whether changes to current management arrangements are 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 the introduction of Individual Transferable Quotas (ITQs) in the fishery was released for comment.

In December 2008, industry provided in principle support for the introduction of ITQs, although there was no agreement on a preferred allocation method.

In 2008, the fishery was again assessed against the Guidelines for the Ecologically Sustainable Management of Fisheries. Export exemption accreditation was subsequently issued under the EPBC Act subject to a number of conditions to ensure the continued sustainable management of the fishery. The fishery is scheduled for re-assessment in 2011.

**Future Plans**

The issues associated with the potential introduction of ITQs in the fishery will continue to be worked through. Advice from SMFMAC in relation to this matter is expected in 2009.

DoR will continue to work with Spanish mackerel licensees and SMFMAC to ensure the conditions of export exemption accreditation are met.
Compliance

A risk assessment of compliance issues in the fishery was undertaken 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 as ‘extreme’ (illegal, unreported and unregulated (IUU) fishing 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. Consultation with other relevant State and Commonwealth 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 Police, Marine and Fisheries Enforcement 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 2008, there were no significant compliance issues for this fishery.

Consultation, Communication and Education

SMFMAC provides advice to the 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 Spanish mackerel fishery.

Senior Research Scientist - Dr Rik Buckworth
Aquatic Resource Management Officer - Mrs Tricia Beatty

REFERENCES


Table 1. Management objectives, performance indicators, trigger points, harvest status and management actions used in the Spanish Mackerel Fishery

<table>
<thead>
<tr>
<th>Species or group</th>
<th>Management objective</th>
<th>Performance indicator</th>
<th>Performance measure</th>
<th>Harvest Status for 2008</th>
<th>Management action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spanish mackerel</td>
<td>Ensure the sustainability of Spanish mackerel stocks</td>
<td>Estimated catch by all sectors does not exceed the estimated sustainable yield of Spanish mackerel.</td>
<td>Aggregate landings by all sectors reach 90% of the sustainable yield (by whole weight) and/or total fishery catch declines by 30% over the calendar year (by whole weight).</td>
<td>The allowable catch for the commercial fishery is 342 tonnes. The 2008 Spanish Mackerel Fishery harvest was 270 tonnes, decreasing from 320 tonnes in 2007 and the 409 tonnes caught in 2006 - trigger reference point not reached.</td>
<td>Within 3 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.</td>
</tr>
<tr>
<td></td>
<td>Genetic studies indicate discrete Spanish mackerel stock(s).</td>
<td>Discrete Spanish mackerel stocks identified.</td>
<td></td>
<td></td>
<td>SMFMAC to review and make recommendations on appropriate management response to ensure the sustainability of discrete Spanish mackerel stocks.</td>
</tr>
<tr>
<td></td>
<td>Sustainable yield estimates are reviewed annually.</td>
<td>Annual review.</td>
<td></td>
<td></td>
<td>Continue existing research and review alternative yield estimate methodologies annually.</td>
</tr>
<tr>
<td>Spanish mackerel</td>
<td>Optimal utilisation of Spanish mackerel.</td>
<td>Estimated catch share (as a percentage of total aggregate landings, by whole weight) for all sectors remains unchanged.</td>
<td>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).</td>
<td></td>
<td>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.</td>
</tr>
<tr>
<td>Species or group</td>
<td>Management objective</td>
<td>Performance indicator</td>
<td>Performance measure</td>
<td>Harvest Status for 2008</td>
<td>Management action</td>
</tr>
<tr>
<td>--------------------------</td>
<td>---------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Byproduct</td>
<td>Ensure the sustainability of byproduct taken in the Spanish Mackerel Fishery.</td>
<td>Byproduct in the Spanish Mackerel Fishery increases significantly.</td>
<td>Byproduct in the Spanish Mackerel Fishery increases to 10% of the total catch over the calendar year (whole weight).</td>
<td>Byproduct in the fishery has a trigger value of 27 tonnes in 2008. Total byproduct harvested in 2008 was &lt;300 kg - trigger reference point not reached.</td>
<td>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.</td>
</tr>
<tr>
<td>Bycatch</td>
<td>Ensure the sustainability of bycatch taken in the Spanish Mackerel Fishery.</td>
<td>Bycatch in the Spanish Mackerel Fishery increases significantly.</td>
<td>Bycatch in the Spanish Mackerel Fishery increases to 10% of the total catch over the calendar year (whole weight).</td>
<td>Without observer coverage this could not be evaluated however given minimal by-product and previous performance of fishery it is highly unlikely much bycatch discarded by the fishery in 2008 - trigger reference point not reached.</td>
<td>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.</td>
</tr>
<tr>
<td>Threatened, endangered or protected (TEP) species</td>
<td>Minimise effects of fishing operations on endangered/threatened /protected species/communities.</td>
<td>Endangered/threatened/protected species/communities are identified in NT waters.</td>
<td>Impacts are observed by commercial fishers or fisheries observers.</td>
<td>No TEP species interaction in 2008 - trigger reference point not reached.</td>
<td>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.</td>
</tr>
</tbody>
</table>
INTRODUCTION

Commercial fishing dominates activities in the remote Timor Reef Fishery, primarily targeting the higher valued goldband snapper (Pristipomoides multidens and other Pristipomoides species). Significant quantities of red snappers (Lutjanus malabaricus, L. erythropterus), red emperor (Lutjanus 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, management of the Fishery went to the 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 2008, there were only 12 licences in the fishery, compared with 22 in 1993.

Fishing by recreational fishers and Fishing Tour Operators (FTOs) is minimal in the fishery. This is due to the remote offshore location of the fishery. No indigenous harvesting has been recorded from this fishery.

The fishery has been recently assessed again against the Guidelines for the Ecologically Sustainable Management of Fisheries. The fishery is exempt from export regulations until May 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 (AFZ). The fishery has an area of approximately 8400 nm² (Figure 1).

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. Then, due to the better quality of line-caught fish, there was a reversal of this trend in 2004 by many operators back to drop lines. Presently, two vessels use traps and the rest use drop lines.
**Catch**

Goldband snappers are the principal target of the fishery, comprising the three species *Pristipomoides multidens*, *P. typus* and *P. filamentosus*. Together they comprise 56% of the total catch (Figure 2), with *P. multidens* being the most common. Other key species caught in the fishery are saddletail snappers (*Lutjanus malabaricus*), red snappers (*L. erythropterus*), red emperors (*L. sebae*) and cods (Family Serranidae) (Figure 2).

![Figure 2. Catch composition of the Timor Reef Fishery, 2008](image)

The species composition of the catch is gear dependent. Drop liners catch a higher proportion of goldband snappers, compared with trap boats, which catch almost equal proportions of red snappers and goldband snappers. There was a higher proportion of trapping in 2008 compared with drop lines, influencing a slight variation in the composition of the total catch from 2007.

In 2008, the total fishery catch was 895 tonnes, out of which 496 tonnes were goldband snappers. This represented an increase of 30% in total catch compared with 2007 (689 tonnes), with a commensurate increase of 23% in the proportion of goldband snappers from 403 tonnes caught in 2007.

Byproduct species make up 6% of the overall catch in the fishery. They include small snappers, such as *Lutjanus 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 2008 byproduct level was below the 10% trigger value required to initiate a review of management arrangements for the protection of byproduct species.

**Effort**

During 2008, 10 licensees actively fished over a total of 1462 boat days, an increase of 122 boat days from the previous year’s figure (Figure 3).

**Catch Rates**

Catch per unit effort (CPUE) has steadily increased since 1999, which reflects the introduction of traps and increasing investment in the fishery by new operators (Figure 4).
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 catfish (*Arius thalassinus*), chinaman fish (*Symphorus nematophorus*), red sea bass (*Lutjanus bohar*), big eye trevally (*Caranx sexfasciatus*), and starry triggerfish (*Abalistes stellatus*).

The reported and observed level of bycatch (non-retained species) in the fishery is less than 2% of the total catch. Bycatch in this fishery is below the 10% trigger value.

**Threatened Species Interaction**

In 2008, no interaction between the fishing gear and protected species was reported or observed in the fishery. Such interactions are not expected to occur in a deepwater 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 traps and dropline weights on the substrate, and the effect of anchors. Traps are connected individually to an identifying float by a single line. Traps are not attached to one another in order to avoid excessive interaction with the substrate upon hauling. 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 Commonwealth Government, operates year round in offshore waters throughout northern Australia. Prawn and scampi (deepwater 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, 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 2008, the overall catch value of the fishery was $5.76 million ($4.53 million in 2007). The goldband snapper component was valued at $4.21 million in 2008 ($3.41 million in 2007) and the saddletail snapper component was valued at $0.77 million ($0.59 million in 2007).

**STOCK ASSESSMENT**

**Monitoring**

This fishery is monitored primarily through logbooks, which operators are required to fill out on a daily basis during fishing operations. These 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 2008, DoR officers also conducted two onboard monitoring trips on Timor Reef fishing vessels. Observers documented vessel and gear information, location, depth, fishing practices, catch composition (including bycatch), and where possible, measured all 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 goldband 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 as 95% of the Demersal Fishery’s catch of goldband snappers is caught in this area. The Timor Reef and Demersal Fisheries target the same goldband 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 goldband 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 goldband snappers should not exceed 10-15% 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).

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 goldband snappers in Kupang (West Timor) and the northwest Australian site (Ovenden et al. 2002). Otolith micro-chemistry 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, goldband snappers are targeted by Indonesian longline vessels.

Future Assessment Needs

Despite the results of the genetic studies on goldband snappers, some key parameters are still required to enable more accurate assessment of the fishery, including:

- Indonesian catch and effort information;
- the identification of goldband juvenile habitats and movement patterns; and
- more accurate growth parameters from the capture of juvenile goldband snappers.

Given the gradual changing species composition to include more red snappers in the catch, similar parameters are required for future assessment of these species.

RESEARCH

Summary

Fine spatial analysis of this fishery was undertaken as part of the project funded by the Fisheries Research and Development Corporation (FRDC) –(2005/047), which commenced in October 2005. 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 goldband snappers.

The stock structure of goldband snapper (*P. multidens*) has been determined using both genetic methods and otolith micro-chemistry (FRDC 1996/131; 1998/154). These were collaborative projects between DoR, Western Australian Department of Fisheries and Queensland’s Department of Primary Industries and Fisheries. 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 nautical miles from
each other on either side of the Timor Trench (Ovenden et al. 2002). Otolith micro-chemistry revealed distinct populations for all sites sampled, indicating that substantial movement of adults between sites is unlikely (Newman et al. 2000).

Growth and reproductive studies were undertaken on *P. multidens*, as part of the collaborative project between Australia and Indonesia, funded by the Australian Centre for International Agricultural Research (FIS/1997/165). This study provided updated parameters that were incorporated into stock assessment models in 2003.

A project to ascertain if hearing damage occurred in goldband snappers due to seismic survey exposure was undertaken by Curtain University in conjunction with DoR. This project was funded by Santos Ltd and was completed in December 2007. However, 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**

The recent research findings have confirmed the validity of present management arrangements for this fishery between the NT, Western Australia and Indonesia.

**Current Research**

Recent research has focused on developing a holistic approach to fisheries management using geospatial statistics and fuzzy rule-based modelling. This FRDC-funded study (project 2005/047), explored new ways of incorporating the very diverse forms of physical and environmental data (often on different spatial scales), with catch and effort data from the fishery. This will enable analysis of the many components that may affect fish abundance and catchability in a geo-referenced framework. The fuzzy rule-based modelling allows the uncertainties of human knowledge to be captured as hard data. The final report is due for release in 2009.

A collaborative project led by the Queensland Government will commence in 2009 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 red snapper assessment. This will provide more information on red snappers across northern Australia.

A research project aimed at identifying juvenile red snapper nursery grounds is underway. This project is being conducted in collaboration with the Groote Eylandt Marine Rangers.

**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 goldband 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 goldband 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.

An industry request to review the levels of permitted gear (traps and drop lines) and management arrangements was undertaken throughout 2006-07 with a view to develop a formal management plan for the fishery.
The Timor Reef Fishery Assessment Group (TRFAG) was established to provide advice to the Timor Reef Fishery Management Advisory Committee (TRFMAC) and DoR on the potential of introducing catch quota management of the target species into revised management arrangements for the fishery.

**Current Issues**

TRFMAC is currently developing a draft catch quota management framework, for consideration by the Minister. Additional cost implications as a result of moving to management by catch quota will be included in the advice to the Minister. 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 Commonwealth 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 industry on matters relating to the proposed introduction of catch quota management.

Goldband snappers landed outside the boundary of the fishery are likely to be part of the same stock. Management triggers recognise this and management arrangements are under constant review.

**Compliance**

The Police, Marine and Fisheries Enforcement Section (PMFES) of the NT Police, Fire and Emergency Services, is responsible for fisheries compliance and enforcement in the NT.

PMFES effectively monitors compliance in the fishery through the inspection of vessel arrivals and departures through the single port of Darwin. This may include verification of fishery logbook returns against processor returns (i.e. requirement for all operators to specify where they are selling their product). If necessary, PMFES has the power to investigate the records of wholesalers and licensees.

In 2008 no domestic compliance issues were recorded for 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 Director of Fisheries on matters relating 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 Management Officer – Mr David McKey
REFERENCES


Table 1. Review of 2008 catch figures against management trigger points for the Timor Reef Fishery

<table>
<thead>
<tr>
<th>Species or group</th>
<th>Management objectives</th>
<th>Performance indicator</th>
<th>Trigger reference point</th>
<th>Current status review</th>
<th>Management response to be taken</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goldband snappers</td>
<td>Ensure inter-generational equity by maintaining ecologically sustainable annual catches in all sectors.</td>
<td>Optimal sustainable yield estimates.</td>
<td>Annual catch exceeds 900 tonnes</td>
<td>Goldband snapper catches in 2008: 496 t. Catch levels increased from 403 t in 2007. Trigger reference point not reached.</td>
<td>TRMAC to review fishery and make recommendations to the Director of Fisheries 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.</td>
</tr>
<tr>
<td>Red snappers (including saddletail snapper)</td>
<td>Ensure inter-generational equity by maintaining ecologically sustainable annual catches in all sectors.</td>
<td>Optimal sustainable yield estimates.</td>
<td>Annual combined catch exceeds 1,300 tonnes</td>
<td>Combined red snapper catches in 2008: 310 t. Catch levels increased from 227 t in 2007. Trigger reference point not exceeded.</td>
<td>TRMAC to review fishery and make recommendations to the Director of Fisheries. Amended arrangements to be implemented within 12 months of trigger being released.</td>
</tr>
<tr>
<td>Red emperors</td>
<td>Ensure inter-generational equity by maintaining ecologically sustainable annual catches in all sectors.</td>
<td>Significant change in catch composition on Timor Reef Fishery grounds.</td>
<td>Annual catch increase in proportion of the total catch by greater than 25% above the five-year average.</td>
<td>Red emperor as a proportion of total catch in 2008: 3%. Decrease from 4% of total catch in 2007. Trigger reference point not exceeded.</td>
<td>TRMAC to review fishery and make recommendations to the Director of Fisheries. Amended arrangements to be implemented within 12 months of trigger being released.</td>
</tr>
<tr>
<td>Byproduct species</td>
<td>Ensure sustainability of byproduct species taken in the Timor Reef fishery.</td>
<td>Monitoring of commercial logbook returns for a significant change in by-product catch composition on Timor Reef Fishery grounds.</td>
<td>Annual catch increase in proportion of the total catch by greater than 10 per cent above the five year average.</td>
<td>Combined byproduct species (includes cods) in 2008: 6%. Trigger reference point not exceeded.</td>
<td>TRMAC to review fishery and make recommendations to the Director of Fisheries. Amended arrangements to be implemented within 12 months of trigger being released.</td>
</tr>
<tr>
<td>Species or group</td>
<td>Management objectives</td>
<td>Performance indicator</td>
<td>Trigger reference point</td>
<td>Current status review</td>
<td>Management response to be taken</td>
</tr>
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</tr>
<tr>
<td>Bycatch species</td>
<td>Ensure sustainability of bycatch species taken in the Timor Reef Fishery.</td>
<td>Onboard monitoring of Timor Reef Fishery.</td>
<td>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.</td>
<td>2008: less than 2%. Trigger reference point not exceeded. On-board monitoring to continue annually.</td>
<td>TRMAC to make recommendations to the Director of Fisheries regarding appropriate remedial action and onboard monitoring to commence at earliest practical opportunity. Amended arrangements to be implemented within 12 months of trigger being released.</td>
</tr>
<tr>
<td>Endangered, threatened or protected species and/or communities</td>
<td>Maintain present level of interaction between Timor Reef fishing operations and species and communities listed under the EPBC Act.</td>
<td>Endangered, threatened or protected species and or communities are identified in Northern Territory waters.</td>
<td>Identifiable impacts observed by commercial fishers, fisheries observers or other agencies regarding EPBC Act listed species or communities.</td>
<td>No identifiable impacts observed in 2008. Trigger reference point not exceeded.</td>
<td>TRMAC to make recommendations to the Director of Fisheries regarding appropriate threat abatement plan implemented and onboard monitoring to commence at earliest practical opportunity. Amended arrangements to be implemented within 12 months of trigger being released.</td>
</tr>
<tr>
<td>Ecosystem components</td>
<td>Minimise effects on ecosystem components.</td>
<td>Identification of threatening processes.</td>
<td>Identification of significant negative interaction with components of the natural ecosystem present on Timor Reef fishing grounds.</td>
<td>No negative ecosystem interactions identified in 2008. Trigger reference point not exceeded.</td>
<td>TRMAC to make recommendations to the Director of Fisheries regarding appropriate remedial action. Amended arrangements to be implemented within 12 months of trigger being released.</td>
</tr>
</tbody>
</table>
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 trepang. Trepang fishing activity in the 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, though 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 to coral reefs and is often found in beds of seagrass. Seagrass plays an important role in triggering larval settlement.

In late 2007, the fishery was re-assessed against the Commonwealth 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 *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 fishery will again be reassessed in 2010.

PROFILE OF THE FISHERY

Commercial

**Area**

The fishery operates in waters seaward of the coast 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, where major harvest areas are around Cobourg and the Groote Eylandt area.

**Fishing Method**

Sandfish is the most important species for tropical sea cucumber fisheries. Sandfish 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 water visibility improves and cyclone activity is minimal.

**Catch**

The total harvest of trepang was low during most of the 1990s before peaking at 247 tonnes in 2000. Since 2000 the harvest has varied, largely in response to fishing effort (Figure 1). Total harvest reported for 2008 was 6.3 tonnes, which is substantially lower than the 109.6 tonnes harvested in 2007 and the lowest recorded in the last nine years of fishing.

Due to the method of operation of the fishery, no byproduct species were taken.

**Effort**

Between 2000 and 2008, fishing effort in the fishery varied substantially (Figure 2). Catch and effort declined substantially from 227 days in 2007 to only 29 days in 2008, the lowest ever recorded in the fishery.
Until the mid 1990s, catch rates in the fishery were low, with 32 kg/hour and 62 kg/hour recorded in 1996 and 1997, respectively (Figure 2). In 2000, the catch rate for trepang peaked at 183.7 kg/hour. Catch rates declined in 2001, levelling out in subsequent years to between 57 kg/hour in 2005 and 99 kg/hour in 2006. However, there were two successive years of declines in the catch rate of trepang in 2007 and 2008. In particular, the catch rate in 2008 (41.2 kg/hour) was the lowest recorded since 1996.

The significant decline in catch, effort and CPUE in 2008 has been attributed to a change in business operations by the licensee. Specifically, this involved relocating vessels to conduct exploratory fishing in the Western Australian fishery. While this exploratory fishing was intended to be short-term, the high abundance of trepang found led to the vessels remaining in WA for most of the 2008 season. Within the NT, only one boat conducted fishing operations for 29 days.

Figure 1. Annual total catch and effort for the commercial Trepang Fishery, 2000 to 2008

Figure 2. Catch per unit effort (CPUE) for the commercial Trepang Fishery, 2000 to 2008
Catch rates represented here are catch per hour of operation, only for operations where 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 of the operators removing the stomach, and then boiling and freezing all caught 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 is typically mechanical drying.

With limited domestic markets, most of the catch is exported.

**Recreational Sector**
The recreational take 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 1995 and 2000. The local Asian community may take limited amounts for personal consumption.

**Fishing Tour Operator (FTO) Sector**
There were no reports of trepang in the catch of FTO clients for 2008.

**Indigenous Sector**
No take of trepang was reported during the national recreational and indigenous fishing survey of northern Australia, conducted in 2000. Information collected during field trips suggested that trepang was never used as a food source.

**Non-retained Species**
The targeted hand collection method of fishing for trepang means that there are no non-retained (bycatch) species.

**Ecosystem Impact**
Collection of trepang by hand is likely to have minimal impact on the sea floor. The effects of removing quantities of trepang from the ecosystem are unknown. However, with current participation rates and precautionary management, impacts are likely to be low.

**Economic Impact**
Confidentiality constraints preclude this information from being published.

**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 in assessing 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 trend information that is of use.

Fishers also continue to report fishing locality and statistical grid, 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 the natural inhibitors - visibility, accessibility, wet season and cyclonic events - limit the potential for over-fishing.

**Current Exploitation Status**

Most performance measures for the fishery, including total catch, average weight and catch composition did not reach the limit reference points. However, the rolling three-year average catch per unit effort (CPUE) has fallen by 35% from 68.6 kg/hour (2006-08) to 41.2 kg/hour in 2008. The decline in CPUE has triggered the limit reference point and, as a precaution, management responses have commenced. These responses will include an examination of the reasons behind the decline in CPUE, in consultation with industry. It is thought that the decline in CPUE is largely due to only one vessel operating in the fishery in 2008.

Licensed commercial operators are permitted to harvest all trepang species. Discussion with fishers indicated 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 valued species, fishers seek to maintain profitability by targeting lower-valued holothurian species.

Such a situation was observed in the Queensland East Coast Bêche-de-mer fishery, in which commercial fishers targeted white teatfish (*Holothuria fuscogilvia*) and prickly redfish (*Thelenato ananas*), and in the Torres Strait fishery, with fishers targeting teatfish (*H. fuscogilvia, H. noblis*), prickly redfish and surf redfish (*Actinopyga mauritiana*). No such trend has been observed in the fishery.

**Future Assessment Needs**

A program to develop a series of cooperative industry and student-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. The availability of suitable students is a current constraint to this work.

**Incorporation into Management**

Future monitoring will depend on 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.

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 DoR and Charles Darwin University, the industry is working on a genetic study of stocks across 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 mixing of genetic information.

In 2007, work was initiated on an industry-funded pilot survey of NT coastal waters (inside 3 nm). The survey involves the entire NT
coastline and will offer a broad scale approach to the distribution of trepang stocks in the NT. The data from the survey will form the basis on which further fine-scale surveys will be conducted to aid in spatial management and projection of trepang distributions in the NT.

The use of GPS data plotters is also being trialled on the tender vessels in the fishery. The plotters are utilised in some abalone fisheries and provide very accurate spatial catch data, which will assist in more refined information for management.

Licensees recently provided support for an application for funding to the Fisheries Research and Development Corporation to investigate early life history, gonad condition and gamete quality for sea cucumbers.

**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 not more than three licensees authorised to operate in each zone;
- limiting fishing to an area extending from the high water to an imaginary line 3 nm from baselines;
- limiting the number of crew and collectors/divers; and
- 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 the tropical inshore waters of the NT with its large tidal range (exceeding 8 m in some areas) and distinct wet/dry monsoon season and highly turbid water, places 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 consideration by management and acknowledged as providing further protection to trepang stocks.

The fishery is further managed in accordance with the management objectives, performance indicators, triggers and management actions as agreed by the industry and the Commonwealth Government assessment process and as part of WTO accreditation.

**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 2008 were within acceptable levels.

There is little information as yet 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 Commonwealth 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 undertaken by the Police, Marine and Fisheries Enforcement Section (PMFES) of the NT Police, Fire and Emergency Services, under the NT Fisheries Act 1988. PMFES monitors and enforces the fishery’s management arrangements through the inspection of vessel arrivals and departures through 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, PMFES has the power to investigate the records of wholesalers and licensees.

In 2008, no significant compliance issues were recorded for this fishery.

Consultation, Communication and Education
Periodic consultation occurs between DoR, the holder of the trepang licences and the NT Seafood Council on matters relating 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 also published to inform and educate stakeholders.

Senior Research Scientist - Dr Thor Saunders
Aquatic Resource Management Officer - Mr Steven Matthews
Table 2. Management objectives, performance indicators, trigger points and management actions used in the NT Trepang Fishery Management Plan

<table>
<thead>
<tr>
<th>Species or group</th>
<th>Management objectives</th>
<th>Performance indicator</th>
<th>Performance measure</th>
<th>Harvest Status for 2008</th>
<th>Management Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target species</td>
<td>Ensure intergenerational equity by maintaining ecologically sustainable annual catches in all sectors.</td>
<td>Sustainable yield estimates developed. Change in total catch. Change in CPUE. Change in average weight. Change in catch composition. Change in licence ownership.</td>
<td>Total catch increases to over 300 t/year. The rolling three year CPUE average varies by a factor of 30% from the current years catch. Average weight decreases by more than 20%. Catch of trepang species other than <em>H. scabra</em> increases to over 30% of total catch. Any licences traded.</td>
<td>Trepang catch in 2008 was 6.3 tonnes - trigger reference point not reached. The 2008 value was 35% less than the rolling three year average - trigger reference point reached. The average individual weight increased by 21% in 2008 - trigger reference point not reached. <em>H. scabra</em> were the only species harvested in 2008 - trigger reference point not reached. There were no licences traded in 2008 - trigger reference point not reached.</td>
<td>The Director of Fisheries 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 Director. 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.</td>
</tr>
<tr>
<td>Byproduct and Bycatch species</td>
<td>Ensure sustainability of byproduct and bycatch species taken in the NT Trepang Fishery.</td>
<td>Monitoring logbook. Onboard monitoring.</td>
<td>NA - no by-product in fishery.</td>
<td></td>
<td>NA</td>
</tr>
</tbody>
</table>
AQUACULTURE INDUSTRY SUPPORT AND DEVELOPMENT
STATUS REPORT 2008

SUMMARY

The aquaculture industry in the Northern Territory (NT) declined by 8% in total value in 2008 compared with 2007. Total industry value reduced to $21.0 million, down from $22.8 million in 2007 due to a reduction in the pearling industry and a cessation of prawn farming activity.

There was a small amount of mud crab production in the first half of the year from one farm. However during the year this farm converted to producing barramundi only and then subsequently ceased all operations by the end of the year. A privately run pilot hatchery for trepang (sea cucumber), continued to meet its research objectives and progress towards the goal of establishment of a sea cucumber farming industry.

Two indigenous communities ceased all activities on their pilot mud crab farming trials however one maintained the option of conducting one further trial in 2009.

PROFILE OF AQUACULTURE

National Issues

The Department of Resources (DoR) maintains an active presence on two national committees of importance to aquaculture, the Aquatic Animal Health Committee and the Aquaculture Committee. These committees provide advice to the national Marine and Coastal Committee on matters relevant to aquaculture.

In 2005, the Aquaculture Committee developed a ‘best practice model of regulatory arrangements for aquaculture in Australia’ which aimed to help simplify the process for licensing aquaculture developments. In 2008 all States and Territories reported their progress against the objectives identified in the model. The NT compared favourably with the States but there is still more that can be done to improve the licensing and regulation of aquaculture.

Aboriginal Liaison

Liaison and industry support continued during 2008 to assist Aboriginal communities to develop aquaculture based projects.

The Gwalwa Dariniki wound up their mud crab farming trials and the ponds have remained unused as no further funding was available. The Maningrida community also ceased to conduct trials into mud crab farming as the results to date had not been encouraging. Discussions on the potential for the aquaculture of sea cucumbers were held with several Indigenous communities.

DoR continues to work with the Tiwi Land Council to try and locate a suitable investor sea cage barramundi farming.

Environmental Management

DoR continued to maintain close contact with staff of the Department of Natural Resources, Environment, the Arts and Sport. The agencies have been working together to maintain the currency and percentage of operators working under an approved Environmental Management Plan. In addition, they have also been working to produce a clearer understanding of the process proponents need to follow to pass environmental assessment before obtaining an aquaculture licence.

Ecologically sustainable development of aquaculture is an on-going focus. Environmental and social guidelines to underpin the future growth of aquaculture in Australia are currently being developed.

New Investment

A pilot hatchery for sea cucumbers continued to be successfully operated by private industry within the grounds of the Darwin Aquaculture Centre (DAC) and commercialisation trials for this species are expected in 2009. The operator of the pilot hatchery is interested in obtaining access to
earthen ponds to allow it to expand production capability. The intention is to conduct pilot pond growout and sea ranching to attempt to increase sea cucumber production.

**RESEARCH**

Research in support of the barramundi farming industry continues to be conducted at DAC. This has resulted in further improvements in larval rearing and nursery production procedures.

DoR in collaboration with the University of Sydney and the Berrimah Veterinary Laboratories (BVL) is undertaking a three year, Australian Research Council funded project investigating improved detection and management of the serious fish pathogen, nodavirus. A new test for nodavirus has been developed and it should be validated by early 2009.

In addition, DoR is involved with Queensland University and BVL in a two year Fisheries Research and Development Corporation funded project investigating improved serotyping (identification of different strains) of the bacterium *Streptococcus iniae*, another serious fish pathogen. Successful completion of this project will assist improved development of vaccines against this disease.

Funding for research into the control and prevention of the parasite Amyloodinium in farmed barramundi commenced in 2008 and has already resulted in an increased understanding of the nature of the disease and improved management techniques for its control.

A Nhulunbuy based business supplied DAC with a number of broodstock of the giant clam, *Tridacna squamosa*, for use in production trials. These broodstock were used to produce a significant number of juvenile clams that were sold into the aquarium trade. Further trials to refine the juvenile rearing process were carried out.

**Aquatic Health**

BVL provided a valuable service for maintaining monitoring programs, certification and diagnostics for aquatic animal health. A full review of translocation procedures and the identification of aquatic health zones, which commenced in 2004 was finalised in 2006. The ‘Transboundary Movements of Living Aquatic Animals: A Zoning Strategy for Disease Control in the NT’ policy is revised and updated as new information on diseases of aquatic animals is obtained.

**Industry Liaison**

Secretarial and logistical support for the Ministerial Advisory Committee on Aquaculture in the NT (MACANT) continued to be provided in 2008. This is a non-statutory committee which provides advice to the Minister on issues affecting the aquaculture industry. The terms of reference for MACANT were amended in 2003 to allow for a greater focus on existing industry whilst still accounting for the needs of developmental sectors.

DAC also maintains a farm-based extension program where experienced technicians assist farming operations.

Manager of Aquaculture – Dr Ann Flemming
INTRODUCTION

Farmed barramundi (Lates calcarifer) production (tonnes whole fish) increased by 41% in 2008. The combined production in 2008 from four pond-based farms was 544 tonnes, compared with 385 tonnes in 2007. The total value increased from $3.3 million in 2007 to $4.3 million in 2008.

The increased production was primarily due to two farms changing from mixed production of either prawns or mud crabs with barramundi, to only barramundi during the year. All farms increased production in 2008 and one farm commenced harvesting for the first time.

PROFILE OF THE FARMING SECTOR

Commercial Production

Of the six licence holders endorsed for barramundi production, four produced marketable fish in 2008. The four operational farms are located on the Adelaide River at Humpty Doo, on the southern side of Middle Arm peninsula in Darwin Harbour and on the estuary of the Blackmore River, near Berry Springs.

Hatchery/Nursery Production

Commercial annual fingerling production from the government-owned Darwin Aquaculture Centre (DAC) declined from 1.5 million fish in 2007 to just over 970 000 in 2008. One of the local farms also produced its own fingerlings for the first time. Only DAC sold fingerlings during the year. Approximately 55% of the fingerlings (536 000) were sold locally and 437 000 were sold interstate. The size of the fingerlings supplied to local farmers ranged between 50 mm and 130 mm, whereas fingerlings sold interstate ranged between 25 mm and 35 mm.

Farm Production

Four pond-based farms: Australian Barramundi Culture Pty Ltd (Humpty Doo), Arda-Tek (Berry Springs), Wild River Farm Seafood (Berry Springs) and Australia Aquaculture Farming NT (Channel Island area) marketed fish in 2008. Pond production of fish increased from 385 tonnes in 2007 to 544 tonnes in 2008. This is a continuing trend of increased pond-based production over the last three years. Australia Aquaculture Farming NT (AAFNT), harvested for the first time in 2008.

Impoundment Stocking

Over 32 000 excess fingerlings from DAC, ranging from 100 mm to 130 mm in size, were stocked into Manton Dam in 2008.

Translocation

A translocation protocol covers health and security issues related to the importation of barramundi larvae or fingerlings and their movement within the NT. The protocol identifies disease control regions within the NT. Fish may be moved between or within zones of equivalent health status, but movement into zones of higher health status requires quarantine and health certification to ensure that diseases are not transmitted along with the stock.

Marketing

In 2008 most of the fish produced on farms was sold either directly or indirectly to interstate markets. Approximately 90% were sold as whole fish over 1.0 kg, compared with 95% in 2007. No fish were sold as “gilled and gutted” or as fillets.

Employment

Permanent labour employed in the grow-out and hatchery/nursery sectors of the industry increased from 16.0 in 2007 to 19.8 in 2008 and casual employment increased from six to eight.
Indigenous Development

Australian Barramundi Culture Pty Ltd employed one full time indigenous worker. DAC also trained one full time indigenous apprentice in 2008 and was looking to employ another in 2009.

Ecologically Sustainable Development/Environmental Management

The Department of Natural Resources, Environment, the Arts and Sports supervises environmental assessments and approvals. As part of aquaculture licence conditions, all farms must have an approved environmental management plan (EMP). EMP 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 and all farms are subject to environmental and aquaculture licence compliance audits.

Research

Summary

Development of barramundi farming in Australia was based originally on the adoption of practices developed in Thailand in the 1970s. The NT Government first invested in the development of barramundi aquaculture in 1988 and has maintained support for the industry since then. European intensive hatchery and nursery technology has been successfully adapted for use in the NT and is now routinely implemented at DAC.

In 2002, Marine Harvest P/L funded work to develop a bacterin against two pathogenic marine bacteria, which are detrimental to barramundi fingerlings (Vibrio harveyi and Photobacterium damselae). These bacteria were responsible for significant mortality at the DAC hatchery/nursery and at the Marine Harvest cage farm. The bacterin was used for bath immersion of all fish prior to being sent to Port Hurd. Use of the bacterin and improved on-farm management of the fish was deemed successful in reducing mortality from these bacteria.

DAC seeks continuous improvement in the techniques used and has assessed new hatchery and nursery feeds (Gemma and Gemma Micro from Skretting) and implemented feeding and grading strategies to improve weaning, growth and survival as well as reducing size variation within batches of juvenile fish. As a result, growth rates in fingerlings of up to 100 mm have been increased by 20 to 30% with a 95 to 100% reduction in Artemia usage, making production more labour efficient.

From 2005 to 2007, DAC improved hatchery culture protocols to reduce the fingerling deformity rate to less than 5%. As a result of further improvements, the deformity rate currently is down to around 1%.

In 2006, an autogenous vaccine against one NT strain of Streptococcus iniae (the causative agent of the disease streptococcosis and the most devastating bacterial disease affecting farmed barramundi in Australia) was developed and commercially produced by Intervet Norbio, Australia, 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.

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 commercially produced by Allied Diagnostics.
Current Research

In 2005, a project proposal was submitted to the Australian Research Council seeking funding to study the causative agent of VER (viral encephalopathy and retinopathy), the most significant viral disease affecting barramundi hatchery and nursery production. The project application was successful and two PhD students commenced research in May 2006 in collaboration with DAC, BVL, the University of Sydney and Marine Harvest. A new broodstock screening test (polymerase chain reaction) was developed and validated. This test will help improve the understanding of the epidemiology of the disease.

In 2006, a project proposal was submitted to the Fisheries Research and Development Corporation (FRDC) for the establishment of 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 application was approved in mid 2007 and research commenced in 2008.

DAC also continues to improve intensive barramundi culture protocols in the hatchery and nursery through better understanding of the evolution of the bacterial populations in rotifer and larval cultures. Cost efficiency of barramundi hatchery and nursery production is also continuously reviewed by using cheaper consumables and culture methods without affecting the quality and the reliability of fingerling production.

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-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 industry development and helped to ensure that aquatic animal health issues are effectively managed.

Current Issues

Further development of the barramundi industry will require continued and sustainable growth of the existing farms over the short to medium term. Industry growth in the longer term is expected from the development of new inland and offshore farm sites. Industry growth will need to be accompanied by increased promotion and marketing to ensure that the market keeps pace with increased production.

DAC is working to develop improved disease control systems and better hatchery and nursery production techniques to enhance the efficiency of barramundi production in the NT.

Australian Barramundi Culture Pty is exploring the use of large-scale, recirculating ponds, an automated grow-out feeding system and a semi-automated nursery as a means of improving both production and sustainability.

Maintenance of strict quarantine and health certification is required to limit the spread of streptococcosis and other potential diseases within the NT.
Future Plans
The projected fingerling requirement for 2009 is in excess of 1.5 million, locally and interstate.

When Marine Harvest was in operation, the NT industry had an aspirational production target of 10,000 tonnes within 10 years. Following the closure of Marine Harvest’s operation, that target has been revised down to 5,000 tonnes. Meeting this target is contingent upon continued expansion of the pond farming sector and the success of current activities by the Tiwi Land Council to find an alternative investor in sea cage aquaculture at the Tiwi Islands. Barramundi production from the NT’s pond-based farms is projected to increase to over 1,000 tonnes in 2009.

DAC is also continuing to review hatchery and nursery production protocols to improve the quality of fingerlings supplied to the industry. For example, larval rearing and live feed production protocols are constantly refined to further reduce the occurrence of deformities.

Industry Liaison
DAC regularly facilitated contact with all active aquaculture licence holders and encouraged open channels of communication with the industry. In addition, all farms had access to an Extension Officer who regularly visited the farms, usually weekly.

Barramundi farmers were able to raise issues of importance and be involved in aquaculture industry development generally through their representative on the Ministerial Advisory Committee on Aquaculture in the NT (MACANT). MACANT acts as a conduit between the industry and the government where aquaculture issues can be formally addressed. All aquaculture licensees were also represented on the NT Seafood Council through the Aquaculture Licensee Committee.

Manager, Aquaculture – Dr Ann Fleming
INTRODUCTION

The two mud crab farming pilot projects that had been set up to test the suitability of farming methods for use in indigenous communities ceased operations in 2008. The only other mud crab project, which involved a commercial farm, also ceased production of mud crabs during the year.

The total production of mud crabs in 2008 reached 270 kg.

PROFILE OF THE FARMING SECTOR

Commercial Production

There were three mud crab farming operations in the Northern Territory (NT) in 2007, two of which were indigenous pilot projects and one was a commercial aquaculture farm. One of the two indigenous projects was a 2.5 ha pond-based farm located in the Darwin metropolitan area, adjacent to Darwin Harbour and the other was a 0.15-ha mangrove enclosure located near Maningrida. The commercial farm was located on Haycock Reach, in Darwin Harbour and used 4ha of recently rehabilitated earthen ponds for growing mud crabs.

The pond-based indigenous pilot project lacked basic infrastructure (including electricity) because of funding delays, which resulted in an inability to control water quality in the ponds. This was a significant additional constraint on the production capacity of the farm. The farm ceased operating in June 2007 and remained idle in 2008.

Operating the mangrove enclosure pilot farm was difficult due to problems of access during the wet season as well as maintenance issues. There was no production at this site in 2007. The enclosure was not stocked in 2008.

These three operations ceased all attempts at mud crab production in 2008. However, the Maningrida community expressed interest in a further trial in 2009.

Hatchery/Nursery Production

All of the crablets previously stocked at the farms were produced at the Darwin Aquaculture Centre (DAC).

Farm Production Methods

All attempts at intensive farming had been carried out in unlined, earthen ponds. The indigenous pond-based pilot farm had no pumps, so sea water was gravity-fed into the ponds through water gates fitted with screens. Depending on the height of the tides, water was exchanged through the ponds at various times of the grow-out cycle in an attempt to control water quality. There was no oxygenation of the pond water because no electricity was available.

The sea water in the commercial farm was gravity-fed to the ponds from an elevated reservoir that was filled by a diesel engine-powered pump.

Crabs in the mangrove enclosure were cultured at low density and were able to move throughout the enclosure and feed on natural feeds as well as the supplementary feed provided. The enclosure was subject to natural tidal regimes and sea water flowed through the enclosure with very little impediment. The enclosure did not impound any water.

Crabs on all three farms were fed a mixture of local fresh fish, fish byproduct and imported formulated pelleted feeds.

Translocation

The 'Transboundary Movements of Living Aquatic Animals: A Zoning Strategy for Disease Control in the NT translocation policy was officially endorsed in 2006. The policy covers health and security issues related to the importation or translocation of live aquatic organisms of all life stages.
Marketing
The harvested crabs were sold whole live, either locally or interstate.

Employment
During 2008, the mud crab farming industry employed 7.5 full time employees and about 7.2 full time on a casual basis.

Indigenous Development
One Aquaculture licence and one scientific permit endorsed for mud crabs were held by indigenous enterprises in 2008. They were for pilot/training operations to test if the methods used were viable.

Ecologically Sustainable Development/Environmental Management
As part of the licence/permit conditions, all farms had an environmental management plan (EMP). EMP stipulated the environmental parameters under which the farm was constructed and operated. The Department of Natural Resources, Environment, the Arts and Sport supervises environmental assessments and approvals. Pond-based farms discharging water into Darwin Harbour are required to have a Waste Discharge licence and are subject to environmental compliance audits.

RESEARCH

Summary
Since 1995, DAC has been involved in two collaborative research projects with interstate and international partners and has been at the forefront of the hatchery production of mud crabs. Methods to produce mud crab juveniles (crablets) have been developed and have been put into practice to supply crabs to pioneer farmers.

Current Research
No research is being carried out in mud crab aquaculture as the mud crab project at DAC has been completed.

INDUSTRY DEVELOPMENT

The first two pilot crab farms were initially stocked with crablets in late 2005 (the mangrove enclosure at Maningrida was stocked first followed shortly after by the pond farm at Kulaluk). The first commercial farm was stocked with crablets in early 2007.

The indigenous pond farm at Kulaluk had previously been a privately-owned prawn farm that had been abandoned. The ponds were rehabilitated and further infrastructure was put in place so that the farm could be managed in a semi-intensive way. Unfortunately, due to funding delays, important aspects of the infrastructure were not established until the farm ceased operation.

The mangrove enclosure was constructed from netting recycled from prawn trawlers and surrounded an area of mangrove that was fronted by a small creek and backed by a sand dune. The mangrove enclosure style of farm requires fewer inputs than a pond farm and is considered potentially more appropriate for remote communities. The Department of Resources (DoR) assisted in setting up the pilot crab farms.

The commercial farm was an abandoned prawn farm that investors leased from the owner and rehabilitated with the intention of farming crabs.

Current Issues
There are many issues confronting mud crab farming as it is a new and unproven type of aquaculture in Australia. Results to date indicate that using currently-available techniques, the grow-out phase of mud crab farming is difficult in the NT.
The main constraints to economically-viable production of mud crabs are low survival due to cannibalism, lack of a commercially available feed, an unexpectedly short shelf-life of the harvested crabs, a large variation in the size of grown out crabs and the labour-intensive method of harvesting.

**Future Plans**

All mud crab farming trials in the NT have ceased and there are no projects planned in the immediate future.

Crab prices remain relatively high but there needs to be further development of farming techniques before it may be possible to attract additional investment in the industry.

**Industry Liaison**

Aquaculture farmers are able to raise issues of importance and be involved in aquaculture industry development generally through representation on the Ministerial Advisory Committee on Aquaculture in the NT (MACANT). MACANT acts as a conduit between industry and government where aquaculture issues are formally addressed.

DoR regularly facilitates contact with all active aquaculture licence holders to encourage open channels of communication. In addition, all farms have access to an Extension Officer who visits the farms regularly.

**COMPLIANCE**

The Police, Marine and Fisheries Enforcement Section of NT Police, Fire and Emergency Services is responsible for the administration of the fishery’s compliance and enforcement provisions contained in the NT *Fisheries Act 1988*.

Senior Aquaculture Scientist - Mr Graham Williams
INTRODUCTION

The Northern Territory (NT) pearling industry produced 127.8 Kan* of pearls in 2008 from farmed pearl oysters (Pinctada maxima). Production declined slightly (by 4%) from the 132.7 Kan produced in 2007. Total industry production declined by 8% from $17.6 million in 2007 to $16.3 million in 2008.

The level of pearl production is expected to remain relatively constant in the next few years but the value of production is expected to fall. The current global economic crisis has resulted in a reduced demand and hence a reduced price for pearls on the international markets.

*Kan and momme are old Japanese units of weight (1000 momme in a Kan). A momme is equal to 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 for the production of Australian South Sea pearls in the NT are hatchery-reared; however, only one company operates a hatchery in the NT. It uses the oysters produced in its hatchery for grow-out on its leases and has the option to sell oysters to other licensees. Pearl oysters farmed by other licensees are sourced from hatcheries or wild harvested oysters from Western Australia (WA).

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) - pearl oyster shell used for buttons, jewellery and decorative inlays- and pearl meat (the pearl oyster’s adductor muscle).

Translocation

A protocol is in place that covers health and security issues related to importing into the NT, and translocating within the NT, of adult and juvenile pearl oysters.
**Marketing**

The marketing of Australian South Sea pearls is undertaken individually by licensees. Most of the pearls produced each year are sold via private treaty, auctions in either Japan or Hong Kong, or through retail outlets operated by the companies in Australia and overseas. MOP is sold in many different 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 114 people were directly employed in pearl farming or farm-related activities in the NT in 2008. Although the current global economic crisis has resulted in reduced employment in the Australian industry, employment in the local industry has remained relatively stable. The closure of several pearling companies in WA along with the down turn in staffing requirements by the mining industry have 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 with 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 effects of pearling operations on the environment. The industry, in cooperation with the Government, has developed EMPs for each farm.

**RESEARCH**

**Summary**

The renewed interest in pearling in the mid-1980s highlighted the lack of knowledge of the NT’s pearl stocks. This resulted in a pearl oyster dive survey in 1989 by the Bureau of Rural Resources. 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 broodstock 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 their 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 taken during the pearl oyster health survey. The samples were submitted to the Veterinary Pathology Laboratories in WA, Queensland and the NT. It was funded by FRDC.

Much of the research undertaken 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; and in Australia from Carnarvon, on the west coast, to south of Cairns on the east coast.

Pearl oysters were 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. Again production increased until 1930 when 32 luggers yielded about 700 tonnes per year. Production stayed around this level until 1939 when WWII halted production until 1948. After the war, production slowly increased until 1953. In 1953, the Commonwealth 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 this level for three years. As the new areas were fished out, production again slowly declined.

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 diving for NT pearl oysters. Unlike the shallow and productive grounds in WA, the local grounds are deeper, more isolated and patchier and have a higher proportion of oysters, which are 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 these oysters to the NT, the reliance on sourcing local oysters declined.

The arrival of plastics made shell harvesting uneconomic and MOP harvesting had virtually ceased by 1964 when only two luggers remained in the industry, harvesting only five tonnes that year. The Japanese fleet’s last harvest was in 1961.

The success of Paspaley Pearls’ pearling activities in the NT and WA, along with an expanding WA industry, prompted the 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, as well as 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 (POCIMP) and Fisheries Regulations were changed to allow trade in
fishing and hatchery units. Further changes occurred in 2006 that included changing the licensing year from a financial to a calendar year, the provision of additional pearl oysters to assist training technicians in the art of pearl oyster seeding and the allowance of additional shell to account for pearl oysters that fail to retain their seeded nuclei. This was achieved by increasing the unit value by 15% i.e. 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 “Mother of Pearl” fishing occurs in most years, no licensee currently fishes for pearl oysters suitable for pearl culture.

The fishery and hatchery units have a value of 1150 oysters. Therefore, with 420 units available the total number of new pearl oysters that may be seeded each year under the NT allocation system is 483 000. About 40% of the seeding entitlement was used in 2008.

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.

A Memorandum of Understanding (MoU) has been developed between the NT and WA Governments that the Australian South Sea pearl industry should be managed in a consistent manner as the industry is highly susceptible to market pressures and any change in management arrangements for 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**

Investigations are continuing in WA to find the causative agent of the significant disease termed oyster oedema disease that occurred in Exmouth Gulf, WA in late 2006. There is no evidence that this disease occurs in the NT. Current translocation protocols mitigate the disease risk posed by the continued importation of WA-sourced oysters for seeding in the NT.

**Future Plans**

The NT pearling legislation will be reviewed as part of the full review of the NT *Fisheries Act 1988*. The amalgamation of POCIMP and Pearling Fisheries Regulations and appropriate parts of the proposed new WA Pearling Management Bill are points for consideration.

**Industry Liaison**

The Department of Resources provides a dedicated management officer for the pearling industry to assist with issues as they arise as well as for the strategic development of the industry. The Pearl Industry Advisory Committee (PIAC) meets once a year to address issues of importance specific to the pearling industry. PIAC is composed of a representative from each pearling licensee and is chaired by the Executive Director of Fisheries.

The industry also has the opportunity to raise any issues of concern and contributes to aquaculture development in the NT through representation on the Ministerial Advisory Committee on Aquaculture in the NT.

Pearling Industry Manager – Mr Murray Barton
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INDIGENOUS FISHING AND ECONOMIC DEVELOPMENT
STATUS REPORT 2008

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 30% of the NT 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 marine and freshwater 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 to traditionally use NT fish and aquatic life.

Most indigenous fishing activities occur close to communities and out-stations and are widespread across the northern part of the NT. Such activity occurs in inshore and estuarine waters (61% and 11%, respectively) and rivers (17%).

Most of NT 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 would seek permission before fishing in someone else’s country. Aboriginal customary fishing and hunting are undertaken according to season, which allows species to be targeted when in abundance and when in prime condition (Davis 1983).

Some areas of significance or 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 management tools that help protect species and habitats. Many indigenous groups continue to manage their resources, with some of the roles being undertaken by community, sea and marine rangers.

PLANNING AND CONSULTATION

The NT Government has identified a need to provide for greater indigenous participation in various economic development activities, including aquaculture, fishing tourism and wild harvest fishing ventures, creating long-term employment and producing positive economic and social outcomes. These outcomes can only be achieved by establishing new partnerships with indigenous communities while maintaining old ones, and by fostering a constructive working environment with Land Councils, indigenous organisations and the fishing industry to identify, negotiate and implement indigenous economic development opportunities in the fishing industry.

A number of indigenous strategies have been successfully implemented by the Department of Resources (DoR) over time, including:

- establishing and maintaining recreational fishing campsites on Aboriginal land;
- establishing agreements with 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 within DoR;

• establishing the NT Government-funded Indigenous Community Marine Ranger Program (ICMRP);

• funding from the Natural Heritage Trust for pilot trial of an indigenous survey for impacts on sharks and rays; and

• 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 DoR, using contemporary management approaches. Information obtained from AFCCs is incorporated into fisheries management decision-making processes. In addition, these committees provide Aboriginal communities with an avenue to voice their concerns to Government about matters relating to fisheries.

Information provided to indigenous communities through AFCC meetings increases indigenous engagement in commercial fishing, aquaculture, tourism, resource management and research.

Currently, there are three established committees in the NT, which meet on a regular basis. The composition of the Aboriginal members on each committee is determined by the relevant community. AFCCs also have representatives from the Police, Marine and Fisheries Enforcement Section (PMFES) of the NT Police, Fire and Emergency Services, DoR, the Amateur Fishermen’s Association of the NT, the NT Seafood Council and other government agencies when required.

Two AFCC meetings and a Marine Ranger Steering Committee meeting were conducted in Darwin and in local communities in 2008.

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 the NT’s aquatic resources.

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.

Indigenous representation also exists on individual Fishery Management Advisory Committees, which provide advice to the Director of Fisheries on sustainable fisheries management.

In the past few years, there has been an increase in the participation rate by indigenous people in the broader use of aquatic resources.

To further enhance the capability and knowledge sharing between Government and Aboriginal people, DoR 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 included the employment of indigenous apprentices. Since employing the first four indigenous apprentices in 2003, another 15 have been employed by DoR.

Four new indigenous apprentices were employed by DoR in 2008 under the
Apprenticeship Scheme. The apprentices develop skills in a wide range of areas in fisheries management and have completed qualifications in Certificate II and III Business Administration and Certificate III Seafood Industry (Aquaculture).

**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 Numbulwar.

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 provide a visual presence on water to help deter illegal fishing activities.

The marine ranger groups provide monthly reports of their coastal activities to DoR. Information contained in these reports is forwarded to other relevant agencies, such as PMFES and the Australian Customs Service, for further action or information. Over 150 patrols were undertaken by funded marine ranger groups in 2008.

The second marine ranger workshop was held in Maningrida in 2008, which provided an opportunity for marine rangers across the NT to meet and develop their skills. Additional 11 ‘field’ training exercises were conducted. These exercises included intelligence, surveillance and evidence gathering, as well as occupational health and safety requirements.

**ECONOMIC DEVELOPMENT**

Indigenous people make up about 30% of the NT population, 80% of whom live in remote or rural areas. Aboriginal identified land covers 84% of the NT coastline. In the past couple of years, there has been an increase in sustainable employment opportunities in remote areas. These opportunities have come through NT and Commonwealth-funded ventures in the fishing and aquaculture industries, as well as through ongoing support to ICMRP.

Many coastal community groups have ideal geographical locations and land ownership, which may be suitable for the implementation of new development and entry into existing activities in the fishing industry. The NT Government is committed to facilitating and enhancing partnerships with Aboriginal groups to increase economic development and employment opportunities.

A number of Aboriginal communities are actively involved in the commercial fishing industry with a number of groups or individuals owning licences, including Aboriginal Coastal, Coastal Net, Barramundi, Mud Crab and Aquarium fish/display licences.

Some Aboriginal groups and individuals have entered into agreements with Fishing Tour Operators for the use of land-based facilities established on Aboriginal land.

**SOCIAL BENEFITS**

Fishing is an important lifestyle activity for indigenous people in northern Australia and assists them to maintain a healthy diet. In part, fishing 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 out-stations.
The value of food collecting, hunting and fishing is important in maintaining the social cohesion of communities, with social networks 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.

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 exist relating 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 skills shortage in remote areas relating to the fishing industry. 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 needs to be implemented in remote communities. However, there also needs to be employment outcomes to complement any training. Fishing industry training that can also be applied to other jobs, thereby providing indigenous people with a range of career options, is necessary.

**Research**

The National Recreational and Indigenous Fishing Survey (NRIFS) was conducted in 2000-01 to better understand the level of fishing undertaken by the indigenous fishing sector in northern Australia. NRIFS showed that 20,700 indigenous people living in communities in the northern region of the NT went fishing. The most preferred fishing method was with lines, which represented 45% of all fishing events. Bait was used in preference to lures. Other popular fishing methods included surface spear-fishing, hand collecting and cast netting.

Indigenous people living in communities in the NT harvested over 1.5 million individual fish and other aquatic organisms, the most predominant species being mussels, which represented 35% of the total harvest. Other species taken included mullet (5% of total harvest), mud crabs (5% of total harvest), catfish (4% of total harvest) and barramundi (3% of total harvest).

Through the establishment of ICMRP, many indigenous groups are becoming more active in the monitoring of community fishing activities.

A Natural Heritage Trust (NHT)-funded survey titled 'Indigenous Fishing Impacts on Sharks and Rays' was conducted in 2008 in the Groote Eylandt region of the NT. The overall aim was to develop a best practice model for engaging indigenous communities in surveys relating to subsistence fishing and to determine the indigenous fishing harvest of sharks and rays.

The development of the pilot program involved consultation between NHT, the local Land Council, schools, and community and Government agencies to design the best methodology and to foster community ownership of the survey. The success of this project can be directed to the level of engagement by the local community and in particular, the lead role undertaken by the local Anindilyakwa Sea Rangers. It is anticipated that the results from this pilot study may provide information relating to the indigenous harvest rates of sharks and rays, which can be incorporated into future management decisions. A final report will be prepared in 2009.

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, as well juvenile mud crab locality, distribution and abundance. Further information on these projects can be found in the Timor Reef Fishery Status Report and the Mud Crab Fishery Status Report.

Manager, Indigenous Liaison and Economic Development – Mr Bo Carne

REFERENCES


INTRODUCTION

Recreational fishing plays an important role in the lifestyle of residents of the Northern Territory (NT), which has the highest level of recreational fishing participation per head of population than any other Australian state or territory. Fishing tourism is important to the NT and its economy. The success and growth of this industry is largely due to the number and size of barramundi available in the NT. More than half of all barramundi caught in Australia come from NT waters.

There are many extensive inland tidal river systems that provide world class sport fishing for barramundi from March to June when wet season flood waters recede from the flood plains to the sea. This is the peak barramundi season. 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 in coastal saltwater environments and freshwater billabongs at these times.

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 months, 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.

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 movement and the presence of saltwater crocodiles make boat fishing a safer, 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 further offshore at Fenton Patches. These structures are also 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. Most tournaments are barramundi-specific with rules that promote catch and release fishing. There are also various saltwater competitions that focus on other sport, game and reef fish. The Department of Resources (DoR) provides marshalling support at some of these tournaments.

The Amateur Fishermen's Association of the NT (AFANT) is the peak representative association for recreational fishing in the NT. The guided fishing tourism industry is represented by the NT Guided Fishing Industry Association (NTGFIA). The NT Government provides funding to AFANT and NTGFIA annually to assist them in their roles. In addition, DoR has a team dedicated to the management, development and promotion of
recreational fishing and the guided fishing industry in the NT.

DoR coordinates the River Watch Program, which is made up of volunteer proprietors located near key recreational fishing areas around the NT. River Watch Centres are located on the Mary, Daly, Roper, Victoria, McArthur, South and East Alligator Rivers. These volunteers provide literature and advice to anglers on recreational fishing and provide useful information to the NT Government about fishing or boating infringements as well as aquatic environmental issues, such as fish kills and noxious weed or animal infestations.

**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.

**Area**

Over 25% of all recreational fishing in NT waters occurs in Darwin Harbour, Shoal Bay and the offshore area adjacent to Darwin. About 40% of recreational fishing activity occurs in estuaries and 30% in rivers. A further 22% occurs within 5 km of the coast, 6% occurs further from the coast and 2% in impounded waters. The Mary River accounts for 11% of all hours fished, while all other areas individually account for less than 10% of hours fished.

![Figure 1. Recreational fishing line hours (time spent with lines in the water) by residents and visitors by area](image)

**Fishing Method**

More than 75% of all recreational fishing in NT waters is undertaken from boats. Eighty-four percent involves the use of lines. Artificial lures are used during half of all time spent line-fishing and bait is used during 41% of this time.

A combination of lures and bait is used for 10% of all time spent line fishing. Fifteen percent of fishing effort involves the use of pots and traps, but NRFSNT recorded very little use of cast nets, drag nets or other gear.
**Catch**

Of the 1.83 million aquatic organisms reported during 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 sought-after caught species by recreational anglers in NT. Over half of the barramundi caught by recreational fishers are released. Saratogas, 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 golden snapper, red emperor, coral trout, black jewfish, blue tusk fish, saddletail snapper, blue lined emperor, queenfish and trevally.

**Effort**

NRFSNT indicates 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 reduction from the average of eight days per year recorded during the 1995 survey, which was known as 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**

Fifty-five percent of all aquatic animals recorded during the NRFSNT period were released. This trend increased from 43% 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 has joined the Released Fish Survival Program, which advocates methods that enhance the survival of released line-caught fish. Similar agencies in other parts of Australia have also done so. The methods include the use of fish-friendly tackle, such as enviro-nets, release weights and circle hooks.

Studies by DoR revealed that at least 90% of lure-caught barramundi survive after release. 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.

**Ecosystem Impact**

Although no significant studies have been made on the effects of recreational fishing on natural NT ecosystems, no significant 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 coordinated by DoR also promotes environmental awareness in the fishing community.

**Social Impact**

Each year, about 40,000 (32%) non-indigenous residents of the NT engage in recreational fishing. NRFSNT found that 32% of anglers fish 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 previously stated, 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.
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 component.

Visitors to the NT contribute 25% of this amount.

The guided fishing tourism industry's annual contribution to the NT economy has never been formally assessed but is thought to be significant.

![Figure 2. Annual expenditure by survey zones](image)

STOCK ASSESSMENT

Monitoring

Broad-scale recreational fishing surveys were undertaken in 1986, 1995 and 2000-01. Another recreational fishing survey is scheduled for 2009.

Many research programs undertaken by DoR focus on the species that are important to recreational, commercial and indigenous stakeholders. Current research on 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 which are relevant to recreational fishing is provided in individual Status Reports in this publication.

Some recreational fishing tournaments provide DoR with catch and effort information, which assists in the understanding of barramundi populations within individual rivers fished. 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 log book returns by Fishing Tour Operators (FTOs). The combined research, survey and FTO data is 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 Status Reports.

Current Exploitation Status

The same data is used to monitor current exploitation levels, which are considered sustainable.

Future Assessment Needs

There is a need to obtain a better understanding of catch and effort in the recreational fishing sector. This will be done through a recreational fishing survey in 2009.

RESEARCH

Summary to Date

The first broad-scale survey of recreational fishing in the NT occurred in 1986. Fishcount 95 provided a more 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. Specific details on researched species are provided in individual Fishery Status Reports in this publication.

Incorporation into Management

Survey, research, monitoring and FTO data was considered before the closure of the McArthur and Adelaide Rivers to commercial barramundi gillnetting during drafting of the Cobourg Marine Park Plan of Management.

Current Research

Currently, the most significant research for the recreational fishing sector relates to barramundi, mud crabs, Spanish mackerel, black jewfish and sharks.

MANAGEMENT/GOVERNANCE

Management

Recreational fishing in the NT is managed by DoR through the Fisheries Act, Fisheries 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 (55cm) 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. Specific fishing controls apply at the East Point Aquatic Life Reserve and access restrictions apply at Stokes Hill Wharf. No fishing is allowed at the Doctors Gully Aquatic Life Reserve. In addition, a series of commercial fishing closures in key areas are designed, in part, to enhance the recreational fishing experience.

Currently, recreational fishers intending to enter waters within or abutting Aboriginal land must obtain a permit from the Northern Land Council to do so.

More information in relation to recreational fishing controls in the NT can be found in the Recreational Fishing Controls booklet from DoR or 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 McArthur River in 2002 and the Adelaide River in 2004. These closures have been implemented together with commercial fishing licence buy-backs.

**Barramundi Stocking**

To provide alternative recreational fishing opportunities, DoR continued its ongoing stocking of Manton Dam in 2008 with the release of approximately 32,168 barramundi fingerlings.

**Current Issues**

The resolution of area-specific pectoral conflict and the maintenance of existing access rights are the two main issues for recreational fishers in the NT.

**Future Plans**

The compilation of a development plan for recreational fishing will commence in 2009. It is envisaged that the draft plan will focus on future management and data collection, catch controls, access and infrastructure requirements, industry development, resource sharing issues and improving community stewardship of fishery resources. The plan will be compiled by a community-based working group and made available for public comment.

DoR is also working with NTGFIA to finalise a discussion paper to identify key issues facing the FTO industry and seeking comment on future management options to elevate service and safety standards and assist in the development of a professional, viable FTO industry in the NT.

**Compliance**

The Police, Marine and Fisheries Enforcement Section of the Northern Territory Police Fire and Emergency Services undertakes all fisheries compliance and enforcement in the NT.

A number of River Watch Centres are located throughout the NT at popular fishing locations. These centres play a valuable role in educating recreational fishers by providing information about recreational fishing rules and regulations in the NT. The River Watch Centres do not undertake any fisheries compliance or enforcement.

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 with AFANT and NTGFIA on recreational fishing issues and future management and development.

The Roper River and King Ash Bay are frequented by a lot of interstate visitors during the dry season months. In 2008, a recreational fishing education and awareness exercise was undertaken by DoR in the Gulf area. The primary purpose of this exercise was to promote fishing controls and educate interstate visitors.

Signage depicting fishery regulations and other advice is erected at boat ramps, launch sites and fishing tourism establishments throughout the NT. Information on recreational fishing in the NT is also available from DoR.

Education is conducted through presentations, workshops, show exhibitions, publications and the River Watch Program. Regional extension occurs in Katherine and Nhulunbuy with three-day junior fishing workshops during school
holidays. Literature on recreational fishing is also provided at various shows and exhibits throughout the NT.

DoR provided marshalling support to the NT Barra Classic and the Barra Nationals in 2008.

Aquatic Resource Management Officer, Recreational Fishing – Mr Phil Hall
Technical Officer, Recreational Fishing – Kane Dysart

REFERENCES


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 fishing tourism that was triggered by the NT Government’s decision to begin allocating barramundi resources in several key areas to the recreational fishing sector. The remarkably rapid growth of this industry induced the need for more formal management by the Department of Resources (DoR). Consultation with the industry led to the introduction of Fishing Tour Operator (FTO) licences in 1993 with licence numbers peaking at 218 in 1997. Licence numbers have since fluctuated between 108 and 168. In 2008, 145 FTO licences were issued.

FTOs operating in Kakadu National Park require an additional permit issued by the Commonwealth Department of Environment, Water, Heritage and the Arts (DEWHA).

Most FTOs target barramundi in coastal and inland areas with a few operating offshore, targeting other species from vessels, which range in size from small up to luxury mother ships.

Some FTOs operate full time while others supplement their income by guiding. FTOs and their clients observe the same fishery controls as recreational fishers and none of their catch may be sold or bartered.

PROFILE OF THE FISHERY

Area

Generally, FTOs operate in areas which are accessible to the 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 there are also resident FTOs based on most of the big tidal rivers, others are based on the various Aboriginal-owned islands that surround much of the NT’s coast. FTOs also operate from bush camps, lodges and commercial accommodations.

There are restrictions on the number of commercial operations allowed in specific areas managed by DEWHA and the NT’s Parks and Wildlife Service. These areas include Kakadu National Park and 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 of the FTO fishing activity is conducted using lines (rod) with bait, or trolling or casting with an artificial lure. The use of pots to harvest mud crabs is also popular.

Catch and Effort

There has been a general increase in barramundi fishing since 1995 although the total barramundi fishing line-hours have remained generally stable since 2005. In 2008, 77 893 line hours were dedicated to barramundi fishing.

Reef fishing has also increased since 1995, notably in the last four years (Figure 1). In 2008, 97 313 line-hours were dedicated to reef fishing compared with 69 310 line-hours in 2005. Over the previous four years, key reef fish species, like Spanish flag and tricky snapper, were a significant component of FTO catches (Figure 2), consistent with an increase in reef fishing.
The number of fish caught and released is recorded by species on FTO log returns, together with the number of hours each client spent per day with lines in the water. There has been a steady increase in fishing effort since 1994 with catch and release rates following a similar trend (Figure 2). Barramundi is one of the key species targeted by FTOs, consistent with the significance of barramundi as an iconic recreational species. Most (85% in 2008) of the barramundi caught by FTOs are released.
The number of each species caught and released by FTO clients is reported by FTOs in their daily logs, which are submitted to DoR monthly. Of all the different species of fish caught during 2008, 76% were released (Figure 3).

A consistently high release rate is one of the more notable attributes of the guided fishing industry, particularly for barramundi (Figure 4).

Figure 3. Catch, release and total line-hours, 1994 to 2008

Figure 4. Total barramundi catch, release and line-hours, 1994 to 2008
Non-retained Species

Generally, the guided fishing tourism industry operates in accordance with a culture of catch and release. That is, most of the caught fish are released into the water, uninjured and alive. The overall release rate for FTOs is 70% or greater, annually. FTOs report the number of each species their clients catch and release in their log returns.

Ecosystem Impact

No detrimental effects on ecosystems were linked to the guided fishing tourism industry.

Economic Impact

The guided fishing tourism industry's annual contribution to the NT's economy has never been formally assessed. While the number of client days is reported by FTOs in their log returns, variable day rates charged by different operators make such an assessment difficult. However, this is clearly a significant industry which generates considerable income for the NT.

Social Impact

There has been a consistent increase in Australian clients to the NT for guided fishing tourism since 1994. The number of Australian FTO clients increased from 30,144 in 2007 to 31,676 in 2008. Most of these clients were from Victoria (8,790 in 2008), the NT (8,127 in 2008) and New South Wales (6,924 in 2008). Figure 5 shows Australian FTO client trends from 1994 to 2008.

Figure 5. Client origin and numbers from 1994 to 2007 (note international clients not included)

STOCK ASSESSMENT

Monitoring

The guided fishing tourism industry is monitored primarily through the logbook return information. Annual log data summaries are compiled to show the number of each species caught and released, fishing methods used and areas fished.
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 document.

Current Exploitation Status
Refer to Figure 1 for the annual numbers of the different fish caught and released.

Future Assessment Needs
The FTO log return system provides essential data to fishery managers. These are combined with data from recreational fishing surveys to provide a comprehensive overview of the NT’s recreational fishing sector.

RESEARCH
Summary
All fisheries research on recreationally significant species is important to FTOs. The current relevant research programs focus on golden snappers, jewfish barramundi, sharks, Spanish mackerels and mud crabs.

Incorporation into Management
Assessment of FTO and recreational fishing survey data, combined with outcomes from various applicable research programs are considered when decisions are made regarding fishery area restrictions, regulation amendments, infrastructure developments and land and native title claims.

Current Research
Spanish mackerel migration is being investigated through gene tagging research.

Market monitoring of adult mud crab size frequency, sex ratio and mating success continues and provides information of relevance to the FTO sector. A two-year collaborative juvenile mud crab monitoring program began in 2008.

The study of barramundi numbers, size and recruitment continues annually on the Mary River.

Results released in 2008 from a study on the effects of suspending barramundi using jaw gripping devices showed that larger barramundi lifted by these devices without any additional support received significant spinal injuries. Educational material promotes correct handling procedures to support the fish in a way to minimise injuries.

MANAGEMENT/GOVERNANCE
Management
Objective
The primary management objective for the guided fishing tourism industry is to ensure that it is developed and managed in a sustainable manner.

History
In the mid 1980s, guided fishing tourism began to increase. By 1989 there were 24 guided fishing businesses in the NT. FTO licences were introduced in 1993. They were issued by DoR free of charge until the 2007 licensing year. Licence numbers are not limited. Figure 6 illustrates the number of actively-operated FTO licences annually compared with the number of licences issued.
**Future Plans**

DoR and NTGFIA have jointly developed a discussion paper on the issues facing the industry. This includes matters such as operator qualifications, vessel survey requirements and licensing framework. It is intended that the issues paper will be released for industry and public comment in 2009, and that the outcomes will guide management for the next five to 10 years. The aim of the review is to ensure a professional and viable FTO industry that operates within a sustainable fisheries framework.

**Compliance**

The Police, Marine and Fisheries Enforcement Section of the NT Police, Fire and Emergency Services is responsible for the monitoring and enforcement of fishery regulations.

There were no reported fishery-related infringements by FTOs in 2008.

**Consultation, Communication and Education**

The establishment of NTGFIA enhanced consultation and communication between Government agencies and the industry.

Aquatic Resource Management Officer, Recreational Fishing – Mr Phil Hall
Technical Officer, Recreational Fishing – Mr Kane Dysart
INTRODUCTION

The Aquatic Biosecurity program performs an important role in helping to protect the Northern Territory (NT)’s valuable aquatic resources, habitats, and fishing and aquaculture industries from introduced aquatic pests.

Aquatic Biosecurity 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 an aquatic resource surveillance program to detect introductions of aquatic pests to the NT;
- document natural changes in the abundance and species composition of marine fouling communities;
- coordinate the inspection and treatment of high-risk vessels;
- provide a contact point for reporting potential pest species observed in the local environment;
- provide an emergency response to detected introductions of exotic species;
- represent the NT in national forums that address the prevention and management of introduced aquatic species;
- coordinate the implementation of national arrangements that will provide Australia with a coordinated approach to aquatic pest issues; and
- raise public awareness of the threat of aquatic pests through educational activities.

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 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 the variety of species of fauna and flora has the potential to dramatically impact on these social values.

Economic Impact

The introduction and establishment of aquatic pests has potential for a significant negative economic impact on the NT. Establishment of aquatic pests may reduce the productivity of fisheries resources and increase expenses associated with maintenance and amelioration costs. Such costs may 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 marine pests may restrict the entry of vessels from infested ports.
ENVIRONMENTAL ASSESSMENT

Water quality and species diversity monitoring 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 data is available for Bayview Marina from the time the marina was first filled with water in November 2000. Such data documents variations in water quality and species diversity.

In 2008, no known marine pests were detected in Darwin Harbour and marinas, or at Milner Bay (Groote Eylandt), Garden Point (Melville Island) or Gove Harbour.

Biological Monitoring

Monitoring of marine bio-fouling organisms continued during 2008 with assistance from local industry. In Darwin, monitoring is undertaken by Aquatic Biosecurity at sites within each of Darwin's locked marinas and at open water locations in Darwin Harbour. Monitoring at locations along the NT coastline is conducted by Aquatic Biosecurity with assistance from industry: Gove Harbour (Rio Tinto Alcan Pty Ltd), Milner Bay (Groote Eylandt, GEMCO), and Garden Point (Aspley Strait, Melville Island – Great Southern Plantations).

Results

No recognised marine pest species were found at any of the locations monitored during 2008.

Differences in the species colonising artificial settlement surfaces are most apparent when comparing enclosed marina sites 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 taxa 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 the tidal regimes and water exchange that characterise open-water environments. Further, they are subject to concentrated vessel movements, which expose them to an increased likelihood of marine pest incursion.

Nuisance fouling and marine pest species include those which are able to colonise vessel hulls quickly and are able to survive long journeys across climatic ranges. As a result, these species are likely to establish within marinas. What separates the two groups is their impact on establishment on the environment and the economy. Several well known marine bio-fouling organisms which are cosmopolitan in distribution, (that is, recorded from many ports around the world) are frequently recorded from Darwin marinas and include the polychaetes *Hydroides sanctaecrucis* and *H. elegans*, the barnacle *Balanus Amphitrite*, the bryozoans *Bugula neritina* and a *Bowerbankia species*. These species are not often recorded outside marinas but when they are, are in much smaller numbers.

In Darwin’s marinas, the fouling community is often dominated by blooms of single species. The most common types of organisms are barnacles and polychaete tube worms. Both these have a calcareous structure and are able to form large quantities of hard fouling matter in short time frames and colonise hard substrates including boat hulls.
Coordinated Marine Pest Monitoring by Remote Coastal Communities

In January 2007, Aquatic Biosecurity commenced a Natural Heritage Trust (NHT) project to build on current monitoring activities by including remote indigenous communities in coordinated marine pest monitoring activities. The project was finalised in late 2008 and engaged five established indigenous marine ranger groups: Anindilyakwa (Groote Eylandt), Djelk (Maningrida), Gumurr Marthakal (Galiwinku), Li-anthawirriyarra (Borroloola) and Tiwi (Tiwi Islands).

The locations and communities included in the project were selected based on the perceived risk of marine pest introductions into those areas. Current marine pest vectors operating in the NT (such as foreign fishing vessels, marine debris and vessel traffic) and gaps in the current Aquatic Biosecurity monitoring program were the keys factors considered when selecting locations.

Although the NHT-funded project has been completed, the processes established through it now form part of Aquatic Biosecurity’s ongoing monitoring program. With assistance from the Department of Resources (DoR) Indigenous Fisheries Development unit, training in marine pest awareness continues where marine rangers are encouraged to become involved in regular monitoring activities.

Educational materials (brochure, poster and marine pest identification cards) developed for use in remote communities and a technical report on the project, are available on the Aquatic Biosecurity part of the Fisheries website.

Water Quality Monitoring

Water quality in the marinas varies seasonally and is largely driven by freshwater run-off 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 gained 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 locked 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.

The bivalve mussel 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.
In recognition of the vulnerability of Darwin Harbour to invasion by exotic organisms and its status as a primary port and popular tourist destination, Aquatic Biosecurity was established. 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 onboard plumbing of vessels arriving in Darwin from international locations (usually South-East Asia). These vessels have included apprehended illegal foreign fishing vessels (FFVs), recreational cruising yachts and commercial vessels, such as rig tenders and tug boats. In such instances, the vessels were treated appropriately to mitigate the pest risk, in consultation with other relevant Commonwealth and local government departments.

Aquatic Biosecurity has also controlled populations of non-native fish and invertebrates on numerous occasions. 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 2008. Most of them were of no concern as they were native or widely-distributed oceanic species. Three reports, however, were of great concern and related to recognised marine pest species on both recreational and commercial vessels. In January, over 1200 individual Asian green (*Perna viridis*) and Asian bag (*Musculista senhousia*) were detected in the sea-chests and internal plumbing of a motor cruiser. The vessel’s hull had been cleaned in Singapore prior to its transit to Darwin. In June, a sailing vessel arrived in Darwin from South-East Asia (including Malaysia and Singapore) with over 250 Asian green mussels on its hull. The third detection of Asian green mussels (over 400 individuals) occurred in September 2008 on the hull of a tug boat. Mussels were also reported in the seawater systems of the vessel. Similar to the other two vessels, this tug boat had also recently visited Singapore.

In all instances, the identity of species was confirmed by the Curator of Molluscs at the Museum and Art Gallery of the NT. In view of the risks posed to the Darwin Harbour environment, the vessels were ordered to be removed from the water for cleaning at local slip yards.

Ten freshwater pest reports were received in 2008. Some of the reports were investigated but no evidence was found of pest fish populations.

As in previous years, established populations of popular small ornamental fish, such as guppies (*Poecilia reticulata*) were found in drainage creeks in urban locations in the Darwin region. Guppies are an exotic fish which can compete with native species and impact on the ecosystem. Overflow from backyard ponds in the surrounding residential areas during wet season rainfall is the most likely pathway for the introduction of these feral fish. Attempts were made to eradicate the exotic pest fish during the dry season while water levels were low. Monitoring during the 2008-09 wet season will determine if the eradication was successful.

Marine Rangers across the NT coastlines submitted seven samples of suspected aquatic pests found attached to marine debris. In all cases, the samples were found to be native species. Most of these samples were lodged with the Museum and Art Gallery of the NT and have contributed to the knowledge of species distribution in these remote areas of the NT coastline.
The Wanga Djakamirr Marine Rangers at Ramingining successfully located and collected a native mussel (*Arcuatula japonica*) from mudflats. This native mussel is similar in appearance and is closely related to the Asian bag mussel (*Musculista senhousia*), a recognised marine pest species. Marine scientists across northern Australia had, for some months, been attempting to collect fresh specimens of *Arcuatula japonica* without success. These scientists have been working on methods to improve detection capability of marine pests in port surveys. A genetic probe is being developed to reliably distinguish between the marine pest *Musculista senhousia* and closely-related (and genetically similar) native mussels, such as *Arcuatula japonica*. Biological material from the samples collected by the Wanga Djakamirr Marine Rangers at Ramingining was forwarded to the relevant agencies conducting the research.

### Future Assessment Needs

With the expansion of port industries and the associated increase in shipping movements, as well as the transient nature of the 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 populations of native fish, including iconic species, such as barramundi.

It is therefore important to continue collecting 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 internationally-travelled vessels entering Darwin marinas and apprehended vessels.

Vessels transiting international waters can transport exotic species as fouling, either on the hull or in the internal pipe-work of the vessel. In addition to those vessels arriving from international waters, vessels arriving in Darwin that have spent a significant time in the Port of Cairns also pose a risk due to previous detections of the Asian green mussel (*Perna viridis*) in the Port of Cairns. The ease with which Asian green mussels may be transported by vessels puts vessels from Cairns in the higher risk category.

Marinas are recognised as being at greater risk of marine pest establishment because they are frequented by high-risk vessels and are subject to extremes in environmental conditions. Although the vast majority of vessels entering marinas are recreational cruising yachts, they also include commercial fishing vessels and tugboats.

Vessels apprehended for illegal activities originate from, or have transited in, areas known to be inhabited by potential aquatic pest species. A subgroup of this class, Iceboats from the Province of Probolinggo in East Java, were declared an extreme risk as a high proportion of them had hulls infested with either black-striped or Asian green mussels.

#### Current Issues

The two vessel categories mentioned above continue to be of concern and the inspection and treatment of high risk vessels entering Darwin marinas continues with the cooperation of marina management.
COMPLIANCE

Vessels intending to enter Darwin marinas are required to undergo an inspection prior to being permitted entry. With assistance of lockmasters, compliance has been excellent. The entry requirements are providing a basis for the development of national protocols to minimise the introduction of marine pest species into Australian waters.

In 2008, 173 vessels were inspected compared with 141, 153 and 135 in 2007, 2006 and 2005, respectively (Figure 1). The number of recreational vessels inspected each month clearly highlights Darwin’s dry season tourism peak.

Figure 1. Total number of vessels inspected prior to marina entry each month, 2005 to 2008

In addition to recreational vessel inspections, FFVs apprehended off the northern Australian coastline and destined for the Ports of Darwin and Gove are examined for the presence of aquatic pest species.

Incorporation into Management

From 2000, DoR coordinated the inspection of FFVs in Darwin and Gove, resulting in the detection of the black-striped and Asian green mussels on numerous occasions. The Commonwealth Government, through the Australian Fisheries Management Authority (AFMA) and the Australian Quarantine Inspection Service (AQIS), assumed responsibility for these inspections in early 2007. All high risk vessels are inspected outside port limits by commercial divers contracted by AQIS. DoR is consulted on decisions that impact on inspection protocols.

Future Plans

The National System for the Prevention and Management of Marine Pest Incursions (NSPMMPI) has been 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 vectors such as hull fouling and ballast water. NSPMMPI will address such pathways by implementing both regulatory and non-regulatory components. Planning for the implementation of NSPMMPI is progressing in consultation with industry groups. The associated transition from current arrangements will impact on Aquatic Biosecurity activities and require appropriate planning and communication with affected stakeholders.
A marine pest website has recently been launched which provides details about NSPMMPI and contains resources for various industry sectors (http://www.marinepests.gov.au/).

The aquarium trade in marine species is also included in NSPMMPI. However, freshwater species fall outside the terms of reference. The management of freshwater feral fish is incorporated in the Australian Pest Animal Strategy.

Consultation, Communication and Education

Vessel inspection and treatment protocols were developed in consultation with fishing industry members, marina owner/operators, ship repair and maintenance facilities and Commonwealth agencies, such as the Australian Customs Service, the Australian Defence Force, AQIS and AFMA. Information from ongoing environmental monitoring is regularly reported to stakeholders and is available via the DoR website and on request. Brochures outlining general marine pest information and vessel inspection protocols have been 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. They 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.

Contact numbers to facilitate the reporting of aquatic pest sightings have been widely publicised via brochures, posters and the website. In 2008, Aquatic Biosecurity received 32 reported sightings of aquatic pest species, comprising 15 marine species, ten freshwater species and seven samples from remote coastal locations sent in by marine rangers.

There is a need to conduct further public education initiatives in relation to aquatic pests in freshwater systems and improve access to native aquarium species and local bait supplies. The use of native species in aquaria and ponds, as opposed to exotics, will 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 preventing the establishment of these invasive fish in the NT. Early detection will largely depend on well-informed and alert local community members.

Manager, Aquatic Biosecurity – Ms Helen Cribb
The Fisheries Licensing Section of the Department of Resources grants and renews licences and permits under Section 11 and 15 of the *Fisheries Act 1988*. In 2008, 1095 licences 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. a 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.

### Table 1. The number of licences and permits issued in 2008

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<th>Licence type</th>
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<tr>
<td>A2 – Coastal Net Fishery licence</td>
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<td>A14 – Development Fishery licence</td>
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<td>A15 – Restricted Bait Entitlement</td>
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<td>C1 – Aquaculture licence</td>
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<td>Licence type</td>
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<td>-------------------------------------------------</td>
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<tr>
<td>C2 – Pearl Oyster Culture licence</td>
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<tr>
<td>D1 – Aboriginal Coastal licence</td>
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<td>D2 – Fishing Tour Operator licence</td>
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<td>D3 – Aquarium Trader licence</td>
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<td>D4 – Net licence</td>
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<td>D5 – Public Aquarium licence</td>
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<td>D14 – Development permit</td>
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<td>S16 – Permit</td>
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<tr>
<td>S17 – Special permit</td>
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<tr>
<td><strong>Total number of licences and permits issued</strong></td>
<td><strong>1095</strong></td>
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FISHERIES COMPLIANCE STATUS REPORT 2008

INTRODUCTION

The Police, Marine and Fisheries Section (PMFES) of the Northern Territory (NT) Police, Fire and Emergency Services (NTPFES) is responsible for the administration of all fisheries compliance and enforcement in the NT.

The Roles of PMFES

The vision of NTPFES is ‘a safe and secure NT’ by ‘working in partnership to reduce crime and enhance community confidence’. PMFES is responsible for achieving this objective in marine and coastal environments. The role of PMFES is to:

- ensure management of the fish stocks of the NT through compliance and enforcement;
- ensure compliance with marine safety requirements;
- provide an effective marine search and rescue capability;
- maintain the NT Police Underwater Recovery Unit.
- provide security for visiting foreign warships;
- provide training, education, advice and support to NTPFES in relation to marine matters;
- provide training, education, advice and support to external stakeholders; and
- maintain the NT Police vessel/outboard replacement program.

Working in Partnership

PMFES works with the Department of Resources (DoR) to develop educational material and programs to increase compliance with NT fisheries legislation. In addition, PMFES works with DoR to develop and provide training to community coastal marine ranger groups, and ongoing support and advice.

PMFES has a position on all Fishery Management Advisory Committees and attends Aboriginal Consultative Committees as required.

Current Status

In 2008, 304 fisheries related patrols equating to 4408 patrol hours were undertaken by PMFES incorporating both short-range and long-range intelligence-led targeted patrols. The areas patrolled included:

- the Darwin and Bynoe Harbours and Shoal Bay;
- the Tiwi Islands;
- the Daly and Finniss River systems, Charles Point and Dundee Beach;
- the Victoria, Adelaide and Mary River systems;
- the Gulf of Carpentaria from Port Roper to Calvert River, including the Roper and MacArthur River systems; and
- Kakadu, including South and East Alligator Rivers, Wildman River, including Pocock’s Beach and West Alligator Head.

In 2008 the number of contacts made with commercial, recreational and fishing tour operators increased to 4469 compared with 3795 in 2007. Random checks were carried out on catch, gear and licences (where applicable) as well as general compliance with other relevant fisheries legislation.
Detected offences included unlicensed fishing, fishing in closed areas, failure to be in attendance of fishing gear, possession of undersized fish, exceeding possession limits, and gear entitlements and failing to submit returns.

In 2008, a total of 225 warnings (142 in 2007) and seven Fisheries Infringement Notices (11 in 2007) were issued; 71 persons (62 in 2007) were summoned to appear in court.

PMFES carried out a number of capacity-building exercises during 2008 with NT marine ranger groups. The exercises primarily focused on evidence and intelligence collection, surveillance techniques and statement preparation.

**Future Plans**

PMFES will continue to focus on increasing the level of compliance by commercial, recreational and fishing tour operators with applicable fisheries legislation. PMFES will also continue to work with DoR to provide training, support and advice to marine rangers throughout the NT.
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>ACIAR</td>
<td>Australian Centre for International Agricultural Research</td>
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<td>ACS</td>
<td>Australian Customs Service</td>
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<td>ADF</td>
<td>Australian Defence Force</td>
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<td>AFANT</td>
<td>Amateur Fishermen’s Association of the NT</td>
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<td>AFCC</td>
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<td>Australian Fisheries Management Authority</td>
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<td>Australian Fishing Zone</td>
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<td>APM</td>
<td>Aquatic Pest Management</td>
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<td>Australian Quarantine and Inspection Service</td>
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<td>Barramundi Fishery Advisory Committee</td>
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<td>CPUE</td>
<td>Catch per unit effort</td>
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<td>Cooperative Research Centre</td>
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<td>CSIRO</td>
<td>Commonwealth Scientific Industrial and Research Organisation</td>
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<td>Environmental Management Plan</td>
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<td>Geographic Information System</td>
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<td>Illegal, Unreported and Unregulated fishing</td>
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<td>SMFMAC</td>
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<td>WTO</td>
<td>Wildlife Trade Operation</td>
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APPENDIX 2: CURRENT CONTACT DETAILS

General Enquiries

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