Northern Territory Government

Fishery Report No. 87

Fishery Status Reports 2006

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Fishery Status Reports 2006

Department of Primary Industry, Fisheries and Mines

Fishery Report No. 87

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Contents

Introduction

The waters of the Northern Territory (NT) hold an abundance of aquatic life which is underpinned by the pristine nature of much of the environment. A key avenue by which NT Fisheries, within the Department of Primary Industry, Fisheries and Mines, reports publicly on the status of these aquatic resources is through the annual publication of Fishery Status Reports. I am therefore pleased to release the Fishery Status Reports 2006, the seventh publication in the series.

The 2006 Report provides detailed information on the NT's wild harvest fisheries, the aquaculture industry, recreational and fishing tourism sectors, indigenous fishing activities and aquatic pest management. It also provides an overview of the types and numbers of licences issued for the 2006 calendar year. Individual reports include information on the ecological sustainability of each fishery as specified under the Australian Government's *Environment Protection and Biodiversity Conservation Act 1999*.

The 2006 report also provides an opportunity to highlight the diverse range of projects and activities undertaken by NT Fisheries, a selection of which are detailed in the document.

As in previous years, the Fishery Status Reports provide a detailed insight into how Fisheries manages the NT's valuable aquatic resources on behalf of all Territorians. I trust you will find the information contained in the 2006 edition valuable.

Heather Brayford

Executive Director, Fisheries

Department of Primary Industry, Fisheries and Mines

NT Fisheries – 2006 Highlights

Economic Value

- In 2006, the gross value of production (GVP) at the point of first sale from wild stock harvest fisheries and aquaculture activities in the NT was $28.2m and $26.8m, respectively.
- The three highest catch value wild harvest fisheries in the NT in 2006 were barramundi ($5.3m), mud crab ($4.7m) and shark ($4.3m). Other high catch value fisheries include finfish trawl, Timor Reef and Spanish mackerel.
- The two highest production value aquaculture activities in 2006 were pearling ($18m) and barramundi farming ($4.7m).

Fisheries Management

- Finalised the northern operational plan for sharks.
- Began buyback of coastal net and bait net fishery licences.
- Began formal review of fisheries legislation.
- Completed an ecological risk assessment for the aquarium fishery.
- Developed a Memorandum of Understanding with the Commonwealth Government to ensure a complementary approach to the northern regional planning process.

Aquaculture

- Advanced commercialisation trials for mud crab aquaculture with industry and indigenous partners.
- Developed a Memorandum of Understanding with the Western Australian Government to ensure (to the extent possible) a consistent and complementary approach to management of the pearling industry.
- Continued hatchery and tank-based juvenile rearing trials for sea cucumber.
- Continued support for pilot-scale mud crab grow-out farm and demonstration site on indigenous land in Darwin.
- Continued support for a pilot-scale mud crab ranching venture at Maningrida.
- Produced more than 1.5 million barramundi fingerlings; excess fingerlings were used to stock Territory impoundments.
- Expanded indigenous economic extension activities.
- Continued to support the investigation to detect and manage nodavirus in barramundi by hosting and partly providing financial support to two PhD students.
- Finalised policy for controlling the movement of aquatic animals into and within the NT.

Aquatic Research

- Conducted a GIS spatial statistics and fuzzy-rule based modelling workshop.
- Conducted the 2006 ‘Barracade’ research project on the Mary River.
- Continued ‘Genetag’ genetic mark-recapture monitoring for the Spanish mackerel fishery and secured further Fisheries Research and Development Corporation (FRDC) funding.
- Began field work on a collaborative project to investigate the stock structure of grey mackerel.
- Finalised a project to assess grey mackerel stocks in the NT and Queensland.
- Continued work on a collaborative research project to develop tagging as a monitoring method for NT shark fisheries.
- Adopted a new three-directional approach for mud crab research.
- Continued a study into artisanal shark and ray fisheries.
- Completed field research work to support habitat mapping, ageing and acoustic tracking of black jewfish.

Recreational Fishing

- Further developed recreational fishing opportunities through the access and infrastructure program.
- Continued stocking barramundi fingerlings in Lake Bennett, Manton Dam and Lake Todd.
- Funded an executive officer position to establish an industry association for fishing tour operators.
- Delivered three day recreational junior fishing workshops at Katherine, Nhulunbuy and Yirrkala.
- Provided logistical support for the NT's major annual fishing tournaments.

Indigenous Fishing

- Continued to expand the indigenous consultative network and indigenous economic extension activities.
- Informed indigenous constituents of business opportunities related to the fishing and tourism industries.
- Fostered the northern Australian indigenous fisheries networks.
- Continued to support the NT indigenous marine ranger program with extensive training.
- Successfully secured additional funding from the Commonwealth for the Djelk Ranger program in Maningrida. Customs signed a 12-month service level agreement with NT Fisheries and Djelk Rangers.
- 'Gifted' three seized fishing vessels to marine ranger groups to enhance their surveillance capability.
- Launched the indigenous community Marine Ranger Program information booklet.
- Employed an indigenous Marine Ranger Coordinator with NT Fisheries, which led to the employment of another indigenous apprentice.

Aquatic Pest Management

- Successfully maintained the aquatic pest monitoring program with assistance from private industry.
- Maintained involvement in, and representation of, the NT on the National Introduced Marine Pests Coordination Group and the Consultative Committee on Introduced Marine Pest Emergencies.
- Fourteen marine and freshwater pest reports were received and investigated.
- Black-striped mussels and Asian green mussels were successfully detected on the hulls of three apprehended illegal fishing vessels during routine inspections. The pests were successfully eradicated using a novel method.
- Successfully applied to Natural Heritage Trust (NHT) for funding to involve remote indigenous communities in marine pest monitoring.

Data Collection

- Collected, recorded and validated all 2006 commercial catch and fishing tour operator data used for reporting purposes to assist with research and management activities targeting the Territory's aquatic resources.
- Maintained database for retrieval of logbook data information for report generation and assessment.
- Provided advice required for the issue and renewal of licences, registrations and permits.

Wild Harvest Fisheries

Aquarium Fishery Status Report 2006

Introduction

The Northern Territory (NT) Aquarium Fishery is a small scale, multi-species fishery operating in inland waters and waters seaward from the coastline to the outer boundary of the Australian Fishing Zone (AFZ).

The abundant and diverse tropical flora and fauna of the NT corresponds to significant potential for the development of the Aquarium Fishery. 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 Aquarium 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. Over the past 10 to 15 years new technology has provided significant improvements in harvesting techniques. Improved packaging and transportation have enabled the industry to cater for the needs of a growing interstate market, as well as for a potential export market.

The NT Aquarium Committee (NTAC) was established in 2003 to provide a formal mechanism to achieve a review of the Aquarium Fishery and devise an approach to capitalise on the recognised potential of the local industry. Subsequently, a review was conducted of the collection of coral and associated benthic species and proposed future management arrangements, to promote development within the principles of ecologically sustainable development (ESD).

In 2004, a report was submitted to the Australian Government Department of Environment and Heritage (DEH), now known as the Department of Environment and Water Resources (DEW), to assess the management arrangements of the fishery against the *Guidelines for the Ecologically Sustainable Management of Fisheries*. The fishery was subsequently declared an approved Wildlife Trade Operation (WTO) under the Commonwealth *Environment Protection and Biodiversity Conservation Act* (the 'EPBC Act'). The WTO declaration endorses the export of product from the sustainable fishery for a period of three years. A further review will occur in 2008.

Profile of the Fishery

Commercial Sector

In 2006, 21 licences were issued for the Aquarium Fishery. Eight were aquarium trader licences that allow holders to trade aquarium species, but do not permit them to collect stock from the wild. The remaining 13 were aquarium fish/display licences that permit the collection and sale of all aquatic life, including freshwater and marine fishes, plants and coral. Only seven licences were active in 2006.

Following the 2004-05 review of the fishery, all of the 13 aquarium fish/display licensees are now able to collect strictly limited quantities of coral and associated benthic species.

Area

Licensees in the Aquarium Fishery may harvest from all inland and marine waters to the outer boundary of the AFZ. However, harvesting is not permitted in a number of designated protected areas, such as Doctors Gully and East Point Aquatic Life Reserves, in the Darwin Harbour area and other areas, such as Aboriginal sacred sites and farm leases.

Most freshwater and estuarine fish and prawns 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 some also occurs in the greater Darwin area.

Some licensees are permitted to harvest up to 1000 undersized barramundi (less than 55 cm long). The harvesting of Spanish mackerel and mud crab is not permitted without specific approval.

Coral and associated benthic species can be collected from anywhere in the NT with the exception of Managed Areas, Marine Reserves, Darwin Harbour and Gove Harbour as detailed in the conditions on each licence.

Fishing Method

Aquarium Fishery licensees are entitled to use barrier, cast, scoop, drag and skimmer nets, hand pumps, freshwater pots and hand held instruments for collecting aquarium species. However, the licensee or an assistant must attend nets whenever they are used.

Catch

Since 1995, over 1.3 million individual aquatic organisms (excluding shrimps) have been harvested by licensees working in the Aquarium Fishery.

The quantity of organisms harvested has variously been recorded by weight or the number of individuals and is presented as such in Tables 1 and 2, as it makes little sense to convert one to the other.

Coral and anemones comprised much of the invertebrate harvest in 2006. Approximately 540 kg of live rock (mostly pieces of dead hard coral that has detached from the reef and has been colonised by other organisms) was taken. Almost 25 000 hermit crabs were also harvested. Some small shrimp (*Acetes* spp.), which occur in massive numbers at certain times of the year, were also collected. A small number of giant clams (only *Tridacna squamosa*) were collected in 2006.

Eel-tailed catfishes, mainly *Neosilurius ater*, were the most popular group of fish taken, followed by blue eyes and archerfishes. All the fish taxa specifically listed in Table 2 are widespread and abundant in the NT.

Table 1. Invertebrates taken during 2006 in the Aquarium Fishery

Invertebrates	Harvest
Coral + anemone	1091 kg + 2349 individuals
Live rock	539 kg
Hermit crab	24 770 individuals
Other crustaceans shrimp others	148 kg + 312 individuals
Giant clam	451 individuals
Other molluscs	499 individuals
Other invertebrates	320 individuals

Table 2. Fish taken during 2006 in the Aquarium Fishery

Fish	Harvest (Individuals)
Eel-tailed catfish (Family Plotosidae)	7980
Blue eyes (*Pseudomugil* spp.)	5120
Archerfish (*Toxotes* spp.)	4524
Red scat (*Scatophagus argus*)	4357
Glassfish (*Ambassis* spp.)	3040
Rainbow fish (*Melanotaenia* spp.)	2473
Gudgeons (Family Eleotridae)	2391
Silver scat (*Selenotoca multifasciatus*)	2358
Saratoga (*Scleropages jardinii*)	1206
Other	4263

Effort

It is difficult to quantify effort within the Aquarium Fishery due to the wide range of species targeted, each with its own specific harvest technique, and inconsistencies between fishers as to what is considered to be ‘one day’ of fishing effort.

Marketing

Advances in affordable aquarium technology have led to significant growth in the demand for a wider range of aquarium species for private aquaria, including corals, sponges and live rocks, in addition to freshwater fish species. Most of the local Aquarium Fishery harvest is exported interstate by air freight.

Recreational Sector

There are no specific regulations on collecting fish for personal aquaria other than recreational fishing rules and regulations on 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.

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 amount taken by the recreational sector for aquarium purposes is unknown, but is assumed to be very low. Surveys of recreational fishers in 1995 and 2000 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 by-catch within the Aquarium Fishery primarily due to the highly selective fishing methods employed and the condition placed on licensees requiring them to immediately return all non-target species to the water with as little damage as possible. Fisheries observers accompanying licensees during their harvesting activities in previous years have verified the extremely low by-catch and mortality rate for all species caught within this fishery.

Threatened Species Interaction

The Commonwealth *EPBC Act* requires fishers to make a report to DEW within seven days of becoming aware of any interaction with listed, protected, endangered and threatened species found in Commonwealth waters.

In 2006, there were no recorded interactions with any threatened species of mammal, reptile, amphibian or bird as listed by the Parks and Wildlife Commission of the NT.

Hard corals and giant clams are the only two groups of organisms targeted by operators in the Aquarium Fishery that are listed on the Convention on International Trade in Endangered Species (CITES). While listed under CITES, low numbers of these species are allowed to be harvested, and their collection is considered to be within acceptable sustainability limits for the fishery. A number of natural factors provide protection to these two groups, including the extensive area of the fishery, seasonal closures and the wide distribution of the species.

Ecosystem Impact

The current harvest is considered to fall well within an extremely precautionary management approach to the sustainable utilisation of a valued natural resource.

The potential for the Aquarium Fishery to impact on the environment is limited as a result of the nature of the industry and the unique climatic and regional characteristics of the NT. The monsoon season 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 the majority of effort being observed around Darwin and Nhulunbuy.

Operators within the fishery are also constrained by limited access to more than 70 per cent of the NT due to restrictions imposed by Aboriginal and private ownership of land, National Parks and Northern Territory Conservation Parks regulations and marine exclusion zones.

All of these factors combine to provide extensive "protection zones" inaccessible for commercial or recreational exploitation.

Social Impact

The harvesting of coral in areas adjacent to major population centres is a significant issue for NT Fisheries largely due to a general lack of community awareness regarding the real impacts of coral harvesting. In an effort to minimise social conflict, NT Fisheries and the NTAC have negotiated for the closure of both Darwin and Gove Harbours for the purposes of coral collection.

Economic Impact

The catch value for the Aquarium Fishery is not available for the 2006 calendar year. However, previous data indicates that in 1998, the catch value of the fishery was worth between $600 000 and $700 000. It is safe to assume with the increase in quantity and quality of aquarium species now harvested that the current value of the fishery is far greater.

Stock Assessment

Monitoring

The Aquarium Fishery is monitored in two ways. Firstly, licensees are required to complete and submit monthly logbook returns reporting catch and effort data from their operations. Secondly, NT Fisheries staff undertake observer trips. The associated monitoring provides significant information on the areas that are fished, the capture methods used and also identifies which are the more common aquarium species targeted by licensees at a particular point in time.

NT Fisheries staff were unable to undertake any observer trips in 2006. However, observer monitoring will continue in this fishery, focusing on the species of corals collected, the collection methods used and the areas from which they are collected. The aquarium industry has shown a willingness to participate in the increased monitoring needed in this fishery as part of the Commonwealth ESD process.

There is a need for finer-scale spatial reporting in order to improve the ability of monitoring programs and to detect any localised impacts from the Aquarium Fishery. This is important to ensure that analysis of catch and ecosystem impacts can be undertaken at a scale that is appropriate for the fishery.

The NTAC also endorsed the development of a logbook guide including photographs of species to assist licensees improve consistency in reporting of species collected and enhance monitoring of all species taken in the fishery.

Current Harvest Status

From an aquatic resource protection perspective, the current level of harvest is low and the impact on the resource by commercial operations is considered to be insignificant. Accreditation of the fishery as a WTO by DEW under the *EPBC Act* validates this position.

Future Assessment Needs

The future assessment needs of the Aquarium Fishery will be driven by the requirements for ESD reporting, in accordance with the *EPBC Act*.

Research

Summary

Dr Victor Gomelyuk from NRETA has been undertaking monitoring of coral reefs around Nhulunbuy and Cobourg Peninsula for several years. In 2005, Cyclone Ingrid destroyed some areas of reef within the Aquarium Fishery. Bleaching of corals, related to high water temperatures, has also been documented in these reefs (Gomelyuk 2003).

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

Current Research

Two large freshwater research projects of relevance were commenced in 2006. The first, "Water Regime Dependence of Fish in the Wet-dry Tropics," is managed by Charles Darwin and Griffith Universities. Its objective is to sample the fish communities of the middle and upper-reaches of the Daly River Basin. The second, "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. It 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.

The biology and potential sustainable yield of the land hermit crab *Coenobitat variabilis* has been proposed as a research project in collaboration with Charles Darwin University.

Management/Governance

Management

Objective

The fishery is currently managed by conditions specified on Aquarium Fishing/Display licences. Licences are non-transferable and aquatic species are only allowed to be collected using gear specified on the licence.

NT Fisheries liaises with stakeholders in the Aquarium Fishery individually or as needed through the NTAC, or through separate consultative processes catering for specific stakeholder groups.

Management arrangements for the Aquarium Fishery aim to ensure the ecological sustainability of collected species with minimal impact to protected, threatened or endangered species and the aquatic environment. Management objectives are achieved through a combination of input and output controls and include limited entry, catch restrictions, area and gear restrictions.

The impact on the resource by commercial operations is considered to be relatively insignificant due to the low number of participants, low harvest levels, multiple species targeted, a large area of habitat available to these species and the selective nature of the fishery. The fishery is also subject to natural seasonal closures. Historically, few operators have been active within the Aquarium Fishery while several active collectors only operate on a part-time basis.

Recreational capture of marine and freshwater fish and benthic species by hobby aquarists is controlled by regulating 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 redclaw by aquarium collectors was prohibited. Redclaw 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 licence permitting the collection, display and sale of aquarium species; 2) Aquarium Trader, dominated by importers of aquarium species, and 3) Aquaculture.

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

Up 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 any new aquarium collection licences was implemented in 2001 in response to concerns over coral collection and the need for a comprehensive review of the Aquarium Fishery.

In 2004, a draft report was submitted to the then DEH, now DEW, to assess the management arrangements of the fishery against the *Guidelines for the Ecologically Sustainable Management of Fisheries*. DEH concluded that the Aquarium Fishery would not be detrimental to the survival or conservation status of any taxon to which it relates in the short term. Similarly, it is not likely to threaten any relevant ecosystem in the short term.

This assessment resulted in the fishery being declared an approved WTO in December 2004. The WTO declaration means that product can be exported from the fishery for a period of three years. During this three-year period, NT Fisheries will report annually to DEW on activity within the fishery and progress to date on the implementation of recommendations made by DEW to ensure the sustainability of the fishery.

A review of the Aquarium Fishery was completed in 2005. The review process resulted in changes to licence conditions for both the aquarium fishery/display licence and the aquarium trader licence.

The new conditions allowed all aquarium fishery/ display licence holders to collect limited 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. Collection of aquatic life is strictly prohibited under an aquarium trader licence.

An ecological risk assessment was completed for the Aquarium Fishery in 2006. Owing to the selective nature of the gear used for this fishery and the generally small harvest quantities taken in the fishery, NT Fisheries advised DEH (now DEW), that all aspects of the fishery were assessed as being negligible or low risk.

Current Issues

NT Fisheries is currently working with the NTAC to meet DEW recommendations to retain, if not improve, on the WTO approval. The outcomes of the ecological risk assessment completed in 2006 will be used to drive the development of performance indicators for the fishery. Additionally, commercial logbook recording will be altered to implement finer spatial recording of catch and effort information.

Future Plans

NT Fisheries will maintain a monitoring program with logbooks and an observer program coincident with the development of appropriate indicators. These activities are designed to ensure the ecological sustainable development of the resource with a view to maintain the export status of the fishery under the *EPBC Act*.

As part of the WTO recommendations and in order to continue to improve the quality of data provided, NT Fisheries is in the process of amending logbook returns to provide finer spatial recording of catch and effort information, and record catch to a species level for key target species, CITES listed species and *EPBC Act* listed species.

In accordance with WTO requirements, a review of the management arrangements and performance of the fishery will be conducted in 2008.

Compliance

The Marine and Fisheries Enforcement Section of NT Police, Fire and Emergency Services, undertakes compliance for this fishery through random on-the-spot inspections of harvesting activities and by conducting targeted enforcement programs with fishers and traders. In 2006, there were no recorded convictions for compliance breaches within the Aquarium Fishery.

Consultation, Communication and Education

The NTAC was formed in February 2003 and is the peak body representing the licensees of the Aquarium Fishery. The NTAC operates under the Northern Territory Seafood Council. Members are drawn from the Aquarium Fishery and from the NTSC.

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

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Barramundi Fishery Status Report 2006

Introduction

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

The Barramundi Fishery is currently fished within sustainable limits and has recovered from a period of overfishing 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.

Profile of the Fishery

Commercial Sector

Area

The commercial Barramundi 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 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 extent of the commercial fishing area was further clarified in the *Barramundi Fishery Management Plan* of 2004, with the inclusion of additional 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 current commercial fishing takes place in Van Diemans Gulf, Buckingham Bay, Murgenella, Finniss River, Daly River and the Mini Mini system.

Commercial operators in the NT fish 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-inch) and within a river the minimum legal mesh size is 175 mm (7-inch). The maximum net allowance per licence is 1000 m (10 units of 100 m) and there are restrictions on the amount of spare netting that may be stored onboard vessels.

Catch

The primary target species are barramundi and king threadfin (*Polydactylus macrochir*). Barramundi enter the fishery during their third year and are generally large enough to get caught in a 150-mm gillnet by the end of the fourth year. Commercial operators target barramundi that are usually three to eight years old.

The commercial catch in 2006 was 644 tonnes of barramundi and 317 tonnes of king threadfin. Figure 1 shows that in 2006 there was an increase in the barramundi catch and a slight decrease in the king threadfin catch compared with 2005. Several other species are also caught while targeting barramundi and king threadfin; however, most commercial barramundi fishers have participated in the fishery for several years and have considerable knowledge of where to set nets to minimise by-catch.

A number of by-product species are also taken in the commercial fishery, depending

on their marketability. The most commonly retained by-product species are blue threadfin (*Eleutheronema tetradactylum*), black jewfish (*Protonibea diacanthus*), queenfish (*Scomberoides commersonianus*) and tripletail (*Lobotes surinamensis*). Sharks are also a by-product, although the number which can be taken is restricted (Figure 2).

In 2006, the total retained by-product was 68 tonnes or about 6.6 per cent of the total harvest, representing an increase of 20 tonnes compared with 2005, which is most likely due to the higher prices paid for by-product species in the market.

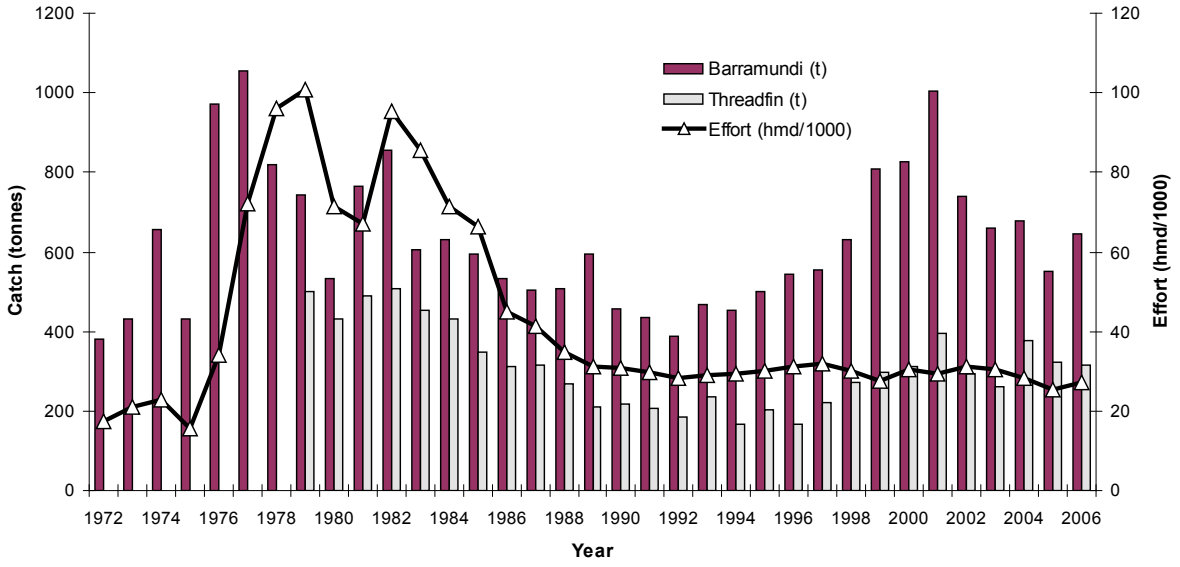

Figure 1. Catch and effort for the commercial Barramundi Fishery from 1973 to 2006

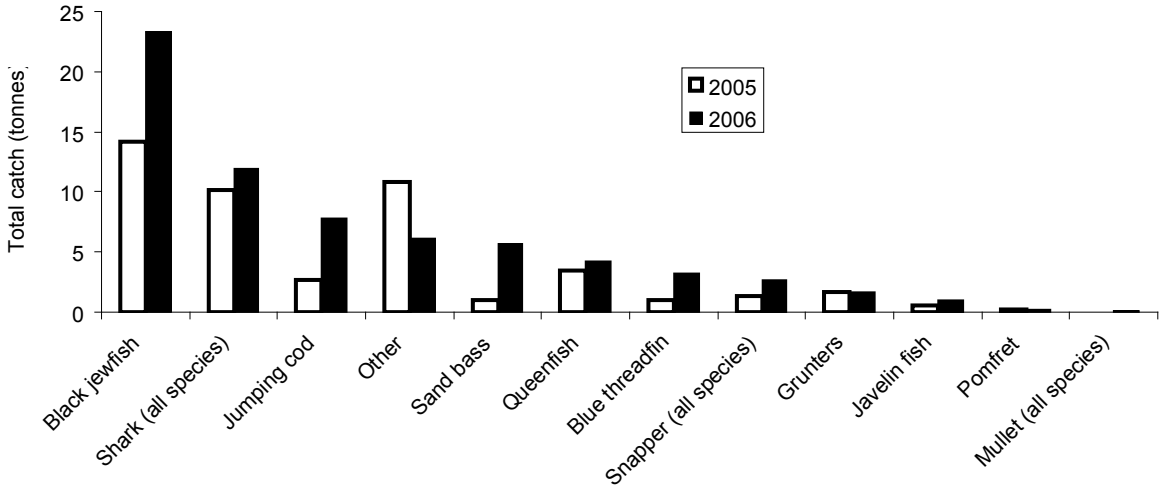

Figure 2. By-product composition for the Barramundi Fishery in 2005 and 2006

Effort

In 2006, there were 24 fully transferable licences in the commercial fishery, all of which were fully utilised. Most of these licences were 'full 10 unit' licences (1 unit = 100 m net) and equated to a total of 19 100 m. Effort is measured in '100 m net days' (hmnd), where one hmnd equals 100 m of gillnet set for one day.

In 2004, commercial barramundi licences were reduced from 25 to 24 due to a licence buy-back. This was reflected in a decrease in the 2004 commercial effort (28 190 hmnd) from that recorded in 2003 (30 600 hmnd). A further decline in effort was observed in 2005 (25 328 hmnd) when cyclonic activity delayed the opening of the commercial barramundi season. Effort increased to 27 108 hmnd in 2006 (Figure 1).

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.

Catch Rates

In the late 1970s and early 1980s, the catch per unit of effort (CPUE) for barramundi showed a sharp downward trend, reaching levels as low as 7.1 kg/hmnd. This decrease was probably caused by excessive commercial fishing effort. Following management changes, the CPUE has steadily increased, reaching 20.8 kg/hmnd in 1998. The 2006 barramundi CPUE was 23.7 kg/hmnd (Figure 3).

In recent years, the CPUE for king threadfin has shown a very similar trend to that for barramundi catches. These trends indicate that the fishery has largely recovered from the period of overexploitation during the 1970s, where the CPUE was as low as 5.0 kg/hmnd. In 2006, the CPUE was 11.7 kg/hmnd with present fluctuations in the CPUE more likely to 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, fishers are now enhancing their fishery by providing the market with barramundi wings and swim bladders, and selling whole barramundi and king threadfin fresh on ice to southern markets.

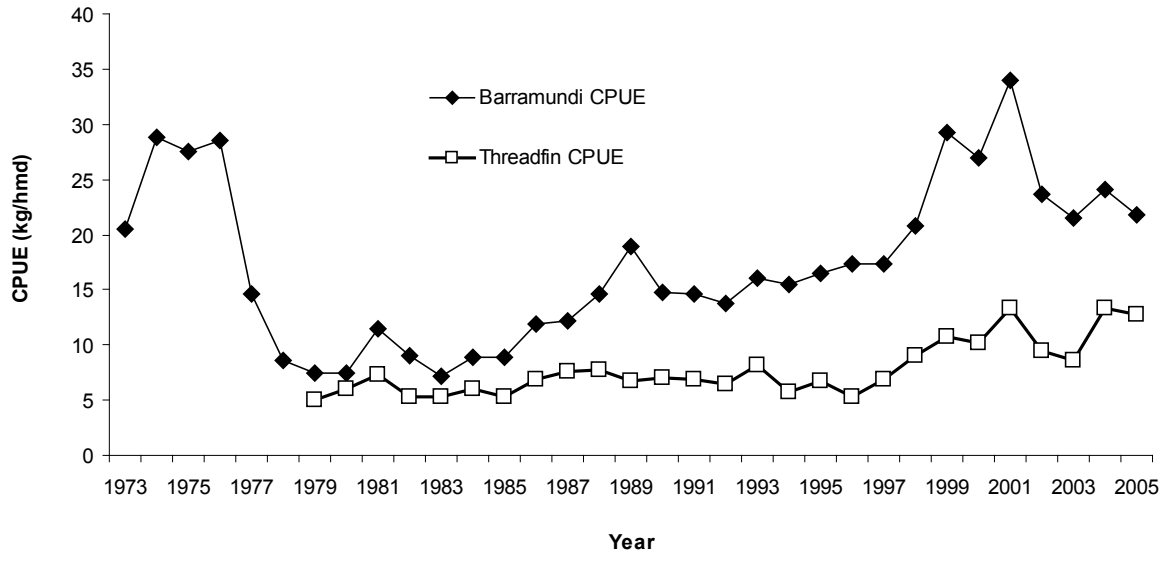

Figure 3. Catch per unit effort (CPUE) for barramundi and king threadfin for the Barramundi Fishery from 1973 to 2006

Recreational Sector

Area

Barramundi have historically been caught by anglers throughout inland billabongs and the upper reaches of rivers and creeks. However, as recreational fishing access has developed, enabling greater access to the coast, many anglers 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, between 3 and 6 m in length, using light rods and reels, fly fishing gear and handlines 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 and reduced possession limits apply in the Mary River Fish Management Zone and additional controls are in place within 100 m of the Shady Camp Barrage.

Catch

Recreational fishers generally target the same species as the commercial fishery and also catch many of the same non-target species. Target and non-target species may be either retained or 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 in age between one and 15 years. Fish three to 10 years old are most common.

In 2000-01, the National Recreational Fishing Survey: the Northern Territory (NRFSNT), identified barramundi as the most popular target species, with an estimated total catch of over 400 000 fish and an annual harvest (retention rate) of 100 400 fish (Coleman, 2004), indicating that 75 per cent of the barramundi caught were released. The total number of barramundi caught has increased by about 60 per cent from that recorded in 1995 (240 000), although the actual number of retained fish has remained about the same (Coleman, 1998; Coleman, 2004). Information from the recreational fishing surveys indicates an increasing trend in catch and release within the recreational sector of the Barramundi Fishery. In 2000-01, it was estimated that 75 per cent of the barramundi caught were released, an increase from 58 per cent recorded in the 1995 survey.

Effort

Recreational fishers often fish for a range of species. However, fishing for barramundi is quite specific in the choice of fishing equipment and location. In 1995, targeted barramundi fishing accounted for 38 per cent of the total recreational fishing effort in the NT, amounting to over 840 000 hours. In 2000-01, targeted barramundi fishing effort increased to 43 per cent of the total recreational fishing effort, but the number of hours fished had decreased 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 National Recreational and Indigenous Fishing Survey (NRIFS) conducted in 2000-01 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 per cent of all fish caught as compared with only 43 per cent 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 accounts for 95 per cent of targeted barramundi fishing effort, while live bait accounts for the remaining 5 per cent. The relative proportions of lure and bait fishing have remained stable since 1995.

Catch

In 2006, FTO clients caught 58 693 barramundi, representing a catch increase of 22.8 per cent on the 2005 FTO catch of 47 783. Of the barramundi caught in 2006, 88 per cent (51 455) were released and 12 per cent (7238) were retained. Allowing for post-release mortality of 10 per cent (de Lestang et al., 2004), the FTO sector would therefore have removed around 12 383 barramundi in 2006.

The proportion of captured barramundi which were retained by FTO clients was much lower than for general recreational fishers and has remained relatively consistent at around 10-15 per cent since 1995.

Over 78 per cent of the barramundi caught by FTOs were from a relatively small number of areas, which included Darwin and Bynoe Harbours (33 per cent), the Tiwi Islands (28 per cent) and the Daly River (17 per cent).

Effort

In 2006, FTOs undertook 4600 trips targeting barramundi. This is an increase of 3 per cent on the 2005 figure of 4469 trips, with a slight increase of 0.36 per cent or 85 217 hours targeting barramundi. The proportion of FTO trips targeting barramundi has also increased by 1 per cent since 2005 to 56 per cent of all FTO fishing charters.

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 in 2001, but decreased to 0.4 fish per hour in 2003. In 2004, the catch rate improved to 0.5 barramundi per hour and has increased further in 2006 to 0.7 barramundi per hour. These fluctuations in FTO catch rates have followed a similar trend to that seen in the commercial fishery, where recruitment is affected by rainfall and river flows.

Indigenous Sector

Barramundi is harvested by Aboriginal people in coastal and some inland areas of the NT and has significant economic, health and social value for this community. In addition, barramundi also has 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 per cent of all fishing is shore-based using baited lines and spears.

Catch

The NRFSNT found that indigenous fishers harvested 44 134 barramundi in 2000, with few fish released (Coleman, 2004).

Non-retained Species

Barramundi gillnets are quite selective in targeting barramundi and king threadfin when placed on mudflats and in rivers. Non-target species may be either retained as by-product or discarded as by-catch, depending on market price.

A small proportion of by-catch that may be discarded includes catfish, blue salmon, queenfish, trevally, tripletail and shark. By-catch has been noted to increase when nets are set in deep channels rather than in shallow mudflats.

The Barramundi Licensee Committee has accepted restrictions to limit the taking of shark, as part of the National Plan of Action - 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 before commencing the next voyage.

In the 2000-01 NRIFS, recreational fishers who targeted barramundi also caught threadfin, snappers, grunters and catfish of which 35.9 per cent were retained. However, retention rates were variable depending on the species. For instance, most of the threadfin were retained, while most catfish were released.

Threatened Species Interaction

In 2006, there were no reported interactions with threatened species in the NT Barramundi Fishery.

Ecosystem Impact

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

A set of guidelines to minimise the incidental capture of dugong has been developed by the NT Seafood Council. 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.

Crocodiles and turtles can also be caught in gillnets; however, they are normally released alive as nets are mostly checked at each tide.

The commercial Barramundi Fishery is restricted to tidal waters, while historically recreational fishers have targeted freshwater stocks. However, 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.

Social Impact

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

Barramundi fishing is an iconic feature of the NT and a popular recreational pastime. About 30 per cent of the resident population go fishing and most recreational fishers target barramundi at some time. Recreational fishers purchase gear, bait and fuel from local businesses where they also service their equipment.

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

As barramundi holds a totemic value for some Aboriginal communities, its abundance is important not only as a major source of food for some coastal communities but as an important component of Aboriginal wellbeing.

Economic Impact

At the point of first sale in 2006, the overall catch value for the commercial Barramundi Fishery was $5.2m. In 2006, the barramundi component was worth just over $4.2m (compared

with $3.6m in 2005) and the king threadfin component was worth $0.86m (compared with $0.92m in 2005). The value of by-product sold in 2006 was $0.18m. Whilst the commercial Barramundi Fishery is not the largest of the Territory's fisheries, its return to the NT community is substantial.

The recreational sector also contributes to the NT economy, especially in the service and fishing tackle industries. In 2000, it was estimated that over $26m was spent on recreational fishing in the NT, although the figure cannot be directly attributed to any one fishery (Coleman, 2004).

Stock Assessment

Monitoring

Monitoring of the Barramundi Fishery is largely focussed on analysis of catch and effort trends in the commercial fishery based on monthly catch returns provided to NT Fisheries by licence holders. Data provided by recreational fishers is also used.

Commercial observer trips were planned for 2006. However, they could not be conducted due to logistical problems. Three commercial observer trips were conducted in 2005, one each to the Finniss River, Chambers Bay and Arnhem Bay.

During these three trips, 437 fish were measured, of which 60 per cent were barramundi and 28 per cent were king threadfin. By-product species contributed 9 per cent to the total observed catches and consisted of jewelfish (*Johnius* spp.), black jewfish (*Protonibea diacanthus*), tripletail (*Lobotes surinamensis*) and mullet (*Liza* spp.). By-catch accounted for 3 per cent of the total catch that was not kept, of which a significant proportion was catfish (*Arius* spp.).

Stock Assessment Methods and Reliability

The Barramundi Fishery was first assessed using catch and effort data in 1978 and 1979. It has been assessed a number of times since then. The early assessments were not completely successful and assumed that the barramundi population of the NT was a single stock. However, between 1980 and 1983, Dr John Salini and Dr James Shaklee determined that there were numerous genetic stocks associated with the major river systems across northern Australia. This information and improved modelling techniques have made subsequent models of the Barramundi Fishery more reliable.

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. In 2005, the National Barramundi Workshop, which was held in Darwin, attempted to create a more complex model which would include all variables used in previous models, as well as further biological information and recreational, fishing tour operator and indigenous sector catches.

All recent reviews have concluded that the barramundi population of the NT has largely recovered from the over-exploitation of the 1970s and that the current level of exploitation in all targeted stocks is sustainable. Given the long and informative time series of catch and effort data available for this fishery and the extensive knowledge of barramundi biology, the stock assessment is considered to be very reliable. However, the latest model developed will require further refinement before it can be used as a basis for management decision making.

Current Harvest Status

No direct estimates of total harvest rate are available for the Barramundi Fishery but output from the stock assessment model indicates that the overall commercial harvest rate is currently around 10 per cent. This data 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 per cent of unfished levels.

Trigger points and performance measures for the Barramundi Fishery are being developed and incorporated into the Barramundi Fishery Management Plan. These trigger points will be reviewed annually to assist in setting the harvest rate of the fishery.

Future Assessment Needs

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 conducted on the physiological effects and survival of released juvenile barramundi has shown that overall post-release mortality in juveniles is about 10 per cent. However, survival rates varied greatly, depending on water temperature. During the cooler months when water temperatures are low, no deaths were recorded during the catch and release experiment, while 20 per cent of barramundi caught and released during warmer months died (de Lestang et al., 2004). Future research will focus on compiling and analysing a vast array of recreational fishing data as well as further investigating how rainfall and river flow rates affect populations of barramundi and other fish.

Future assessment of the commercial Barramundi Fishery is needed to meet the NT Government's commitment to ecologically sustainable development. This assessment includes identifying the impact of the fishery on by-catch species, by-product 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. 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 between 1978 and 1980. 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. A major assessment of the status of barramundi was undertaken in the Mary River system, including intensive monitoring of both commercial and recreational catches during 1986 and 1987. Results from this study showed that the stock was over-fished, with a substantial reduction evident in the numbers of mature fish. The results of this study created some controversy. Professor William Fox of the University of Miami was engaged as an independent assessor. The results of his assessment confirmed that the mature stock was over-fished, which led to a seasonal closure of the river system to protect spawning fish, accompanied by a reduced recreational possession limit (Griffin, 2006).

In addition to monitoring commercial and recreational catches on the Mary River, an annual fishery independent monitoring experiment was set up on Corroboree Billabong in 1987. During this annual experiment, 450 m of the billabong is closed off using heavy nets to stop barramundi moving into or out of the study site. The area is then fished using gillnets and an estimate of the total population within the study site is made. Results from this annual experiment have revealed a very consistent

pattern of cyclic abundance with high numbers of recruits every second year.

An estimated 892 barramundi were in the 450 m site in 2006 (95 per cent confidence interval between 596 and 1190). This was higher than the 20-year average of 793 fish. Most fish (88.5 per cent) were less than one year old and between 30 and 45 cm long, demonstrating that barramundi are reproducing successfully in the Mary River system.

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). It was identified that the placement of saline intrusion control walls along the wetlands significantly reduced the composition and relative numbers of fish, including barramundi, in areas impacted by control works. Such a reduction has the potential to impact on the growth rate and ultimate survival of juvenile barramundi. The placement of spillways within the walls was found to negate the negative effects of the control walls, facilitating access for both juvenile barramundi and other species.

Between 2002 and 2004, research effort concentrated on quantifying the survival and physiological effects of angler catch-and-release on barramundi in a freshwater habitat. This showed that around 90 per cent of barramundi survived after being caught and released in fresh water and that the action of hooking and landing barramundi elicited a physiological (plasma cortisol) and a metabolic (plasma lactate) stress response. Survival also varied significantly throughout the year. Those fish sampled in warmer months suffered more stress and lower survival (80 per cent) compared with fish caught in cooler months (100 per cent survival) (de Lestang et al., 2004).

The effects of different landing nets on fish health were also investigated. “Fish friendly” knotless nets cause significantly less damage to fish skin and fins than more traditional knotted mesh nets. 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 to support major changes to the management of commercial and recreational sectors.

Research in the Mary River wetlands identified the beneficial effects of spillways within saline intrusion control walls. The findings of this research have been incorporated into the future planning of saline intrusion control works.

Data from creel surveys and population monitoring in the Mary River has made significant contributions to the 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. It provides 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 both a management tool and conservation practice for barramundi in a freshwater environment. 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 recruitment levels and populations in the Mary River
- further development of stock assessment models for barramundi
- on-board monitoring of the commercial Barramundi Fishery
- investigations into how different river flow patterns affect barramundi and threadfin populations and
- investigations into freshwater fish species and abundance across the Top End.

Much of this work is externally funded.

Management/Governance

Management

Objective

Objectives, performance criteria and trigger points for the Barramundi Fishery will be defined as a result of a proposed future review of the Barramundi Fishery Management Plan. The proposed objectives for the fishery are listed in Table 1. These objectives will be incorporated as an appendix to the revised Barramundi Fishery Management Plan. 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.

Recreational anglers pay no licence fees, but gear restrictions apply and seasonal area closures are in place on the Mary and Daly Rivers. A specific possession limit of two barramundi applies to the Mary River Fish Management Zone with a limit of five applicable elsewhere in the NT. A minimum length of 55 cm for both the commercial and recreational sectors applies throughout the NT.

Current Issues

The issues currently facing the management of barramundi stocks in the NT relate mainly to resource allocation, that is which sector or group is granted access to the existing barramundi resource. Improvements in technology have allowed recreational fishers to travel farther afield in the search of barramundi. This has meant that recreational and commercial fishers now often fish for barramundi in similar waters and this situation has led to user conflict issues in some of the more popular areas such as Chambers Bay, Finniss River, Daly River and Roper River.

The Adelaide River was closed to commercial barramundi fishing in 2004 and one full 10-unit licence was bought back by Government so that fishing effort was not displaced into other areas of the fishery.

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

Future Plans

During 2005, key fishery stakeholder representatives drafted a five-year plan and ten-year vision for the Barramundi Fishery, setting out a proposed strategic direction for the fishery over the next decade in order to provide certainty for industry and future expansion of the recreational fishery. Further development of the plan requires consideration by Government.

The current logbooks used in the commercial Barramundi Fishery require modification to

enhance the definition of species caught and finer spatial information regarding areas fished.

Results of the 2000-01 NRIFS gave an insight into the recreational sector's catch and effort. These results have been incorporated into modelling and stock assessments to further define the state of the fishery. However, owing to improvements in technology (larger boats, improved sounder and GPS units), a growing population and the time period since the last recreational and indigenous fishing survey (2000), there is a real need to update this data so that informed management decisions can be made in the future.

Compliance

Monitoring, compliance and enforcement activities are undertaken by the Marine and Fisheries Enforcement Section (MFES) of NT Police, Fire and Emergency Services, under the *NT Fisheries Act 1988*.

Major issues of concern with respect to compliance in the commercial sector are the use of excess gillnet, 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 Barramundi Fishery stakeholder groups are consulted when required.

A series of Aboriginal Consultative Committees have been formed to provide NT Fisheries with the opportunity to consult with coastal Aboriginal communities on fishing and related matters.

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 are intended to provide the fisher with an understanding of the legislation, status of the fishery, research, management and compliance issues.

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

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Table 1. Proposed management objectives and performance indicators for the Commercial Barramundi Fishery

Species/ Group	Management Objectives	Performance Indicators	Trigger Reference Points	Management response to be taken
Barramundi	To maintain the sustainability of the barramundi resource.	Significant decline in the annual catch or a significant increase in fishing effort.	If catch or effort by any sector, or the fishery as a whole, increases or decreases by 20 per cent for each year for two consecutive years.	Stakeholders to make recommendations to the Executive Director, Fisheries regarding appropriate remedial action. Amended arrangements to be implemented within 12 months of trigger being reached.
Barramundi	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 per cent for each year for two consecutive years.	Stakeholders to make recommendations to the Executive Director, Fisheries regarding appropriate remedial action. Amended arrangements to be implemented within 12 months of trigger being reached.
Barramundi	Maintain and enhance quality fishing experiences for recreational fishers into the future.	A significant number of recreational fishers or FTO clients do not enjoy their barramundi fishing experience.	If more than 20 per cent of participants in stakeholder fishing surveys or FTO clients state that they are unsatisfied with their barramundi fishing experience.	Stakeholders to make recommendations to the Executive Director, Fisheries regarding appropriate remedial action. Amended arrangements to be implemented within 12 months of trigger being reached.
By-product species				Stakeholders to make recommendations to the Executive Director, Fisheries regarding appropriate remedial action. Amended arrangements to be implemented within 12 months of trigger being reached.
By-catch species	Ensure ecological sustainability of by-catch species.	Onboard monitoring of commercial barramundi vessels.	If by-catch species increase by more than 50 per cent in any year for two consecutive years.	Stakeholders to make recommendations to the Executive Director, Fisheries regarding appropriate remedial action. Amended arrangements to be implemented within 12 months of trigger being reached.
Endangered, threatened or protected species and/or communities	Ensure the continued protection of species and communities listed under the *EPBC Act* (1999), and as listed under the *Territory Parks and Wildlife Conservation Act* (2001).	Endangered, threatened or protected species and or communities are identified in NT waters.	Identifiable impacts observed by commercial fishers, fisheries observers or other agencies regarding EPBC listed species or communities.	Stakeholders to make recommendations to the Executive Director, Fisheries regarding the implementation of a threat abatement plan, if required. Amended arrangements to be implemented within 12 months of trigger being reached.
Ecosystem components	Minimise effects on ecosystem components.	Identification of threatening processes.	Identification of significant negative interaction with components of the natural ecosystem.	Stakeholders to make recommendations to the Executive Director, Fisheries regarding appropriate remedial action. Amended arrangements to be implemented within 12 months of trigger being reached.

Coastal Line Fishery Status Report 2006

Introduction

Coastal ecosystems are dynamic, diverse resources of great ecological, social and economic significance. They contain some of the most diverse ranges of fish stocks in the Northern Territory (NT). Four major sectors utilise coastal fish stocks, namely commercial, recreational and indigenous fishers, as well as Fishing Tour Operators (FTOs). With careful stewardship, the NT's coastal finfish resources will continue to meet the needs of all sectors without compromising ecological integrity or biological diversity.

The commercial Coastal Line Fishery is a multi-species line and trap fishery that operates in coastal waters along the NT coastline. The fishery primarily targets black jewfish (*Protonibea diacanthus*) but a range of other reef species such as snappers, emperors and cods are also harvested. The commercial Coastal Line Fishery began as a lifestyle fishery, but has now developed into a professional industry.

The Coastal Line Fishery is also an important recreational fishery. Several species targeted by the commercial sector are also favoured by recreational fishers and FTOs. Conservative estimates suggest that the recreational harvest of jewfish, snappers and emperors alone surpasses the total commercial take. Hence, the primary management objective for the fishery is to ensure the sustainable harvest of coastal fish species by all sectors.

Profile of the Fishery

Commercial Sector

Area

The Coastal Line Fishery extends from the high water mark to 15 nautical miles from the low water mark across the entire NT coast.

Some finer scale access restrictions apply due to the presence of Aboriginal sacred sites and protected area reserves.

Fishing Method

Coastal Line Fishery licensees are permitted to use a variety of fishing gear. Vertical lines, a cast net (for bait only) scoop net or gaff can be used from the high water mark to 2 nautical miles from the low water mark. Drop lines and a maximum of five fish traps per licence may also be used from the 2 to the 15 nautical mile 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 between six and 40 hooks per drop line, but typically they use up to 20.

The use of different fishing gears was reported for the first time in 2002, with drop lines and traps adopted by a small number of commercial fishers. In 2006, line fishing was the only method reported in the fishery.

Catch

The total reported catch for the Coastal Line Fishery in 2006 was 236 tonnes, a decrease from the peak catch in 2004 of 311 tonnes (Figure 1). Historical data shows that the catch fluctuated between 60 and 138 tonnes from 1990 to 1998 then steadily increased until 2004. The subsequent decrease is thought to be due to a drop in market demand.

There have been significant changes in the catch composition of the Coastal Line Fishery over time. A mix of reef fish dominated the catch from 1990 to 1998. Since then, the proportion of black jewfish in the catch has steadily increased, peaking in 2006 at 87 per cent of the total hand line catch. The golden snapper catch has declined from an average of around 16 per cent of the total catch for the period 1990 to 1999 to 2 per cent in 2006.

The catch of by-product species in the Coastal Line Fishery is minimal given the targeted nature of the fishery and the use of line tackle.

Effort

In 2006, there were 22 licences active in the Coastal Line Fishery. The number of active licences varies each year, with 26 licences active in 2005 and 25 licences active in 2004.

Fishing effort is recorded as 'hook days', which equates to the total number of hooks used per day over the entire fishery. Figure 2 shows the catch and effort totals for the hand line-only component of the Coastal Line catch. Note that the drop line and trap components of the fishery have not been displayed as the data comes from less than five active licensees. Fishing effort (for the hand line-only component of this fishery) reached a peak of 28 970 hook days in 1992 then declined to an all time low in 1998. Since 1998, effort has increased slightly each year reaching 7133 hook days in 2004. This figure fell to 5649 hook days in 2005, then again to 4474 hook days in 2006.

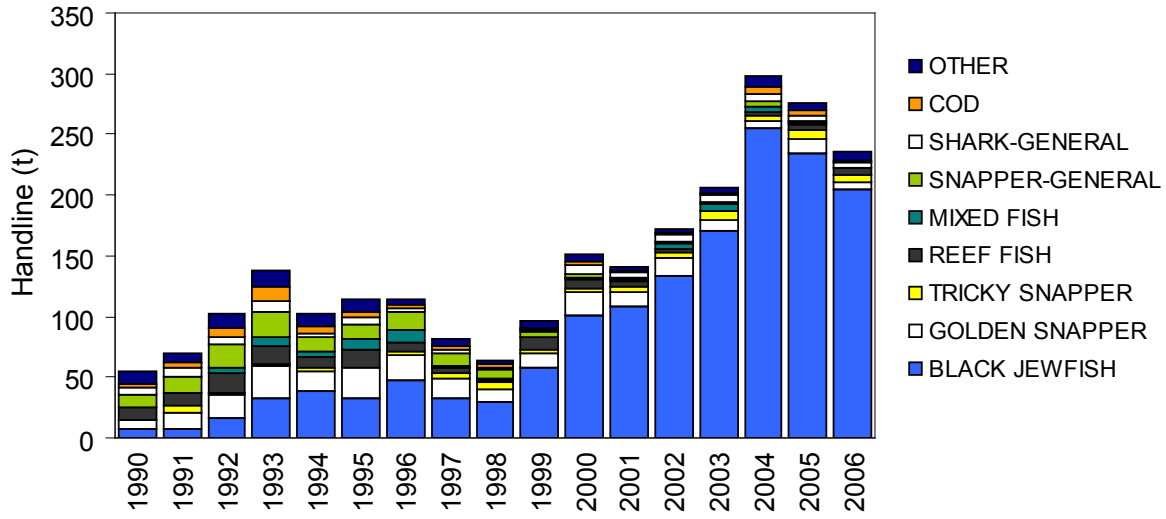

Figure 1. Catch composition for the NT Coastal Line Fishery, 1990-2006 for hand line only

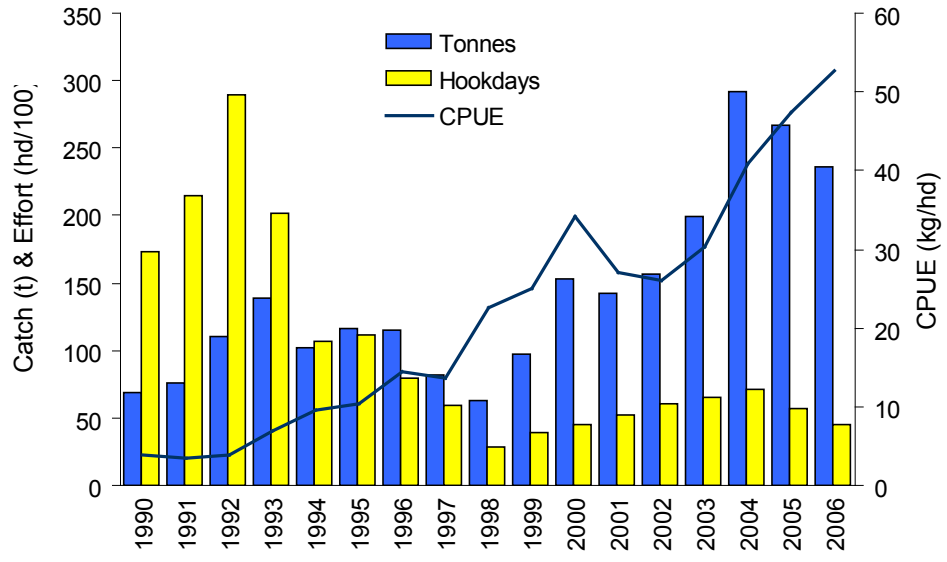

Figure 2. Catch, effort and CPUE for the Coastal Line Fishery, 1990-2006

Catch rates

The catch per unit effort (CPUE) for the hand line-only component of the fishery has steadily increased as the fishery has developed (Figure 2). There was a lull in the catch rate from 2001 to 2003 but this was followed by a sharp rise (above the 2000 figure) in 2004 and has continued to increase thereafter. The catch rate in 2006 was 52.7 kg/hook day.

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 small local market, most of the product is sold to southern markets.

Recreational Sector

Area

Recreational fishing for coastal species occurs throughout the coastal waters of the NT. The most important areas are close to the larger coastal population centres – the coastal strip between the Adelaide and Daly Rivers and the Nhulunbuy area. The Darwin area supplies 31 per cent of the total recreational fishing catch in the NT.

Fishing Method

A variety of fishing gear is utilised by the recreational sector. Most of the fishing effort is by line (84 per cent), with this effort shared almost equally between the use of lures and bait. Fishing from a boat is more common than shore fishing, with over 75 per cent of all fishing effort occurring from a boat.

Catch

The National Recreational Fishing Survey conducted in 2000 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 per cent of the total harvest). Within the snapper group, golden snapper and Spanish flag (stripeys) accounted for the largest portion of the harvest, representing an estimated 68 000 and 22 000 individuals, respectively (Henry and Lyle, 2003; Coleman, 2004). Jewfish (approximately 18 000 individuals) and emperors (approximately 12 000 individuals) were also significant components of the harvest.

Effort

Recreational effort, in the Coastal Line Fishery is significant, accounting for roughly 30 per cent of the total recreational fishing effort in 1995 and 2000 (Coleman, 1998; Coleman, 2004). The fishery not only accounts for dedicated reef fishing but also a large amount of fishing with no specific target species.

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 per cent of the coastal line fishing effort (Coleman, 2004).

Fishing Tour Operator Sector

Area

FTO charters are mostly conducted around Darwin, Fenton Patches, Bynoe Harbour, Fog Bay to Point Blaze and the Peron Islands. A small number of charters operate out of Nhulunbuy, Borroloola and across Arnhem Land.

Fishing Method

Fishing guides use the same gear as recreational fishers and mainly fish for reef fish by using lines with bait. FTO clients use bait for 95 per cent of the hours spent fishing for reef species.

Catch

Logbook data for 2006 reveals that FTOs catch and release large numbers of coastal fish, most notably Spanish flag (17 813 landed, 88 per cent released), golden snapper (17 555 landed, 52 per cent released) tricky snapper (14 352 landed, 55 per cent released), trevally (12 397 landed, 96 per cent released) and cod (9767

landed, 77 per cent released). These numbers were exceeded only by the barramundi landed.

Effort

Targeting reef fish was the second most prevalent fishing activity reported by FTOs in 2006. This type of fishing activity accounted for 76 537 hours fished by FTO clients, an increase of over 10 per cent since 2005. This increase can be attributed to a slight rise in licence activity and client numbers since 2005. The overall increase in reef fishing hours has been relatively steady, with line hours almost five times those recorded in 1995.

Reef fishing has become an increasingly important component of the FTO industry. The number of trips targeting reef fish has more than doubled since 1995.

Indigenous Sector

Area

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

Fishing Method

The National Recreational and Indigenous Fishing Survey (NRIFS) conducted during 2000-01 revealed that over 90 per cent of all indigenous fishing in the NT was shore-based, with half of those events using baited lines (Henry and Lyle, 2003).

Catch

Mullet and snappers are the main groups of fish harvested by indigenous fishers. The indigenous component of the NRIFS reported a harvest of 83 000 individual mullet by Indigenous subsistence fishers in the Northern Territory.

The NRIFS provides details on the catch of several other fish, some of which are important to both indigenous fishers and those operating in the Coastal Line fishery. Other species caught included catfish (60 000), snapper (27 500), shark and rays (12 000), salmon (8500) and trevally (8000).

Non-retained Species (By-catch)

While the Coastal Line Fishery harvest has increasingly focused on black jewfish and snappers, over 40 different species have been retained in recent years. Fisheries Regulations prohibit Coastal Line licensees from taking barramundi, threadfin salmon, Spanish mackerel or mud crab. Coastal Line licensees have also agreed, at the request of the Offshore Net and Line Fishery Licensee Committee, to accept shark limits being introduced to their licence conditions.

During targeted reef fishing, recreational fishers catch a wide variety of species. The popular table species such as snappers, emperors and jewfish have retention rates of up to 76 per cent. Species such as sharks, rays and catfish have a retention rate of less than 5 per cent. The number of reef fish released by indigenous fishers is negligible, with fishing being essentially a subsistence activity.

Threatened Species Interaction

In 2006, there were no reported interactions with threatened species. The targeted nature of the Coastal Line Fishery minimises the risk of interactions with threatened species.

Ecosystem Impact

Presently, there is a deficit of information on the wider impact of coastal line fishing activities conducted in the NT. Therefore, it is not possible to accurately assess the impact on coastal ecosystems and the aquatic environment as a whole.

Alleviating the dearth of sound information will be necessary to assess the impact of recent changes in species catch composition and fishing practices.

Social Impact

In 2006, there were 22 active coastal line licences which provided both direct and indirect local employment opportunities. A large proportion of the NT wild harvest seafood is dedicated to domestic consumption, with the commercial seafood industry supplying products to major Australian seafood markets. Subsistence fishing and recreational fishing continue to form an important component in the lifestyle and culture of a large proportion of people residing in the NT.

Economic Impact

At the point of first sale in 2006, the catch value of the commercial Coastal Line Fishery was $0.67m ($0.75m in 2005). The jewfish component was $0.59m ($0.60m in 2005) and golden snapper was $18 000 ($29 060 in 2005).

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

Stock Assessment

Monitoring

The Fisheries Research and Development Corporation (FRDC) project “Implications of Target Fishing Black Jewfish Aggregations” commenced in July 2004. One of the project aims is to collect biological information that will help explain the drivers of black jewfish aggregation behavior. This data was reviewed and presented at a public workshop held in Darwin in 2006.

Catch and effort trends in the commercial and fishing tour sectors are monitored through analysis of logbook data submitted by fishers on a monthly basis as a condition of their 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 - 1000 tonnes was derived. Since then, estimates of recreational catch have been released. The total coastal line catch, including the indigenous fishing component, is moving toward the upper estimate of the original stock assessment.

Current Harvest Status

The current research study “Implications of Target Fishing Black Jewfish Aggregations” is reviewing the current harvest status and reports of localised depletions, around major population centres.

Future Assessment Needs

There is a lack of definitive information on the biological characteristics for the bulk of coastal species, the size of, and relationships between the coastal fish stocks, and the level of catch that may be harvested in a sustainable manner. NT Fisheries is seeking to rectify this deficit and has recently re-directed research towards this area. Information gained by the project “Implications of Target Fishing Black Jewfish Aggregations” will contribute to future assessment needs.

Research

Summary

Concerns about the sustainability of this fishery raised by key stakeholders in 1995 resulted in the implementation of a four-year coastal fish project. The project aimed to collect important fisheries information on age and growth of key coastal species and incorporate this information into the sustainable management of the fishery.

The results of this work include the following findings:

- Black jewfish have a fast growth rate, reaching sexual maturity at around 97 cm in total length and four years of age.
- Golden snapper are a long-lived and late-maturing fish. Fifty percent of females reach sexual maturity at 63 cm (8 to 10 years old). Males reach maturity at a smaller size, with 50 per cent mature at 47 cm. The oldest golden snapper sampled was 23 years old with a fork length of 82 cm.
- Tricky snapper undergoes a sex change, beginning life as a female and developing into a functional male at around 37 cm and six years of age.

Results of the project "Implications of Target Fishing Black Jewfish aggregations" will be available in 2007.

Incorporation into Management

Growth and age data collected in this program resulted in the implementation of two recreational fish possession limits with recreational fishers now restricted to a five fish possession limit for black jewfish and golden snapper, included within a general reef fish possession limit of 30 fish.

Current Research

Two linked research projects have been funded by the NT Government and the FRDC. The collaborative three-year projects involve NT Fisheries, the Tasmanian Aquaculture and Fisheries Institute, the Australian Institute of Marine Science and Charles Darwin University.

The projects will bring together standard fisheries science in the collection and analyses of age, growth and reproduction information and innovative technology. A key element of the research is to have acoustic tags implanted into 80 jewfish and individual movement between key aggregation sites tracked via acoustic receivers located on the ocean floor. In addition, key aggregation sites habitat will be mapped using sophisticated underwater video technology and oceanographic equipment.

Management/Governance

Management

Objective

In consultation with stakeholders, NT Fisheries aims to manage the Coastal Line Fishery in a manner that is equitable and in line with nationally agreed ecologically sustainable development principles to optimise benefits to the community now and into the future.

History

Prior to the introduction of the Fisheries Regulations in 1993, the number of coastal line non-transferable licences (formerly inshore reef licences) peaked at around 160.

The number of licences was reduced to 65 in the early 1990s through a moratorium on the renewal of inactive licences and the issuing of new licences. In the mid-1990s, an additional 26 coastal line licences were granted as a result of negotiations to extend the fishery area.

In 1995, significant amendments to the Regulations came into force to allow the seaward extension of the fishery area and to introduce the transferability of commercial licences in a two-for-one licence reduction program. This program was introduced to allow for the transfer of coastal line licenses while removing excess fishing capacity. Currently there are 56 coastal line licences. However, the outcome of the licence reduction program may result in a maximum of 45 fully transferable licences.

The re-alignment of the Coastal Line Fishery was undertaken to enhance the economic viability and productivity of the fishery, while increasing the opportunity for the sustainable management of coastal resources. The need for the licence reduction program was highlighted during the 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 this fishery.

Current Issues

Black jewfish form large spatially and temporally predictable aggregations and as such, can be vulnerable to over-fishing. There is an extensive body of evidence derived from stocks throughout the tropics that indicates target fishing of aggregations can rapidly deplete fishery stocks. Although recent research has indicated that overall NT jewfish stocks are in good condition, a number of areas of potential concern have also been identified which require closer consideration. It is anticipated that a Coastal Line Fishery Management Advisory Committee will be re-established in 2007 to assist the ongoing sustainable management and development of the Coastal Line 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. Currently, 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, it has recently been proposed to reduce the recreational possession limit for jewfish from five to three.

Future Plans

The maintenance of the two-for-one licence reduction program will continue to contribute to the removal of excess fishing capacity in the commercial fishery. Ensuring that the harvest of coastal fish by all sectors is sustainable remains a primary management objective.

Compliance

The Marine and Fisheries Enforcement Section of the NT Police, Fire and Emergency Services undertakes compliance-related activities under the *NT Fisheries Act 1988* for all fisheries managed by the NT including the Coastal Line Fishery.

The *Fishwatch* toll-free number has become an increasingly popular mechanism for the public to provide Police with information on suspicious fishing activity. However, there have been few reported problems with compliance in this fishery. The major area of concern is the potential for the black market sale of fish by unlicensed fishers.

Consultation, Communication and Education

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

It is anticipated that a Coastal Line Fishery Management Advisory Committee, comprising representatives from various user groups will be re-established in 2007 to assist in the ongoing sustainable management and development of the Coastal Line Fishery.

Prepared by

Michael Phelan – Senior Research Scientist
Dr Mark Grubert – Research Scientist
Patti Kuhl – Aquatic Resource Manager

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Coastal Net Fishery Status Report 2006

Introduction

The inshore waters of the Northern Territory (NT) support a wealth of fish and shark species. The Coastal Net Fishery, using small mesh nets, harvests coastal species within three nautical miles of the coastline. While over 40 species are utilised, the major commercial species are blue salmon, mullet, queen fish and shark. Commercial licence holders are not permitted to retain barramundi, threadfin salmon, Spanish mackerel or mud crab. To facilitate the release of any by-catch, coastal net licence operators are required to clear coastal nets and gillnets in not less than 30 cm of water.

Commercial fishing effort in the Coastal Net Fishery is comparatively low, and the number of licences is limited. There are only 14 coastal net licences with no further entry to the fishery allowed. Development fishery coastal net licences (of which there are two currently active) may be issued to allow commercial fishing outside of the area designated for the Coastal Net Fishery. There is a temporary moratorium on the issue of further licences of this type while the current management arrangements governing the Coastal Net Fishery are reviewed.

Recreational and indigenous fishers utilise some of the same species and areas as commercial fishers. There is also a rapidly expanding fishing tourism industry that encourages many people to visit the NT to experience its high quality recreational fishing.

In February 2006, the NT Government announced a voluntary buy-back of Coastal Net fishery licences, with the aim of closing Darwin Harbour and Shoal Bay to coastal net fishing. The proposed closure was to reduce competition between commercial fishers, recreational fishers and Fishing Tour Operators (FTOs), and to enhance the long-term quality of recreational fishing in the area.

Profile of the Fishery

Commercial Sector

Area

The Coastal Net Fishery extends from the high water mark to 3 nautical miles from the low water mark. The Coastal Net Fishery is regionalised, with licensees able to fish only the one region nominated on their licence. The Coastal Net Fishery area encompasses:

- 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) and
- other areas approved by the Executive Director, Fisheries.

Development fishery coastal net licenses have been issued for areas near Numayanga and Galiwinku. Some further access restrictions apply due to the presence of Aboriginal sacred sites and protected area reserves.

Fishing Method

Coastal Net Fishery licensees are permitted to use a coastal net of no greater than 300 m in length, with a maximum drop of 5 m, and mesh not exceeding 65 mm. Licensees are also permitted to use a cast net with a diameter not greater than 6 m, and mesh size not exceeding 25 mm.

Three Coastal Net Fishery licensees are permitted (on the grounds of historical use) to use nets of the same dimensions as coastal nets, but made of mesh up to 100 mm (gillnets).

Catch

The reported catch for 2006 totalled 47.7 tonnes, an increase from 34.4 tonnes reported in 2005 and 14.9 tonnes reported in 2004 (Figure 1). The Coastal Net Fishery has averaged around 35 tonnes per year since 1997, usually fluctuating between 25 and 35 tonnes per year. Landings peaked in 2001 when 53.9 tonnes were caught.

Over 40 species are utilised in the commercial fishery, with the major target species being blue salmon, mullet, queenfish and shark. Other common species include garfish, snappers, and whiting. As mentioned previously, commercial licence holders are not permitted to retain barramundi, threadfin salmon, Spanish mackerel or mud crab.

Effort

In 2006, there were 14 non-transferable fishing licences in the commercial fishery. Only eight licences were active.

Effort is measured as '100 m net days' (hmnd). One hmnd equals 100 m of net used for one day. The amount of fishing effort in 2006 was 1464 hmnd, a significant increase from the 621 hmnd recorded in 2005, and 436 hmnd recorded in 2004. The level of effort reported in 2006 greatly exceeded the average level of effort recorded since 1997 (856 hmnd).

Catch Rates

The catch rate in the Coastal Net Fishery has averaged 40.67 kg/hmnd since 1997 (Figure 1). The catch rate for 2006 was 32.6 kg/hmnd, a significant change from the 55.3 kg/hmnd reported in 2005. As there are few operators in the fishery, the catch rate is highly variable.

Marketing

The majority of fish is sold fresh on ice as either fillet, whole, or gilled and gutted. Most sales are to local markets close to the port of landing. However, there is increasing interest from southern markets.

Recreational Sector

Area

Historically, recreational fishing effort has been centred near the vicinity of Darwin, Gove and Borroloola.

Fishing Method

The use of amateur drag nets is popular among some recreational fishers to target small fish and prawns for bait or human consumption.

It is illegal for an amateur drag net to be longer than 16 m, have a maximum drop of more than 2 m, or have a mesh size exceeding 28 mm. Additionally, restrictions are placed on the method of use of these nets (e.g. only hand hauling is allowed) and where such nets can be used (e.g. only seaward of the coastline). However, a licence is not required to use such nets for recreational purposes. The NT component of the National Recreational Fishing

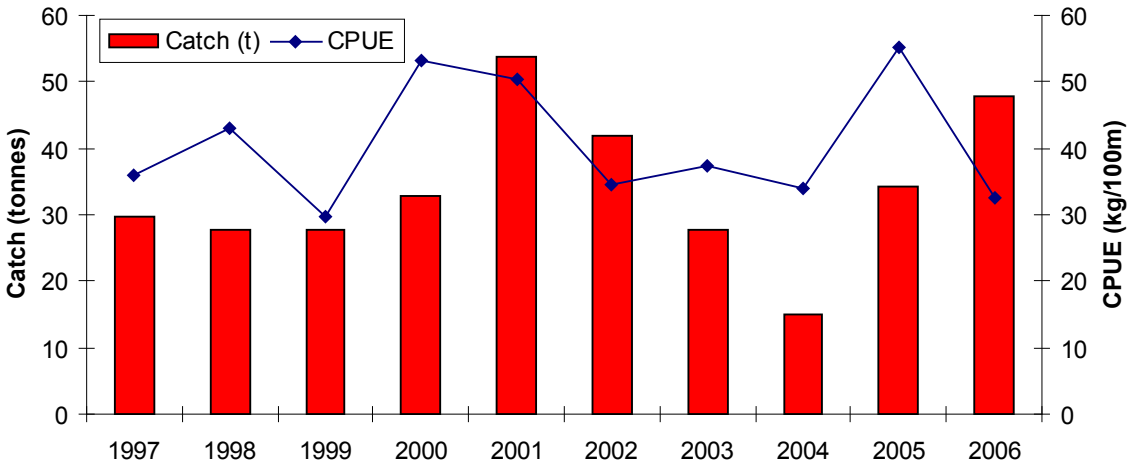

Figure 1. Catch and catch rates for the Coastal Net Fishery, 1997-2006

Survey, undertaken in 2000, estimated that recreational fishers spent close to 10 000 hours per year using nets in the NT.

Catch

Many of the key taxa harvested by the Coastal Net Fishery also form an important component of the recreational fishery of the NT.

A survey of recreational anglers undertaken in 2000-01 revealed the importance of snapper (approximately 160 000 individual fish harvested), mullet (approximately 85 000), salmon (approximately 37 000), and jewfish (approximately 18 000) to the recreational fishing sector. Recreational fishers also harvested an estimated 8000 sharks and rays.

It is not clear what proportion of this catch was utilised as bait. However, the survey indicated that almost half of the recreational line fishing effort in the NT used bait.

Fishing Tour Operator Sector

Area

In 2006, FTOs operated throughout the Top End of the NT but mostly from and around Darwin.

Fishing Method

Under the NT's Fisheries Regulations, people conducting fishing tours are required to observe the same rules and regulations as recreational fishers. The level of use of amateur drag nets by this sector is negligible at present.

Catch

The FTO catch by drag net is considered to be minor.

Indigenous Sector

Area

A large number of indigenous communities and outstations are scattered along the length of the NT coastline. Fishing effort is likely to be greatest close to large indigenous communities such as those on the Tiwi Islands, Maningrida, Port Keats and Borroloola.

Fishing Method

Aboriginal subsistence fishers in the NT utilise drag nets, cast nets and spears to harvest inshore fish and shark species. Indigenous people in the NT are largely exempt from catch restrictions in regards to the utilisation of aquatic resources when they are harvested for the purpose of traditional or subsistence use.

Catch

It appears that significant overlap occurs among the primary taxa harvested by the Coastal Net Fishery and the indigenous fishing sector. Based on catch return data submitted by commercial fishers and the results of a survey of indigenous fishing activities conducted in 2000-01, it was found that mullet were the primary group of fish harvested by both sectors. The survey of indigenous activities identified an annual harvest of 83 000 individual mullet by subsistence fishers in the NT (Henry and Lyle, 2003). The survey provides numbers for several other fish of importance to both fisheries including catfish (60 000), snapper (27 500), shark (12 000 including rays), salmon (8500) and trevally (8000).

Non-retained Species (By-catch)

While the Coastal Net Fishery continues to be centred on the harvest of blue salmon and mullet, the number of other coastal species retained as by-product is increasing. For example, over 40 different by product species have been recorded in recent years.

As mentioned earlier, the Fisheries Regulations prohibit coastal net licensees from taking barramundi, threadfin salmon, Spanish mackerel or mud crab under the coastal net licence. As a result, coastal net licence operators are required to clear coastal nets and gillnets in not less than 30 cm of water to facilitate the release of any by-catch.

Threatened Species Interaction

The Fisheries Regulations prohibit the take of aquatic life listed as a protected species under the *Territory Parks and Wildlife Conservation Act 1976*. Listed species inhabiting the waters of the

Coastal Net Fishery include dugong, turtles, and crocodiles. The risk of interaction with protected species is managed through the requirement of all coastal net licence operators to remain in attendance of nets whilst set. Operators of coastal nets may only use such gear as a haul or surrounding net, and gillnet operators are required to remain within 500 m of the net in use. In 2006, there were no reported interactions with threatened species.

Ecosystem Impact

Small pelagic fish occupy a fundamental niche in aquatic food webs. While there is a lack of information regarding any specific ecosystem impact of the coastal net fishing activities conducted in the NT, the commercial fishery is likely to have little impact on coastal ecosystems due to the inherent low level of effort. Furthermore, the fishing methods used in the Coastal Net Fishery have negligible physical impact on the benthic environment in which the fishery operates.

Social Impact

Eight coastal net licences were active in 2006 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 lifestyle and culture of a large proportion of people residing in the NT.

Economic Impact

At the point of first sale in 2006, the catch value from the commercial Coastal Net Fishery was $190 000, up from $124 000 in 2005. The mullet component was $75 000 up from $52 000 recorded in 2005.

While relatively small in overall value, the production from the commercial fishery provides a valuable input to the local fresh food market.

Stock Assessment

Monitoring

Under the NT *Fisheries Act 1988*, Coastal Net Fishery licensees are required to submit monthly records of their catch to NT Fisheries. Fishery-dependent monitoring trips were conducted in the initial phases of the fishery when the use of haul nets was still being developed under Special Purpose Permits. Irregular observer trips are conducted and complement data gained from fishery-independent studies conducted by NT Fisheries.

Stock Assessment Methods and Reliability

No stock assessment has been undertaken on this fishery.

Current Harvest Status

The level of fishing effort in this fishery is low. It is considered that the harvest rate of all sectors is less than the estimated sustainable catch levels for this fishery.

Future Assessment Needs

Further monitoring of the Coastal Net Fishery for species composition and other factors is required.

Research

Summary

In the initial phases of the fishery, several gear trials were conducted to examine the suitability of various netting methods. Fishery-dependent monitoring trips were also conducted in this early stage. A desk-top study on the fishery was completed in 1997.

A Fisheries Research and Development Corporation (FRDC) funded study in the mud crab fishery produced a habitat map of the inshore environment and coastal waters of the entire NT coastline of relevance to this fishery.

Incorporation into Management

The gear trials provided important information on the different net methods available. In the initial years of the fishery, several changes in the fishing method, such as mesh size and anchoring conditions, were implemented.

Current Research

Currently there is no research underway in the NT that is directly related to this fishery. The research focusing on barramundi and demersal netting will be of benefit to this fishery.

Management/Governance

Management

Objective

In consultation with stakeholders, the objective is to manage the harvest of aquatic resources by the Coastal Net Fishery in a manner that is sustainable, in line with nationally agreed principles of ecologically sustainable development, and which optimises the benefit to the NT community.

History

Four experimental special purpose (haul net) licences were issued in 1986. The original intention of these licences was to permit the taking of mullet and blue salmon by haul netting. The number of species harvested, and the fishing methods permitted, progressively expanded in subsequent years. The inception of the Coastal Net Fishery licence came about in 1993 with the introduction of the Fisheries Regulations.

In 1992, Coastal Net Fishery licences were made available only to 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 (three remain current as Coastal Net Fishery licences), and almost 60 Bait Net Fishery licences (11 remain current as Coastal Net Fishery licences and two as Bait Net Fishery licences).

In May 2000, the then Government announced that the Darwin Harbour and Shoal Bay areas would be closed to the Coastal Net Fishery and that an associated voluntary buy-back of licences would be implemented. However, in December 2002, it was determined that a review of the management arrangements for the Coastal Net Fishery would take place in preference to a licence buy-back scheme. The review occurred concurrently with similar reviews of the Bait Net, Development Coastal Net and Aboriginal Coastal Net fisheries. Fisheries facilitated a consultation process that included all fisheries stakeholders and a discussion paper incorporating the views of stakeholders and the preferred options for the future management of the fishery was developed.

Current Issues

The former proposal to close Darwin Harbour and Shoal Bay to the Coastal Net Fishery was intended to alleviate increasing demands placed upon coastal fish stocks by the various fishing sectors.

Following further examination of this and several other issues relating to the future direction of the fishery, the Government resumed the voluntary buy-back of licences from the Coastal Net Fishery in February 2006.

Future Plans

Once the voluntary licence buy-back process is finalised, further consideration will be given to future management options for the Coastal Net Fishery.

Compliance

The Marine and Fisheries Enforcement Section of the NT Police, Fire and Emergency Service is responsible for compliance and enforcement for all fisheries managed by the NT under the *NT Fisheries Act 1988*. 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 taking of juvenile managed species such as barramundi and threadfin salmon.

Consultation, Communication and Education

Since the inception of the fishery, NT Fisheries has maintained regular, ongoing dialogue with the Coastal Net Licensee Committee and the NT Seafood Council. Such liaison is central to the sustainable management of the fishery.

Prepared by

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Patti Kuhl – Aquatic Resource Manager

Reference

Henry, G.W. and Lyle, J.M. (2003). The National Recreational and Indigenous Fishing Survey. FRDC Project 99/158. NSW Fisheries Final Report Series No 48.

Demersal Fishery Status Report 2006

Introduction

The Demersal Fishery targets goldband snapper (*Pristipomoides multidens*), but also catches increasingly significant quantities of red snappers (*Lutjanus malabaricus, L. erythropterus*), with the remainder of the catch comprising red emperor (*Lutjanus sebae*) and cods (Family Serranidae). Most products from this fishery are marketed as 'fresh on ice' with the majority sold as whole fish on the Australian domestic market.

The Demersal Fishery utilises dropline and trap gears operating in waters 15 nautical miles from shore to the outer limit of the Australian Fishing Zone (AFZ), excluding the area of the Timor Reef Fishery.

In 2006, many Timor Reef fishers (who also hold demersal licences) began exploring grounds immediately adjacent to the Timor Reef Fishery area for goldband and red snapper species. The lingering effects of oil and gas exploration companies carrying out seismic surveys within the more productive regions of the Timor Reef Fishery in combination with business decisions to more actively target the Demersal Fishery has led to an expansion of fishing effort in the Demersal Fishery from mid 2006 onwards.

Limited supply, enhanced product quality, improved marketing techniques and a greater acceptance of red snapper by the Australian public has led to an increase in product prices. In turn, these factors have made previously underutilised red snapper stocks within the Demersal Fishery a more attractive prospect.

Red snappers and red emperors are also caught, primarily by hook and line, by the recreational and Fishing Tour Operator (FTO) sectors. However, there is little overlap with commercial operators given the offshore nature of the fishery.

The fishery is managed as a Joint Authority fishery under the Northern Territory (NT) *Fisheries Act 1988*. Day to day management of the fishery is undertaken by NT Fisheries.

The Demersal Fishery has been assessed by the Australian Government Department of Environment and Heritage (now known as the Department of Environment and Water Resources) against the Guidelines for the Ecologically Sustainable Management of Fisheries to receive full Export Exempt accreditation under the Commonwealth *Environment Protection and Biodiversity Conservation Act* (the EPBC Act). The assessment is due for review in May 2009.

Profile of the Fishery

Commercial Sector

Area

The Demersal Fishery operates in waters from 15 nautical miles from the low water mark to the outer limit of the AFZ, excluding the area of the Timor Reef Fishery (Figure 1).

Within the Demersal Fishery, the majority of fishing effort occurs in areas adjacent to the Timor Reef Fishery.

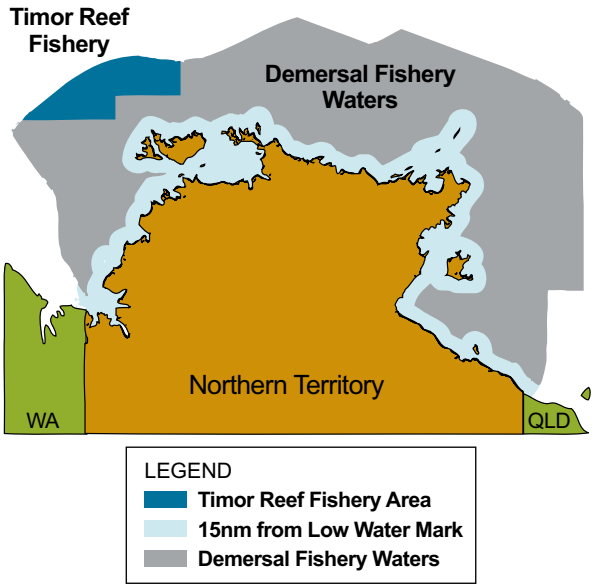

Figure 1. Location of the commercial Demersal Fishery area in 2006

Fishing method

Methods in this fishery are identical to those of the Timor Reef Fishery where operators use either traps or drop lines to target goldband snapper.

Catch

The principal target species of the Demersal Fishery is goldband snapper, which comprises the three species, *Pristipomoides multidens*, *P. typus* and *P. filamentosus*. Together these species make up 49 per cent of the total catch, with *P. multidens* being the most common of the three *Pristipomoides* species. Other major target groups are saddletail snapper (*Lutjanus malabaricus*), red snapper (*L. erythropterus*), red emperor (*L. sebae*), and cod (Family Serranidae) (Figure 2).

The species composition of the catch is gear dependant (Figure 3). Drop liners catch a higher proportion of goldband snapper, compared with trap boats which catch almost equal proportions of red snappers (*L. malabaricus, L. erythropterus*) and goldband snapper (*P. multidens*). A higher proportion of trapping was conducted during 2006 compared with drop lining; hence the species composition of the total catch has changed significantly from 2005.

In 2006, the total catch from the Demersal Fishery was 223 tonnes, a significant increase from the 2005 total catch of 79 tonnes (Figure 4). The goldband snapper component was 109 tonnes. This increase in catch was due to an increase in focus on the Demersal Fishery by Timor Reef Fishery operators in response to seismic survey activity in the Timor Sea and business decisions to more actively target the Demersal Fishery.

By-product Species

By-product catch (mixed reef, cod and red emperor) is well below the 10 per cent trigger value required for a review of management arrangements for the protection of by-product species.

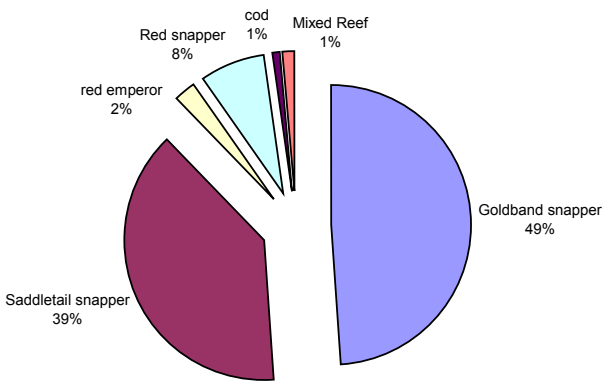

Figure 2. Overall catch composition of the Demersal Fishery for 2006

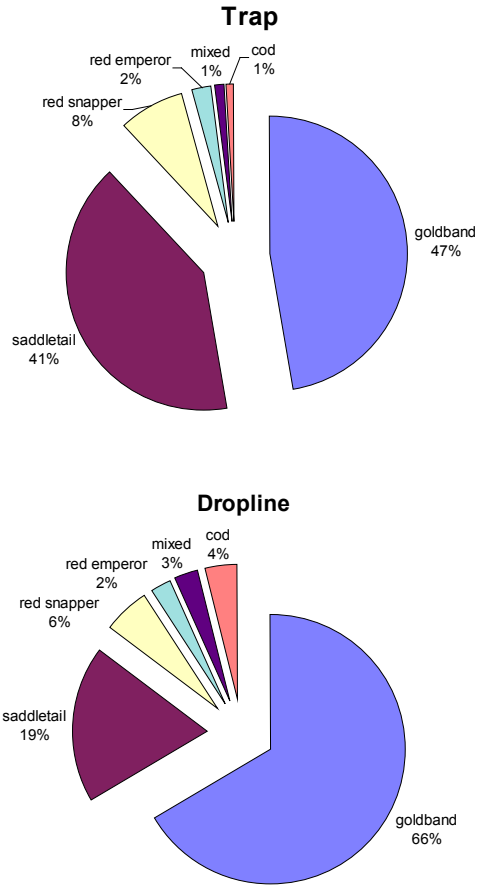

Figure 3. Comparison of catch composition harvested using different fishing gear in the Demersal Fishery during 2006

Effort

During 2006, there were six active licences in the Demersal Fishery. The reported effort in this fishery was 281 boat days, which was substantially higher than the 173 boat days recorded in 2005 (Figure 4).

Catch Rates

Catch per unit effort (CPUE) has fluctuated considerably over the history of this fishery (Figure 5). However, this is probably a reflection of the small number of operators and small amount of fishing activity rather than changes in fish abundance.

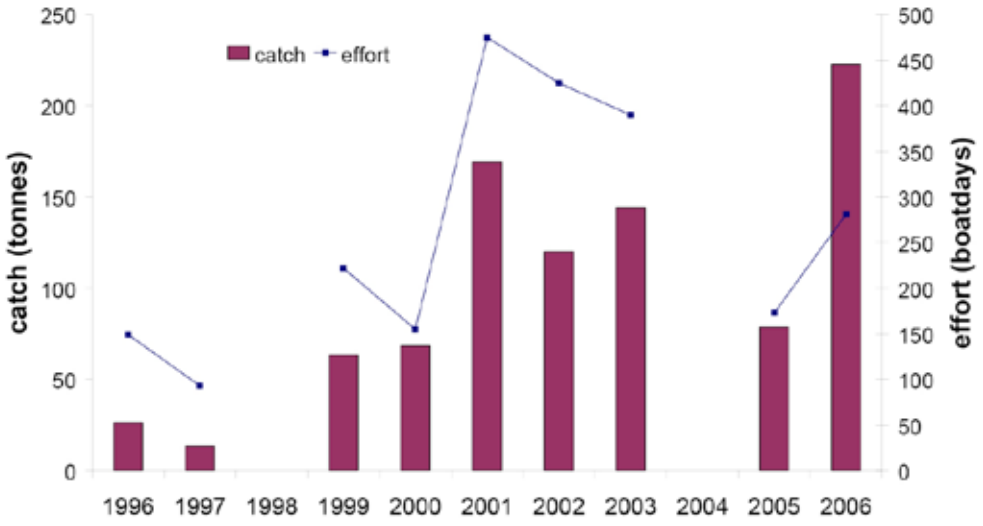

Figure 4. Catch and effort for the commercial Demersal Fishery, 1996 to 2006*

*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.

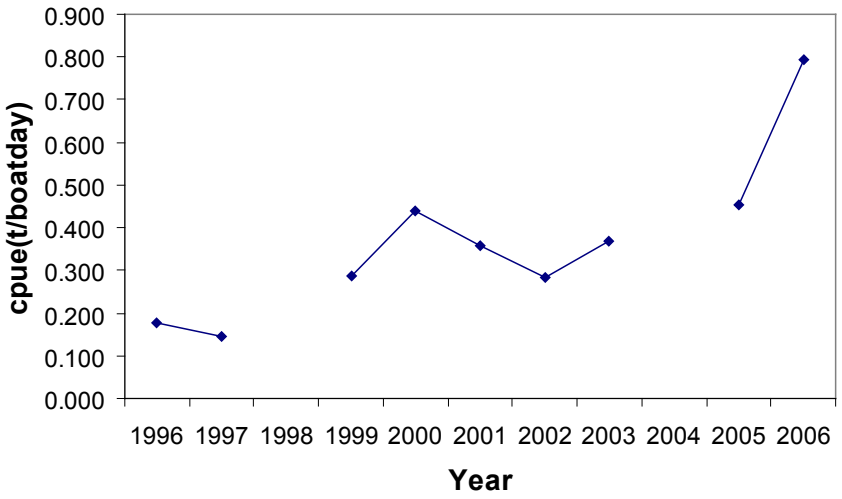

Figure 5. Total CPUE for the commercial Demersal Fishery, 1996 to 2005*

*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 means most of the product is forwarded 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 the Demersal Fishery, particularly red snappers and red emperor, from inshore waters. However, the overall impact on the offshore commercial fishery is considered negligible.

Fishing Tour Operator Sector

Very few FTOs are active in the offshore Demersal Fishery areas and therefore their activities are not considered to impact on the commercial fishery catch.

Non-retained Species

No monitoring trips were conducted in the Demersal Fishery during 2006. However, due to its similarity to the Timor Reef Fishery, the same assumptions have been made about the levels of non-retained species, that is levels of less than 7 per cent.

Non-retained species include Chinaman fish (*Symphorus nematophorus*), red sea bass (*Lutjanus bohar*), big eye trevally (*Caranx sexfasciatus*), and starry triggerfish (*Abalistes stellatus*).

By-catch in this fishery is well below the 10 per cent trigger value.

Threatened Species Interaction

In 2006, there were no recorded interactions with threatened species in the Demersal 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 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”, that is 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 entry and exit of fish from the traps used in the Demersal Fishery.

Social Impact

The commercial fishery directly employs fewer than 20 people as crew on boats. Numerous people are employed in other industries, such as transport and boat repairs. However, recreational fishers target some of these demersal species which form an important component in the lifestyle and culture of a large proportion of people residing in the NT.

Economic Impact

In 2006 there were six active operators in the Demersal Fishery. It is the policy of NT Fisheries that information obtained from a Fishery with fewer than five active operators will not be released without prior consent from the licensee(s). As a result, the 1998 and 2004 catch value for the fishery remains confidential. The 2006 catch value was $1.32m ($0.49m in 2005).

Stock Assessment

Monitoring

The Demersal 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.

No monitoring trips were conducted in the Demersal Fishery during 2006, due to the high level of observer activity required in the Timor Sea to monitor fish catches prior to, during and following seismic survey activity in the area. However, due to the similarity of methods, fishing grounds and catch composition of this fishery with the Timor Reef Fishery, it is felt that observer information from the Timor Reef Fishery adequately covers the Demersal Fishery, especially given the low level of fishing activity in this fishery.

Stock Assessment Methods and Reliability

Stock assessment for goldband snapper has been combined for both the Demersal and Timor Reef Fisheries as 95 per cent of fishing effort undertaken in the Demersal Fishery occurs on grounds adjacent to the Timor Reef Fishery, which is likely to encompass the same goldband snapper stocks.

Current Harvest Status

The most recent stock assessments of tropical snappers in relation to sustainable harvest levels indicate that current catch levels in the Australian sector of the Arafura Sea are below triggers set for a review of management arrangements.

Future Assessment Needs

Future assessment needs to concentrate on the degree of movement of both goldband and red snappers between Australia and Indonesia, the identification of juvenile snapper habitats and obtaining more accurate growth parameters from the capture of juvenile snapper.

Research

Summary

GIS spatial statistical methods have shown that there is a relationship between bathymetry and geomorphology and high catches of goldband snapper. Although this work (Fisheries Research and Development Corporation [FRDC] project 2005/047), was undertaken in the Timor Reef Fishery, there are implications for the Demersal Fishery with respect to these findings.

The stock structure of goldband snapper (*P. multidens*) has been determined through a number of externally funded projects.

FRDC funded projects 1996/131; 1998/154, were collaborative projects between NT Fisheries, WA Department of Fisheries and Queensland Department of Primary Industry and Fisheries. These studies used mitochondrial DNA (mtDNA) and otolith microchemistry techniques to determine the stock structure of *P. multidens* resources between the NT and Western Australia. Opportunistic samples were obtained from Kupang (Indonesia). 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 north-west Australian site less than 200 nautical miles on either side of the Timor Trench (Ovenden et al., 2000). Otolith microchemistry 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 a collaborative Australian Centre for International Agricultural Research (ACIAR) funded project between Australia and Indonesia (FIS/1997/165). This study provided updated stock assessment parameters which were incorporated into stock assessment models for the current assessment.

Incorporation into Management

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

Current Research

Current research is focused on developing a holistic approach to fisheries management using geospatial statistics and fuzzy logic rule-based modeling (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 analyis 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. This work is expected to be completed in 2007.

Management/Governance

Management

Objective

Management arrangements for the Demersal Fishery aim to maintain catches of goldband snapper and red snappers by all sectors within acceptable ranges. Red snappers are also a target species of the Finfish Trawl Fishery. Should landings of goldband snapper from the Timor and Arafura Seas 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

With the passage of the revised jurisdictional arrangements contained in the Offshore Constitutional Settlement (OCS) of 1988, management responsibility for line fishing and trapping in waters adjacent to the NT passed to the NT Government from the Commonwealth.

In 1993, the area of the Timor Reef Fishery was annexed from the Demersal Fishery and the inshore boundary was altered to separate the Demersal Fishery from the inshore Coastal Line Fishery. All operators who had previously held a fishing entitlement to this area were issued a demersal licence if they did not already hold such an entitlement.

A further revision of the jurisdictional arrangements occurred in 1995. At that time, management responsibility for the Demersal Fishery was passed to the NT Fisheries Joint Authority (NTFJA).

The NTFJA provided for the Commonwealth and the NT to jointly manage the fishery given the likelihood of shared resources with adjacent national and international jurisdictions.

Under this arrangement, NT Fisheries undertakes day to day management of the Timor Reef, on behalf of the NTFJA.

Current Issues

Encouraging further development of this under-utilised fishery and encouraging operators to undertake fishing throughout the entire fishery area continue to be the key objectives for industry and government.

The impacts of illegal, unreported and unregulated (IUU) fishing in northern Australian waters, primarily by foreign fishers, are poorly understood. The NT Government continues to work with the Australian Government to ensure adequate resources are allocated by

the Australian Government (the governing body is the Australian Fisheries Management Authority [AFMA]) to mitigate IUU impacts on the sustainability of red snapper stocks.

While it is accepted that most IUU fishers are primarily targeting sharks, apprehended vessels holding significant quantities of red snapper are becoming more prevalent. Coastwatch data highlights the significant illegal foreign fishing vessel presence in northern Australian waters. Research to determine the probable impact this illegal foreign presence is having on domestic shark and snapper stocks is continuing with a number of projects attempting to determine the species and volumes of sharks and snappers being harvested. It is not yet possible to determine the potential effect IUU fishing is having on the tightly regulated domestic Demersal Fishery.

Future Plans

NT Fisheries, in consultation with industry has held a series of workshops to develop a sectorial development plan for offshore snappers. The levels of permitted gear (hand and drop lines) will be incorporated into discussions with industry over the development plan for the combined offshore snapper fisheries.

Fishers in the Demersal Fishery share the same offshore snapper stocks with the Finfish Trawl Fishery and operators from both fisheries are involved in discussions to develop the shared resource. Discussions held so far have indicated a conservative development plan for the offshore snapper resource. Operators sharing the offshore snapper resource in the Arafura Sea have sought to introduce an additional finfish trawl licence to increase resource utilisation, particularly in the more remote regions.

Other issues discussed by industry have been long-term protection of the deepwater goldband snapper habitat areas from potential finfish trawl gear damage and the re-allocation of potential red snapper catch from the Demersal Fishery to the Finfish Trawl Fishery. This is proposed to be achieved through a licence reduction scheme that should avoid any potential for future catch conflicts and ensure the ongoing sustainability of red snappers.

The management arrangements relating to the Demersal Fishery have been assessed against the Guidelines for the Ecologically Sustainable Management of Fisheries under the EPBC Act. The fishery has received the highest level of accreditation and thus has been declared exempt from export regulations under the *EPBC Act* for five years.

The NT and Australian Governments are working closely with the Indonesian Government to develop a bilateral Management Plan for red snapper shared stocks in the Arafura Sea.

Compliance

Compliance with the Demersal Fishery management arrangements are undertaken by the Marine and Fisheries Enforcement Section (MFES) of the NT Police, Fire and Emergency Services, under the Northern Territory *Fisheries Act 1988*.

MFES effectively monitors and enforces the Demersal Fishery management arrangements through the inspection of vessel arrivals and departures through the single port of Darwin. This includes verification of catch returns against processor returns (that is requirement for all operators to specify where they are selling their product). MFES has the power, if necessary, to investigate the records of wholesalers and licensees.

In 2006, there were no recorded compliance issues for the Demersal Fishery.

Consultation, Communication and Education

Regular consultation occurs between NT Fisheries, the NT Demersal Fishermen's Association and the NT Seafood Council. In addition, NT Fisheries officers make regular visits to the wharf to speak informally with fishers.

The low levels of participation in the Demersal Fishery allow all stakeholders to be directly involved in discussions on any proposed management arrangements. A framework for a Demersal Fishery Management Advisory Committee (DFMAC) has been developed to formally represent the interests of all stakeholders and provide a forum for any proposed amendments to the management regime.

Conservation groups and non-government organisations are updated on current fisheries issues, including the Demersal Fishery, through regular meetings with senior fisheries officers. Members of the public, including community and environment/conservation groups are also invited to provide their views to NT Fisheries through the release of public discussion papers and other consultative processes.

NT Fisheries also puts out publications in the form of Fisheries Reports and newsletters to inform and educate stakeholders.

Prepared by

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Julie Lloyd – Senior Research Scientist
Chris Errity – Technical Officer, Marine Fish section

References

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Ovenden, J.R., Lloyd, J., Newman, S.J., Keenan, C.P. and Slatter, L.S. (2002). Spatial genetic subdivision between northern Australia and south-eastern Asian populations of Pristipomoides multidens: a tropical marine reef fish species. Fisheries Research 59, 57-69.

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

Species or Group	Management objectives	Performance indicator	Trigger reference point	Management response to be taken
Goldband snappers	Ensure inter-generational equity by maintaining ecologically sustainable annual catches in all sectors. Optimal sustainable yield estimates.	Optimal sustainable yield estimates.	Catch levels increase to 90 per cent of estimated sustainable annual yield.	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.
Red snappers				
Red emperor		Significant change in catch composition on Demersal Fishery grounds.	Annual catch increase in proportion of the total catch by greater than 10 per cent above the 5 year average.	DFMAC to review fishery and make recommendations to the Director of Fisheries and onboard monitoring to commence at earliest practical opportunity.
Cods				
By-product species	Ensure sustainability of by-product species taken in the Demersal Fishery.	Monitoring of commercial logbook returns.	Annual catch increase in proportion of the total catch by greater than 10 per cent above the 5 year average.	
By-catch species	Ensure sustainability of by-catch species taken in the Demersal Fishery.	Onboard monitoring of Timor Reef Fishery.	Total by-catch within the Demersal Fishery increases to 10 per cent of total catch or a decline in a species relative numbers without a corresponding change in fishing area or fishing technique.	DFMAC to make recommendations to Director of Fisheries regarding appropriate remedial action and onboard monitoring to commence at earliest practical opportunity.
Endangered, threatened or protected species and/or communities	Maintain present level of interaction between demersal fishing operations and species and communities listed under the *EPBC Act 1999.*	Endangered, threatened or protected species and or communities are identified in Northern Territory waters.	Identifiable impacts observed by commercial fishers, fisheries observers or other agencies regarding EPBC listed species or communities.	DFMAC to make recommendations to Director of Fisheries regarding appropriate threat abatement plan implemented and onboard monitoring to commence at earliest practical opportunity.
Ecosystem components	Minimise effects on ecosystem components.	Identification of threatening processes.	Identification of significant negative interaction with components of the natural ecosystem present on demersal fishing grounds.	DFMAC to make recommendations to Director of Fisheries regarding appropriate remedial action.

Development Fisheries Status Report 2006

Introduction

The commercial fishing industry is characterised by constantly evolving technologies and changing market opportunities. In order to conduct trials on new fishing gear, or to encourage sustainable harvest of aquatic resources not utilised by existing fisheries, commercial fishers may be issued with development permits or licences. Such trials are termed Development Fisheries.

Fishers who wish to conduct trials are required to lodge written applications providing detailed information about their proposed activities. The Northern Territory Fisheries Development Opportunities Committee (NTFDOC) reviews all applications.

Approved applications are issued with a development permit usually valid for a licensing year. Performance criteria are assigned to each permit so that the feasibility of a potential commercial fishery may be demonstrated. Permit holders who have satisfied all aspects of the performance criteria may apply for a development licence.

Development licences may be issued to approved applicants for up to one licensing year and may be renewed a maximum of four times. Applicants must meet all performance criteria within the term of each licensing year if they wish the NTFDOC to consider recommending the upgrade of a Development Fishery to a managed fishery. Administration of the Development Fisheries is guided by the Policy for the Appraisal and Administration of Northern Territory Development Fishery Applications.

Profile of the Fishery

Commercial Sector

Area

A development permit or licence may be issued to a fisher to conduct fishing trials targeting a resource not already targeted by a managed fishery or a resource outside the boundary of an existing fishery. Within the area of an existing fishery, a development permit or licence may be issued for the purpose of trialling new fishing gear or methods. Fishers are required to declare the proposed fishing area in their application, and this is incorporated into the conditions of the permit or licence.

Development trials may be permitted to occur in specific areas requested, or may be granted widespread access to Northern Territory (NT) waters. Generally, the boundaries of a Development Fishery will replicate relevant existing fisheries and will also incorporate restrictions where Aboriginal sacred sites and protected area reserves exist.

Fishing Method

In 2006, a number of different development permits were issued. These included development permits for blue swimmer crabs, tropical rock lobsters, sponge and squid.

Five permits were issued to trial the harvest of tropical rock lobsters or sponge using scuba or hookah gear and hand-held implements. One permit was also issued to trial the use of crab pots to harvest blue swimmer crabs.

Two permits were approved to trial the harvest of squid and bait fish using a lift net. A lift net is a horizontal net that is lowered to the bottom, left for sometime and then lifted rapidly to the surface. One permit was also issued to trial the use of a small purse-seine net for harvest of the same resources. 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

Due to the low number of operators in each Development Fishery, confidentiality constraints prohibit the release of catch information.

Marketing

Development permits are issued to assess both the sustainability and economic feasibility of new commercial fishing activity. During the initial trials, the market acceptance and potential is investigated. Only if it can be demonstrated that the product of the Development Fishery is commercially viable, will a trial progress to the next stage.

Recreational Sector

It appears that there is negligible overlap of the aquatic resources currently utilised by the Development Fisheries and the recreational fishing sector. Recreational catch data gathered during the National Recreational Fishing Survey (NRFS) conducted during 2000-01, revealed no significant conflict between the two sectors.

Fishing Tour Operator Sector

There is little overlap in terms of the resources utilised by the Development Fisheries and Fishing Tour Operators (FTOs). It is possible that FTOs may occasionally utilise squid and bait fish stocks. However, it is unlikely that present catch levels in the Development Fishery will impact on their operations.

Indigenous Sector

There is little overlap in terms of the resources utilised by the Development Fisheries and the indigenous subsistence fishing sector. The NRFS conducted during 2000-01, indicated that there is little conflict between the indigenous fishing sector and the current Development Fisheries.

Non-retained Species (By-catch)

Development permit holders were not required to record details of non-retained species in 2006.

Threatened Species Interaction

In 2006, there were no reported interactions with threatened species.

Ecosystem Impact

A major consideration in the assessment of new applications for a development permit or licence is the impact of the development activity on the ecosystem. All applications are considered on the premise of the precautionary principle to provide the greatest care to the environment in which the trials are conducted.

The 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 by-catch species. Formal performance criteria are applied to all development permits and licences, which must be achieved for the trials to continue.

Social Impact

The social impact of a Development Fishery is incorporated into the assessment of new applications and progress of current permits and licences. If a development permit application is considered to present a significant impact on other user groups, the application will be forwarded to the relevant representative bodies for advice. If a development licence is deemed to present potential for conflict with other stakeholders, an information paper may be circulated to the relevant representative bodies.

Economic Impact

Development permits and licences provide the means for fishers to trial more efficient gear or new market opportunities. The economic potential or impact of a Development Fishery is incorporated into the assessment of new applications and progress of current permits and licences. The value of these fisheries is confidential. As indicated earlier, information

from fewer than five active operators within a fishery will not be released without seeking prior consent of all licensees/permit holders.

Stock Assessment

Monitoring

Permit and licence holders are required to provide records of the daily catch and may be required to accommodate observers on board their vessel to assess the Development Fishery. The NTFDOC annually reviews the logbook returns and observer reports for each of the Development Fisheries.

Stock Assessment Methods and Reliability

At any stage, if the NTFDOC requires more information about a proposed fishery in order to make a decision, the NTFDOC may seek a report on the resource. NT Fisheries may then coordinate research and provide a report to the NTFDOC for their consideration at the next scheduled meeting. Alternatively, the applicant may be requested to supply or resource an appropriate report. No stock assessments have been conducted to date.

Catches in the Development Fisheries in 2006 were below the maximum harvest levels specified in the permit conditions. A precautionary approach was applied to the setting of the maximum harvest levels of the developing fisheries. The initial yields are set at a low level of harvest rate so as not to present adverse impacts on the environment in which the Development Fishery operates. The total allowable catch may be increased as more information on the sustainability of the fishing activity is gained.

Research

Summary

The establishment of a managed fishery requires informed decision-making based on advice on the status of target stocks and the impact on the aquatic ecosystem as a whole. Information of this nature has been gained through the reports of independent observers. Such reports have been produced on skimmer net trials and squid harvesting activities. There are no other studies under way in the NT that are related to the current Development Fisheries.

Incorporation into Management

Development trials will only progress to the next stage where the development permit or licence holder is able to demonstrate that the trials are both ecologically and economically viable.

Current Research

At the request of the NTFDOC, NT Fisheries has conducted a desktop study of the development options for harvesting squid and bait fish. The results of this study form the basis of the current management arrangements for this Development Fishery.

Management/Governance

Management

Objective

The Policy for the Appraisal and Administration of NT Development Fishery Applications aims to encourage the development of new fisheries and new fishing gear through ecologically sustainable development, ensuring that aquatic resources are properly utilised now and preserved for the future.

History

The NTFDOC (formerly the Ministerial Committee on NT Fisheries Development Opportunities) was founded in September 1998. The NTFDOC was formed to streamline the assessment of applications for development trials. The NTFDOC is required to provide informed, impartial recommendations to the Executive Director, Fisheries and the Minister for Primary Industry, Fisheries and Mines about the issuance of development permits or licences.

The NTFDOC comprises an independent chair, two commercial fishing sector representatives, two recreational fishing sector representatives, an indigenous fishing sector representative and two members of NT Fisheries. The NTFDOC Charter dictates the principles governing the NTFDOC.

In 2001, the Policy for the Appraisal and Administration of Northern Territory Development Fishery Applications was released. Within this document, details are provided of the policies endorsed by the NTFDOC following the assessment of previous applications. Applications reviewed have focused on pelagic fish, jellyfish, squid, octopus, crabs, crayfish, prawns, mussels, corals and shells. Harvest methods assessed have included a variety of nets, pots and lines.

The NTFDOC meets annually in March so that development permits and licences may be issued in the new licensing year commencing in July. Sections 11 and 17 of the NT *Fisheries Act 1988* provide for the issue of development permits and licences. The granting of a development permit or licence does not guarantee access to a resource or fishing method that advances to a managed fishery. However, history accumulated in the Development Fishery will be taken into account when determining access.

Future Plans

The NTFDOC undertakes regular reviews of the Policy for the Appraisal and Administration of Northern Territory Development Fishery Applications. The last comprehensive review was undertaken in 2004. Further, it is required to provide advice on amendments to the NT *Fisheries Act 1988* or the *Fisheries Regulations 1993*.

Compliance

Compliance and enforcement activities are undertaken by the NT Marine and Fisheries Enforcement Section of the NT Police, Fire and Emergency Service.

While the novel technologies of Development Fisheries continue to draw the attention of the general public, there have been no reported problems with compliance in any of the Development Fisheries operating in 2006.

Consultation, Communication and Education

NT Fisheries provides an Executive Officer to the NTFDOC. It is the role of this position to facilitate the application and assessment process and coordinate the daily administration of the Development Fisheries. The Executive Officer, together with the NT Seafood Council, are available to provide assistance to fishers regarding their applications and development activities.

Development permit and licence applicants are invited to attend the annual meeting of the NTFDOC, providing the opportunity to present additional details of a particular development project. Regular dialogue with permit and licence holders is maintained. All permit holders are required to submit a progress report six months from the issuance of the permit.

Prepared by

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Finfish Trawl Fishery Status Report 2006

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 with the majority sold on the Australian domestic market.

The Finfish Trawl Fishery is comprised of a single Finfish Trawl operator fishing in offshore waters east of Darwin and includes the northern region of the Gulf of Carpentaria.

The fishery is managed as a Joint Authority fishery under the Northern Territory (NT) *Fisheries Act 1988*. Day to day management of the fishery is undertaken by NT Fisheries.

The Finfish Trawl Fishery has been assessed by the Australian Government Department of Environment and Heritage (now known as the Department of Environment and Water Resources) against the Guidelines for the Ecologically Sustainable Management of Fisheries to receive full Export Exempt accreditation under the Commonwealth *Environment Protection and Biodiversity Conservation Act* (the EPBC Act). The assessment is due for review in May 2008.

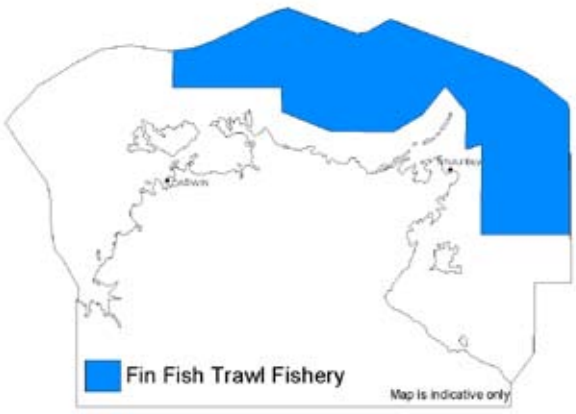

Figure 1. Fishing area available to the commercial Finfish Trawl Fishery

Profile of the Fishery

Commercial Sector

Area

The Finfish Trawl Fishery operates in 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, 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.

Fishing Method

This fishery has been limited to a single trawl operator. Fishing operations are conducted using a semi-pelagic demersal trawl. This trawl net was developed cooperatively by industry and NT Fisheries 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.

Catch

Saddletail snapper (*Lutjanus malabaricus*) and red snapper (*Lutjanus erythropterus*) are the target species of the Finfish Trawl Fishery, comprising 78 per cent of the total catch (Figure 2).

Since 1995, catches have increased steadily, peaking in 2001 (Figure 3). In 2006, the catch was 866.2 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 fishery trends.

In 2006, by-product harvest was 186 tonnes. These species include primarily goldband snappers (*Pristipomoides multidens* and *P. typus*), red spot (*L. lentjan*), and painted sweetlip (*Diagramma pictum*).

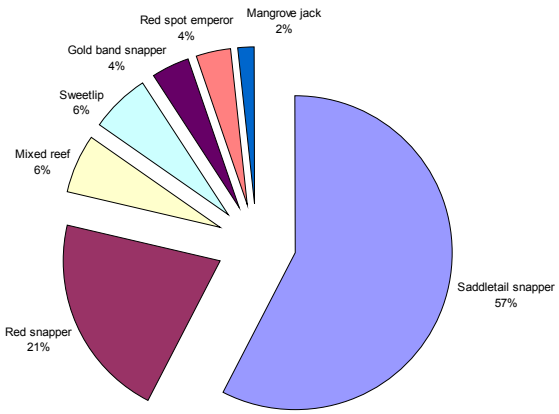

Figure 2. Catch composition for the Finfish Trawl Fishery, 2006

Effort

Fishing effort has increased steadily from 158 boat days in 1995, peaking at 294 boat days in 2003. During 2006 effort was 235 boat days (Figure 3). However, as there is only one operator, care should be used in interpreting any trends in this fishery based on effort, as there are many reasons for any changes in fishing effort.

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 2006 was 3.7 tonnes/boat day.

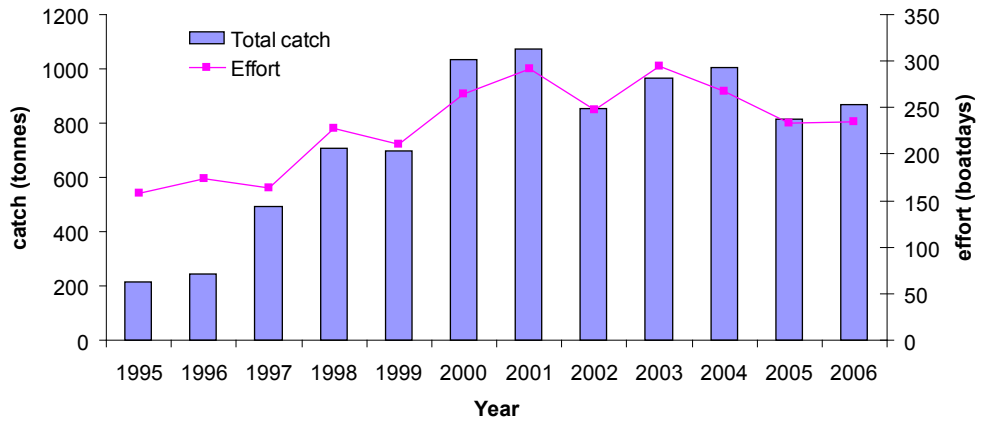

Figure 3. Total catch and effort within the Finfish Trawl Fishery, 1995-2006

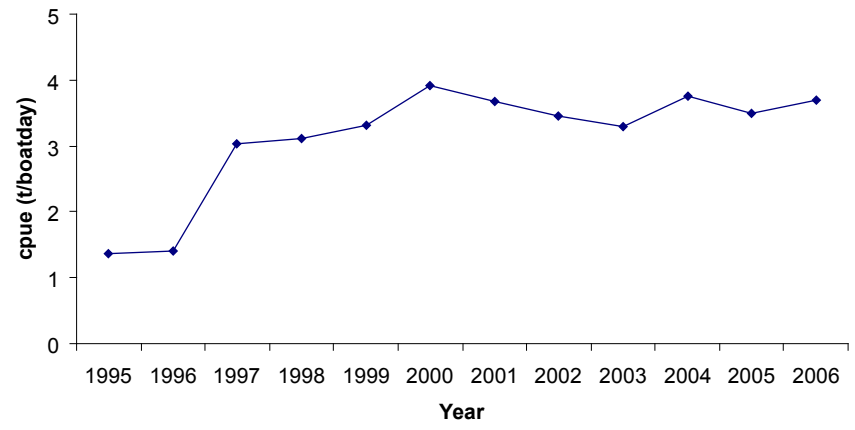

Figure 4. CPUE for the Finfish Trawl Fishery, 1995-2006

Marketing

The product is transported from Darwin in refrigerated trucks as 90 per cent of it is sold in Australia as fresh fish. A considerable amount, but a small proportion, is sold in Darwin. About 10 per cent is exported, 5 per cent as frozen to Asia and 5 per cent fresh to the US.

Recreational Sector

Recreational fishers take some of these species, particularly saddletail snapper, red snapper and red emperor from inshore waters; however, their impact on the offshore commercial fishery is considered negligible.

Fishing Tour Operator Sector

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

Non-retained Species (By-catch)

For the commercial Finfish Trawl Fishery, only 17.3 per cent of the total catch is discarded. High proportions of discarded species (by weight) are sharks and rays as there is a 'no-take' regulation in place with regard to these species. To assist in reducing release mortality considerably, 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. This system is being evaluated by other trawl fisheries interstate with the intention of incorporating its use as standard operating practice.

Threatened Species Interaction

In 2006, there were no recorded interactions with threatened species in the Finfish Trawl Fishery. The method of fishing and the location of the fishery generally prevent the interaction with these species.

Ecosystem Impact

NT Fisheries has encouraged fishing practices that cause minimal impact on the ecosystem. The development, in conjunction with industry, of a semi-pelagic demersal trawl net that minimises seabed disturbance and reduces the amount of by-catch was important in reducing the environmental impact of this fishery.

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

The value of this particular fishery (one operator only) is confidential.

Stock Assessment

Monitoring

Due to resource constraints in 2006, only one monitoring trip was conducted in the calendar year. While on-board, observers document vessel and gear information, location and depth fished, fishing practices, catch composition and measure landed species.

Stock Assessment Methods and Reliability

Stock assessments for the Finfish Trawl Fishery were undertaken in 1996 and 2004. The initial assessment used a Stock Reduction Analysis model developed by Professor Carl Walters (Ramm, 1997). There is a more recent assessment method called Yield per Recruit and Biomass Dynamics model, which incorporates updated biological parameters.

An absolute figure cannot be placed on sustainable harvest for the fishery because key parameters (Indonesian catch and effort, level of interchange of fish and recruits, and important productivity parameters for red snapper) are not known. However, for the Australian sector of this fishery, the biomass of red snappers has been estimated from a fishery independent survey in 1990 to be 24 000 tonnes. It has been agreed that a trigger point be implemented for management purposes if harvest levels exceed 10 per cent of this figure.

Genetic studies undertaken as part of an Australian Centre for International Agricultural Research (ACIAR) project (FIS/1997/165) indicate that red snapper (*L. erythropterus*) and saddletail snapper (*L. malabaricus*) stocks are shared with Indonesia in the Arafura Sea (Salini et al., 2006).

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 upon where recruitment occurs and the level of movement of fish between the two countries. If movement rates of red snapper between Indonesia and Australia are low, and there is good recruitment to the Australian fishery from nursery areas within Australia, then the effect of large scale Indonesian fishing may be small. However, if recruitment was primarily from Indonesia and movement rates between sectors were high, then the effect would be more significant.

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 Stock Assessment Group. There is consensus that the following areas are of high priority:

- Completion of an updated red snapper stock assessment.
- Data warehousing for historical data.
- Investigation of the degree of movement of red snappers.
- Investigation of the effect of illegal, unreported and unregulated (IUU) fishing on red snapper stocks.
- Identification of juvenile habitats.
- Undertaking of fishery independent surveys.

Research

Summary

A joint project between NT Fisheries, CSIRO and Indonesia (funded by ACIAR) has investigated the biology, life history and sustainability of the target species for this fishery - (*Lutjanus malabaricus, L. erythropterus*) - which account for 78 per cent of the Finfish Trawl Fishery catch. Findings from this project are outlined in the final report of ACIAR project FIS/1997/165 (available on the ACIAR website, http://www.aciar.gov.au).

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

Research is presently being undertaken to identify juvenile red snapper grounds.

Management/Governance

Management

Objective

Management of the Finfish Trawl Fishery seeks to ensure the ecological sustainability of target, by-product and by-catch species. Trigger points and management actions for the Finfish Trawl 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 (OCS) of 1995, management of the trawl, shark and line fishing and trapping in waters adjacent to the Northern Territory 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. NT Fisheries, on behalf of NTFJA, undertakes the day-to-day management of the fishery.

Current Issues

The Finfish Trawl Fishery has been assessed against the Australian Government Guidelines for the Sustainable Management of Fisheries under the *Environment Protection and Biodiversity Conservation Act* (EPBC Act). The fishery received the highest level of accreditation and has been added to the list of fisheries exempt from export regulations for five years.

The impact of IUU fishing in northern Australian waters, primarily by foreign fishers, is poorly understood. The NT Government continues to work with the Commonwealth to ensure it allocates adequate resources, to mitigate IUU impacts on the sustainability of red snapper stocks.

While it is accepted that most IUU fishers are primarily targeting sharks, apprehended vessels holding significant quantities of red snapper are becoming more prevalent. Coastwatch data highlights the significant illegal foreign fishing vessel presence in northern Australian waters. Research to determine the probable impact this illegal foreign presence is having on domestic shark and snapper stocks is continuing with a number of projects attempting to determine the species and volumes of sharks and snappers being harvested. It is not yet possible to determine the potential effect IUU fishing is having on the tightly regulated domestic Finfish Trawl Fishery.

Future Plans

NT Fisheries, in consultation with industry, has held a series of workshops to develop a Sectorial Development Plan for offshore snappers.

Fishers in the Demersal Fishery share the same offshore snapper stocks with the Finfish Trawl Fishery and operators from both fisheries have been involved in discussions to develop the shared resource. Discussions held so far have indicated a conservative development plan for the offshore snapper resource. Operators sharing the offshore snapper resource in the Arafura Sea have sought to introduce an additional Finfish Trawl licence to increase resource utilisation, particularly in the more remote regions. In 2006, the NTFJA granted approval to issue an additional finfish trawl licence for the fishery subject to certain criteria being filled. NT Fisheries is developing a fair and transparent Expression of Interest process seeking applications from persons wishing to be selected for the right to apply for a single finfish trawl licence.

Other issues discussed by industry have been long-term protection of the deepwater goldband snapper habitat areas from finfish trawling and the permanent re-allocation of potential red snapper catch from the Demersal Fishery to the Finfish Trawl Fishery to avoid any potential for

future catch conflicts and to ensure the on-going sustainability of red snappers.

NT Fisheries will continue to monitor the fishery to ensure catches are maintained within agreed ranges.

Compliance

Compliance with the NT Finfish Trawl Fishery management arrangements are undertaken by the Marine and Fisheries Enforcement Section (MFES) of the NT Police, Fire and Emergency Services, under the NT *Fisheries Act 1988*.

MFES effectively monitors and enforces the Finfish Trawl Fishery management arrangements through the inspection of vessel arrivals and departures through the port of Darwin. This includes verification of catch returns against processor returns (i.e. requirement for all operators to specify where they are selling their product). MFES has the power, if necessary, to investigate the records of wholesalers and licensees. In 2006 there were no recorded compliance issues with this fishery.

The compliance operations for the Finfish Trawl Fishery are appropriate for the size of the fishery (i.e. one operator). A compliance risk assessment has been undertaken for the fishery, but 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. NT Fisheries also publishes a range of material including Fishery Status Reports to inform and educate stakeholders.

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Salini, J.P., Ovenden, J.R., Street, R., Pendrey, R., Haryanti and Ngurah (2006). Genetic population structure of red snappers (Lutjanus malabricus Bloch & Schneider, 1801 and L. erythropterus Bloch, 1790) in central and eastern Indonesia and northern Australia. Journal of Fish Biology Vol.68, no. SB, pp.217-234.

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

Species/ Group	Management objectives	Performance indicator	Trigger reference point	Current status review	Management response to be taken
Red snappers	Ensure intergenerational equity by maintaining ecologically sustainable annual catches in all sectors.	Sustainable yield estimates for nominated regions.	Combined Finfish Trawl and Demersal fishery catch levels increase to 2500 t over the next calendar year. Catch levels decline by 30 per cent over the next calendar year (Finfish Trawl only).	Combined red snapper catches in 2006 781 tonnes Catch levels increased by 1.2 per cent over 2005 catch levels. Trigger reference point not exceeded.	Stakeholders to review fishery and make recommendations to the Executive Director, 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.
By-product species	Ensure ecological sustainability of by-product species taken in the Finfish Trawl Fishery.	Monitoring of commercial logbook returns.	Annual catch increase in proportion of the total catch by greater than 35 per cent.	2006 – 22 per cent. Trigger reference point not exceeded.	Stakeholders to review fishery and make recommendations to the Executive Director, Fisheries. Amended arrangements to be implemented within 12 months of trigger being released.
By-catch species	Ensure ecological sustainability of by-catch species taken in the Finfish Trawl Fishery.	Onboard monitoring of Finfish Trawl Fishery.	Total by-catch within the Finfish Trawl Fishery increases to 35 per cent of total catch or a decline in a species relative numbers without a corresponding change in fishing area or fishing technique.	2006 – 17.3 per cent. No identified decline in a species relative numbers. Trigger reference point not exceeded.	Stakeholders to make recommendations to Executive Director, Fisheries regarding appropriate remedial action. Amended arrangements to be implemented within 12 months of trigger being released.

Species/ Group	Management objectives	Performance indicator	Trigger reference point	Current status review	Management response to be taken
Endangered, threatened or protected species and/or communities	Ensure the continued protection of species and communities listed under the *EPBC Act 1999* and the *Territory Wildlife and Conservation Act 2000*,	Endangered, threatened or protected species and or communities are identified in NT waters.	Identifiable impacts observed by commercial fishers, fisheries observers or other agencies regarding EPBC listed species or communities.	No identifiable impacts have been observed in 2006. Trigger reference point not exceeded.	Stakeholders to make recommendations to the Executive Director, Fisheries regarding the implementation of a threat abatement plan, if required. Amended arrangements to be implemented within 12 months of trigger being released.
Ecosystem components	Minimise effects on ecosystem components.	Identification of threatening processes.	Identification of significant negative interaction with components of the natural ecosystem present on Finfish Trawl fishing grounds.	No negative ecosystem interactions identified. Trigger reference point not exceeded.	Stakeholders to make recommendations to Executive Director, Fisheries regarding appropriate remedial action. Amended arrangements to be implemented within 12 months of trigger being released.

Mud Crab Fishery Status Report 2006

Introduction

The Mud Crab Fishery is one of the key Northern Territory (NT) managed wild harvest fisheries. In 2006, the commercial wild-harvest sector caught 266 tonnes, valued at more than $4.7m.

Surveys conducted in 2000-01 highlighted the importance of the mud crab resource to recreational and indigenous fishers who harvested 82 000 and 86 500 crabs in a 12-month period, respectively. The combined weight of the catch was about 135 tonnes (Henry and Lyle, 2003) which equated to roughly 10 per cent of the commercial catch at that time (Haddon et al., 2004).

Four species of mud crab have been identified from the Indo-West Pacific region, with two species found in NT waters. *Scylla serrata* accounts for 99 per cent of the catch from all sectors with *S. olivacea* accounting for the remainder. There is little by-product/by-catch in this fishery due to the highly selective gear utilised to target large mud crabs.

The Mud Crab Fishery has been assessed by the Australian Government Department of Environment and Heritage (now known as the Department of Environment and Water Resources (DEW) against the Guidelines for the Ecologically Sustainable Management of Fisheries. This resulted in the fishery receiving full export exempt accreditation under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The assessment is due for review in 2007.

A revised Mud Crab Fishery Management Plan (MCFMP) was introduced on 1 May 2006. The plan included an increase in the minimum size limit for both sexes of commercially harvested mud crabs, greater penalties for fishery offences and the ability for the Executive Director, Fisheries to revoke a licence under certain circumstances.

The MCFMP also contains a set of conditions that elicit a review of the management arrangements. None of the trigger points were exceeded during the 2006 fishing year.

Fisheries staff accompanied commercial fishers as observers on eight trips covering Bynoe Harbour and the Adelaide, Wearyan, Roper and McArthur Rivers in 2006.

Profile of the Fishery

Commercial Sector

Area

The Mud Crab 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 mudflats.

Small mesh nets may be used under a restricted bait net entitlement to harvest fish for use as crab bait. These 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 their use of purchased bait and decreasing the amount of time spent netting for bait.

Fishing activity is not permitted in Darwin Harbour, most creeks adjoining Shoal Bay, Leaders Creek and the waterways of Kakadu National Park.

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 in excess of 100 km to

set their pots 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 cubic metres in volume or 1 metre 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 checked to ensure that it is above the minimum size, not berried (i.e. with eggs attached) and commercially suitable. The latter criterion is an industry initiative to ensure that no empty (i.e. low meat content) mud crabs are harvested. This measure helps maintain the reputation and high market value of NT crabs and reduces mortality during transport.

Catch

In 2006, 266 tonnes of mud crabs were harvested by the commercial fishery (Figure 1). Five years prior, the annual commercial mud crab catch exceeded 1000 tonnes. It is believed that those exceptional catches were a product of high recruitment during favourable environmental conditions. The 'soft crab' rule introduced in 2001 accounts for some of the decline in catch and catch per unit effort (CPUE) since that time.

Both male and female mud crabs can be retained in the NT. The minimum size limit (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 action was taken in response to recommendations in the 2004 NT Mud Crab Stock Assessment Report (Haddon et al., 2004). The size limit change resulted in a decline in the 2006 catch relative to that in 2005 (noting that the new size limit was in place for the last eight months of 2006).

As a by-product of commercial crabbing operations, 50 kg of cod and 163 kg of catfish were caught in 2006. Most was used to bait pots. No by-catch was reported in the 2006 logbooks.

Please note that the harvest of 'soft crabs' was prohibited in 2001 and explains some of the change in catch and CPUE. Also note that the minimum size limit for both sexes was increased by 10 mm in May 2006.

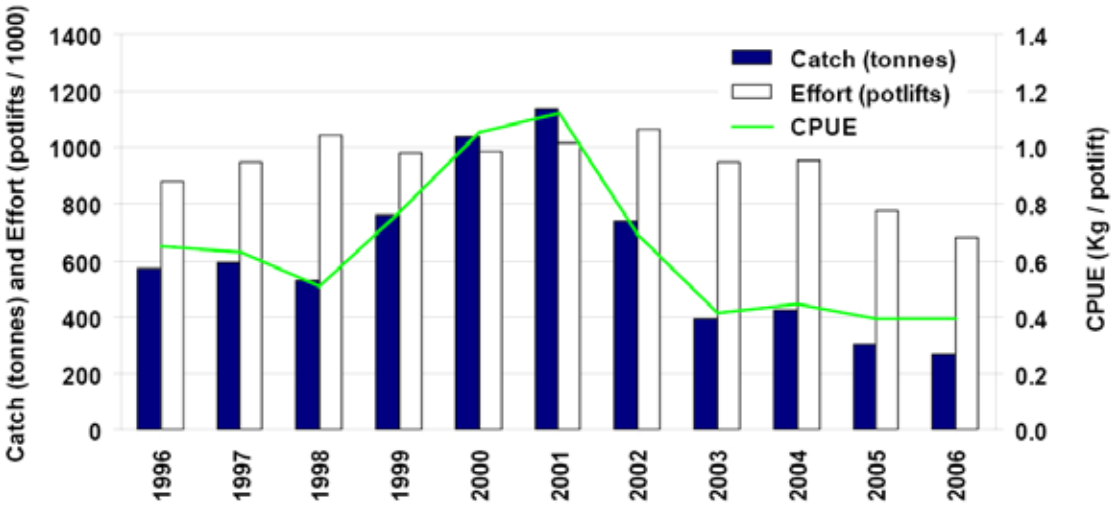

Figure 1. Catch and effort for the NT Commercial Mud Crab Fishery, 1996 to 2006

Effort

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

Total reported effort in 2006 was 680 179 pot lifts (Figure 1). 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 per cent during 2000 to 2004. This figure dropped to 9 per cent in 2005 and again to 7 per cent in 2006.

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 2006 equated to 0.39 kg per pot lift (Figure 1). 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. The catch rate has remained stable over the last four years.

Marketing

Mud crabs are a premium seafood, with strong demand for live product from the Sydney and Melbourne markets. Live mud crabs are transported to Darwin from around the Territory 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 the majority of 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 steel mesh pots (although collapsible mesh pots are becoming increasingly popular). Dillies, which consist of a panel of mesh on a steel frame that is baited and set on the substrate, may also be used, but must not be constructed in such a way that would cause entanglement of mud crabs or other aquatic life. A gear restriction of five pots (or dillies) per person applies, with a maximum of 10 pots per vessel. Mud crabs may also be harvested by a hand spear, hand-held hook, hook and line, hand net, cast net or drag net.

Catch

The recent increase in the minimum size limit for commercially harvested mud crabs did not apply to the recreational sector. The minimum size limit (measured across the widest part of the carapace) 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, NT Fisheries has produced extension material (i.e. 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 per cent (or approximately 61 000 crabs) 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 their pots 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 per cent of the total recreational fishing effort. However, targeted fishing for mud crabs was not quantified. Over 50 per cent 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).

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 pot and possession limits as recreational fishers. Pots are used to catch 94 per cent of all crabs caught by FTO clients.

Catch

In 2006, the FTO sector landed 2537 mud crabs, of which 1383 (54 per cent) were retained. This is a slight decrease in the harvest rate compared to the previous 12 years since records began, when the catch ranged from 62 per cent to 79 per cent.

Effort

In 2006, FTO clients spent 5359 hours of fishing effort targeting mud crabs. This represents a decline from the 6550 hours of mud crab effort in 2005.

Mud crabbing is a small part of the total FTO fishing effort. Since 1995, 3 per cent or less of all fishing trips reported annually have targeted mud crabs as part of their trip and mud crabbing accounts for 3 per cent or less of all fishing time.

Catch Rates

The mean mud crab catch rate for FTO clients in 2006 was 0.5 crabs per hour, which falls within the previous 12-year range of 0.4 to 0.8 crabs per hour. The mean mud crab harvest rate for FTO clients in 2006 was 0.3 mud crabs per hour, again within the previous 12-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 the vast majority of their catch. The indigenous harvest over a 12-month period from 2000-01 was approximately 86 000 crabs or about 69 tonnes (Henry and Lyle, 2003). Indigenous groups now hold 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 wide-mesh metal sheet 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 by-catch 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 by-catch.

Threatened Species Interaction

There were no reported interactions between threatened species and the Mud Crab Fishery in 2006.

Ecosystem Impact

The Mud Crab Fishery has minimal impact on the ecosystem due to passive fishing methods that effectively target large mud crabs.

DEW has reviewed the impacts of the fishery on the ecosystem and has determined that crocodiles, turtles and sharks may feed on mud crabs. However, the current level of mud crab harvest is unlikely to significantly impact on these species.

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 or 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 2006, the NT commercial mud crab catch was 266 tonnes, valued at about $4.73m.

The recreational sector also contributes to the NT economy, particularly, 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 (i.e. the Roper River, the 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 are 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 minimum size limits 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 and 2004.

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

The latest assessment (Haddon et al., 2004) revealed that catch-rates in 2004 were similar to those prior to 1996. However, the assessment concluded that the effort had spread across a wider temporal and spatial scale, creating a greater dependence on new recruits to the fishery.

Current Harvest Status

Recent assessments indicate that the Mud Crab Fishery is fully developed. In 2005, details of future management options were presented to the Minister for Fisheries. Changes to the management arrangements were implemented in 2006.

Future Assessment

The next assessment of the Mud Crab Fishery will occur during 2007. The assessment will re-examine the status of the fishery and will also look at the effect of recent changes to the Mud Crab Fishery management arrangements.

Research

Summary

The NT Mud Crab Research Program commenced in 1990 and has collected 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 include the 2004 stock assessment (Haddon et al., 2004) and a study of critical mud crab habitat and abundance estimation techniques (Hay et al., 2005).

Incorporation into Management

NT Fisheries reviews results of all research programs annually. If research determines that significant changes are required in any aspect of the fishery, particularly with respect to catch and effort, a review of the management arrangements is undertaken.

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

As a result of the 2004 stock assessment, a revised MCFMP was introduced on 1 May 2006. The plan included an increase in the minimum size limit for both sexes of commercially harvested mud crabs, greater penalties for fishery offences and ability for the Executive Director, Fisheries to revoke a licence under certain circumstances. The MCFMP also contains a set of conditions that elicit a review of the management arrangements.

Current Research

In 1999, Fisheries hosted a workshop to develop a 'National Strategy for Research on Mud Crabs' (see Calogeras, 2000). The workshop was attended by fisheries managers, researchers and industry representatives. The workshop developed a phased approach to guide future mud crab research in Australia.

The three phases were:

- Estimate relative productivity of mud crab habitat based on satellite imagery and abundance estimation techniques.
- Utilise validated commercial catch and effort data as an index of stock abundance.
- Develop a fishery independent index of stock abundance based on a juvenile pre-recruit index.

In 2000, the Fisheries Research and Development Corporation granted funding to implement Phase 1 of the national strategy. The three-year project was coordinated by NT Fisheries and was completed in 2004 (Hay et al., 2005). The project quantified the area of critical mud crab habitat and developed methods to estimate the size of mud crab stocks in northern Australia. Since the completion of Phase 1 of the national strategy, several projects consistent with Phase 2 have been undertaken. For example, catch and effort data was employed as an index of stock abundance during the 2004 NT Mud Crab Fishery Stock Assessment Workshop (Haddon et al., 2004).

A second National Mud Crab Fishery Research Strategy Workshop will be held in Darwin in 2007. That meeting will assess the merits of attempting Phase 3 of the current research strategy and identify research priorities for the Mud Crab Fishery over the next six to eight years.

Management/Governance

Management

Objective

A range of fishery objectives with performance indicators were agreed by the MCFAC to ensure that the sustainability of the fishery is maintained. Triggers against the performance indicators are presented in Table 1.

History

Conservative management, focusing on containing fishing effort and protection of breeding stocks through size limits has been adopted in the Mud Crab Fishery. Since 1991 the fishery has been controlled under the MCFMP. Amendments to the Plan were made in 1993 relating to non-retention of berried females and again in 1995 relating to a 10-mm increase in the minimum size limit for females to protect breeding stocks. An “in possession” limit of a maximum of 10 mud crabs per person applies with a vessel limit of 30 mud crabs if there are three or more people on board.

Current Issues

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 per cent in any one year or by 10 per cent per year over two consecutive years; total effort increases by 10 per cent 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, then the MCFAC will assess the situation and provide advice to the Executive Director, Fisheries.

Several trigger points were met in 2003 and 2004. As a result, Fisheries undertook a stock assessment of the fishery in 2004. Expert stock assessment scientists were commissioned to assist the Fisheries research team with the analysis. The report “Mud crab (*Scylla*

serrata) Assessment Workshop" (Haddon et al., 2004) provides a summary of the workshop proceedings and outcomes.

After extensive stakeholder consultation, a revised management plan was developed for public comment in November 2005. The proposed plan incorporated a range of management actions to increase compliance and ensure the continued sustainability of the Mud Crab Fishery. The revised plan received Ministerial approval and became effective on 1 May 2006.

Future Plans

The restricted bait net entitlement will be reviewed during 2007 to determine its suitability given the degree of conflict between user groups, particularly in the Gulf of Carpentaria region. A risk assessment for the removal of mud crabs from the ecosystem will also be undertaken and any outcomes will be incorporated in the fishery's management arrangements. These reviews meet the conditions of export certification awarded to the fishery by DEW. A further DEW assessment of the fishery will occur in 2007.

Compliance

The Marine and Fisheries Enforcement Section of the NT Police, Fire and Emergency Services undertakes surveillance and enforcement activities under the NT *Fisheries Act 1988* in relation all fisheries managed by the NT, including the Mud Crab Fishery.

In 2006 there were eight successful prosecutions in the mud crab fishery.

Major compliance issues included illegal use of excess or unmarked pots and the tying of mud crabs as soon as practicable after capture.

Consultation, Communication and Education

The MCFAC is the peak advisory body to the Executive Director, Fisheries. It comprises representatives from various user groups and government. As well as MCFAC, a series of regional coastal consultative committees have been formed. These provide formal advice to coastal Aboriginal communities on all aspects of fishing, including mud crab. The NT Crab Fishermen's Association and the Amateur Fishermen's Association of the NT have also taken an active role in formulating management policy for this fishery.

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 may utilise the services of an interpreter and are aimed at providing the fisher with an understanding of the legislation, status of the fishery, research, management and compliance issues.

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Table 1. Management Objectives and Performance Indicators for the Mud Crab Fishery

Species	Management Objectives	Performance Indicator	Trigger Reference Point	Management response to be taken
Mud crabs	Ensure the intergenerational equity by maintaining ecologically sustainable annual catches in all sectors.	Significant decline in the annual catch.	Commercial catch decreases by 10 per cent per annum for two or more consecutive years or decreases by 50 per cent in any one year.	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. Advice provided to the Executive Director within 12 months of trigger being reached.
		Significant increase in fishing effort.	Commercial fishing effort increases by 10 per cent per annum for two or more consecutive years.	
		Significant decrease in the median size of mud crabs.	Median size of mud crabs decreases by 5 mm per annum for two or more consecutive years.	
By-product species	Ensure ecological sustainability of by-product species.	Monitoring of commercial logbook returns.	By-product increases by more than 0.5 t in any one-year period.	MCFAC to review fishery and make recommendations to the Director of Fisheries regarding appropriate remedial action. Advice provided to the Director within 12 months of trigger being reached.
By-catch species	Ensure ecological sustainability of by-catch species.	Monitoring of commercial crabbing operations.	By-catch abundance increases by more than 50 per cent in any one-year or more than 100 per cent in any three-year period.	MCFAC to review fishery and make recommendations to the Director of Fisheries regarding appropriate remedial action. Advice provided to the Director of Fisheries within 12 months of trigger being reached.
Endangered, threatened or protected species and/or communities	Maintain present level of interaction between mud crab fishing operations and species and communities listed under the *EPBC Act 1999.*	Endangered, threatened or protected species and/or communities are identified in Northern Territory waters.	Identifiable impacts observed by commercial fishers, fisheries observers or other agencies regarding EPBC listed species or communities.	MCFAC to make recommendations to the Director of Fisheries regarding the implementation of a threat abatement plan, if required. Advice provided to the Director of Fisheries within 12 months of trigger being reached.
Ecosystem components	Minimise effects on ecosystem components.	Identification of threatening processes.	Identification of significant negative interaction with components of the natural ecosystem present on mud crab fishing grounds.	MCFAC to make recommendations to the Director of Fisheries regarding appropriate remedial action. Advice provided to the Director of Fisheries within 12 months of trigger being reached.

Offshore Net and Line Fishery Status Report 2006

Introduction

The commercial Offshore Net and Line Fishery (formerly known as the Shark Fishery) is a mixed target fishery. The target species are the blacktip sharks (*Carcharhinus tilstoni* and *C. sorrah*) and grey mackerel (*Scomberomorus semifasciatus*), with a variety of other sharks and pelagic finfish also landed.

A joint authority between the Northern Territory (NT) and the Commonwealth established under an Offshore Constitutional Settlement (OCS) arrangement manages the Offshore Net and Line Fishery. This provides for the NT to manage the day to day operations of the fishery on behalf of the NT Fishery Joint Authority (NTFJA). A conservative approach has been adopted in managing the northern Offshore Net and Line Fishery, given the well-documented low productivity of many shark species. This is a limited entry fishery in which the number of commercial participants has been reduced considerably through a three-for-one licence reduction scheme.

Cooperative research efforts are under way with adjacent jurisdictions, with the NT actively contributing to the implementation of an Operational Plan for the Sustainable Use of Northern Australian Shark Resources (OPSUNASR).

In 2004 the Offshore Net and Line Fishery received a Wildlife Trade Operation level of export as assessed against the Australian Government Guidelines for the Sustainable Management of Fisheries under the *Environment Protection and Biodiversity Conservation Act* (the EPBC Act). The management arrangements of the fishery are recognised by the Australian Government to be operating in a sustainable manner and the fishery is exempt from export regulations for three years. The fishery is due for reassessment in November 2007.

Concerns over illegal, unregulated and unreported (IUU) activities by foreign fishing vessels operating in NT waters led to a contraction of domestic fishing activity closer to the mainland during 2005, which is apparent again in 2006.

Sharks are also taken as limited by-product in a range of fisheries targeting other species. The incidental take of sharks in other NT fisheries remains around 5 per cent of the total combined fisheries shark catch, indicating that the dedicated Offshore Net and Line Fishery accounts for 95 per cent of the total shark catch.

Profile of the Fishery

Commercial Sector

Area

Operators are authorised to fish in NT waters from high water to the Australian Fishing Zone (AFZ) boundary, an area of approximately 522 632 km^2, with spatial restrictions placed on the use of certain gear. However, the majority 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. Little fishing was undertaken in the offshore area of the fishery during 2006.

Fishing Method

Operators may use either long lines or pelagic nets, but the use of bottom set gillnets is prohibited.

Most shark fishing is undertaken by pelagic gillnets. Although the legal maximum length is 2000 m, for operational reasons, nets are generally 1000 to 2000 m in length 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.

Catch

As described above, operations in the Offshore Net and Line Fishery are such that there are two separate target species groups: sharks, principally the blacktip sharks, and grey mackerel.

Logbook records indicated a total catch of all species for the fishery in 2006 of 1292 tonnes, decreasing slightly (7.6 per cent) from the 2005 catch of 1398 tonnes. There was also a small decline in the total shark catch in 2006 of 6.1 per cent, to 780 tonnes, from the 831 tonnes of 2005 (Figure 1).

Effort in the fishery again decreased, with 899 days fished. Precautionary measures introduced to contain effort in the fishery in 2005, as well as activities of IUU fishers and operational considerations have successfully led to reduced domestic effort in both 2005 and 2006, relative to the previous few years (Figure 1).

Blacktip shark catches were 457 tonnes, similar to the 440 tonnes landed in 2004 and represents a 20.6 per cent increase over the 379 tonnes landed in 2005. The proportion of blacktips in the landed catch was 37.2 per cent compared to 27 per cent of the catch in 2004 and 2005 (Figure 2). The grey mackerel catch of 404 tonnes (32.8 per cent of the total landings) was a 23 per cent decrease from the 526 tonnes taken in 2005 (Figure 2).

The previously strong increasing trend in catches evident since 1999 came to an end in 2005 (Figure 2). Although grey mackerel remained the principal single target species in the fishery, operators report that market forces and other operational considerations such as weather conditions may be among the principal drivers of variation within grey mackerel catches. Catch variations largely result from variations in targeting. However, it has not been 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.

By-product Species

The weight of catches of sharks other than blacktips was 323 tonnes or 26.2 per cent of the total catch (Figure 2), a decline from the 452 tonnes in 2005. By-product species were principally several species from the Family Carcharhinidae (the whaler or requiem sharks), mostly *Carcharhinus* spp. and *Rhizoprionodon* spp., as well as hammerhead sharks (*Eusphyra blocchii* and *Sphyrna* spp.)

The weight of mackerels other than grey mackerel was 26.4 tonnes (2.2 per cent of the total catch), all declared to be narrow-barred Spanish mackerel (*Scomberomorus commerson*). Small quantities of other fish species caught included tuna, mainly *Thunnus tonggol*, (corresponding to a combined total of 10.4 tonnes), 3.8 tonnes of trevallies (mostly *Caranx* spp. and *Carangoides* spp.,), 1.8 tonnes each of queenfish (*Scomberoides* spp.) and pomfret (*Parastromateus niger*) as well as several coastal species, each of less than 1 tonne.

Sharks were also landed as an incidental catch in a range of commercial fisheries targeting other species. Catches in 2006 under the Restricted Bait Net entitlement held by these fisheries were 18.3 tonnes. The Barramundi Fishery harvested 11.9 tonnes, while the Coastal Net Fishery landed 6.1 tonnes and the Coastal Line Fishery 4.5 tonnes. The total catch of 41 tonnes of shark landed by fisheries other than the Offshore Net and Line Fishery in 2006 was similar to the 44 tonnes landed by these fisheries in 2004 and a reduction from the 54 tonnes caught in 2005. Shark landings from fisheries other than the Offshore Net and Line Fishery have fluctuated between 32 and 79 tonnes since 1994.

Effort

Effort fluctuations have largely driven the high variability in catches of sharks and mackerel in the Offshore Net and Line Fishery. Fishers indicate that effort reflects both operational and market conditions. Recorded effort prior to 1 July 2005 (when it 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 initial low effort in the early 1980s, effort in the Offshore Net and Line Fishery was stable 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. Measures introduced to contain effort resulted in a decline to 1538 boat days in 2004, 1176 boat days in 2005 and 899 boat days in 2006.

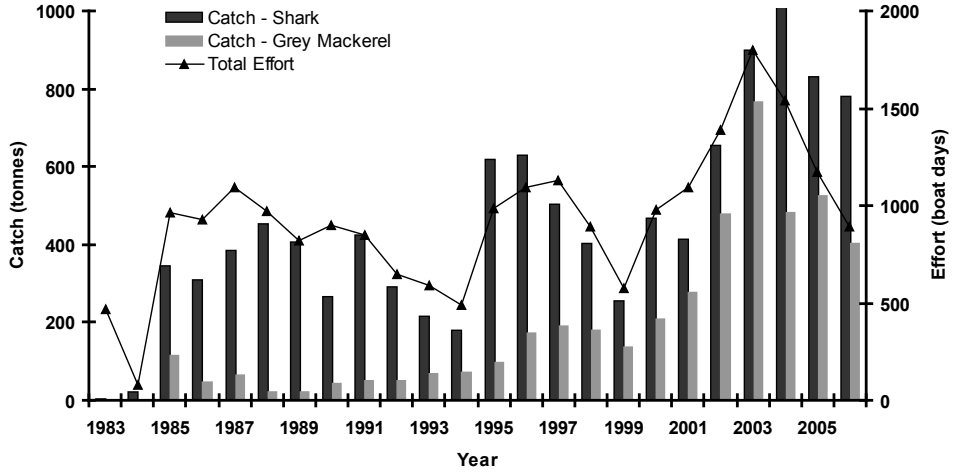

Figure 1. Catches and effort for the commercial Offshore Net and Line Fishery, 1983-2006

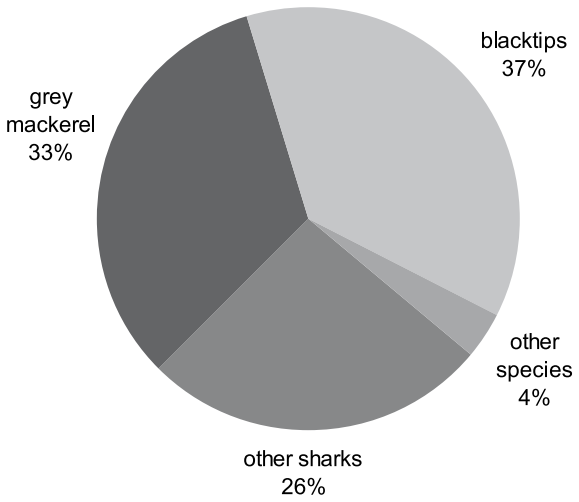

Figure 2. Composition of the commercial Offshore Net and Line Fishery catch, 2006

Catch Rates

Catch rates for shark (Figure 3) have shown a relatively flat trend over the last two decades, except during high points in the mid-1990s and 2004-06. Catch rates for total shark in the Offshore Net and Line Fishery, for most years since 1983, have been between 300 and 500 kg/day fished, but reached 626 kg/day in 1995, exceeded 700 kg/day in 2004 and 2005 and were 877 kg/day in 2006. Catch rates for blacktip sharks have shown a similar pattern, varying in the range 244-398 kg/day between 1997 and 2003. However, with catch rates of 286 kg/day in 2004 and 322 kg/day in 2005, only in 2006 was there a similar increase in catch rate to that shown by sharks in total, with the catch rate for 2006 being 514 kg/day. Grey mackerel catch rates have generally followed a pattern of a steady increase from the early 1990s, with the average catch rate in 2006 of 455 kg/day, similar to 2005's 448 kg/day.

Marketing

Grey mackerel is marketed domestically as fillet, trunks and whole fish. Shark is 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 measure 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 per cent of total shark catch earmarked for direct export overseas.

Recreational Sector

Area

The significant areas for recreational shark catches are the Darwin Harbour, McArthur River and Cobourg Peninsula areas.

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.

Catch

Sharks are not specifically targeted by recreational fishers, but are caught during other targeted fishing activities. In 1995, over 80 000 individuals were caught, but only 18 per cent were retained, giving a harvest of 15 000 individuals. Reef fishing and non-target fishing accounted for 74 per cent and 18 per cent of the

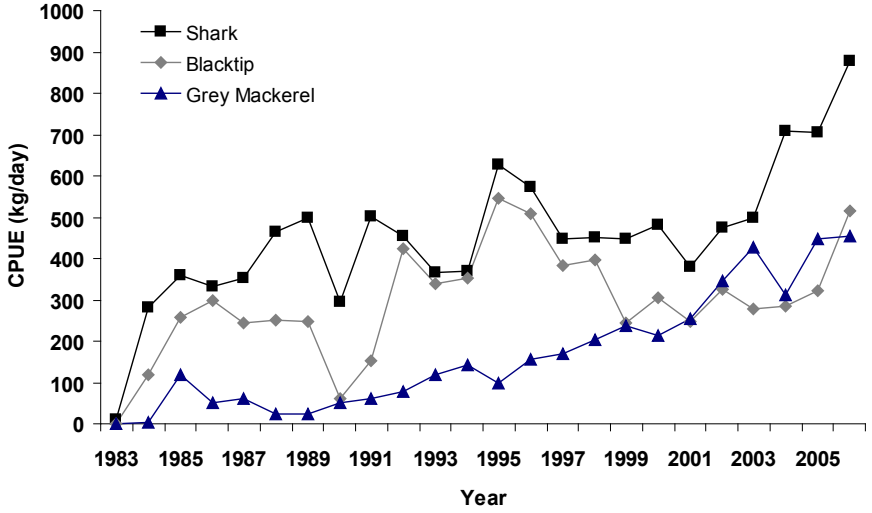

Figure 3. Catches and effort for the commercial Offshore Net and Line Fishery, 1983-2006

total shark catch, respectively. The proportion of shark harvested depends on the type of fishing undertaken. During non-target fishing, 34 per cent of sharks caught are harvested, whilst reef fishers only harvest 12 per cent.

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 per cent reduction in harvest rate since 1995. Barramundi fishing, reef fishing and non-target fishing accounted for 14 per cent, 26 per cent and 52 per cent of the total shark catch, respectively. The mortality rate of released sharks is not known.

Fishing Tour Operator Sector

Area

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

Catch

In 2006, 8039 sharks were caught by FTOs. Of these, 7639, or 95 per cent, were released, representing a 6 per cent increase in sharks caught by FTO clients over 2005 figures. 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 FTO clients has more than doubled since 1995, when fewer than 3000 sharks were caught.

The proportion of captured sharks that are harvested by FTO clients is about the same as the general recreational fisher community.

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 were one of the more important groups of fish caught by indigenous people in the coastal areas of the NT. In 2000-01, a survey of indigenous fishing activities found that over 12 000 sharks and rays were harvested, comprising just over 3 per cent of the total finfish harvest. The species of sharks and rays caught and harvested were not identified.

Non-retained Species (All Sectors – By-catch)

Sharks are generally seen as a non-targeted or incidental catch for the recreational sector. Only the Offshore Net and Line Fishery harvests more than the generally low proportion of sharks caught, although this does depend on the type of fishing and the fishing location. Besides various mackerel species, the majority of other species caught by the recreational sector during targeted game fishing activities are trevally and queenfish (Family Carangidae). Most of these fish are retained, with a harvest rate of over 83 per cent. Other minor species caught also have a high retention rate of 78 per cent.

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 by-catch depends strongly on location and season. Most shark species are now retained, apart from the tawny shark (*Nebrius ferrigineus*), and species subject to ‘no take” policy, the sawfishes and *Glyphis* spp. Rays are an uncommon by-catch in the surface set nets. Non-retained, rays are usually released alive. Some finfish with poor market acceptability (for example some trevally and queenfish) are retained only when there are suitable markets.

Threatened Species Interaction

In the Offshore Net and Line Fishery, operators reported interactions with one speartooth shark (*Glyphis* spp) and seventeen turtles which were recorded as caught and released. To assist with the release of animals, operators in the fishery

are advised of the recovery methods for turtles and all vessels carry a copy of the *'Protected species awareness information for professional fishing operations – Marine Turtles'*, which details recovery methods. To assist accurate reporting, operators also carry the National Heritage Trust publication *'Protected Marine Species Identification Guide'* to assist with identification of turtles, sawfish, sharks and other protected species.

Ecosystem Impact

A number of studies are under way which examine the relative impact of harvesting sharks and grey mackerel.

Little is known about the large scale stock structure of most of the shark species harvested, particularly the extent to which Indonesia, Western Australia, Queensland and the NT share fishery resources. However, this problem has been investigated in an Australian Centre for International Agricultural Research (ACIAR) sponsored project (FIS/2003/037) led by the CSIRO. The project *Artisanal shark and ray fisheries in eastern Indonesia: their socioeconomic and fisheries characteristics and relationship with Australian Resources* was a collaborative effort between several Australian and Indonesian agencies. The project provided basic biological information, examined stock status and described socioeconomic attributes of the fisheries. Although, as an aid project, it was principally designed for the benefit of fisheries management in Indonesia, it made a substantial contribution of biological data to the regional fund of knowledge on shark stocks. An important result was that Australian and Indonesian populations of *Carcharhinus sorrah* and *Rhizoprionodon acutus* were demonstrated to be genetically separate. As such, these stocks can now be managed separately. Populations of *Sphhynra lewini, Prionace glauca, C. falciformis, C. obscurus* and *Rhynchobatus* spp. however, were genetically not distinguishable across the two countries. Caution and cooperation in their management is suggested.

A Fisheries Research and Development Corporation (FRDC) project, *Northern Australian Sharks and Rays: the Sustainability of Target and By-catch Species, Phase 2* was recently completed (Salini et al., 2007). The project has provided comprehensive data on species composition and biological characteristics of sharks and rays taken in northern Australian fisheries, including those fisheries for which the sharks and rays are by-catch. The major output of the project was a risk analysis which provides for prioritisation for research and management direction. Both the ACIAR and FRDC funded projects provide genetic and other information that adds to the understanding of the spatial relationships of northern shark stocks.

The catch composition information provided by these projects forms a baseline against which the Offshore Net and Line Fishery can be monitored for biodiversity change in the future and is considered of particular importance in assessing the potential ecological impact of foreign illegal fishing on Australian shark stocks.

In 2006, NT Fisheries observers initiated four observer trips on shark fishery vessels. An FRDC funded research project (representing further collaboration among the northern research agencies) is examining the spatial stock structure of grey mackerel. The project began in 2005 and will continue to 2008.

Controls on fishing gear have been introduced to minimise any physical impact on the seabed, other than anchoring. A prohibition on the use of bottom set gillnets was introduced following interactions with turtles.

Social Impact

In 2006, there were 17 licensees operating in the Offshore Net and Line Fishery. Most vessels employ a skipper and have two or three crew members.

Economic Impact

At the point of first sale in 2006, the overall catch value of the commercial shark fishery was just over $4.34m ($6.2m in 2005). The black tip shark component was valued at $0.70m ($0.66m in 2005), $1.6m for other sharks ($2.0m in 2005) and $ 1.87m for grey mackerel ($3.14m in 2005).

Stock Assessment

Monitoring

The basic monitoring information from the Offshore Net and Line 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. From July 2005 the target species have additionally been 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. Four observer trips on commercial shark boats were undertaken during 2006. These provided data on species composition for both harvest and by-catch (retained and non-retained catch). An expanded program of such monitoring activities has been planned for the future.

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 (ARC) 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 Charles Darwin University in collaboration with the fishing industry, NT Fisheries and the Australian Institute of Marine Science. The project will evaluate various combinations of monitoring and management regimes through experimentation to present managers with an informed choice of management options. A total of 877 sharks of different species were tagged and released, with seven recaptures reported during 2006.

Stock Assessment Methods and Reliability

The Offshore Net and Line Fishery has a history of continual assessment. In the 1980s, a joint assessment was conducted between the then NT Department of Primary Industry and Fisheries, CSIRO, and the Australian Fisheries Service. 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.

Although CSIRO studies 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 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).

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 6-7 per cent 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 per cent and 10 per cent

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. However, the unreliability of the assessment was emphasised. In particular, 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 Stock Assessment Group (consisting of researchers and managers from the management agencies responsible for the northern shark fisheries) 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 it does the abundance of the fish. This is illustrated by apparent targeted fishing within the fishery. The very strong and persistent increasing trend in the catch rate of grey mackerel suggests that this species has been increasingly targeted, rather than the abundance of stocks increasing steadily. The downturn of 2004 probably reflected general targeting of sharks during that year in response to market pressures, while the resumption of the trend in 2005 and 2006 again probably reflected target fishing of grey mackerel. The catch rate variations among the total shark, blacktip shark and grey mackerel (Figure 3) are substantially in counterpoint i.e. those years in which catch rates of grey mackerel peaked, shark catch rates 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 value at any time.

Current Harvest Status

Exploitation by FTOs and recreational sectors is considered to be 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 et al., 2006).

Logbooks did not indicate target species until July 2005. Given the very strong increasing trend in grey mackerel catches and catch rates, variations and trends in CPUE could result from increased direction of fishing in response to contrasting market demands for mackerel or shark. However, given the high degree of uncertainty in stock estimates and a declining CPUE trend in blacktip and total shark in the late 1990s, and uncertainties about the status of grey mackerel, conservative management currently precludes any significant increase in harvest rates. The Offshore Net and Line Fishery is thus considered to be fully-fished.

Future Assessment Needs

There is clearly a need for continued updated assessment of the Offshore Net and Line Fishery. It is planned that target species in the fishery will be re-assessed at least every three years. However, the information on fishery status

that can be provided by logbook catch and effort data alone is limited and new assessments are unlikely to be more informative without additional information.

A key recommendation from previous assessments has been to establish sources of information on harvest rates or abundance levels of the NT shark stocks, independent of logbook data. Consequently, research to develop mark-recapture (tagging) to provide an on-going index of harvest levels for the NT shark fishery has been instituted, as described above. Further, there should be a concerted effort to obtain blacktip catch statistics from foreign fisheries currently operating in the Arafura Sea, north of the AFZ. Constraints on resources have meant that these recommendations are yet to be implemented.

There is little information available as yet on the magnitude and impact on northern Australian shark and finfish stocks of illegal, unreported and unregulated (IUU) fishing by foreign vessels operating in northern Australian waters. The consequences of this fishing for the Australian fishery are difficult to predict. This is not only because we do not yet know the magnitude and composition of IUU fishing over time, but also because movement rates and life history linkages between inshore (where most Australian fishery effort is directed) and offshore (most IUU fishing) are poorly known for most species. Thirdly, we do not know the ecological effects that may arise by fishing down many of the top predatory fish from the offshore area. Thus broader ecosystem effects of fishing and the effect of high levels of IUU effort need to be addressed in future assessments. Current CSIRO/AFMA - led projects are examining the magnitude of IUU effort and catches, as well as effects on the ecosystem.

An initial assessment for grey mackerel was undertaken in 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

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/ Qld/ 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. Outcomes from this research have been discussed above. With the fishery being very small until the mid 1990s, 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 sharks species taken in northern Australia prompted a series of national projects on the sustainability of sharks and rays in northern Australia, which were conducted since the late 1990s (Stobutzki et al., 2003; Rose et al., 2003; Salini et al., 2007). These projects progressively 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 indicate knowledge gaps that should be addressed and/or the need for improved management.

Incorporation into Management

Results of research have allowed informed and conservative management regimes to be implemented for the Offshore Net and Line Fishery.

Current Research

An ongoing observer program has been developed 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 frequently caught. Thus the biological information accumulated and communicated (e.g. Beatty and Crofts, 2004) from previous and ongoing projects is valuable for the future management of the fishery.

Development of a collaborative tagging program with commercial fishers is also under way, as described above, with the intention of delivering a protocol for monitoring harvest rates of the principal shark species. In addition, the participation of the Charles Darwin University and the Australian Institute of Marine Science has expanded the scope of projects undertaken on NT sharks. Projects for 2007 and 2008 include studies of the distribution and abundance of *Glyphis* spp. and the genetics and biology of bull and pig eye sharks (*Carcharhinus 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 increase stakeholder information 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, initiated in 2005.

Management/Governance

Management

Management of the Offshore Net and Line 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 economic value. This is achieved through a range of input and output controls and containment of fishing capacity through a three-for-one licence reduction program. The licence reduction program requires new entrants to acquire and transfer three restricted Offshore Net and Line Fishery licences to the NT for the issuance of an unrestricted Offshore Net and Line Fishery licence. In 2006, overall capacity had been reduced from 38 licences to 17 licences.

Fin ratio licence conditions were imposed on Offshore Net and Line licensees in late 2003 and seek to prevent the targeting of large shark for their fins alone and to maximise product quality. The fin ratios are reviewed periodically and have resulted in a general ratio reduction of 17 per cent. A review of the fin ratios was conducted in 2006 with another review scheduled for late 2007.

The current ratios are 6.5 per cent fresh or frozen fin as a proportion of trunk weight, 13 per cent fresh or frozen fin as a proportion of fillet weight and 3 per cent fresh or frozen fin as a proportion of whole weight. Licensees must have an appropriate amount of meat for every fin in their possession. The ratio is designed to factor in operational circumstances such as unintentional loss of useable product through machinery malfunctions, chiller breakdowns, predator and sea-lice attack.

Catch restrictions apply to the harvest of Spanish mackerel in the Offshore Net and Line Fishery. The by-product 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.

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, with the fin to meat ratios imposed in addition to trip limits.

In 2004, the Offshore Net and Line Fishery underwent an ecological assessment of management arrangements by the Australian Government against the Guidelines for Ecological Sustainable Fisheries under the *Environmental Protection and Biodiversity Conservation Act*. The Offshore Net and Line Fishery was found to be operating in a sustainable manner and was accredited with a Wildlife Trade Operation (WTO), which permits the fishery to export shark products until November 2007.

Annual advice regarding the status of the fishery and progress in meeting the recommendations of WTO have been provided by NT Fisheries.

In 2006, as part of WTO recommendations, NT Fisheries reviewed the catch logbook program to allow a record of by-catch by weight on a shot-by-shot basis. Validation of the logbook program is conducted during observer trips and compliance checks. Data collected from observer trips compared with logbook returns from non-observer trips is consistent, indicating that the logbook returns are factual. Similarly NT Police officers conducting compliance checks of logbook returns with catches onboard the vessels have found no irregularities.

To improve the identification and quantification of shark catch on a species-specific basis, NT Fisheries has issued a shark identification guide booklet 'Field Guide to Australian Sharks and Rays' (Daley, et al., 2002) which has been provided to each vessel in the fleet and is used as the basis for further identification training by observers. NT Fisheries is also participating in a Natural Heritage Trust funded research project, *Pilot study to develop methodology to determine indigenous fishing impacts on sharks and ray in the Northern Territory*, to gain an understanding of the harvest of shark by the indigenous sector.

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 nautical miles (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 the AFZ in 1979, the foreign fishing fleet's exclusion zone adjacent to Arnhem Land and the Wessel Islands increased to between 40 and 50 nautical miles offshore. A bilateral agreement between Australia and Taiwan permitted continued access for 30 gillnet users 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.

Current Issues

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).

This northern operational plan was endorsed at a meeting of fisheries officers from all jurisdictions in September 2004 and is the only Operational Plan to address issues raised in the NPOA - Sharks in Australia at this time.

A review of the impact of IUU fishing in northern Australian waters, primarily by foreign fishers, is currently under way. An expected outcome of this review is to ensure adequate resources are allocated by the Australian Government (to its appropriate operational arm the Australian Fisheries Management Authority [AFMA]) to mitigate the impacts of IUU on the sustainability of shark stocks. This review is expected to conclude in 2007-08.

The impacts of foreign IUU fishing in northern Australian waters are poorly understood. The NT Government continues to work with the Australian Government to ensure adequate resources are allocated to mitigate IUU impacts on the sustainability of shark stocks.

Most IUU fishers are primarily targeting sharks, and are a significant illegal presence in northern Australian waters. Research to determine the probable impact IUU is having on domestic shark stocks is continuing with a number of projects attempting to determine the species and volumes of sharks being harvested. It is not yet possible to determine the potential effect IUU fishing is having on the predominantly inshore, tightly regulated, small domestic Offshore Net and Line Fishery.

The collaborative research project to develop mark-recapture (tagging) protocols to provide on-going monitoring for the NT Offshore Net and Line 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.

The Offshore Net and Line Licensee Committee of the NT Seafood Council implemented a voluntary 'no-take' policy in December 2004 for all sawfish in NT waters in recognition of the higher risk these species face in the fishery. Logbooks were amended in 2005 to allow for accurate reporting of threatened species and species of scientific interest. This will enable recording of sawfish interactions by species and assist to determine their distribution and status.

A review of the management objectives, performance indicators and trigger points (see Table 1) was undertaken in early 2005 to determine if imposed gear and effort reductions were adequate to address trigger reference points being exceeded for grey mackerel and other shark by-product during 2004. New effort reduction strategies were put in place in 2005. Catch and effort statistics for 2005 and 2006 indicate that the new strategies are having the desired effect.

The fishery will be subject to further review during 2007 based on the recommendations of the FRDC report *Northern Australian sharks and rays: the sustainability of target and by-catch species, phase 2* (Salini et al., 2007). NT Fisheries will continue to develop species-specific management measures in light of information from the report with respect to the identified risks for northern shark species.

Future Plans

The incidental landings of sharks in fisheries targeting other species are subject to annual review. The fin ratios are to be reviewed periodically to ensure they meet the sustainability criterion. Due to changing fishing methods within the fishery, the fishery was reviewed at the annual Offshore Net and Line Fishery Management Advisory Committee (ONLFMC) meeting in September 2006.

The Australian Government assessment of the Offshore Net and Line Fishery for ecological sustainability under the *EPBC Act* was completed in May 2005, with an extension of accreditation of WTO until November 2007. The implementation of new effort controls in the management arrangements of the fishery during 2005 has ensured a significant reduction in shark catches taken by the long line fishing method. The Offshore Net and Line Fishery is now working toward meeting all WTO recommendations

with industry committed to ensure ecological sustainability through a cooperative working relationship with government.

Compliance

Compliance activities for the Offshore Net and Line Fishery management arrangements are undertaken by the Marine and Fisheries Enforcement Section (MFES) of the NT Police, Fire and Emergency Services, under the *NT Fisheries Act 1988*.

MFES effectively monitors and enforces management arrangements for the Offshore Net and Line Fishery through the inspection of vessel arrivals and departures through the single port of Darwin. This includes verification of catch returns against processor returns (i.e. requirement for all operators to specify where they are selling their product). MFES has the power, if necessary, to investigate the records of wholesalers and licensees.

In 2006, 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 Offshore Net and Line Fishery. Stakeholders involved in such discussions include the NT Offshore Net and Line Licensee Committee, the NT Seafood Council, neighboring jurisdictions, other extractive stakeholders and wider interest groups.

Workshops have been convened as required to serve as a forum for industry, management and researchers to canvass all issues of interest to the Offshore Net and Line Fishery.

ONLFMAC comprises membership from a wide range of stakeholder interest groups to provide advice to the Executive Director, Fisheries. It met in September 2006 to work through issues to ensure the fishery continues to be managed sustainably in an open and transparent manner.

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

	Species/ Group	**Management objectives**	**Performance indicator**	**Trigger reference point**	**Management Response Taken**	**Proposed Future actions**
Target shark species	Black tip sharks *C.tilstoni* & *C. sorrah*	Ensure inter-generational equity by maintaining ecologically sustainable annual catches in all sectors.	Sustainable yield estimates.	Catch levels increase to 2000 t over the next calendar year. Catch levels decline by 30 per cent over the previous two calendar years.	· Annual analysis and reporting of status. · Cap on licences. · Licence reduction scheme. · Significant reduction of allowed effort in long line and pelagic net fishing gear.	MACs to review fisheries annually and make recommendations to the Executive Director, Fisheries. Any amended arrangements will be implemented within 12 months of trigger being reached.
	Grey mackerel		Sustainable yield estimates are developed.	Until sustainable yield estimates are determined the trigger will be a rise or decline of 30 per cent of the catch from the previous calendar year.		

	Species/ Group	Management objectives	Performance indicator	Trigger reference point	Management Response Taken	Proposed Future actions
By-product species	Combined other shark species.	Ensure ecological sustainability of these species in all fisheries	Monitoring of commercial logbook returns. Onboard monitoring of Offshore Net and Line Fishery (ONLF).	Catch increases in proportion of the total catch by greater than 35 per cent over the next calendar year. Catch increases to 10 per cent of the total catch over the next calendar year.	· As above · ONLF code of conduct · Improved logbooks enabling more accurate reporting of shark species in ONLF. · Fin to meat ratios introduced. · Shark ID guidebooks distributed through ONLF. · Strict limit of shark harvest in Barramundi, Coastal Line and Coastal Net Fisheries. · Research targeting increasing knowledge of shark species catch composition, distribution and abundance.	MACs to review fisheries annually and make recommendations to the Executive Director, Fisheries. Any amended arrangements will be implemented within 12 months of trigger being reached. All Fishery logbooks to be reviewed regarding the reporting of by-product species. Continuing research via aligned projects and observer program to collect samples, information on catch composition, fishing mortality, distribution and abundance of specific shark species.
	Combined other species			Catch increases to 10 per cent of the total catch over the next calendar year.		

	Species/ Group	Management objectives	Performance indicator	Trigger reference point	Management Response Taken	Proposed Future actions
By-catch species	Combined by-catch species	Ensure ecological sustainability of by-catch species in all fisheries.	Monitoring of commercial logbook returns. Onboard monitoring of Offshore Net and Line Fishery.	Total by-catch within the shark fishery increases to 10 per cent 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.	· As above. · No take of shark in Timor Reef, Demersal, Finfish Trawl & Spanish Mackerel Fisheries.	MACs to review fisheries annually and make recommendations to the Executive Director, Fisheries. Any amended arrangements will be implemented within 12 months of trigger being reached. All Fishery logbooks to be reviewed regarding the reporting of by-catch species. Continuing research via aligned projects and observer program to collect samples, information on catch composition, fishing mortality, distribution and abundance of specific shark species.
Endangered, threatened or protected species.	All listed at-risk species	Ensure the continued protection of species and communities listed under the *EPBC Act 1999* and the *Territory Wildlife and Conservation Act 2000*.	Endangered, threatened or protected species and or communities are identified in NT waters.	Identifiable impacts observed by commercial fishers, fisheries observers or other agencies regarding EPBC listed species or communities.	· As above · "No take" policy of sawfish. · ONLF code of conduct. · Release Techniques Education Program.	MACs to review fisheries annually and make recommendations to the Executive Director, Fisheries. Any amended arrangements will be implemented within 12 months of trigger being reached Fishery logbooks to be amended to include records of any interaction with endangered, threatened or protected species.

	Species/ Group	Management objectives	Performance indicator	Trigger reference point	Management Response Taken	Proposed Future actions
Ecosystem components.		Minimise effects on ecosystem components.	Identification of threatening processes.	Identification of significant negative interaction with components of the natural ecosystem present on fishing grounds.		MACs to review fisheries annually and make recommendations to the Executive Director, Fisheries. Any amended arrangements will be implemented within 12 months of trigger being reached

Spanish Mackerel Fishery Status Report 2006

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) fishery is based on the capture of the narrow-barred Spanish mackerel (*Scomberomorus commerson*), using lures or baited lines. The commercial troll fishery area comprises all waters seaward of the NT coast extending to the outer limit of the Australian Fishing Zone (AFZ). Spanish mackerel are also landed as an incidental catch during pelagic shark fishing and finfish trawl operations, with catch limits set for these sectors. In 2006, there were 15 active commercial licences operating in the fishery. Spanish mackerel are also keenly sought after by recreational fishers.

On 1 January 2005 the NT Spanish Mackerel Fishery Management Plan came into effect. The Spanish Mackerel Fishery is managed under a catch-sharing arrangement with other user groups recognising commercial, recreational, fishing tour operator and indigenous stakeholders. The wider community also has an interest in the way Spanish mackerel resources are used, conserved and enhanced to ensure the quality of the fishery is preserved for future generations.

Historically, there were significant landings of Spanish mackerel taken 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. Catches by foreign fishing vessels stabilised to between 400 and 500 tonnes through the late 1970s and early 1980s. Since the mid 1990s the fishery has stabilised as a small, tightly controlled Territory-based troll fishery that has since grown steadily. Possession limits have been implemented for the recreational sector.

In 2003 the Spanish Mackerel Fishery received the highest level of export accreditation against the Australian Government's Guidelines for the Sustainable Management of Fisheries under the *Environment Protection and Biodiversity Conservation Act* (EPBC Act). As the management arrangements for this fishery are recognised by the Australian Government to be operating in a sustainable manner, the fishery is therefore exempt from export regulations until 2008 when it will be reviewed again against the guidelines.

Profile of the Fishery

Commercial

Area

Licensees in the Spanish Mackerel Fishery may fish in NT waters seaward of the coast and river mouths, to the outer limit of the 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

In the troll fishery for Spanish mackerel, fishers 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 rod lines. 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 (fewer 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 amount of Spanish mackerel are taken by pelagic gillnet in the Offshore Net and Line Fishery (previously the Shark Fishery) and demersal trawl in the Finfish Trawl Fishery

Catch

As the name suggests the key target species for the Spanish Mackerel Fishery is the narrow-barred Spanish mackerel (*Scomberomorus commerson*). Small amounts of other *Scomberomorus* species are included in the catch in some years.

The Spanish mackerel catch for the troll fishery in 2006 increased to 409 tonnes, from the 2005 catch of 390 tonnes (Figure 1). Each of these values exceeded the past peak annual

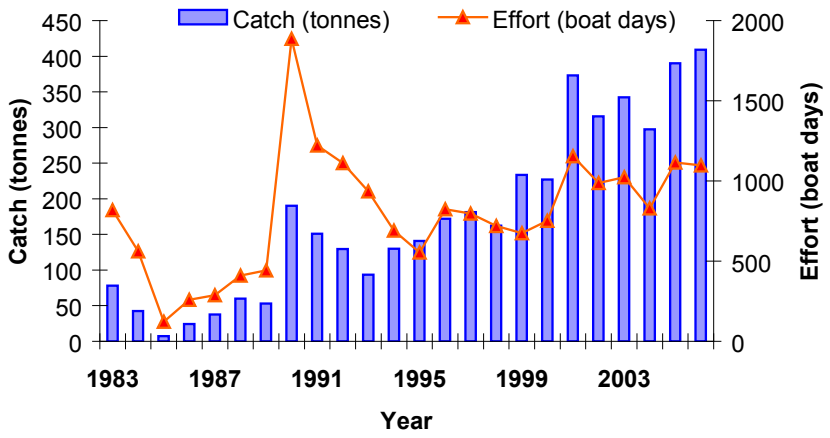

Figure 1. Catch and effort for the commercial Spanish Mackerel Fishery, 1983 - 2006

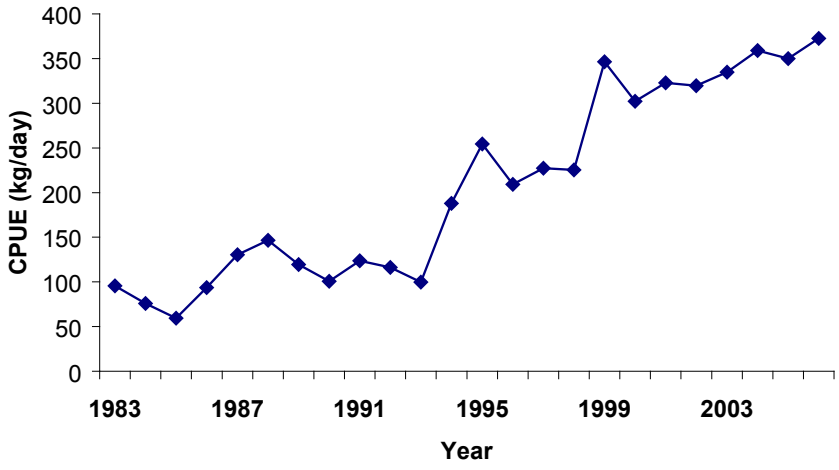

Figure 2. Catch per unit effort (CPUE) for the commercial Spanish Mackerel Fishery, 1983 - 2006

catch from the fishery achieved in 2001, of 373 tonnes. The changes in annual total catches largely reflect effort, which in turn reflects causes as varied as prices, wind strength and crew availability. The low availability of skilled skippers and crew is a continuing complaint from operators in this and several other fisheries. Sometimes it is not possible to crew a vessel, which prevents fishing.

The landed catch of the troll fishery in 2006 was exclusively *Scomberomorus commerson*. In most years, a very small catch of other mackerel species is recorded. For example, in 2005, Australian spotted mackerel (*S. munroi*), Queensland school mackerel (*S. queenslandicus*) and grey mackerel (*S. semifasciatus*) were also taken but in total, accounted for less than 100 kg.

Similarly, there is a small amount of by-catch landed in most years. By-product species in the troll fishery in previous years have included wahoo (*Acanthocybium solandri*), 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. Landings of Spanish mackerel as by-catch in other fisheries increased during 2006. The Offshore Net and Line Fishery landed 26.5 tonnes of Spanish mackerel. This represents a 29 per cent increase on the 20.6 tonnes caught by that fishery in 2005 but is comparable to the 2004 catch of 26.0 tonnes. The Finfish Trawl Fishery landed 1110 kg of Spanish mackerel in 2006, an increase of 7.6 per cent on the 1032 kg landed in 2005.

Effort

With a reported 1098 boat days of fishing during 2006 in the Spanish Mackerel Fishery, effort was only a little less than the 1115 boat days reported in 2005. Effort since the early 1990s has shown a generally increasing trend (Figure 1) with a high value of 1155 boat days in 2001. Although effort levels since 2001 have been higher than the average effort for the late 1990s, the peak value of 1887 days for the Fishery was recorded in 1990.

Catch Rates

The catch per unit of effort (CPUE) for the commercial Spanish mackerel 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). The 2006 catch rate of 372.5 kg/day was a slight increase over the previous few years and represents a new peak for the fishery. The long-term trend may reflect improved efficiency in fishing operations and thus should be interpreted with care. However, it may include the recovery of the Spanish mackerel population from historical over-fishing by the licensed Taiwanese-Australia joint venture fishery of the 1970s and 1980s.

Marketing

Spanish 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 frozen after processing and stored onboard. The catch may be unloaded to barges that service remote ports or delivered directly to the major ports of Darwin and Gove.

Recreational Sector

Area

Highly prized as a sport and table fish, most Spanish mackerel taken by recreational fishers is 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 per cent) of the targeted effort for game fish (e.g. mackerel) occurred in the Nhulunbuy area.

Fishing Method

Fishing gear and methods employed by recreational fishermen 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. In such cases fishing methods can vary.

Catch

FISHCOUNT, a general population 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, giving a harvest of approximately 170 tonnes. The proportion of Spanish mackerel within the recreational mackerel catch was not identified.

In 2000-01, the National Recreational Fishing Survey found that the annual NT catch of all mackerel by the recreational sector was 25 233 individuals, slightly higher than the FISHCOUNT survey conducted in 1995. Over half of the mackerel catch was not identified to species. However, during recent survey work done with recreational fishers, 49 per cent of the mackerel catch was thought to be Spanish mackerel. The survey results also indicated that the average weight of individual Spanish mackerel was estimated to be approximately 5.9 kg, coupled with an estimated release mortality of 54 per cent. 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 per cent) of the total recreational fishing effort of over 37 000 hours. In 2000, targeted game fishing increased to nearly 8 per cent of the total recreational fishing effort of over 139 313 hours.

Fishing Tour Operator Sector

Area

Fishing guides can fish in all areas of the fishery.

Fishing Method

Fishing gear and methods employed by FTO clients 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

In 2006, the catch of Spanish mackerel decreased by 21 per cent to 2960 individuals. This decrease was reflected in a similar decrease in line hours devoted by FTO clients to game fishing. Significantly, the release rate of Spanish mackerel caught by FTOs increased in 2006 to 63 per cent. As a result, the total harvest of Spanish mackerel by FTOs in 2006 was 1072 fish. In 2006, 971 other species of mackerel were caught with 700 of those fish retained (72 per cent).The catch of other mackerel species is also down from 2005 figures.

Effort

Targeted game fishing by FTOs is a small component of the industry. Game fish targeted trips decreased in 2006 from 1023 to 813 trips.

Similarly, FTO clients expended over 10 905 hours on targeted game fishing activities in 2006. This was a decrease of 28 per cent since 2005, although the figure is more than double the number of hours recorded in 1995.

It is believed that the decrease in FTO catch and line hours is due to the increase in high winds during 2006 which impacts on the ability of operators to take clients out fishing for pelagic species

Indigenous Sector

Only a very few (1400) individual mackerel captures were reported during the 2000-01 National Recreational Indigenous Fishing Survey of northern Australia and specific types of species were not recorded.

Non-retained Species (By-catch)

The commercial fishery catches very little apart from its primary target and almost all by-catch items are returned to the water alive. Monitoring of the commercial fishery identified very low levels of by-catch which illustrates the highly targeted nature of this fishery. There was one interaction with a protected species, a sea snake (species not recorded), which was released alive.

During an eight-day monitoring trip in July 2006, the NT Fisheries observer on board recorded the capture and live release of five by-catch items: one barracuda (*Sphyraena barracuda*), three giant trevally (*Caranx ignobilis*) and one small shark (*Carcharhinus* sp.). Similarly during 2005, by-catch was recorded during four observer trips (31 observer days), in which small numbers of trevally, barracuda, queenfish, and various shark and tuna species were captured. No by-catch at all was observed on nine of the observer days. None of these by catch species were retained as by-product, and the majority of the fish were observed to be alive at the time of release.

Besides various mackerel species, the majority of other species caught by the recreational sector during targeted game fishing are trevally and queenfish. Most (over 83 per cent) of these fish are retained. Other minor species caught also have a high retention rate of 78 per cent.

Threatened Species Interaction

Due to the highly targeted nature of the troll fishing method, interactions with threatened species are highly unlikely. No records of threatened species were reported in the logbooks or observer trips for 2006.

Ecosystem Impact

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

Social Impact

The social value of the commercial Spanish Mackerel Fishery is mostly derived from the employment and economic activity generated by fishing operations. The fishery has 19 licences. A vessel typically operates with a skipper and two crew members, with most processing undertaken onboard (and therefore very limited processing of catch occurs onshore). Although some fish is processed for further sale and consumption locally, most Spanish mackerel is sold interstate.

Spanish mackerel is a highly regarded sport and food fish by the recreational sector and to a lesser extent, the FTO sector.

Economic Impact

At the point of first sale in 2006, the value of the catch from the commercial Spanish Mackerel Fishery was $2.49m, up from $2.41m in 2005. The catch of Spanish mackerel species effectively represented the total catch value for the fishery.

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

Stock Assessment

Monitoring

Monitoring of the Spanish Mackerel Fishery comprises two main elements. The first is a logbook system which provides catch and effort information on the commercial fisheries, including catches by clients of FTOs. In addition, research staff and fishers regularly monitor catches onboard commercial vessels, measuring the fish and obtaining biological information such as sex and maturity. Details of fishing effort and strategy are also recorded. Some fishers also routinely provide length measurements of the fish taken. In 2006 just one monitoring trip was undertaken due to a shortage of suitable berths (many of the mackerel vessels are relatively small). However, an additional trip was conducted dedicated to Gene-tagging. The Genetag project (see Research section below) intends to develop a protocol for directly monitoring catchability and harvest rates.

Stock Assessment Methods and Reliability

Various stock assessment methods have been applied to the NT Spanish Mackerel Fishery. Age structured models using the available time series of catch and effort have provided the best results. However, even those assessments are considered to be only moderately reliable.

Stock assessment of Spanish mackerel in the NT has been problematic in that the time series of catches and catch rates, as a measure of abundance, are explained with similar probability by a very wide range of harvest levels. 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 (chiefly with measures to contain fishing effort) was adopted to ensure protection of the resource.

Assessments in 1997 and 2000 (Walters and Buckworth, 1997; unpublished) and 2003 (Buckworth 2004) indicated that the fishery was recovering from over-fishing by the Taiwan-Australia joint venture fishery of the 1970s and 1980s. Stevens and Davenport (1991) also interpreted declining size and catch rates in that fishery as indicating over-fishing, while a decline in genetic diversity (Buckworth et al., in prep) also suggests over-fishing by that joint venture fishery.

However, despite a longer time series of catch and effort, as well as age structure information, the real impact of the fishing in any of the assessments could not be ascertained without better information on harvest rates or abundance. In addition to stocks being finely divided geographically, it is difficult to estimate Spanish mackerel abundance, as the fish are not amenable to survey by trawling or gillnet or even by air and are difficult to capture uninjured for tagging. Furthermore, catch rates are poor indicators of abundance as Spanish mackerel are strongly schooling fish.

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. This was reiterated at a workshop held in August 2000, where it was suggested that the Spanish Mackerel 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 2000 assessment also cautioned that while there were strong

management measures to contain commercial fisheries, if the NT follows world trends, the room for growth may be taken up by recreational, guided and charter fishing. The North American experience has seen explosive growth in this area, as there are no ceilings on the number of participants, with a substantial increase in their share of the catch.

Current Harvest Status

Recent assessments indicate that the NT Spanish Mackerel Fishery is currently fished below or at the optimum level.

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 for the Spanish Mackerel Fishery seek to improve knowledge required for fishery assessment and management. Recent research in this fishery has focussed on spatial stock structure and the measurement of harvest rates. Cooperative research undertaken with the commercial and recreational sectors, as well as other fisheries research and management agencies, contributes to the success of these projects.

A Fisheries Research and Development Corporation (FRDC) funded project initiated 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 11 years. Most of the catch was about 100 cm (length to caudal fork) and between three and six years of age, indicating that NT Spanish mackerel are 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, the females were usually larger than the males.

A study to describe the geographic structure of the Spanish mackerel stocks across northern Australia was completed in 2002. NT Fisheries, Queensland Department of Primary Industries and Fisheries (QDPI&F), 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., in prep). 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 are not highly migratory but are actually divided into a mosaic of separate adult groups. Little interaction between groups is evident from the parasite and otolith isotope results, which demonstrated that the fish do not mix much over distances as short as 100 km. Thus very few fish from Cape Wessel, for example, would mix with fish from Groote Eylandt, or from the Darwin region. However, just three distinct genetic stocks were identified: one on the east coast, one across northern and western Australia, and a third distinct stock lying between the two in the Torres Strait area. 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 (i.e. from the vicinity of Kupang to Australian waters) was not discounted. There may be some mixing between these four 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 these fine scales. Several articles are expected from this work.

Incorporation into Management

NT Fisheries staff review results of all research programs annually. If research determines significant changes 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 Fishing Industry Research and Development Fund. This pilot study developed methods to "tag" Spanish mackerel using DNA fingerprinting techniques, without the need to actually catch the fish. A special hook, 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 quite accurately determine harvest rates for monitoring the state of the fishery.

Following the success of the pilot work described above, an FRDC supported project was started titled *GENETAG: Genetic mark-recapture for real-time harvest rate monitoring. Pilot studies in northern Australia Spanish mackerel fisheries*. This is a collaborative project between the DPIFM, QDPI&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 1000 Genetag lures to collect tissue, developed protocols for preserving and storing samples, and extracting and identifying DNA.

The project was expanded to cover combined conventional/genetic tagging. A panel of expert anglers tagged nearly 1000 fish in 2004-06. Over 2 per cent of the 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 first recaptured Genetagged fish - a fish that was Genetagged and subsequently Genetagged again six weeks later - was detected in genetic screening in 2004. Several more short-term recaptures have since been detected from Genetag activities of subsequent years. In these 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

On 1 January 2005 the Northern Territory Spanish Mackerel Fishery Management Plan came into effect.

Objective

The overall objective is to ensure the long-term sustainability of the fishery by maintaining landings within acceptable ranges. The management framework seeks to maintain all landings of Spanish mackerel at or below 450 tonnes per annum. A review of management arrangements is to commence should estimated aggregate landings by all sectors reach 405 tonnes (90 per cent of the estimated yield) or total fishery catch declines by 30 per cent over 12 months. Catch shares have been established for all sectors ensuring the optimal utilisation of Spanish mackerel resources. Should the

estimated catch share by stakeholder group(s) either commercial or recreational, vary by more than 20 per cent over 12 months, a review of the management regime will be commenced (see Table 1).

Current arrangements also seek to ensure the sustainability of by-product taken in the Spanish Mackerel Fishery by maintaining its contribution at less than 10 per cent of the total catch.

These objectives are achieved by the Management Plan primarily by reducing commercial participation rates to extremely low levels, further reducing effort levels, monitoring catches and regularly reviewing management plans.

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 the main species. The foreign fishing fleet was permitted to fish within 12 nautical miles 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 that year.

Important milestones in the evolution of the domestic fishery included the passage of fisheries legislation in 1980, in which the net and line licence was superseded and commercial mackerel fishers were issued with a reef and mackerel licence. In 1984, the licensing scheme was further refined, with pelagic, inshore reef fish or offshore reef fish fishery endorsements allowing 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 nautical miles 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 the AFZ.

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

With the declaration of the Spanish Mackerel 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.

Current Issues

In 2005 and 2006 the aggregate catch of all sectors exceeded 90 per cent of the total allowable catch for the fishery, triggering a review of the management arrangements. The review will be undertaken in 2007 by the Spanish Mackerel Fishery Management Advisory Committee (SMFMAC) to determine whether or not mitigation management measures are required. At this time it is felt that catches are not sufficiently high to warrant any immediate concern or urgent management responses unless indicated in the review by SMFMAC.

Incidental landings of Spanish mackerel in the Offshore Net and Line Fishery and Finfish Trawl Fishery continue to be monitored and managed through a by-product management plan.

Future Plans

Catch share allocations for each sector are reviewed regularly to ensure catches are maintained within agreed parameters.

The Spanish Mackerel Fishery received export exempt accreditation under the Australian Government *Environment Protection and Biodiversity Conservation Act 1999*. NT Fisheries has undertaken to conduct a compliance risk assessment of the fishery, report on yearly results of observer surveys, continue to seek alternative cost-effective fishery-independent sampling techniques and conduct risk assessment for by-product and/or by-catch species, should its contribution to the total catch change. NT Fisheries will continue to monitor the size and composition of the commercial catch of Spanish mackerel and will introduce additional management measures if the catch includes immature fish.

Compliance

The Marine and Fisheries Enforcement Section of the NT Police, Fire and Emergency Services conducts surveillance and enforcement activities under the *NT Fisheries Act 1988* in relation to all fisheries managed by the NT, including the Spanish Mackerel Fishery.

In 2006 there were no significant compliance issues for this fishery.

Consultation, Communication and Education

SMFMAC was formed to provide a collaborative group to make recommendations on the future management of the Spanish Mackerel Fishery.

Notable achievements of SMFMAC include formulating management arrangements that led to the initial Spanish Mackerel Fishery Management Plan and its subsequent amendment. These measures included the introduction of a Spanish mackerel total allowable catch and sector shares into the fishery, continuation of the licence reduction scheme and recommendations for the reduction of the incidental by-product of Spanish mackerel in other commercial fisheries.

Regular consultation occurs between NT Fisheries, the Troll Line Fisherman's Sub-committee of the NT Seafood Council, the Amateur Fishermen's Association of the NT and other extractive stakeholders to discuss matters of concern in the fishery.

Prepared by

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

Objective	Performance indicator	Trigger point	Management action
Ensure the sustainability of Spanish mackerel stocks	Estimated catch by all sectors does not exceed the estimated sustainable yield of Spanish mackerel.	Aggregate landings by all sectors reach 90 per cent of the sustainable yield (by whole weight) and/or total fishery catch declines by 30 per cent over the calendar year (by whole weight)	Management arrangements for the Spanish mackerel fishery will be reviewed by SMFMAC within 12 months of a trigger being reached. Management regime to be implemented to ensure that aggregate landings by all sectors do not exceed estimated sustainable yield.
	Genetic studies indicate discrete Spanish mackerel stock(s).	Discrete Spanish mackerel stocks identified	SMFMAC to review and make recommendations on appropriate management response to ensure the sustainability of discrete Spanish mackerel stocks.
	Sustainable yield estimates are reviewed annually.	Annual review	Continue existing research and review alternative yield estimate methodologies annually.
Optimal utilisation of Spanish mackerel.	Estimated catch share (as a percentage of total aggregate landings, by whole weight) for all sectors remains unchanged.	Estimated catch share by a stakeholder group(s) (commercial or recreational) changes (increase or decrease) over the calendar year by more than 20 per cent (by whole weight).	Undertake a desktop study to determine the circumstances leading to the increase/decline in catch share arrangements. SMFMAC to make recommendations to the Executive Director, Fisheries on appropriate management arrangements to address any changes in catch shares.
Ensure the sustainability of by-product taken in the Spanish Mackerel Fishery.	By-product in the Spanish Mackerel Fishery increases significantly.	By-product in the Spanish Mackerel Fishery increases to 10 per cent of the total catch over the calendar year (whole weight).	SMFMAC to make recommendations to the Executive Director, Fisheries on appropriate management arrangements to address any changes and reduce by-product levels.
Ensure the sustainability of by-catch taken in the Spanish Mackerel Fishery.	By-catch in the Spanish Mackerel Fishery increases significantly.	By-catch in the Spanish Mackerel Fishery increases to 10 per cent of the total catch over the calendar year (whole weight).	SMFMAC to make recommendations to the Director of Fisheries on appropriate management arrangements to address any changes and reduce by-catch levels.
Minimise effects of fishing operations on endangered/ threatened/ protected species/ communities.	Endangered/ threatened/protected species/communities are identified in NT waters.	Impacts are observed by commercial fishers or fisheries observers.	Threat abatement plan implemented.

Timor Reef Fishery Status Report 2006

Introduction

The Timor Reef Fishery primarily targets 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 products from this fishery are marketed as 'fresh on ice' product with the majority sold as whole fish on the Australian domestic market.

With the passage of revised jurisdictional arrangements in 1995, management of the fishery passed to the Northern Territory (NT) Fisheries Joint Authority (NTFJA). The fishery is managed by the NTFJA under the NT *Fisheries Act 1988*. Day to day management of the fishery is undertaken by NT Fisheries. In 2006, there were 12 licences in the fishery, a reduction from 22 licences in 1993.

Recreational fishing by individuals or through Fishing Tour Operators is very low in the Timor Reef Fishery. This is due to the remote offshore location of the fishery. There has been no indigenous harvest recorded from this fishery.

The management arrangements relating to the Timor Reef Fishery are recognised by the Australian Government Department of Environment and Heritage (now known as the Department of Environment and Water Resources) to be operating in an ecologically sustainable manner. The fishery is exempt from export regulations until May 2008.

In 2006, oil and gas exploration companies carried out 3D seismic surveys within some of the more productive regions of the Timor Reef Fishery. During these surveys operators temporarily relocated fishing activities to elsewhere within the fishery.

Profile of the Fishery

Commercial Sector

Area

The Timor Reef Fishery operates well offshore out 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 nm^2 (Figure 1).

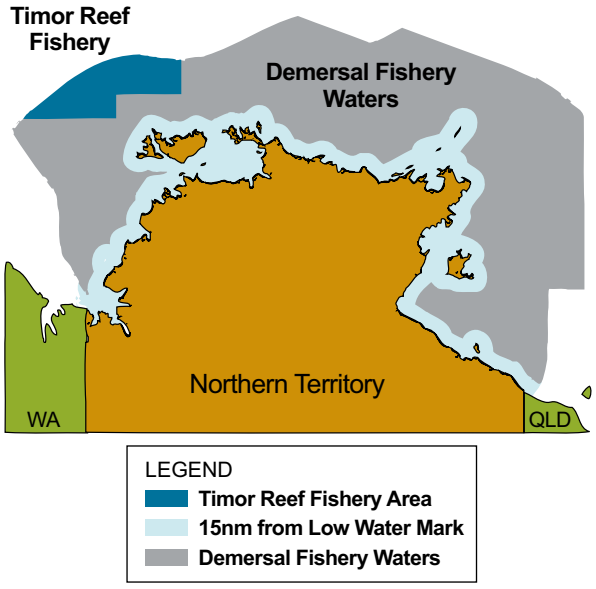

Figure 1. Area of the Timor Reef Fishery

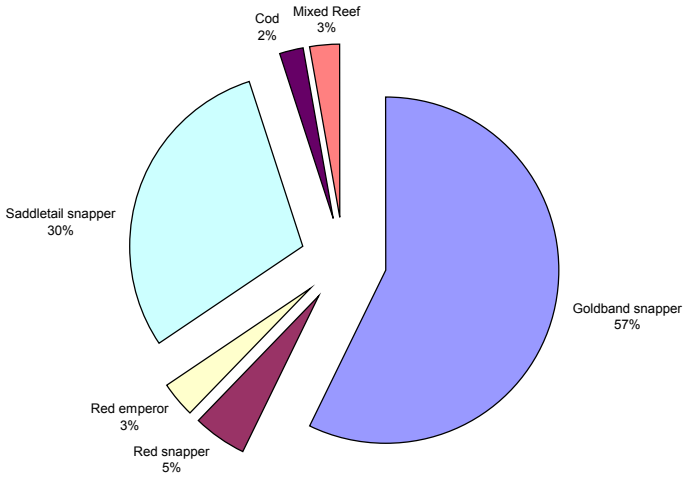

Figure 2. Composition of the catch from the Timor Reef Fishery for 2006

Fishing method

Commercial operators are authorised to use baited traps and vertical lines, including hand lines and drop lines. Prior to 1999, the majority of operators in the Timor Reef Fishery used drop lines. However, during 1999-2000 there was an industry-wide change to trap fishing, with only one operator using drop lines during 2002. However, owing to the better quality of line-caught fish, there was a reversal of this trend back to drop lines by many operators in 2004. Presently, two vessels use traps and the rest use drop lines.

Catch

The principal target species of the Timor Reef Fishery are goldband snapper, which comprise the three species *Pristipomoides multidens, P. typus* and *P. filamentosus*. Together these species comprise 57 per cent of the total catch (Figure 2), with *P. multidens* being the most common of the three *Pristipomoides* species. Other key species in this fishery are saddletail snapper (*Lutjanus malabaricus*), red snapper (*L. erythropterus*), red emperor (*L. sebae*) and cods (Family Serranidae) (Figure 2).

The species composition of the catch is gear dependant (Figure 3). Drop liners catch a higher proportion of goldband snapper, compared with trap boats which catch almost equal proportions of red snappers (*L. malabaricus, L. erythropterus*) and goldband snapper (*P. multidens*). There was a higher proportion of trapping this year compared with using drop lines. This is reflected in a significant species composition change in the total catch compared with that in 2005.

In 2006, the total catch from the Timor Reef Fishery was 726 tonnes, of which the goldband snapper catch was 416 tonnes. This is an increase in total catch compared to 2005 when 669 tonnes were landed, but a small decrease in the proportion of goldband snapper harvested compared to the 2005 figure of 453 tonnes.

By-product species for the Timor Reef Fishery only make up 3 per cent of the overall catch. These predominantly include small snappers such as *Lutjanus vitta, L. russeli*, and emperors such as red spot emperor (*Lethrinus lentjan*) and Robinson's sea bream (*Gymnocranius grandoculus*).

The 2006 by-product level is well below the 10 per cent trigger value required to initiate a review of management arrangements for the protection of by product species.

Effort

During 2006, seven licence holders actively fished and 1178 boat days were recorded, which is a decrease from last year's figure of 1503 boat days (Figure 4).

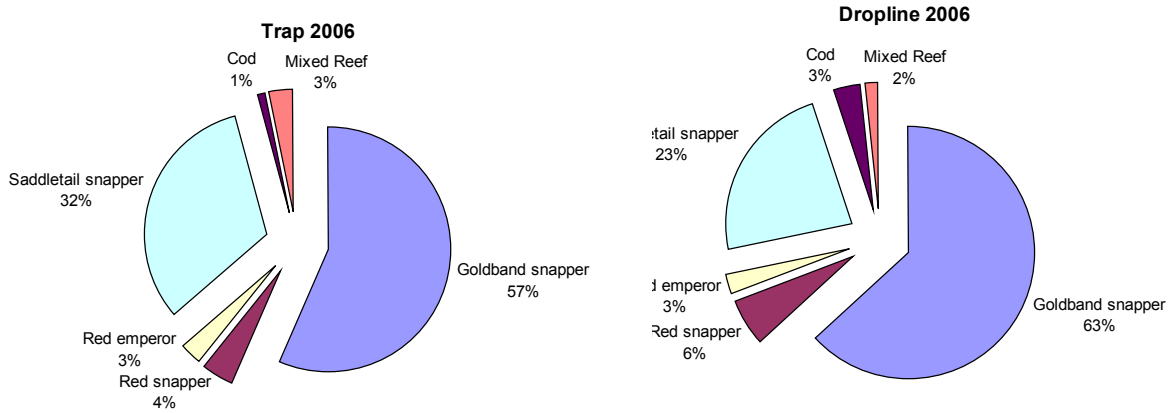

Figure 3. Comparison of catch composition harvested using different fishing gear in the Timor Reef Fishery during 2006

Catch Rates

Catch per unit effort (CPUE) increased in 2000 with the introduction of traps; however, there was a decline in CPUE in 2001, with catch rates relatively steady from 2001 to 2005, and an increase in CPUE during 2006 (Figure 5).

Marketing

Due to the lack of consumer familiarity with tropical snappers and emperors during the early developmental phase of the fishery, initial catches were processed and sold as frozen fillets on southern domestic markets.

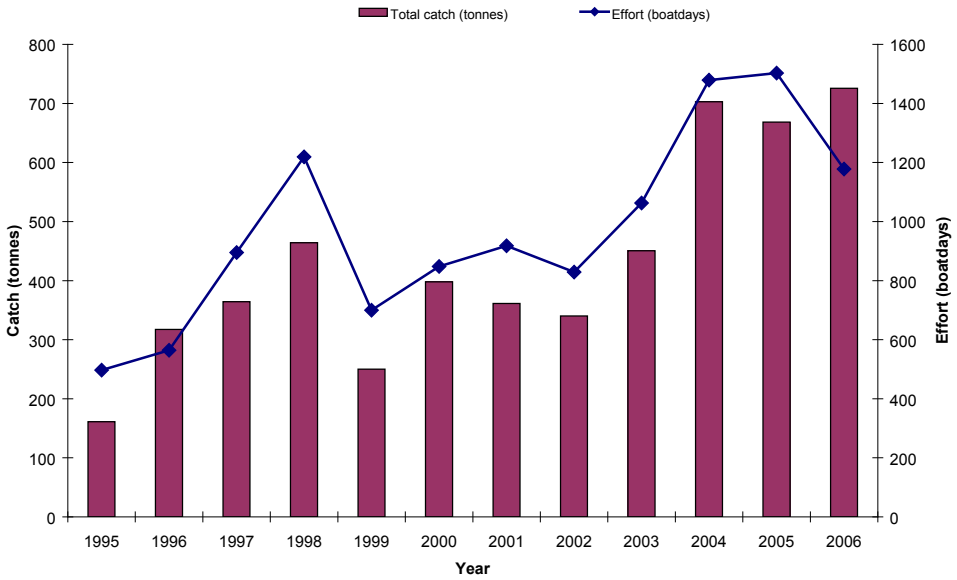

Figure 4. Catch and effort for the Timor Reef Fishery, 1995-2006

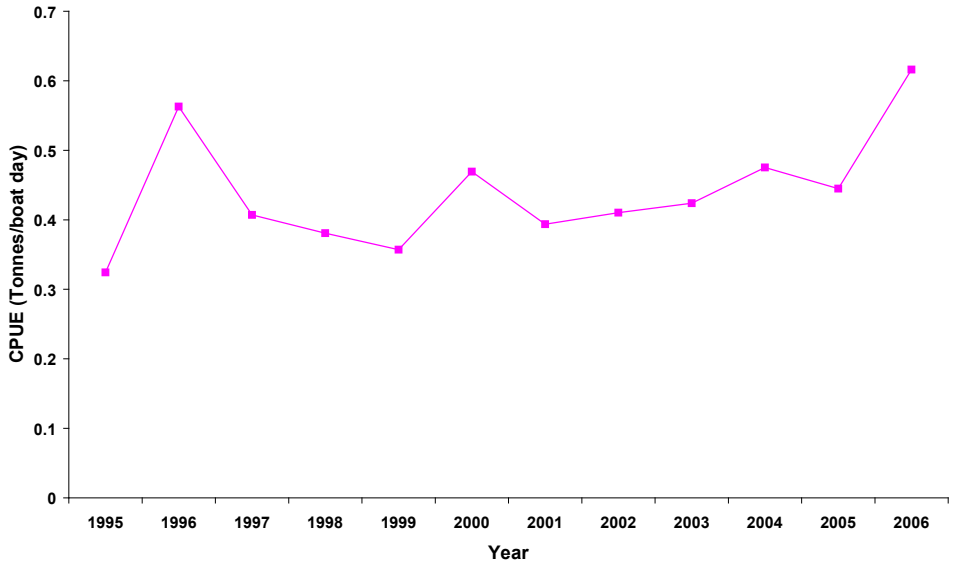

Figure 5. CPUE for the Timor Reef Fishery, 1995-2006

Trial shipments of whole fresh "gilled and gutted" goldband snapper were well received. Studies on tropical snappers indicated a shelf-life of up to 20 days after capture. This led to a marketing break-through for these species.

Currently, almost all snappers landed within the line 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

For the Timor Reef Fishery, the reported and observed level of by-catch (non-retained species) is less than 1 per cent of the total catch. The demersal tropical species landed in the fishery are well received throughout existing marketing channels.

Non-retained species include Chinaman fish (*Symphorus nematophorus*), red sea bass (*Lutjanus bohar*), big eye trevally (*Caranx sexfasciatus*), and starry triggerfish (*Abalistes stellatus*).

By-catch in this fishery is below the 10 per cent trigger value.

Threatened Species Interaction

In 2006, there were no recorded interactions with threatened species in the Timor Reef Fishery. The method of fishing and the location of the fishery generally prevent interactions with threatened species.

Ecosystem Impact

The management arrangements for the fishery allow operators to use passive fishing gear comprised of vertical lines and traps. Interaction with the habitat is limited to the effects of traps and vertical line 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 each other in order to avoid excessive interaction with the substrate upon hauling. Anchoring is usually limited to overnight stand down of fishing activity.

No interaction between the fishing gear and protected species has been observed. Such interactions are not expected with a deep-water trap fishery.

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.

A prohibition on fish trawling within the area of the Timor Reef Fishery was declared in the late 1980s. Such a declaration sought to provide greater protection of the then emerging fishery from the impact of demersal fish trawling. The Australian Government managed Northern Prawn Fishery allows prawn trawlers to operate year round in offshore waters throughout northern Australia. Prawn and scampi (deepwater shellfish) trawling activity is generally limited to water greater 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 numerous people in other support industries, such as transport and boat repairs.

Economic Impact

At the point of first sale in 2006, the overall catch value of the commercial Timor Reef fishery was $4.08m. The goldband snapper component was $2.77m (in 2005 it was $3.3m) and the catch value of saddletail snapper was $0.86m (in 2005 it was $0.45m).

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 logbooks 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, NT Fisheries officers conduct on-board monitoring of commercial fishing trips. While on-board, observers document vessel and gear information, location, depth, fishing practices, catch composition (including by-catch), and where possible, measure all landed species.

Eight on-board monitoring trips were conducted during 2006. This increased number of observer trips was due to the need to monitor immediately before, during and after seismic surveys that were conducted within the fishery. These additional trips were funded by Santos Ltd.

Stock Assessment Methods and Reliability

A stock assessment of goldband snapper for the Timor Reef Fishery was undertaken in 2003. This analysis also included part of the Demersal Fishery from the boundary of the Timor Reef Fishery to longitude 133º E, as 95 per cent of the Demersal Fishery catch of goldband snapper is within this area. These two sectors encompass the same goldband snapper stocks. The models used in this stock assessment were an extension of those developed by Professor Carl Walters at a workshop in Darwin in 1996. Details can be found in Ramm (1997).

An absolute figure cannot be placed on sustainable harvest because key parameters (Indonesian catch and effort, the level of interchange of fish and recruits, and important productivity parameters for goldband snapper) are not known. However, the goldband snapper biomass has been estimated to be between 3000 and 20 000 tonnes, with 9000 tonnes considered the more realistic estimate. It has been recommended that the harvest level of goldband snapper should not exceed 10-15 per cent of estimated biomass.

Current Status

In the Timor Sea, goldband snappers are targeted by Indonesian long line vessels as well as Australian trap and drop line vessels. These methods target fish above the size of maturity. Harvest levels in the Australian sector of the Timor Sea are below current reference points.

Future Assessment Needs

Future assessment needs to concentrate on the degree of movement of snappers between Australia and Indonesia, the identification of goldband and red snapper juvenile habitats and obtaining more accurate growth parameters from the capture of juvenile goldband snapper.

Research

Summary

Fine spatial analysis of this fishery was undertaken as part of a Fisheries Research and Development Corporation (FRDC) funded project (2005/047) which commenced in October 2005. This project used GIS spatial statistical methods to look at new ways to incorporate the very diverse forms of physical and environmental data, often on different scales, with Timor Reef Fishery logbook data. This study showed that bathymetry and geomorphology

strongly influence catches of goldband snapper (Figure 6).

The stock structure of goldband snapper (*P. multidens*) has been determined using both genetic methods and otolith micro-chemistry. It was funded by FRDC (1996/131, 1998/154). These studies were collaborative projects between NT DPIFM, Western Australian Department of Fisheries and Queensland 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 north-west 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 microchemistry 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 ACIAR funded project between Australia and Indonesia (FIS/1997/165). This study provided updated parameters that were incorporated into stock assessment models for the current assessment.

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

Current research is focused on developing a holistic approach to fisheries management using Geospatial statistics and fuzzy rule-based modelling. This work, funded by FRDC (project 2005/047), explores 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 Timor Reef 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 modeling allows the uncertainties of human knowledge to be captured as hard data. This work is expected to be completed in 2007.

A project to ascertain if hearing damage has occurred in goldband snappers due to seismic survey exposure was undertaken by Curtin University in collaboration with NT Fisheries. The project was funded by Santos Ltd and is expected to be completed in December 2007.

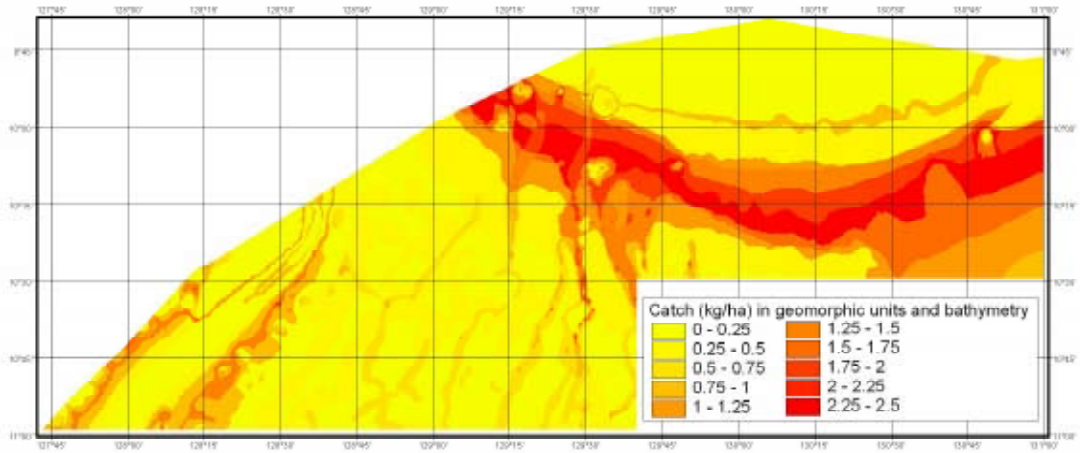

Figure 6. Abundance of goldband snapper catch (kg/ha) in relation to geomorphic units and bathymetry

Management/Governance

Management

Objective

Management objectives for the Timor Reef Fishery are achieved by maintaining target, incidental and non-retained catch levels within acceptable ranges. Should landings of goldband snapper 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 (Table 1).

Existing arrangements also seek to ensure the sustainability of by-product species taken in the Timor Reef Fishery. Acceptable catch ranges for by-product are not more than 10 per cent of the weight of aggregate landings in the fishery.

Monitoring of the fishery is achieved through analysis of commercial logbook reports and onboard observers.

Controls on the construction and use of fish traps and vertical lines minimise the effects on ecosystem components. Should significant interaction with components be identified, the appointed advisory group will make recommendations regarding appropriate remedial action. No such interactions were identified throughout the reporting period.

History

A joint venture feasibility study between an Australian and Japanese company was undertaken in the early 1980s to investigate the potential for a domestic drop line fishery. Landings from the trial were around 1500 tonnes per year. It was not until 1987 that commercial drop-lining by domestic operators commenced. 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.

In responding to concerns that excess fishing capacity may lead to the over-exploitation of goldband snapper stocks, a moratorium on the issue of further entitlements for what is now known as the Timor Reef Fishery was announced in December 1991. Only those fishers active in the fishery or licence holders able to demonstrate a commitment to entering the fishery retained access.

Separate management measures were implemented for the Timor Reef Fishery in 1993 when it was annexed from the Demersal Fishery. Overall fishing capacity within the boundary of the Timor Reef Fishery was reduced from a potential 60 to 22 licences. Limits on the number of operators were implemented in response to concerns that fishers displaced from interstate fishing restructuring programs may lead to over exploitation of goldband snapper stocks.

A further revision of the jurisdictional arrangements occurred in 1995. At that time management responsibility for the Timor Reef Fishery was passed to the NT Fisheries Joint Authority (NTFJA). NTFJA provided for the Commonwealth and the NT to jointly manage the fishery given the likelihood of shared resources with adjacent national and international jurisdictions. NT Fisheries undertakes day-to-day management of the Timor Reef Fishery.

Agreement was reached on a ceiling of 45 fish traps during 2002. The limit was imposed as a precautionary measure and to provide clarity on the amount of fishing gear used under each licence.

Current Issues

Anecdotal reports from domestic fishers suggest illegal foreign fishing catches are increasing significantly.

The impacts of illegal, unreported and unregulated (IUU) fishing in northern Australian waters, primarily by foreign fishers are poorly understood. The NT Government continues to work with the Australian Government to ensure adequate resources are allocated by the Australian Government (the governing

body is the Australian Fisheries Management Authority [AFMA]) to mitigate IUU impacts on the sustainability of red snapper stocks.

While it is accepted that most IUU fishers are primarily targeting sharks, apprehended vessels holding significant quantities of red snapper are becoming more prevalent. Coastwatch data highlights the significant illegal foreign fishing vessel presence in northern Australian waters. Research to determine the probable impact this illegal foreign presence is having on domestic shark and snapper stocks is continuing with a number of research projects attempting to determine the species and volumes of sharks and snappers being harvested. It is not yet possible to determine the potential effect IUU fishing is having on the tightly regulated domestic Timor Reef Fishery.

Oil and gas exploration companies have carried out 3D seismic surveys within the Timor Reef Fishery, which have impacted on commercial harvests from the immediate survey areas. Industry and NT Fisheries, with financial assistance from exploration companies, are carrying out additional research and monitoring of the survey areas in an attempt to better quantify the surveys impacts. Industry and NT Fisheries continue to liaise with oil and gas exploration companies in an effort to increase cooperation and to reduce the economic impact on fishing operators. These surveys have forced operators to temporarily relocate fishing activities to other areas within the fishery.

Future Plans

An industry request to review the levels of permitted gear (hand lines and drop lines) and management arrangements will be undertaken throughout 2006 and 2007 with a view to develop a formal plan of management for the fishery. The Timor Reef Fishery Management Advisory Committee (TRMAC) has formed and tasked a Timor Reef Fishery Assessment Group (TRFAG) to explore the potential of introducing catch quota management of the target species into revised management arrangements. The Fishery Assessment Group is expected to report its findings, along with recommendations to a meeting of TRMAC during 2007.

Goldband snapper are also landed outside the boundary of the Timor Reef Fishery, but are likely to be part of the same stock. Management triggers recognise this and the management arrangements are under constant review.

Compliance

Compliance with the Timor Reef Fishery management arrangements are undertaken by the Marine and Fisheries Enforcement Section (MFES) of the NT Police, Fire and Emergency Services, under the NT *Fisheries Act 1988*.

MFES effectively monitors compliance and enforces the Timor Reef Fishery management arrangements through the inspection of vessel arrivals and departures through the single port of Darwin. This includes verification of catch returns against processor returns (i.e. requirement for all operators to specify where they are selling their product).

MFES has the power, if necessary, to investigate the records of wholesalers and licensees.

In 2006, there were no significant domestic compliance issues recorded for this fishery.

Consultation, Communication and Education

Regular consultation occurs between NT Fisheries, the NT Timor Reef Licensee Committee and the NT Seafood Council. In addition, NT Fisheries staff undertake regular visits to the wharf to speak informally with fishers.

The low levels of participation in the Timor Reef Fishery allow all stakeholders to be directly involved in discussions on any proposed management arrangements. TRMAC met in February. It formally represents the interests of all stakeholders and provides a forum to discuss any proposed amendments to the management regime. TRFAG was convened in June to

discuss the potential for alternative management arrangements. Recommendations from this group will be passed to the TRMAC for consideration.

Conservation groups and non-government organisations are advised and consulted on topical fisheries issues, including the Timor Reef Fishery, through regular meetings with senior fisheries officers. Members of the public, including community and environmental/ conservation groups are also invited to provide their views to NT Fisheries through the release of public discussion papers and other consultative processes.

NT Fisheries also puts out publications in the form of Fisheries Reports and newsletters to inform and educate stakeholders.

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Table 1. Management objectives and performance indicators for the Timor Reef Fishery, 2006

Species or group	Management objectives	Performance indicator	Trigger reference point	Management response to be taken
Goldband snappers	Ensure inter-generational equity by maintaining ecologically sustainable annual catches in all sectors. Optimal sustainable yield estimates.	Optimal sustainable yield estimates.	Annual catch exceeds 900 tonnes (estimated sustainable yield) (2006 414 tonnes).	TRMAC to review fishery and make recommendations to the Executive Director, 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.
Red snappers (including saddletail snapper)			Annual combined catch exceeds 1,300 tonnes (estimated sustainable yield) (2006 254 tonnes).	
Red emperor		Significant change in catch composition on demersal fishery grounds.	Annual catch increase in proportion of the total catch by greater than 25 per cent above the five-year average.	TRMAC to review fishery and make recommendations to the Executive Director, Fisheries. Amended arrangements to be implemented within 12 months of trigger being released.
Cods			Annual catch increase in proportion of the total catch by greater than 10 per cent above the five-year average.	
By-product species	Ensure sustainability of by-product species taken in the Timor Reef fishery.	Monitoring of commercial logbook returns.	Annual catch increase in proportion of the total catch by greater than 10 per cent above the five-year average.	
By-catch species	Ensure sustainability of by-catch species taken in the Timor Reef Fishery.	Onboard monitoring of Timor Reef Fishery.	Total by-catch within the Timor Reef Fishery increases to 10 per cent of total catch or a decline in a species relative numbers without a corresponding change in fishing area or fishing technique.	TRMAC to make recommendations to the Executive Director, Fisheries regarding appropriate remedial action and onboard monitoring to commence at earliest practical opportunity.
Endangered, threatened or protected species and/or communities	Maintain present level of interaction between Timor Reef fishing operations and species and communities listed under the *EPBC Act 1999*.	Endangered, threatened or protected species and or communities are identified in NT waters.	Identifiable impacts observed by commercial fishers, fisheries observers or other agencies regarding EPBC listed species or communities.	TRMAC to make recommendations to the Executive Director, Fisheries regarding appropriate threat abatement plan implemented and onboard monitoring to commence at earliest practical opportunity.
Ecosystem components	Minimise effects on ecosystem components.	Identification of threatening processes.	Identification of significant negative interaction with components of the natural ecosystem present on demersal fishing grounds.	TRMAC to make recommendations to the Executive Director, Fisheries regarding appropriate remedial action

Trepang Fishery Status Report 2006

Introduction

Trepang fisheries throughout northern Australia date back to at least the 1700s, when Macassans from Celebes (Sulawesi Island group, Indonesia) visited northern Australia to fish for trepang. Activity in the fishery declined around 1880. By 1907, the South Australian Government had 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 catch levels.

A lower level of commercial exploitation continued until around 1945. Commercial fishers were generally European Australians assisted by Aboriginal people who inhabited the remote Arnhem Land coast. Little subsequent fishing activity was observed until the early 1980s, with virtually no reported exports. Increasing interest in the late 1980s led to the re-opening of the Northern Territory (NT) Trepang Fishery. At that time, six licences were issued for the hand harvesting of trepang.

Initially, the fishery was divided into three separate management areas, with two licensees 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.

The principal species for the fishery is the sandfish (*Holothuria scabra*). These prefer coastal areas to coral reefs and are often found in beds of sea grass. Sea grass plays an important function in triggering larval settlement. Sexual reproduction is via broadcast spawning which generally occurs in the warm months (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. Genetic studies in Queensland indicate limited genetic variability between shallow and deep populations of sandfish. The latter finding may be consistent with the view that juveniles settle in shallow sea grass beds and then migrate to areas of deeper water during their life span.

The terms trepang, sea cucumber or bêche-de-mer are often used interchangeably, although “trepang” actually refers to the high valued dried body wall of sea cucumbers which belong within the taxonomic group of holothurians.

In late 2004, the NT Trepang Fishery was assessed by the Australian Government Department of Environment and Heritage (now known as the Department of Environment and Water Resources, [DEW]). As a result, the fishery received certification as an accredited Wildlife Trade Operation (WTO). This assessment demonstrated that the Trepang Fishery is managed in a manner that does not lead to over-fishing, and that fishing operations have minimal impact on the structure, productivity, function and biological diversity of the ecosystem. The fishery will be reassessed against the Guidelines for the Ecologically Sustainable Management of Fisheries in 2007.

Profile of the Fishery

Commercial

Area

The Trepang Fishery operates in waters seaward of the coast to 3 nautical miles seaward of baselines (i.e. the NT coastline and surrounding islands).

Fishing Method

Sandfish (*Holothuria scabra*) 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 tides 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

As mentioned earlier, the target species for the fishery is the sandfish (*Holothuria scabra*). Due to the method of operation of the Trepang Fishery, no by-product species are taken.

Total harvest* in the Trepang Fishery was low until the late 1990s, growing from a little over 75 tonnes in 1996 and 1997, to vary in the range of 110.5 to 247 tonnes, responding largely to fishing effort (Table 1; Figure 1). Total harvest reported for 2006 was 169.8 tonnes.

Note* Catch and effort values and derived quantities may differ between annual status reports due to variation in data retrieval procedures and corrections of minor data errors.

Effort

Over the period 1996 to 2006, fishing effort* in the Trepang Fishery was highly variable, with between 172 and 521 days fished per year (Table 1; Figure 2). Effort peaked at the latter value in 1998 and gradually declined to pre-1998 levels in 2001. Effort then increased in 2002 (404 days fished) but declined nearly 30 per cent to only 295 days fished in 2003. Effort declined

Table 1. Catch and effort* for the Trepang Fishery, 1996 to 2006

Year	Catch weight (tonnes – wet weight)	Catch no.	Total catch (tonnes)	Effort (days)	Effort (hours)
1996	12.6 `	119077	77.4	279	1244
1997	15.6`	111619	76.4	249	1149
1998	82.3`	51723	110.5	521	2251
1999	199.3`	85610	245.9	365	1751
2000	247.0	N/A	247.0	274	1344
2001	115.0	N/A	115.0	172	799
2002	207.0	N/A	207.0	404	2684
2003	152.3	N/A	152.3	295	2241
2004	102.4	N/A	102.4	255	1471
2005	83.1	N/A	83.1	200	1451
2006	169.8	N/A	169.8	246	1711

’ Indicates calculated catch

further in 2004 and 2005 to 255 days and 200 days, respectively. However, effort has again increased in 2006 to 246 days.

Fishers report that effort levels reflect fishing conditions, such as turbidity, weather conditions and tidal state, rather than stock abundance or market factors.

For some periods during 1996-99, catches were reported alternatively as numbers or weights. The total catch weight for these years was estimated by multiplying catch declared as a number by a typical individual weight (0.544618 kg).

Catch rates*

Until the mid 1990s, the catch rates in the Trepang Fishery were low, with 32 kg/hr and 62 kg/hr recorded in 1996 and 1997, respectively (Figure 2). In 2000 the catch rate for trepang peaked at 183.7 kg/hr. Catch rates declined in 2001 levelling out in subsequent years to between 57 kg/hr (2005) and 99 kg/hr (2006). These catch rates remain greater than the early catch rates for this fishery. With a low number of participants, catch rates are subject to high variation as a consequence of skippers and crew entering or leaving the fishery, as well as extrinsic factors such as inter-annual variation in water clarity that affects catchability.

Licensees are permitted to harvest all trepang species. Discussions with licensees indicate that the fishery continues to target sandfish in preference to other lower valued species found in tropical waters. A review of trepang fisheries elsewhere indicates that in the event of a population decline in the higher 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, where fishers targeted teatfishes (*H. fuscogilvia, H. noblis*), prickly redfish and surf redfish (*Actinopyga mauritiana*). No such trend has been observed in the NT Trepang Fishery.

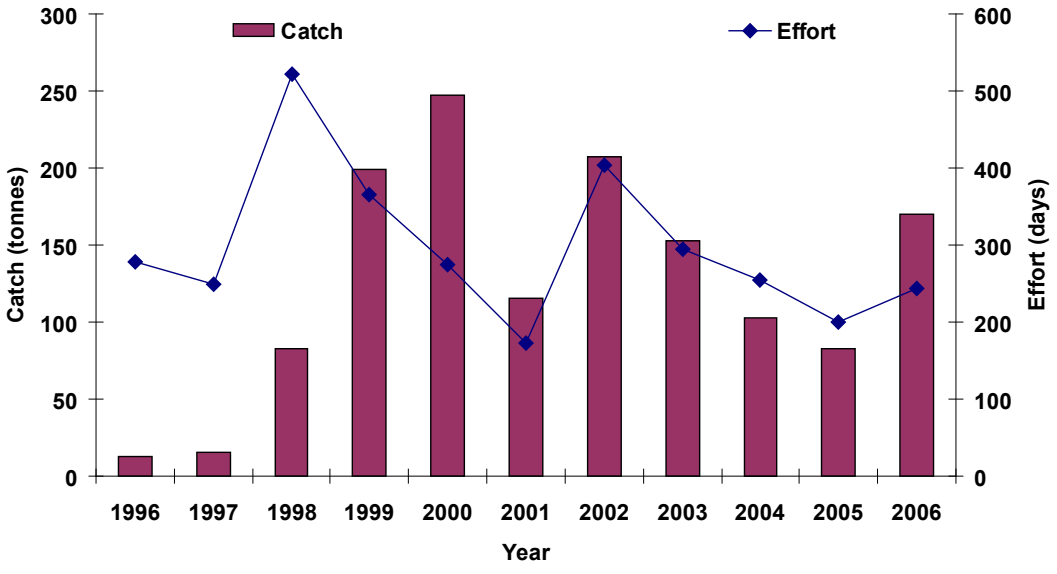

Figure 1. Annual total catch and effort* for the commercial Trepang Fishery, 1996 to 2006

Marketing

With restricted land access to the majority of the NT coastline, all fishing operations are vessel-based. Initial processing includes washing, grading and freezing the harvested product. In a majority of cases the stomach is removed, the remaining product then boiled and the trepang frozen. 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, the majority of the catch is exported.

Recreational Sector

The recreational take of trepang is not known but likely to be low. No trepang catch was reported by recreational fishers during either of the two recreational fishing surveys conducted in 1995 and 2000-01. The local Asian community may take limited amounts for personal consumption.

Fishing Tour Operator (FTO) Sector

There are no reports of trepang in the catch of FTO clients for 2006.

Indigenous Sector

No take of trepang was reported during the National Recreational Indigenous Fishing Survey of Northern Australia undertaken in 2000-01. Information collected during field trips suggested that trepang is 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 (by-catch) species collected.

Ecosystem Impact

Collection of trepang by hand is likely to have minimal impact on the ecosystem.

Economic Impact

The value of the fishery is confidential as there are fewer than 5 licencees in the fishery.

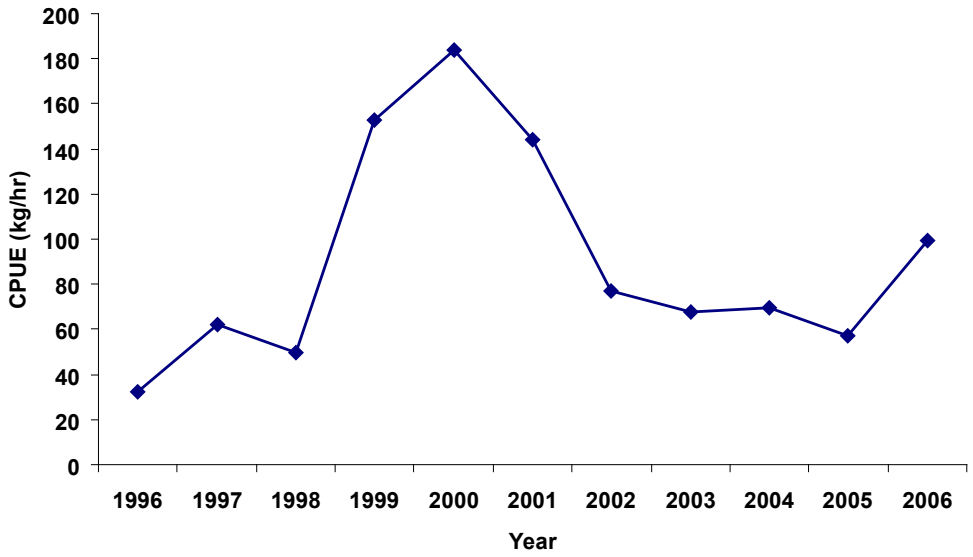

Figure 2. Catch rate for the commercial Trepang Fishery, 1996 to 2006. Catch rates represented here are catch per hour of operation only for those operations where catch was declared in units of weight.

Stock Assessment

Monitoring

Commercial fishers in the Trepang Fishery are required to complete daily reports on fishing effort and the level of harvest by both weight and numbers of individuals. This information provides for future detailed assessment of the status of the Trepang Fishery, including the estimation of the average weight of individual trepang harvested as an indicator of the status of the fishery. However, 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 the animals have no hard parts that might be a reliable proxy. By reporting total weight and number in the catch, fishers nevertheless provide trend information that is of benefit. 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

There is no current stock assessment for trepang. As a consequence, NT Fisheries has adopted a precautionary management approach with a limit of six licences in the fishery able to operate within 3 nautical miles of the baseline. This number of licences together with the natural inhibitors, visibility, accessibility, wet season and cyclonic events, limit the potential for over-fishing.

Current Exploitation Status

Performance measures for the fishery, catch rates and average size, indicate that the current level of harvest has not exceeded appropriate levels.

Future Assessment Needs

A program to develop a series of cooperative industry and student based projects is currently being developed with the fishing industry and Charles Darwin University. A program of management strategy evaluation (MSE) is to be initiated, to indicate both research directions and monitoring information that would be appropriate for various management options. Research and assessment will seek to assess the status of stocks both within and external to the current fishery area. The availability of suitable students is a current constraint to this work.

Incorporation into Management

Research outcomes indicate that current management and monitoring are adequate. However, future monitoring will depend on information needs identified above and future fishery performance.

Research

Current research is limited to analysis of trends in fishery statistics and assessment and assimilation of research from other areas and jurisdictions. A framework for the MSE described above is being developed.

Management/Governance

Management

Objective

Management of the fishery seeks to satisfy legislative objectives of conserving, enhancing, protecting, utilising and managing the fish and aquatic life resources of the NT. Key management strategies to achieve the objectives of management 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 three nautical miles 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 premier species, the sandfish, indicate that the current arrangements are appropriate to achieve the management objectives of the NT Trepang Fishery.

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, also 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 the inability to harvest trepang during the time of spring (larger) tides and the heavy flooding often associated with the monsoon. 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 the fishery.

The Trepang Fishery is further managed in accordance with the management objectives, performance indicators, triggers and management actions as agreed through industry and the Australian Government assessment process and as part of the WTO accreditation.

Current Issues

Reported catch levels for target sandfish species *Holothuria scabra* throughout 2006 were within acceptable levels.

Over the next 12 months NT Fisheries will be working with the licence owners to develop and implement finer scale data collection and reporting. This will enhance the quality of data collected and mitigate the potential risk of localised depletion of trepang in the fishery.

Compliance

Compliance activities associated with management arrangements for the Trepang Fishery are undertaken by the Marine and Fisheries Enforcement Section (MFES) of the NT Police, Fire and Emergency Services, under the NT *Fisheries Act 1988*.

MFES effectively monitors and enforces the Trepang Fishery management arrangements through the inspection of vessel arrivals and departures through the single port of Darwin. Compliance includes verification of catch returns against processor returns (i.e. requirement for all operators to specify where they are selling their product). MFES has the power, if necessary, to investigate the records of wholesalers and licensees.

In 2006, no significant compliance issues were recorded for this fishery.

Consultation, Communication and Education

Regular consultation occurs between NT Fisheries, licence holders and the NT Seafood Council. In addition, NT Fisheries staff conduct regular visits to the wharf to speak informally with fishers.

Conservation groups and non-government organisations are updated on current fisheries issues, including the Trepang Fishery, through regular meetings with senior fisheries officers. Members of the public, including community and environment/conservation groups are also invited to provide their views to NT Fisheries through the release of public discussion papers and other consultative processes.

NT Fisheries also issue publications in the form of Fisheries Reports and newsletters to inform and educate stakeholders.

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Aquaculture

Barramundi Farming Status Report 2006

Introduction

Barramundi (*Lates calcarifer*) farmed production (tonnes whole fish produced) decreased by 32 per cent in 2006. Combined production from two pond-based farms, one sea cage farm and one small-scale tank-based farm was 569 tonnes in 2006 compared with 837 tonnes in 2005. The total value of barramundi production decreased from $7.3m in 2005 to $4.8m in 2006.

The decrease in production from the commercial barramundi farms was mainly related to technical issues in sea cage farming due to exceptionally bad weather conditions. During 2006 the operators of the sea cage farm endeavoured to secure three new sites to expand their production capacity to more than 6000 tonnes. Late in 2006 a change in corporate direction for the sea cage farm's parent company saw the Darwin operation close and all remaining equipment and intellectual property sold to the development arm of the Tiwi Land Council. Attempts are being made to attract a replacement investor.

One pond-based farm increased production in 2005 compared with 2004 and another pond farm and a tank-based farm commenced harvesting barramundi for the first time.

Despite the setback in production in 2006, the strong growth in production the industry experienced since 2000 has demonstrated the excellent potential for further industry growth.

Profile of the Fishery

Commercial Production

Distribution of Farms

Of the seven licence holders endorsed to produce barramundi, four produced marketable fish in 2006. A fifth farm, currently producing prawns, stocked several ponds with juvenile fish and first harvests were intended for the middle of 2007. The four operational farms are at Humpty Doo, Berry Springs and the Tiwi Islands.

Hatchery / Nursery Production

Commercial fingerling production decreased from 1.7 million in 2005 to just over 1.5 million in 2006. Only one hatchery, the government run Darwin Aquaculture Centre (DAC), sold fingerlings during the year. Over 46 per cent of the fingerlings were sold locally (725 000). The size range of the fingerlings supplied to local farmers was 50 mm to 130 mm and 818 000 25-35 mm fish were also sold interstate. This reduction in sales from the previous year was due to the cessation of fingerling supply to the sea cage farm in the middle of 2006. The reduction in fingerling supply to the sea cage farm was partially offset by increases in fingerling supply to local pond farms.

Stock Assessment

In 2006 over 102 000 excess fingerlings from DAC, ranging from 100 to 130 mm in size, were stocked in Manton Dam and a number of other freshwater impoundments in the Darwin area.

Farm Production

Three land-based farms, Australian Barramundi Culture Pty Ltd (Humpty Doo), Arda-Tek (Berry Springs) and Aquaculture Systems NT (Darwin River) marketed fish. The amount of fish produced in ponds increased from 133 tonnes in 2005 to 327 tonnes in 2006. Another pond-based farm, Wild River Farmed Seafood (Berry Springs), started stocking ponds with juvenile barramundi early 2006 and was expected to commence harvesting in the middle of 2007.

There was only one barramundi sea cage farm in the NT, operated by Marine Harvest, located on Bathurst Island. The amount of fish produced by Marine Harvest decreased in 2006 compared with 2005. This decrease in production was related to technical issues associated with bad weather conditions in February.

Translocation

There is a translocation protocol which covers health and security issues relating to the importation of barramundi larvae or fingerlings and their movement within the NT. This protocol identifies disease control regions within the NT. Fish may move 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 translocated stock.

Marketing

In 2006 most product was sold to interstate markets; 88 per cent as whole fish (over 1.0 kg) and 12 per cent as plate size fish (less than 1.0 kg).

Employment

Permanent labour employed in the grow-out and hatchery/nursery sectors of the industry had decreased from 27.5 in 2005 to 18.5 in 2006 and casual employment decreased from 8.5 in 2005 to 3.0 in 2006.

Indigenous Development

Marine Harvest employed two full time indigenous workers from the Tiwi Islands and, in collaboration with the Vocational Education and Training programs operated at the Charles Darwin University, provided a training program for others interested in gaining employment with the company. Australian Barramundi Culture Pty Ltd also employed one full time indigenous worker.

Ecologically Sustainable Development/ Environmental Management

The Environment Protection Agency Program within the Department of Natural Resources, Environment and the Arts oversees environmental assessments and approvals. As part of aquaculture licence conditions, all farms must have an approved environmental management plan (EMP). The 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 that time. Recently, 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 funded work on the development of a bacterin against two pathogenic marine bacteria detrimental to barramundi fingerling production: *Vibrio harveyi* and *Photobacterium damselae*. These bacteria were responsible for a significant mortality at the DAC hatchery/nursery and at the Marine Harvest cage farm.

DAC has also assessed new hatchery and nursery feeds (Gemma and Gemma micro from Nutreco), and implemented feeding and grading strategies to improve weaning, growth, survival and reduce size variation within the same batch of juvenile fish. Fingerling growth rate to 100 mm has been increased by 20-30 per cent with a 95-100 per cent reduction in the use of Artemia.

Current Research

In 2005, a project proposal was prepared and submitted to the Australian Research Council seeking funding for the development of improved detection methods and management of nodavirus, the causative agent of viral encephalopathy and retinopathy (VER), the most

important 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, Berrimah Veterinary Laboratories (BVL), the University of Sydney and Marine Harvest. It is expected that broodstock screening tests (Polymerase Chain Reaction and two Enzyme Linked Immuno-Sorbent Assay tests) will be developed by the end of 2008. These tests will help improve the understanding of the epidemiology of the disease.

An autogenous vaccine against *Streptococcus iniae*, the causative agent of the disease streptococcosis, a devastating bacterial disease which affects farmed barramundi in Australia, was developed and commercially produced by Intervet Norbio Australia in collaboration with Marine Harvest and BVL. The vaccine was approved by the Australian Pesticides and Veterinary Medicine Authority for use only on Marine Harvest's barramundi sea cage farm.

A project proposal was prepared and submitted to FRDC for the establishment of a method to improve the rapid diagnosis of *S. iniae* strains which could assist in the development of appropriate vaccines against *S. iniae* for use on all barramundi farms.

Industry Development

History

Commercial barramundi farming was first introduced 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. Recently, depressed prawn prices have seen at least one prawn farmer return to barramundi culture.

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 the Darwin Aquaculture Centre.

The 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 assessment of new inland and offshore farm sites. Areas in Darwin and Tiwi Islands region are the most likely for expansion in the short-medium term.

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

Humpty Doo Barramundi is exploring the use of large-scale recirculating ponds and semi-automated nursery as a means to improve 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 Territory.

Future Plans

The projected fingerling requirement for 2007 is in excess of 1.5 million (local and interstate).

Barramundi production from the NT is projected to increase to over 1000 tonnes in 2007. A long term vision of developing a barramundi farming sector of over 10 000 tonnes per year in the NT has been espoused by the NT industry.

DAC is currently helping industry to develop a fourth pond farm located near Channel Island. The farm should be operational during 2007.

DAC is also continuing to review hatchery and nursery production protocols to improve

the fingerling quality supplied to the industry. For instance, fingerling deformity issues are constantly assessed and investigated through larval rearing and live feed production systems.

Industry Liaison

Aquaculture staff regularly facilitate contact with all active aquaculture licence holders and encourage open channels of communication with industry. In addition, all farms have access to an Extension Officer who visits the farms regularly, usually weekly.

Barramundi farmers are 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 industry and government where aquaculture issues can be formally addressed. All aquaculture licensees are also represented on the NT Seafood Council through the Aquaculture Licensee Committee.

Prepared by

Jerome Bosmans – Senior Aquaculture Scientist
Glenn Schipp – Manager Aquaculture

Mud Crab Farming Status Report 2006

Introduction

In 2006, a 0.15 ha mangrove enclosure and a 2.5 ha pond farm, were used to trial grow out of mud crabs. Production was 669 kg from the pond farm and none from the mangrove enclosure.

The pond-based farm lacked basic infrastructure, including electricity, due to funding delays. It was therefore not possible to control water quality in the ponds, which severely restricted the capacity of the farm.

It was difficult to operate the mangrove enclosure pilot farm due to access problems in the wet season.

Over the year the pond farm was stocked with about 66 000 crablets (juvenile crabs) and the mangrove enclosure with 2500 crablets.

Both the pilot enterprises were operated by indigenous communities to test the viability of the farming methods.

In late 2006 a private company started the process of acquiring an aquaculture licence to raise mud crabs in ponds previously used for prawn farming.

Profile of the Farming Sector

Commercial Production

Distribution of Farms

In 2006, there were two mud crab farming operations in the Northern Territory (NT). One is a 2.5 ha pond-based farm located in the Darwin metropolitan area, adjacent to Darwin Harbour and the other is a 0.15 ha mangrove enclosure located near a Top End indigenous community in Maningrida.

Hatchery / Nursery Production

All the crablets for the farms were produced at the Darwin Aquaculture Centre (DAC). Over the year DAC produced 68 000 crablets for the two farms.

Farm Production

The pond farming was carried out in unlined, earthen ponds. Tidal seawater entered into the ponds through gates fitted with screens. To control its quality, water was exchanged through the ponds at various times of the grow-out cycle depending on the height of the tides. There was no oxygenation of the water in the ponds because there was no electricity available.

Crabs in the mangrove enclosure were able to move throughout the enclosure and feed on natural feeds as well as supplementary feed provided. The enclosure was subject to the natural tidal regime and sea water flowed through the enclosure with very little impediment. No water was impounded in the enclosure.

Crabs were fed on a mixture of local fresh fish by-product and imported formulated pelleted feeds.

Translocation

The NT's translocation policy, 'Transboundary Movements of Living Aquatic Animals' was endorsed in 2006. This policy covers health and security issues relating to the importation or translocation of live mud crabs of all life stages.

Marketing

The harvested crabs were sold as whole live product either locally or interstate.

Employment

Throughout 2006, the mud crab farming industry employed 1.5 full time employees and about eight full-time equivalent staff on a casual basis.

Indigenous Development

During the year, one aquaculture licence and one scientific permit, were held by indigenous enterprises. The farms are pilot/training operations to test the viability of the methods used.

Ecologically Sustainable Development/ Environmental Management

The Environment Protection Agency Program within the Department of Natural Resources, Environment and the Arts oversees environmental assessments and approvals. As part of aquaculture licence conditions, all farms must have an approved environmental management plan (EMP). The 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.

Summary

Since 1995 DAC has been involved in two collaborative research projects with interstate and international partners and has been at the forefront of hatchery production of mud crabs. The methods to produce mud crab juveniles have been developed and are now used to supply crabs to pioneering farmers.

There is no current structured research program in place; however, continual refinement of techniques occurs during production.

Industry Development

History

Crab farming is in its infancy with the first two crab farms, a mangrove enclosure at Maningrida and a pond farm at Kulaluk, being initially stocked with crablets in late 2005.

The pond farm at Kulaluk was a previously abandoned dilapidated prawn farm. The ponds have been rehabilitated and infrastructure is being developed to establish a semi-intensive farm.

The mangrove enclosure is constructed from prawn netting and surrounds an area of mangrove that is fronted by a small creek and backed by a sand dune. The mangrove enclosure style of farm requires lower inputs than a pond farm and is considered to be more appropriate for remote communities.

Both communities received assistance from Fisheries to help set up the farms.

Current Issues

There are many challenges confronting mud crab farming in Australia as it is a new and unproven type of aquaculture. High amongst them is the need to develop a suitable "pelleted" feed, to develop techniques to reduce cannibalism, to develop suitable harvesting methods and to control the timing of spawning.

Future Plans

The two existing crab farms plan to continue operations in 2007. The mangrove enclosure will concentrate on dry season production. The pond-based farm will hold off further stocking of ponds until electricity is connected in the second half of 2007.

A new proposal was lodged in late 2006 for an aquaculture licence to operate a commercial mud crab farm in the Darwin area.

Industry Liaison

Crab farmers are 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 industry and government where aquaculture issues can be formally addressed.

Aquaculture staff regularly facilitate contact with all active aquaculture licence holders and encourage open channels of communication with industry. In addition, all farmers have access to an Extension Officer who visits the farms regularly, usually weekly.

Prepared by

Graham Williams – Industry Case Management Officer

Pearling Industry Status Report 2006

Introduction

In 2006 the Northern Territory (NT) pearling industry produced 113 825 momme* of pearls from farmed pearl oysters *Pinctada maxima*. This was an increase of 20 per cent over the 90 789 momme produced in 2005. The total value of production increased also by 20 per cent from $14.2m in 2005 to $18m in 2006. The increase in income was due to an increase in production as the wholesale market price of pearls remained steady over the last two years.

It is predicted that the value of the NT pearling industry will continue to increase, partly due to refined production practices, industry rationalisation and increased marketing opportunities. However, the main reason will be increased production.

*Momme is an old Japanese unit of weight equal to 3.75 g. A 13 mm round pearl weighs about one momme.

Profile of the Farming Sector

Commercial Production

Distribution of Farms

Active pearl oyster farms are distributed along the northern coast of the NT in two main areas, Cobourg Peninsula/Croker Island and English Company Islands/Truant Island areas. There are other lease sites, which are not used currently 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. This company uses oysters produced in its hatchery for grow out on its leases and has the option to sell these oysters to other licensees. Pearl oysters farmed by other licensees are sourced from hatcheries or wild harvested oysters from Western Australia (WA).

Farm Production

Pearl oyster farms are usually located in sheltered embayments to protect the pearl oysters, which are placed in panels suspended from floated long lines. Each shell is attended regularly to ensure that fouling does not impede the viability of the oyster or production of the pearl.

Pearl oysters are seeded by artificially placing a nucleus derived from the shell of the Mississippi mud mussel with a piece of donor mantle tissue into the oyster. Pearl nacre forms around the nucleus creating the pearl. A series of turning programs occur after the nucleus is implanted to assist in the development of a good shaped pearl sac to ensure even coating of the nacre. It then takes two years to produce a pearl.

If an oyster produces a good quality round pearl, the oyster may be re-seeded with another nucleus and maintained for another full grow-out cycle. Only a small proportion of good pearl-producing oysters are seeded a second time and even fewer a third time. Re-seeded pearl oysters generate larger pearls as there is already space in the oyster created by the first pearl.

Farmed pearls vary in size, shape and quality, and are priced accordingly. There are also several other products from pearl oyster culture, namely half pearls or Mabe, Keshi (natural pearls of various shapes and sizes), Mother of Pearl (MOP) - pearl oyster shell used for buttons, jewellery and decorative inlays, and pearl meat, which is the pearl oyster's adductor muscle.

Translocation

A translocation protocol is in place that covers health and security issues relating to the importation into the NT and translocation within the NT of adult and juvenile pearl oysters.

Marketing

The marketing of Australian South Sea Pearls is conducted individually by licensees. However, most of the pearls produced each year are sold

at auction either in Sydney or Hong Kong, or through shops operated by the companies in both Australia and overseas. MOPs are sold to many different countries; Italy a major customer. Pearl meat, which is valued at around $85/kg, is sold in Australia.

Employment

About 170 people were directly employed by the NT pearling industry in 2006, in farming or farm related activities. This is less than the number reported the previous year because in that year several WA based workers were included in the records. There was also some industry rationalisation in 2006.

Indigenous Development

Aboriginal people play an important role in the servicing of pearl farms. The land-based infrastructure of most farms is located on indigenous-owned land and is controlled through access agreements with traditional owners and land councils. Employment opportunities exist for local Aboriginal people to assist in the operation of the farms.

Ecologically Sustainable Development/ Environmental Management

The Environment Protection Agency Program within the Department of Natural Resources, Environment and the Arts oversees environmental assessments and approvals. As part of aquaculture licence conditions, all new farms must have an approved environmental management plan (EMP). Existing farms are encouraged to operate under an EMP. The EMP stipulates the environmental parameters under which the farm must be constructed and operated. Farms are subject to environmental and aquaculture licence compliance audits.

Research

Summary

The renewed interest in pearling in the mid-1980s highlighted the lack of knowledge of NT pearl stocks. To assess stocks, a pearl oyster dive survey was conducted in 1989 by the Bureau of Rural Resources. This was followed by a Fisheries Research and Development Corporation (FRDC) funded project, which started in 1991. Its objectives were to provide a description of 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 to improve the feeding of pearl oysters spat and broodstock was conducted in the mid-1990s with funds from the Cooperative Research Centre for Aquaculture.

In 1994, a health survey of pearl oyster across northern Australia commenced, which was funded by FRDC, provided valuable information to assist industry and Government to improve disease management protocols.

Much of the research conducted by the pearling industry is in-house and its outcomes contribute to the competitive advantage of individual companies.

Funded by FRDC, a book titled “The Pearl Oyster *Pinctada maxima*: An atlas of functional anatomy, pathology and histopathology” was published, based on samples taken during the pearl oyster health survey and submitted to Veterinary Pathology Laboratories in WA, QLD and the NT.

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 have been fished commercially from 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 their MOP value – the lustrous nacres of the shells which are used for the production of buttons, ornaments and as an additive in paints and cosmetics. Oysters were collected in the following three years 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 down. This resulted in large MOP yield fluctuations during the next 80 years. By 1899 there were 51 luggers working the grounds harvesting about 200 tonnes of MOP a year. This slowly fell to 60 tonnes by 1910 and then ceased during WWI. It did not start again until 1923. Again production increased until 1930 when 32 luggers yielded about 700 tonnes a year. Production stayed around this level until 1939 when WWII halted production until 1948. Once again production slowly increased until 1953 when the Commonwealth Government permitted 35 Japanese divers into Australia in an attempt to rebuild the industry. The MOP industry flourished again with production peaking at 1100 tonnes a year and remained at that level for the next three years. As the new areas were fished down, production again slowly declined.

The arrival of plastics made shell harvesting uneconomical and MOP harvesting 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.

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 Western Australia, the local grounds are deeper, more isolated, 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 Western Australia and as techniques improved in the transport of the oysters to the NT, the reliance on sourcing local oysters declined.

The success of Paspaley Pearls pearling activities in the NT and WA, along with an expanding WA industry, prompted the Government to promote the expansion of a local pearling industry. Five additional companies that met the Government's selection criteria 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 of 40 tonnes per year. Since 1994, there has been very limited harvesting of pearl oysters due to a reliable supply of hatchery-reared oysters, combined with poor yields of good culture stock from the local pearling grounds.

Management/Governance

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 his/her annual pearl oyster fishing allocation for hatchery-reared pearl oysters. This year no licensee fished for culture pearl oysters in the NT.

In 2006 there were several changes to the Pearl Oyster Culture Industry Management Plan and Fisheries Regulations to assist with the development of the industry. These changes included changing the licensing year from a financial to a calendar year, the provision of additional pearl oysters to assist in training technicians in the art of pearl oyster seeding and the allowance of additional shells to account for pearl oysters that fail to retain their seeded nuclei.

This last change was achieved by increasing the unit value by 15 per cent i.e. from 1000 to 1150 oysters. Now the number of new pearl oysters that may be seeded each year under the NT allocation system is 483 000. The full entitlement of NT pearl oysters was not seeded in 2006.

After successful negotiations with WA Fisheries and the WA pearling industry, NT licensees have the option now of seeding their NT allocation in WA and afterwards moving these oysters to their NT farms for culture.

Following general agreement between the NT and WA Governments that the Australian South Sea Pearl industry should be managed in a consistent manner given that it is highly susceptible to market pressures and any change in management arrangements for one jurisdiction could impact on the other, a Memorandum of Understanding (MoU) was developed. The MoU was signed by respective Fisheries Minister in June 2006 to ensure that complementary management measures are put in place and that both jurisdictions are consulted on any matter affecting the industry.

The WA Government and industry have undertaken an extensive review of the pearling industry, including their current hatchery policy. The review includes mechanisms for assessing the total quota level, determining new quota levels and allocating models for any increases in hatchery quota. The NT was consulted and provided input during this review process. The policy developed by this review process has been supported by industry and WA and NT Governments.

Current Issues

A compliance program has been developed for NT pearling operations and is planned to be implemented in 2007.

A significant disease event in Exmouth Gulf, WA in late 2006 was a major concern to the pearling industry in both jurisdictions. A large proportion of NT-seeded oysters are sourced from WA. Consequently, the translocation of potentially diseased oysters may represent a serious threat to the NT industry and needs to be carefully considered in accordance with translocation and disease testing protocols.

Future Plans

NT pearling legislation will be reviewed as part of the review of the *NT Fisheries Act*. The amalgamation of the Pearl Oyster Culture Industry Management Plan and Pearling Fisheries Regulations and appropriate parts of the proposed new WA Pearling Management Bill are points for consideration.

Industry Liaison

NT Fisheries provides a dedicated management officer for the pearling industry to assist with issues as they arise as well as the strategic development of the industry. The Pearl Industry Advisory Committee (PIAC) meets once a year to address issues of importance to the pearling

industry. PIAC is composed of a representative from each pearling licensee and is chaired by the Executive Director, 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, which meets about four times a year.

Prepared by

Murray Barton – Pearling Industry Manager

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Prawn Farming Status Report 2006

Introduction

In 2006, about 55 ha of ponds were used in the Northern Territory (NT) to produce marine prawns from two possible crops per year. The two producing farms harvested 213 tonnes of prawns at a market value of $2.96m. There was an increase in production of 197 tonnes compared with 2005.

All of the prawns produced were “black tiger” prawns (*Penaeus monodon*).

Approximately 32.7 million post-larvae (PL) were produced locally and an additional 8.6 million were imported from Queensland.

One of the prawn farms ceased to operate in October 2006. There was no new pond development in 2006.

Profile of the Farming Sector

Commercial Production

Distribution of Farms

In 2006, there were seven aquaculture licences with endorsements to culture marine prawns in the NT. Of these, two were active prawn farms, one was an operating farm that had switched from farming prawns to barramundi, two were inactive established farms and two were held by licensees without farm facilities. Black tiger prawn was the only species cultured on the active prawn farms, all of which are located in the Darwin area.

Hatchery / Nursery Production

Local hatcheries associated with the active farms produced approximately 32.7 million PL whilst an additional 8.6 million PL were imported from Queensland.

A joint project between an industry partner and Charles Darwin University was discontinued after the industry partner ceased its activity. This project aimed to collect and domesticate specific pathogen-free black tiger prawn broodstock.

Farm Production

All marine prawn farming was carried out in unlined, earthen ponds. Sea water was pumped into the farms and delivered to the ponds via channels or pipes. Depending on the management method, water was exchanged through the ponds at various times of the grow-out cycle to control water quality.

There has been a trend to reduce the throughput of water during the grow-out period to limit the likelihood of introducing pests and disease into the farms and also reducing effluent. Oxygenation of the pond water was by mechanical aeration, usually using paddle-wheel aerators or aspirators. Prawns were fed imported formulated pelleted feeds.

Translocation

The NT’s translocation policy, ‘Transboundary Movements of Living Aquatic Animals’ was endorsed in 2006. This policy covers health and security issues relating to the importation or translocation of live prawns of all life stages.

Marketing

The majority of prawns are sold as whole, cooked, or frozen product to interstate wholesale markets. Small amounts of green or cooked prawns are sold locally.

Employment

In 2006, the prawn farming industry employed 12 full time employees and 15 full-time equivalent staff on a casual basis, usually to assist with harvesting.

Indigenous Development

During the year two licences were held by businesses with indigenous principals. One of these farms has facilities but was not operational and the other was held by a group without farm facilities.

Ecologically Sustainable Development/ Environmental Management

The Environment Protection Agency Program within the Department of Natural Resources, Environment and the Arts oversees environmental assessments and approvals. As part of aquaculture licence conditions, all farms must have an approved environmental management plan (EMP). The EMP stipulates the environmental parameters under which the farm must be constructed and operated. 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

In 1999 a project to identify aggregations of *P. monodon* broodstock in the NT was undertaken by the Darwin Aquaculture Centre in collaboration with the then Queensland Department of Primary Industries (QDPI). The project was funded by the Fisheries Research and Development Corporation (FRDC - project F1999/199) and was completed in 2002.

A collaborative project undertaken by Charles Darwin University and an industry partner was seeking to domesticate specific pathogen-free black tiger prawn broodstock. Activity in this project has ceased.

Current Research

Current research is being fully funded by industry and includes hatchery and grow-out techniques to maximize production as well as ground-truthing broodstock aggregation sites for P. monodon identified in the FRDC project (F1999/199).

Industry Development

History

Prawn farming began in the NT in the early 1980s when overseas and local companies invested in farms in the Darwin area and later in the Roper River area. These first attempts failed for a variety of reasons. In the mid 1990s a small pilot prawn farm was established on the Elizabeth River and a Barramundi farmer on Haycock Reach in Darwin Harbour switched from fish to prawn farming to become the first long-term viable prawn farmer in the NT. The Haycock Reach farm has since changed hands several times and has recently ceased operations as a prawn farm.

In the late 1990s the proprietor of the pilot prawn farm on the Elizabeth River established a new farm on the Blackmore River using an innovative pond design and production techniques. Another farm with a similar operational system was constructed close to this farm soon after.

Following on from these developments another large farm was established in 2003 on the Blackmore River estuary and is the major operating prawn farm in the NT.

There was no prawn farm expansion in 2006.

Current Issues

One of the major issues of concern to the industry is the availability of broodstock. If locally caught or cultured broodstock are available, local hatcheries can provide quality PL for stocking in ponds. PL supplied from local broodstock will not suffer from stress due to long periods of transport or bring in disease as imported PL may.

There are a limited number of sites available for prawn farming close to Darwin. As a result, future prawn farm development is likely to occur in coastal areas away from Darwin.

A recent issue of concern to farmers has been the low price of imported prawns. Imported

prawns put local farmers under increased economic pressure. Imported green prawns also can be a vector for exotic diseases.

Future Plans

Cheap imported prawns have negatively affected prawn prices in Australia. There are no planned expansions in prawn production in the NT. At the end of 2006 the only operating prawn farm was preparing an EMP for expansion of its pond area, but because of a change in method of operation from two crops per year to one crop, this will not lead to a significant increase in production.

Negotiations with the Australian Fisheries Management Authority (AFMA) to gain more open access to *P. monodon* broodstock in NT waters have opened the way for their collection under an AFMA Permit.

Industry Liaison

Prawn farmers are 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, which acts as a conduit between industry and government where aquaculture issues can be formally addressed.

Aquaculture staff regularly facilitate contact with all active aquaculture licence holders and encourage open channels of communication with industry. In addition, all farmers have access to an Extension Officer who visits the farms regularly, usually weekly.

Prepared by

Graham Williams – Industry Case Management Officer

Industry Support and Development Status Report 2006

Introduction

After several years of steady growth the expansion of the Northern Territory's (NT's) aquaculture industry slowed in 2006. The main reason for the slow down was the decision by Marine Harvest to close its barramundi sea cage operation at Port Hurd, Bathurst Island. Marine Harvest's closure was offset by a significant increase in both pearl and prawn production and continued steady growth in production from pond-based barramundi farms. The pilot hatchery for trepang (sea cucumber) continued to meet its research objectives and progressed towards the goal of establishing a sea cucumber farming industry. Two indigenous run projects continued their investigation of mud crab farming.

Profile of Aquaculture

Aquaculture policy

In 2004, NT Fisheries created the temporary position of Aquaculture Policy Officer. This position was responsible for developing the general policy on aquaculture, as well as several operational policies including translocation and access to the Northern Prawn Fishery for broodstock purposes. A policy on sea cucumber fishery enhancement and ranching was finalised in 2006.

Pearl Industry Management Officer

The pearl industry was managed by a full-time Pearl Industry Management Officer.

Involvement with National Issues

NT Fisheries maintains an active presence on two national committees of importance to aquaculture, the Aquatic Animal Health Committee and the Aquaculture Committee, both of which report to the Australian Fisheries Management Forum.

In 2005 the Aquaculture Committee developed a best practice model of regulatory arrangements for aquaculture in Australia' to help simplify the process for licensing aquaculture developments. In 2006 all States and the NT had to report their progress against the objectives identified in the model. The NT compares favourably against the States but there is still more that can be done to improve the licensing and regulation of aquaculture.

Aboriginal Liaison

The Gwalwa Daraniki Association, with assistance from NT Fisheries and a local company with expertise in aquaculture development, continued its project investigating the culture of mud crabs using previously disused ponds at Kulaluk in Darwin. Several Federal funding agencies have provided financial assistance for this project.

The Tiwi Land Council approached the NT Government for assistance in locating a suitable investor to replace the Marine Harvest barramundi sea cage farming operation.

The trial of mud crab farming in a simple net enclosure in mangroves continued at Maningrida. There is a need to construct a suitable nursery enclosure and find a way to access the site during the wet season. The access issue is expected to be resolved by bringing forward the timing of stocking the juvenile crabs.

Briefing and discussions on aquaculture of trepang were undertaken with the members from the Warruwi community of Goulburn Island.

Environmental Management

NT Fisheries continued to maintain close contact with staff of the Environment Protection Agency Program. Both agencies have been working together to maintain the currency and proportion

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.

Several producers are working toward full adoption of ISO 14000 standards.

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

New investment

A pilot hatchery for trepang continued to be operated by private industry within the grounds of the Darwin Aquaculture Centre (DAC). The results from the pilot study have been very encouraging and the company is now looking at options for the expansion of the industry.

A new company has taken on the operation of a disused prawn farm at Middle Arm and intends to revamp it and use it to grow mud crabs and barramundi.

Research

Research in support of the barramundi farming industry was conducted at DAC resulting in continued improvements in larval rearing and nursery production procedures.

DAC joined the University of Sydney and the Berrimah Veterinary Laboratories (BVL) in a three year Australian Research Council funded project investigating improved detection and management of the serious fish pathogen, nodavirus.

Aquatic Animal Health Program

The Berrimah Veterinary Laboratories (BVL) provided a valuable service for maintaining monitoring programs, certification and diagnostic services for aquatic animal health. A full review of translocation procedures and the identification of disease zones, which commenced in 2004, was finalised in 2006 and adopted as NT Fisheries policy titled ‘Transboundary movements of living aquatic animals: a zoning strategy for disease control in the Northern Territory’.

Industry Liaison

The Aquaculture group provided secretarial and logistical support for the Ministerial Advisory Committee on Aquaculture in the NT. This is a non-statutory committee offering a formal channel by which advice from industry can be passed on to the Minister for Primary Industry and Fisheries. The terms of reference for the committee were changed 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.

Prepared by

Glenn Schipp – Manager Aquaculture

Indigenous Fishing

Indigenous Fishing Status Report 2006

Introduction

Aboriginal and Torres Strait Islander people have lived in Australia for over 40 000 years. Many indigenous groups live on the coast and depend on the sea for social, cultural and subsistence benefits. Subsistence fishing is an important part of Aboriginal culture in the Top End as well as a traditional source of protein. 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.

A majority of Northern Territory (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 the others' boundaries for hunting and fishing. Some Aboriginal families are obliged to act as sea managers while others expect people to undertake this role in their mothers' country. 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 is undertaken according to seasons, which allows species to be targeted when in abundance and are in prime condition (Davis, 1983). Aboriginal people restrict access to certain areas of significance, such as sacred sites. These are some examples of the customary management practices used by Aboriginal people to ensure the sustainability of their aquatic resources.

Today Aboriginal groups have established community ranger programs for the purpose of natural resource management and protection. Six community ranger groups received annual funding and support from NT Fisheries in 2006 under the Indigenous Community Marine Ranger Program. Ranger groups contribute to the enhancement of monitoring and compliance activities by providing reports to NT Fisheries on any coastal surveillance they have undertaken.

Profile of the Fishery

Commercial Sector

Under the NT *Fisheries Act 1988*, indigenous people have the same access to commercial fishing licences as those from any other cultural group. The exact number of indigenous-owned commercial licences is not known as current and new applicants are not required to advise of their ethnicity. It is known, however, that one barramundi licence and two developmental coastal net licences were held by indigenous people in 2006. A further two development permits for the harvest of tropical crayfish (including other species such as stingrays and mullet) were issued to indigenous groups. At least one mud crab licence and one coastal line licence are owned and operated by indigenous people.

In 2006, two Aboriginal coastal licences were issued to Aboriginal people in the NT. Each community may have only one Aboriginal costal licence and the community council or traditional owners must nominate the licensee. The fishing licence allows the licensee to catch and sell fish (except managed species) within their own community. There are no reporting requirements for this type of licence. To look at ways of increasing opportunities and capacity for indigenous people in the NT to enhance participation in commercial fishing, the NT Government is currently reviewing the nature of Aboriginal coastal licences.

Area

In 2006, Aboriginal coastal licences were in operation in north east Arnhem Land and Bathurst Island.

While a commercial fishing licence allows fishing to take place across a range of the NT coastal habitats, indigenous operators are reluctant to fish 'sea country' without appropriate permission from the traditional owners. In 2006, an indigenous owned and operated mud crab licence was working in the Maningrida region. There were also two development permits harvesting tropical rock lobster, mullet, blue swimmer crabs and stingrays operated by indigenous groups in the Nhulunbuy region.

Fishing method

Aboriginal coastal licences allow the use of amateur fishing gear, including amateur dragnets that are the most common fishing method used with this type of licence. All other forms of commercial fishing by indigenous people are undertaken according to the rules and regulations under the *Fisheries Act 1988* and relevant Management Plans.

Fishing Tour Operator Sector

Some Aboriginal groups and individuals have established agreements with Fishing Tour Operators (FTOs). Such agreements may include employment opportunities or payments for the use of land-based facilities established on Aboriginal land. In 2006 there was one known indigenous owned and operated fishing tour operator based near Nhulunbuy. Bawaka Aboriginal Cultural Experiences offers clients a taste of Aboriginal culture and some exceptional fishing activities. This business was established mostly to cater for the increased staff at the Alcan Mine facility.

Indigenous Sector

Indigenous subsistence fishing does not value individual species according to the same values as the commercial and recreational fishing sectors, but rather as a valuable source of protein. As previously mentioned, the indigenous sector targets species when they are most abundant and in prime condition. Other fishing is done opportunistically with virtually no waste or by-catch. The impact of indigenous fishing activities were only assessed on a large scale for the first time in 2000-01 with the completion of the NT component of the National Recreational and Indigenous Fishing Survey (NRIFS). The data described below is taken from the survey.

Area

Some 50 per cent of indigenous people in the NT reside in remote or rural areas and make up around one third of the NT's population (ABS, 2001). This is why the majority of indigenous fishing activities occur in the close vicinity of communities and out-stations and is widespread across the northern part of the NT. Such activity occurs in inshore waters (61 per cent), estuarine waters (11 per cent) and rivers (17 per cent). It should be noted that 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 act as management tools that help protect species and habitats.

Fishing Method

The most preferred fishing method for indigenous people in 2000-01 was the use of lines, which represented 45 per cent of all fishing events. Not surprisingly the use of bait (84 per cent) was far more common than using lures (16 per cent). Surface spear-fishing, hand collecting and cast-netting accounted for most of the remaining fishing effort.

Catch

In 2000-01, indigenous people living in communities in the NT harvested over 1.5 million individual fish and other aquatic organisms. The most prevalent species of finfish taken by

indigenous people were mullet (83 000 or 5 per cent of the total harvest), catfish (60 000 or 4 per cent) and barramundi (44 000 or 3 per cent). The most important non-fish species were mussels (580 000 or 35 per cent of the total harvest) and mud crabs (86 000 or 5 per cent).

Effort

In 2000-01, 20 700 indigenous people living in communities in the northern region of the NT went fishing. This represented 91 per cent of the area population. A total of 245 698 fishing days were recorded, which equates, on average, to 12 days of fishing per fisher per year.

Non-retained Species

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. That is why many indigenous groups would prefer not to waste any food that is caught, so only a very small amount of the catch is released and the rest is taken home to feed the family.

Ecosystem Impact

The effect on the ecosystem by indigenous fishing is unknown. However, in localised areas near to indigenous population centres, fishing activities will have some impact on the surrounding ecosystem.

Social Impact

Fishing is an important lifestyle activity for indigenous people in northern Australia and assists in maintaining 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 and seafood has also been shown to contribute a large proportion of the caloric intake for those living in coastal out-stations.

The value of food collecting, hunting and fishing is also 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.

Economic Impact

Aboriginal coastal net licence holders are able to catch and sell non-managed species, allowing them to gain some economic benefit. The licence holder can only sell to his/her local community or outstation and this has forced some indigenous people to give away their catch to their extended families rather than sell it, as cultural status and obligations still remain strong in many Aboriginal communities. New applications for these licences are currently not being considered until a review of the Coastal Net Fishery has been completed.

Stock Assessment

Monitoring

As mentioned earlier, indigenous fishing activities have only been assessed on a large scale for the first time through the NRIFS research undertaken in 2000-01. Other monitoring programs tend to be fishery-specific and such details have been included in individual Fishery Status Reports in this publication. Through the establishment of community marine and sea ranger programs, many indigenous groups are becoming more active in monitoring their fishing activities. Most of these groups have included the monitoring of fishing activities in their own specific management plans.

Stock Assessment Methods and Reliability

Information gained from the indigenous fishing sector may also be used as part of species-

specific stock assessments. A variety of Aboriginal and non-Aboriginal agencies and groups, however, have questioned the reliability of data collection methods that have been used. More specific stock assessment information has been included in the individual Fishery Status Reports in this document.

Current Exploitation Status

Catch data on the impact of indigenous fishing has been included in individual Fishery Status Reports.

Future Assessment Needs

Continuing assessment of the indigenous fishing sector is required. A methodology for such assessment may be established with a view to collect this information as part of future surveys of recreational fishing. Some marine/sea ranger groups have expressed an interest in undertaking their own surveys to gain more accurate and area-specific information.

Research

Summary

Prior to 2000-01, no research had been conducted specifically on the indigenous fishing sector. In 2000-01, NRIFS was conducted to provide detailed information that would be available on a total fishery basis. In some States this was possible by combining the recreational catch with that of the commercial sector. However, in some areas, particularly northern Australia, indigenous people are also important users of fisheries resources. On this basis, the terms of reference for the national survey were expanded to include all non-commercial fishing, which included a survey of indigenous fishing in northern Australia. The specific objectives of a component of NRIFS were to quantify the catch and effort of the indigenous fishing sector in northern Australia.

A community/dwelling-based area sample with face to face interviewing was used for the purpose of obtaining survey information.

Incorporation into Management

Information obtained from the 2000-01 NRIFS, which focused research on indigenous fishing, has been used by NT Fisheries for a variety of purposes, including as part of the management of individual fisheries as well as for planning future activities.

Current Research

Up until the end of 2006, there had been no specific research conducted on general indigenous fishing activities.

Management/Governance

Management

Objective

Indigenous groups have been included in the management process through the establishment of Aboriginal Fisheries Consultative Committees (AFCCs). These committees offer a mechanism for indigenous people to contribute to the management of resources within their ‘sea country’. The aim of the AFCC process is to provide a mechanism that allows an information flow between Aboriginal people engaging in customary fishery management practices and NT Fisheries, using contemporary management practices. Additional information is obtained from AFCCs and then used by fisheries managers in their decision making process. It is also anticipated that marine ranger groups will provide valuable data and technical advice to support an inclusive management system.

In addition to AFCCs, indigenous people are also represented on individual Fishery Management Advisory Committees (FMACs).

History

Aboriginal groups throughout the NT have managed their marine resources in a sustainable manner for many thousands of years. European settlement saw the implementation of western management regimes. Prior to 1993, consultation between NT Fisheries, Aboriginal communities and the fishing industry in regards to fisheries management regimes tended to be on an informal basis only. In 1993, the first AFCC was established in the NT, which focused on information sharing between the parties and providing coastal Aboriginal communities a mechanism to contribute to fisheries management in a more formal manner. There are now seven consultative committees across the NT; however, only four continue to meet on a regular basis. Other avenues to engage Aboriginal people in management decisions are through the various marine ranger groups and their respective steering committees. On another level, NT Fisheries consults with the Anindilyakwa, Northern and Tiwi Land Councils.

Further recognition of Aboriginal people as an important stakeholder group occurred in 1996 with the creation of a dedicated Aboriginal Liaison Officer position in NT Fisheries. Subsequently, this led to the formation of the Indigenous Liaison and Economic Development Unit in NT Fisheries, which is staffed by three full-time officers and one indigenous apprentice.

Current issues

Management of the indigenous fishery in the NT is part of an integrated approach. Certain key species have specific management arrangements and their details are included in individual Fishery Status Reports in this publication.

Customary fishing rights are enshrined in the NT *Fisheries Act 1988* which exempts Aboriginal people from the restrictions of bag limits, size limits or taking of any protected species, if they are fishing and hunting within their own traditional country. This allows Aboriginal people to continue with their custodial rights and to practise customary management with regard to aquatic resources.

Aboriginal groups have had to face the challenge of managing their traditional resources while living in communities made up of multiple clan groups. Over recent years there has been a trend for Aboriginal people to move back to their homelands. This outcome may reduce some of the pressure on local fish and other aquatic stocks. However, these stocks often have the added fishing pressure from outside influences such as the recreational, fishing tour and commercial fishing sectors, as well as the unknown harvest quantity from illegal foreign fishing vessels.

This combined impact on fishing resources may lead to a need to restrict the level of total fishing activity. It is important to note that under the NT *Fisheries Act 1988*, specific provisions exist ensuring that Aboriginal fishing activities would be the last area targeted if restrictions should be implemented to protect any particular resource.

To further enhance the capability and knowledge sharing between Government and Aboriginal people, NT Fisheries employed a manager, a liaison officer 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 indigenous apprentice in 2003, NT Fisheries has employed nine apprentices, almost all of whom have moved on to other employment or gained full employment with Fisheries.

A range of issues exists relating to indigenous engagement in resource management and economic development. As previously mentioned, entry cost into the fishing industry is not affordable to the majority of 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 need to be employment

opportunities to complement training. Fishing industry training that can be transferred into other disciplines would be most beneficial for offering people a range of career choices.

Future plans

There is a desire to maintain AFCCs and broaden their scope to build on the consultative approach adopted by NT Fisheries. Further, the department will engage with indigenous community ranger groups to work together on a range of research projects that will benefit all residents of the NT. Funds have been approved for an additional two ranger groups in 2007 to carry out coastal surveillance activities. NT Fisheries will continue to employ indigenous apprentices when and where possible.

Compliance

The NT Police Marine and Fisheries Enforcement Section (MFES) undertakes monitoring, compliance and enforcement of fishing activities in NT waters. In addition, a network of indigenous community marine rangers has been established across the NT to deal with localised monitoring and surveillance of coastal waters. Increasingly, these rangers play an important role in educating both indigenous and non-indigenous fishers, as well as provide a visual presence on the water to deter illegal fishing activities.

The Indigenous Community Marine Ranger Program allocates annual grants of $60 000 each to the Tiwi Islands, Borroloola, Port Keats, Maningrida, Goulburn Island and Elcho Island ranger groups. In 2006, marine/sea rangers completed a Certificate II in Fisheries Compliance (Seafood Industry). In total, some 77 rangers have successfully completed their Certificate II through Charles Darwin University. NT Fisheries was one of the agencies that helped deliver the training. The majority of these rangers were also issued with Marine Safety Inspector cards and they play a vital role in the education of marine safety as well as carrying out a number of search and rescue activities. Ranger groups funded under the Marine Ranger Program provide NT Fisheries with monthly reports of all coastal activities either witnessed or reported. This information is then forwarded to other agencies such as MFES and Australian Customs. In 2006, Djelk rangers signed a service level agreement between Djelk, Customs and NT Fisheries. The agreement is for a 12-month pilot project to carry out coastal surveillance relating to foreign fishing vessel incursions.

Consultation, Communication and Education

AFCCs were established to give coastal Aboriginal communities an avenue to provide an opportunity for indigenous people to play a more formal role in the contemporary management of aquatic resources. After the first committee was established in 1993, five more were established between 1995 and 1998. The Maningrida Fisheries Consultative Committee was established in 2004. There are currently seven such committees; four of them meeting on a regular basis.

Aboriginal members decide on the composition of each committee, which also includes representatives from MFES, NT Fisheries, Amateur Fishermen's Association of the NT, NT Seafood Council, relevant Land Councils and other government agencies when required. In 2006, four AFCC meetings and three Marine Ranger Steering Committee meetings were conducted, both in Darwin and in local communities.

The consultative process provides an opportunity for the NT Government to discuss, plan and implement new initiatives relevant to coastal communities. This may include exploring commercial development opportunities for remote coastal communities in order to help with social and economic problems that many of them face. These committees give Government the opportunity to work closely with indigenous people on issues from the 'grass roots' level.

Up to now, a number of issues and projects which were discussed through the AFCC

process have successfully contributed to the development and management of NT fisheries. These include:

- the introduction of a possession limit on tropical rock lobster
- the establishment of recreational fishing campsites on Aboriginal land
- agreements with commercial fishermen
- a fisheries compliance course for Aboriginal community police officers
- linking partnerships relating to economic development initiatives
- a greater emphasis on indigenous economic development in the fishing industry
- development of an indigenous aquaculture policy for the NT
- the implementation of a dugong code of practice for the commercial fishing sector
- the establishment of the Fisheries indigenous apprenticeship program
- increased number of indigenous employees with NT Fisheries
- introduction of the indigenous community marine ranger program
- the donation of vessels* to coastal ranger groups to carry out coastal surveillance
- joint project submission to Natural Heritage Trust for indigenous survey for impacts on sharks and rays and
- new innovative aquaculture farming models suitable for remote indigenous communities.

*Note: A number of vessels were seized by MFES officers for allegedly engaging in illegal fishing activities contrary to provisions under the *Fisheries Act 1988*. If convicted under the Act, such vessels (and other items) used in the commissioning of an offence may be forfeited to the Executive Director, Fisheries, who in turn, has the power for their disposal.

Other projects included research activities, school visits, show displays and the disposal of marine debris.

Prepared by

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Recreational Fishing

Recreational Fishing Status Report 2006

Introduction

Recreational fishing is an intrinsic part of the Northern Territory (NT) lifestyle. There is greater participation in recreational fishing and a higher level of boat ownership in the NT per capita than in any other Australian jurisdiction. Fishing tourism is also important to the NT and its economy. The success and growth of this industry is based largely on 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 big inland tidal rivers 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, the fish are available throughout the year and can be caught in a range of fresh and saltwater habitats, including Manton Dam near Darwin where a healthy well-stocked population exists. The months preceding the Top End's wet season are also highly productive and most barramundi are caught in coastal saltwater environments and freshwater billabongs during this period.

Although barramundi are a famous table fish, nearly half (47 per cent) of those caught by NT and visiting anglers are released. Clients of NT fishing tour operators release over 80 per cent of the barramundi they catch. Although some are released to conform to catch control regulations, such a high release rate is a clear indication of their abundance.

Also abundant are the many alternative fresh and saltwater species which are commonly caught while targeting barramundi. Part of the great appeal of barramundi fishing is the diversity of fish species, habitats and fishing methods that anglers experience. Saratoga, sooty grunter, threadfin salmon, golden snapper and mangrove jack are some of the species that are often caught on the same lures, baits and flies anglers use to target barramundi.

Many anglers target inshore migrations of mackerel and tuna during the cooler dry season months, and although sailfish and black marlin are often caught, little is known about billfish populations or movement in NT waters. The dry season is also the best time for mud crabs, which are abundant and easy to catch.

Many other popular saltwater species can be caught throughout the year, including blue-lined emperor, red emperor, coral trout, black jewfish, blue tusk fish, saddle-tail snapper, queenfish and trevally. NT waters are lightly fished compared with other Australian waters and they are naturally abundant with aquatic life. However, 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 are closed to commercial barramundi netting to benefit recreational fishing and tourism. Details on these closures are provided below. Additionally, all waters within Kakadu National Park are closed to any type of commercial fishing. The NT Government has also constructed artificial reefs close to Darwin and farther offshore at Fenton Patches. These structures are for the specific benefit of recreational fishers and divers and may not be commercially fished.

There are several fishing clubs throughout the NT and several major annual fishing tournaments. Most tournaments are barramundi-specific with rules that promote catch and release fishing. However, there are also various saltwater competitions that focus on other sport, game and reef fish.

The Amateur Fishermen's Association of the NT (AFANT) was established in 1981. Now AFANT is partly funded each year by the NT Government in recognition of its role as the peak representative association for recreational

fishing. The guided fishing tourism industry was represented by a Fishing Tour Operators' Association throughout much of the 1990s and is now represented by the NT Guided Fishing Industry Association, which also receives funding from the NT Government. During the 1990s a fisheries officer was appointed specifically to manage, develop and promote recreational fishing. Two additional recreational fishing officers were appointed in 2004 to provide enhanced support of this nature.

Size and possession limits are the primary catch controls for recreational fishing in the NT, however, seasonal area closures apply to the lower Mary and Daly Rivers during barramundi spawning periods. Signage depicting fishery regulations and other advice is erected at boat ramps, launch sites and fishing tourism establishments. Information on a range of fishery regulations and other useful literature is also available from NT Fisheries.

NT Fisheries personnel manage the NT's River Watch Program. River Watch Centres are located on the Mary, Daly, Roper, Victoria, McArthur, South and East Alligator Rivers. Proprietors of these centres provide literature and advice to anglers and convey reports to Government agencies regarding fishing or boating infringements and aquatic environmental issues, such as fish kills and noxious weed or animal infestations.

The NT Government conducted broad-scale recreational fishing surveys in 1986, 1995 and 2000-01 as part of its wider fisheries research program. Most of the information conveyed in this report is extracted from the most recent survey, the National Recreational Fishing Survey: the Northern Territory (NRFSNT). The survey was conducted between May 2000 and April 2001.

Profile of the Fishery

Between the surveys conducted in 1995 and 2000-01, recreational fishing participation levels among NT residents remained stable at around 32 per cent. The NRFSNT provides a comprehensive overview of the recreational fishery in the NT. The survey report can be obtained from NT Fisheries.

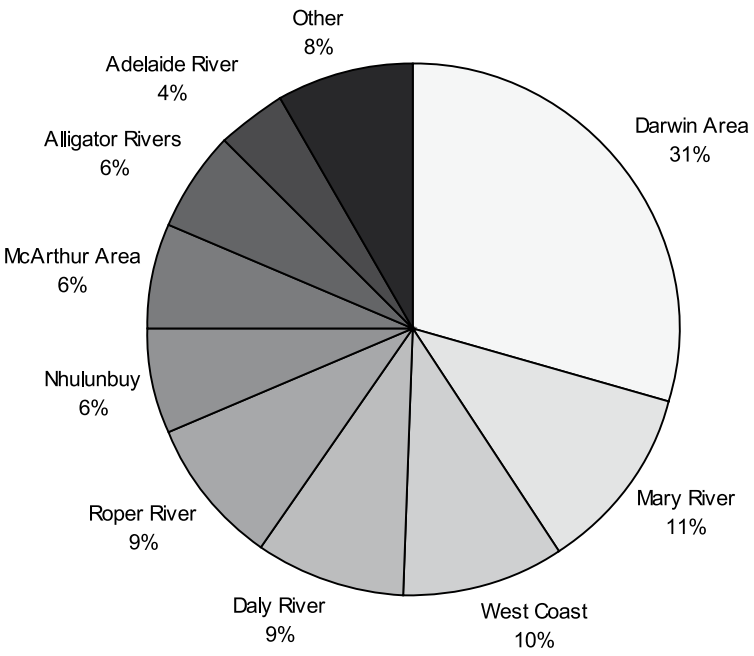

Figure 1. Recreational fishing line hours (time spent with lines in the water) by residents and visitors by area

Area

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

Fishing Method

More than 75 per cent of all recreational fishing in NT waters is conducted 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 per cent of this time. A combination of lures and bait is used for 10 per cent of all time spent line fishing. Fifteen percent of fishing effort involved the use of pots and traps, but the NRFSNT recorded very little use of cast nets, drag nets or other gear.

Catch

Of the 1.83 million aquatic organisms reported during the NRFSNT, 1.6 million (89 per cent) were fish, while fewer than 0.2 million were crabs, molluscs and other types of aquatic life. Twenty-nine percent of these captures were made in the offshore area adjacent to Darwin, in its Harbour and Shoal Bay. All other areas provided between 1 per cent and 11 per cent of the overall catch. Detailed catch information is provided in the NRFSNT report.

Effort

People in the NT spent 314 272 days (1.9 million hours) recreational fishing in the 2000-01 NRFSNT period. Residents fished an average of five days in that year, a decline from the average eight days per year recorded during the 1995 survey, which was known as Fishcount 95. However, the number of hours visitors to the NT spent fishing increased from 23 per cent in 1995 to 37 per cent in 2000-01.

Queensland visitors accounted for 33 per cent of this increased effort while New South Wales and Victorian visitors accounted for 26 per cent and 16 per cent respectively. Recreational fishing visitor numbers are highest in the dry season, when they account for 40 per cent of all fishing effort, and lowest in the wet season when visitors account for 15 per cent of the overall effort.

Non-retained Species

Fifty-five percent of all aquatic animals recorded during the NRFSNT period were released, which is an increase from the 43 per cent reported in 1995. The introduction of more restrictive size and possession limit controls since the mid-1990s may account for some of this increase but 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.

NT Fisheries has joined similar agencies in other parts of Australia in recent years to promote a program known as Released Fish Survival, which advocates methods that enhance the survival of released line caught fish. Studies conducted by NT Fisheries researchers revealed that at least 90 per cent of lure-caught barramundi survive after release. However, there has been little research on the post-release survival of other recreational species.

Ecosystem Impact

Although no significant studies have been conducted on the effects of recreational fishing on natural NT eco-systems, no significant damage 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 NT Fisheries' River Watch Program is another example of how environmental awareness is promoted among the fishing community.

Social Impact

Approximately 40 000 non-indigenous Territorians (32 per cent) fish for recreation each year. The NRFSNT queried people's fishing motives and found that 32 per cent of anglers fish to be outdoors, 28 per cent fish to relax and unwind and 11 per cent 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 higher than elsewhere in Australia and fishing for consumption is not always the primary motive.

Economic Impact

Territorians and visitors spend nearly $35m each year on recreational fishing and most of this sum is directed toward the purchase of boats, vehicles and their associated running costs. The purchase of fishing gear is another significant expenditure component. Visitors to the NT contribute 25 per cent of this income overall.

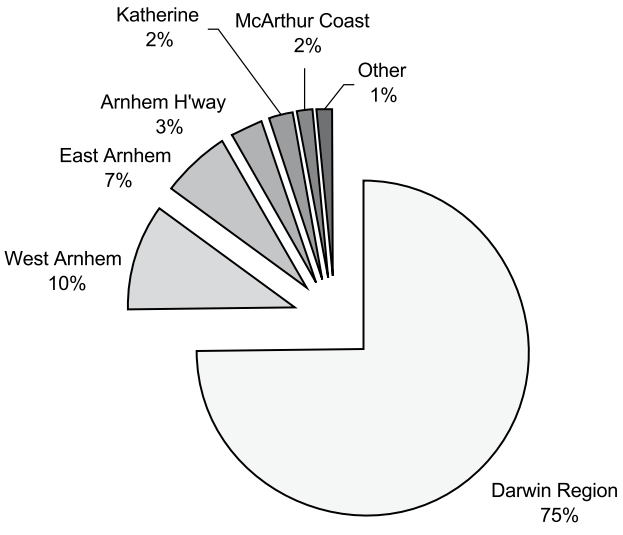

Figure 2. Annual expenditure by survey zones

Stock Assessment

Monitoring

Much of the research conducted by NT Fisheries focuses on species which are important to recreational, commercial and indigenous fishery stakeholders. Current research on black jewfish, Spanish mackerel, sharks, barramundi and mud crabs is particularly important to recreational fishing. Outcomes of this research will influence future management decisions. More information on specific research programs which are relevant to recreational fishing is provided in individual Status Reports in this publication.

Monitoring is based on data from surveys such as the NRFSNT, log book returns from fishing tour operators, research and catch, size and effort information from annual fishing tournaments. More information of this nature is obtained from specific monitoring programs administered by AFANT on the McArthur, Roper and Adelaide Rivers.

Stock Assessment Methods and Reliability

Research, survey, fishing tour operator and commercial fishing data is used for fishery stock assessment purposes. Details are included in other Fishery Status Reports in this publication.

Current Exploitation Status

The same data is used to monitor current exploitation levels and assess sustainability.

Future Assessment Needs

Much of the information in this report is from the NRFSNT, which was conducted between April 2000 and May 2001. A new survey to update the NRFSNT data is the most important current priority for the management of recreational fishing.

Research

Summary

The first broad-scale survey of recreational fishing in the NT was in 1986. FISHCOUNT95 provided a more useful database which was updated by the NRFSNT in 2000-01.

NT Fisheries research is generally species or area-specific. Many species which are currently being researched are important to recreational, commercial and traditional fishers. Specific details on researched species are provided in individual Fishery Status Reports elsewhere in this publication.

Incorporation into Management

Survey, research, monitoring and fishing tour operator data were considered before the closure of the McArthur and Adelaide Rivers to commercial barramundi gillnetting, during drafting of the Cobourg Marine Park Plan of Management and in relation to NT Fisheries submissions regarding various land and native title claims.

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

Objective

Recreational fishing in the NT is managed by the Department of Primary Industry, Fisheries and Mines in accordance with the *Fisheries Act 1988* and Regulations.

Management controls include species-specific personal possession limits and a 30 fish general personal possession limit. Minimum size limits apply to barramundi (55 cm) and mud crabs (male 13 cm, female 14 cm) and a maximum size limit of 1.2 m applies to cod and groper. Seasonal area closures apply on the lower Daly and Mary Rivers from 30 September to 1 February. 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.

The NT Fisheries' Recreational Fishing Controls Booklet stipulates fishery regulations as well as the gear that recreational fishers may use.

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 10 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 10 mud crabs per person and 30 mud crabs per vessel with three or more people on board.

Possession limits of five Spanish mackerel and five black jewfish were introduced in 1993 and 1997 respectively. In 1997 a general possession limit of 30 fish per person was introduced, but this did not include the specific possession limits for managed finfish (including golden snapper) until 2002.

To enhance recreational fishing, 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 licence buy-back schemes.

Current Issues

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

Future Plans

In 2006, the Minister announced that fishing tour operators would pay licence fees for the 2007-08 licensing year. He also announced the intention to use revenue from the fees to help fund the NT Guided Fishing Industry Association (NTGFIA) that year.

Compliance

The Marine and Fisheries Enforcement Section of the NT Police Fire and Emergency Services is responsible for monitoring and enforcing infringements under the *Fisheries Act* and its Regulations. Proprietors of River Watch Centres play a supporting role, but have no enforcement powers. Recreational fishing controls are displayed widely at boat ramps, launching sites, tourist establishments and River Watch Centres throughout the Top End of the NT.

Consultation, Communication and Education

NT Fisheries primarily consults with the leading recreational fishing body, AFANT. The establishment of NTGFIA is expected to enhance more formal consultation with, and development of, the guided fishing tourism industry.

Education is promoted through presentations, workshops, show exhibitions, publications, signage and the River Watch Program. Regional extension occurs in Katherine and Nhulunbuy with three-day junior fishing workshops during school holidays.

Prepared by:

Phillip Hall and Tricia Beatty– Aquatic Resource Management Officers, Recreational Fishing Unit

Fishing Tour Operators

Fishing Tour Operator Status Report 2006

Introduction

By the mid 1980s, a small number of barramundi guides and fishing lodges had began 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 (FTOA).

This was the start of a boom period in fishing tourism that was largely triggered by the NT Government's decision to begin reallocating barramundi resources in several key areas exclusively to the recreational fishing sector. The remarkably rapid growth of this industry created a need for more formal management by NT Fisheries. Consultation with the industry led to the introduction of Fishing Tour Operator (FTO) licences in 2003-04. Legislation was introduced to ensure that people who conducted paid fishing tours did so under a current FTO licence.

In the 1995-96 licensing year NT Fisheries issued 167 FTO licences. In 1997-98 licence numbers peaked to 232. The number of FTO licences issued each year usually exceeds the number issued to any other extractive fishery by NT Fisheries. FTOs who operate in Kakadu National Park require an additional permit issued by the Commonwealth Department of Environment and Water Resources (DEW).

Daily log returns must be provided to NT Fisheries each month as a condition of FTO licences. The same condition applies to Kakadu permits. This has enabled the development of a significant database, which is important to the management of the guided fishing tourism industry and recreational fishing generally. Much of the information conveyed in this status report is extracted from the FTO log returns database.

Information from FTO log returns is combined with data from broad-scale recreational fishing surveys to provide a comprehensive overview of the recreational fishing industry. Fishery managers rely on these combined data when making decisions or recommendations regarding land and native title claims, fishing area closures, marine park planning and regulation changes.

Most FTOs target barramundi in coastal and inland areas but some operate offshore targeting other species from vessels which range in size up to luxury mother ships. Most operate out of Darwin but the industry is well represented in the regional areas of Nhulunbuy, Borroloola and Katherine. While there are also resident FTOs based on most of the big tidal rivers, several others are based on the various Aboriginal owned islands that surround much of the NT's coast.

Apart from using boats of varying sizes, FTOs operate from comfortable bush camps, lodges and commercial accommodation. A few run bus tours and there are even those who offer helicopter transport to fishing hot spots. Some FTOs operate full time while others supplement their income by guiding.

FTOs and their clients must observe the same fishery controls as recreational fishers with no provision for the sale of catch. Throughout much of the 1990s the industry was represented by the FTOA, but this was disbanded in 1996. Between that time and the beginning of 2005 the industry was not formally represented. This made consultation with Government and other organisations difficult.

To encourage the re-establishment of a representative association, the Department provided funding in 2005 and 2006 to enable the industry to employ an executive officer. This led to the incorporation of the NT Guided Fishing Industry Association (NTGFIA). A condition of funding required industry to consult and provide advice to Government on the most appropriate means to permanently fund the executive officer position. This led to a recommendation to introduce annual licence fee for FTOs. In September 2006 the Minister for Primary Industry and Fisheries announced that FTO licence fees would become payable in 2007-08.

Profile of the Fishery

Area

FTOs operate in areas which are generally accessible to the public. However, there are restrictions on the number of commercial operations allowed in specific areas managed by DEW and the Parks and Wildlife Service. Some FTOs maintain financial agreements with landholders to operate exclusively from land of Aboriginal and other tenure.

Fishing Method

The methods and gear used by FTOs and their clients are the same that may be used by other recreational fishers. Fishing methods used are indicated on FTO log return sheets. Figure 2 shows the number of line hours spent using specific methods.

Catch and Effort

Numbers of fish caught and released are recorded by species on FTO log returns together with the number of hours each client spent per day with lines in the water. Figure 1 shows the number of line hours fished each year between 1994 and 2006 in relation to numbers of fish caught and released.

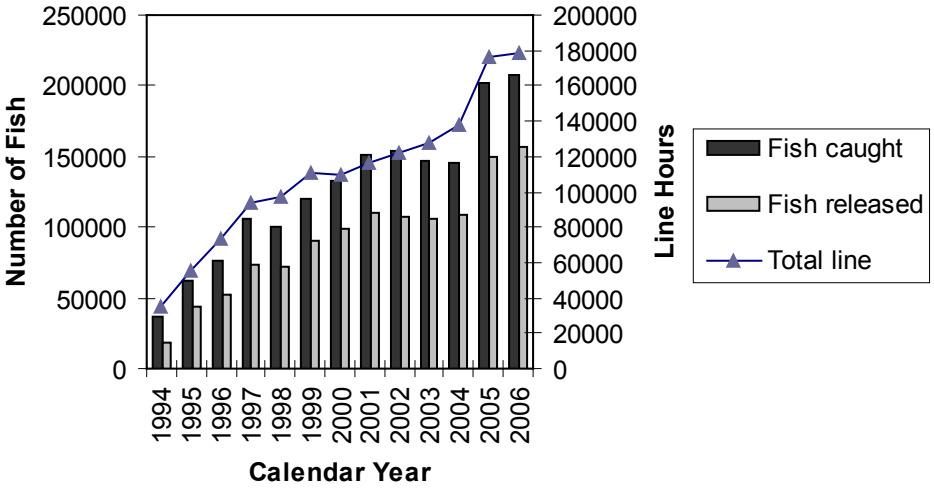

Figure 1. Catch, release and line hours 1994 to 2006

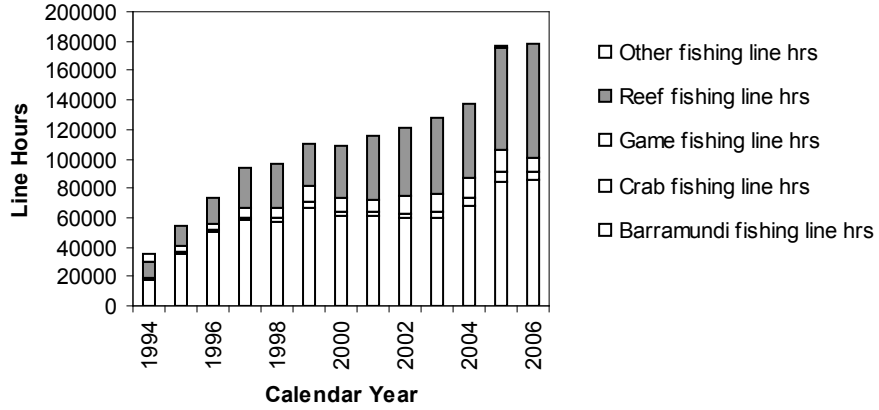

Figure 2. Line hours spent using various fishing methods

Non-retained Species

FTOs are required to report in log returns the number of each species their clients catch and release. A consistently high release rate is one of the more notable attributes of this fishery, particularly for barramundi. In 2006, 88 per cent of all barramundi captured were released. Of all the different species of fish caught in 2006, 75 per cent were released.

Ecosystem Impact

No detrimental impacts on ecosystems have been linked to the guided fishing tourism industry. A strong culture of catch and release fishing within this industry is evident by a consistent overall release rate of 70 per cent or higher.

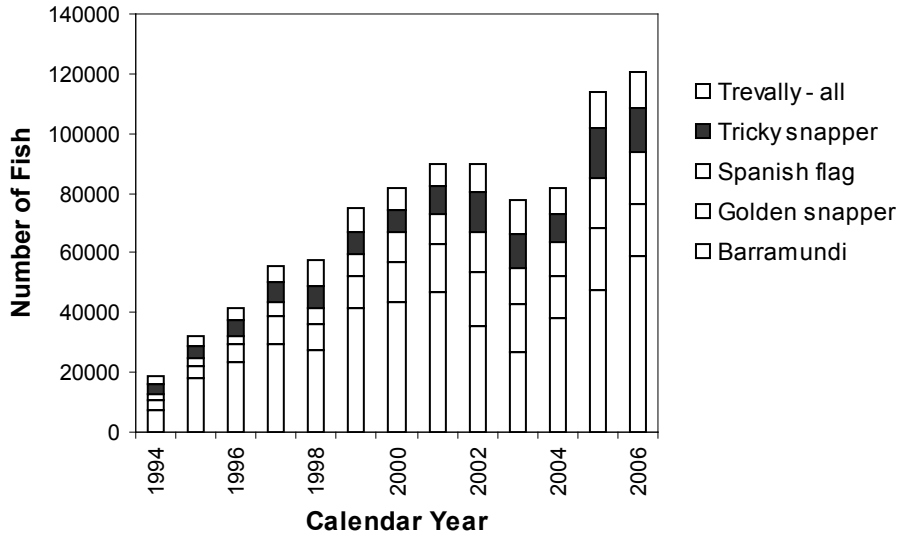

Figure 3. The five most frequently caught species 1994 to 2006

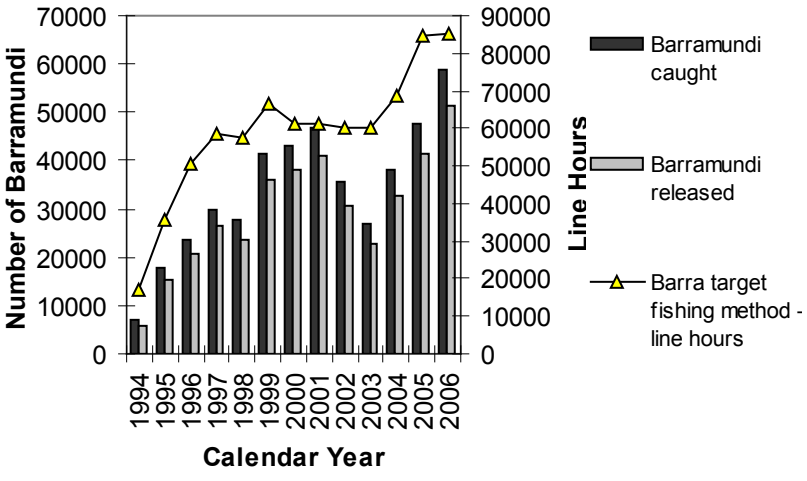

Figure 4. Total barramundi catch, release and line hours 1995 to 2006

Social Impact

The number and origins of FTO clients are recorded on their log returns. The number of clients from New South Wales is nearly matched by those from the NT. About half of all clients are residents of New South Wales, the NT or Victorian. The NT's high number of clients reflects the data from the National Recreational Fishing Survey: the Northern Territory (NRFSNT), which revealed that there was a higher recreational fishing participation rate per capita in the NT than in other Australian jurisdictions.

Economic Impact

The guided fishing tourism industry's annual contribution to the NT's economy has not been formally assessed. While the number of client days is recorded each year through log return data, 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.

Stock Assessment

Monitoring

The fishery is monitored primarily through a system of log returns, which must be provided as a condition of licence. Annual log data summaries are compiled which show the number of each species caught and released, fishing methods used and areas fished.

Stock Assessment Methods and Reliability

Data from FTO log returns and the NRFSNT are used for species specific stock assessments. Details have been included in individual Fishery Status Reports in this document.

Current Exploitation Status

Refer to Figure 1 for the annual numbers of fish caught and released.

Future Assessment Needs

The FTO log return program provides essential data to fishery managers. This data is combined with that from surveys such as the NRFSNT 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 barramundi, black jewfish, shark, Spanish mackerel and mud crabs.

Table 1. FTO client origin trend from 1994 to 2006

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Northern Territory	1684	2376	2841	4018	4228	4336	4559	4572	4871	5191	5633	6530	6250
New South Wales	1039	2377	3022	3351	3400	4148	3980	4518	4893	5388	5646	6976	7268
Victoria	1102	1580	2082	2924	2690	2731	3137	3408	3948	4171	4567	6092	6788
Queensland	448	999	1275	1532	1529	1826	1902	1666	1756	2264	2085	3003	3282
South Australia	436	649	505	876	930	1164	1045	1230	1316	1468	1455	1811	2151
Western Australia	237	334	395	490	546	577	575	808	1017	707	685	1018	1333
Tasmania	93	43	51	126	114	231	152	159	378	285	287	469	474

Incorporation into Management

FTO and the NRFSNT data is 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 and black jewfish spawning aggregations are being investigated using tagging and sonic tracking technology. Mud crab monitoring and habitat productivity is currently being researched. The annual study of barramundi numbers, size and recruitment also continues in the Mary River.

Management/Governance

Management

Objective

The primary objective of NT Fisheries is to assist the sustainable management and development of the guided fishing tourism industry.

History

FTO licences have been issued free of charge since 1994 and no limit on licence numbers is set.

The industry was represented by the FTOA throughout much of the 1990s but representation languished between then and the incorporation of NTGFIA in 2005. A valuable database has evolved through the FTO log returns system and this is essential for fishery managers.

Current Issues

The introduction of FTO licence fees was announced in September 2006. A licence fee of $400 will apply in 2007-08 and increase by $100 each year until a fee of $800 is reached. Not all FTOs are NTGFIA members and membership is not compulsory. However, membership is expected to significantly increase in 2007.

Future Plans

It is expected that NTGFIA will enhance industry cohesion and consultation. The Association has indicated support for a limit on the number of FTO licences, the introduction of a management plan for the guided fishing tourism industry and the electronic lodgement of catch returns.

Compliance

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

Consultation, Communication and Education

The establishment of NTGFIA is expected to enhance consultation and communication between Government agencies and the industry.

Prepared by

Phillip Hall and Kane Dysart
Recreational Fishing Unit.

Table 2. The number of FTO licences issued each calendar year from 1995 to 2006, showing active and inactive licence.

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Licences issued	93	137	155	218	152	145	124	121	116	108	120	160	168
Active licences	62	71	97	126	104	110	69	88	82	75	88	117	122

Aquatic Pest Management

Aquatic Pest Management Status Report 2006

Introduction

Aquatic Pest Management (APM) protects the aquatic resources of the Northern Territory (NT) from introduced aquatic pests. Recreational fishing, commercial fishing and aquaculture industries rely on these resources, which are worth an estimated $315m to the NT annually.

The APM unit was established following recognition of the vulnerability of NT waterways to invasion by exotic species, highlighted by the incursion of the black-striped mussel (*Mytilopsis sallei*) in April 1999.

The APM unit:

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

Profile of Pest Management

Ecosystem Impact

The introduction and subsequent establishment of an aquatic pest species in NT fresh, estuarine or marine waters has the potential to seriously impact on biological diversity and the productivity of NT 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 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. The establishment of aquatic pests may reduce the productivity of fisheries resources and increase the cost associated with maintenance and remedial action. Such costs may be associated with increased fouling of infrastructure (e.g. nets, pipes, 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 marine pest black-striped mussel (*Mytilopsis sallei*) 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 the changes in water quality and species diversity.

In 2006, no marine pests were detected in Darwin Harbour and marinas, or at Raffles Bay (Cobourg Peninsula), Milner Bay (Groote Eylandt), Garden Point (Melville Island) or Gove Harbour.

Biological Monitoring

Monitoring of marine bio-fouling organisms continued during 2006 with the assistance of local industry. APM monitors within each of Darwin's locked marinas as well as in open water locations in Darwin Harbour. Monitoring at other locations along the NT coastline is conducted by APM assisted by industry as follows: Gove Harbour (Alcan Pty Ltd), Raffles Bay, Cobourg Peninsula (Paspaley Pearls Co. Pty Ltd), Milner Bay, Groote Eylandt (GEMCO) and Garden Point, Aspley Strait, Melville Island (Great Southern Plantations). During 2006, no recognised marine pest species were found at any of the monitored locations.

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 Territory 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 at open water sites.

Marinas, however, are an artificial environment and are not exposed to tidal regimes and water exchange that characterise open water environments. The extreme variation in temperature and salinity that occurs when wet season cool freshwater runoff is trapped in the marinas creates an environment hostile to native species. Furthermore, marinas 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, such species are likely to establish within marinas. What separates the two groups is the impact each has on the environment and economy resulting from the establishment of the species. Several well known marine bio-fouling organisms which are cosmopolitan in distribution (recorded from many ports around the world), are frequently found in 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 detected often outside marinas. However, when detected, they are in much smaller numbers.

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

Tables 1 and 2 list the types of organisms which initially grew on artificial settlement surfaces (primary coloniser) placed in Cullen Bay Marina and Frances Bay Mooring Basin in 2006 and those which subsequently grew over them (secondary coloniser). Tables 1 and 2 also indicate the relative abundance of each organism (high, > 70 per cent estimated cover; medium, 30 to 70 per cent; low, < 30 per cent).

Barnacles and polychaete tube worms were generally the first organisms to colonise new substrates (artificial settlement surfaces) in the marinas, but in turn, were often colonised by a secondary layer of marine growth. These 'secondary' organisms were frequently ascidians and non-calcareous bryozoans and protozoa.

Monitoring Water Quality

Water quality in the marinas varies seasonally and is largely driven by freshwater run-off as a result of wet season rainfall. Stratification (layering 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 (Figures 1 and 2).

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.

It should be noted that changes in water quality between the dry and wet seasons (Figures 1 and 2) correspond to changes observed in the fouling communities at Cullen Bay Marina (Tables 1 and 2).

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 managers by adopting practices that promote the mixing and flushing of marina waters.

Table 1. Primary and secondary colonising taxa recorded from Cullen Bay Marina during 2006

	Primary colonising taxa		Secondary colonising taxa	
	Taxa	Level	Taxa	Level
Jan	Polychaete	High	Ascidian	Medium
Feb	Barnacle	High	Protozoa	High
Mar	Barnacle	High	Protozoa	High
Apr	Barnacle	Low	Protozoa /Bryozoa	High
May	Barnacle/Polychaete	Low	Ascidian /Bryozoa	High
Jun	Barnacle/Polychaete	Low	Ascidian	Low
Jul	Polychaete	Medium	Ascidian	Medium
Aug	Polychaete	Low	-	-
Sep	Polychaete	Medium	Ascidian	Low
Oct	Polychaete	Medium	Ascidian/Bryozoa	Low
Nov	Polychaete/Bryozoa	Low	Ascidian	Medium
Dec	Polychaete	Low	Ascidian	Medium

Table 2. Primary and secondary colonising taxa recorded from Frances Bay Mooring Basin during 2006

	Primary colonising taxa		Secondary colonising taxa	
	Taxa	Level	Taxa	Level
Jan	Barnacle	Low	Polychaetes	Medium
Feb	Barnacle	Medium	Bryozoa	Medium
Mar	Barnacle	High	Bryozoa	High
Apr	Barnacle	Low	Bryozoa	High
May	Barnacle	Low	Bryozoa	Medium
Jun	Polychaete	High	-	-
Jul	Polychaete	High	-	-
Aug	Polychaete	High	-	-
Sep	Polychaete	High	-	-
Oct	Polychaete	Medium	-	-
Nov	Polychaete	High	-	-
Dec	Polychaete	High	Ascidian	Medium

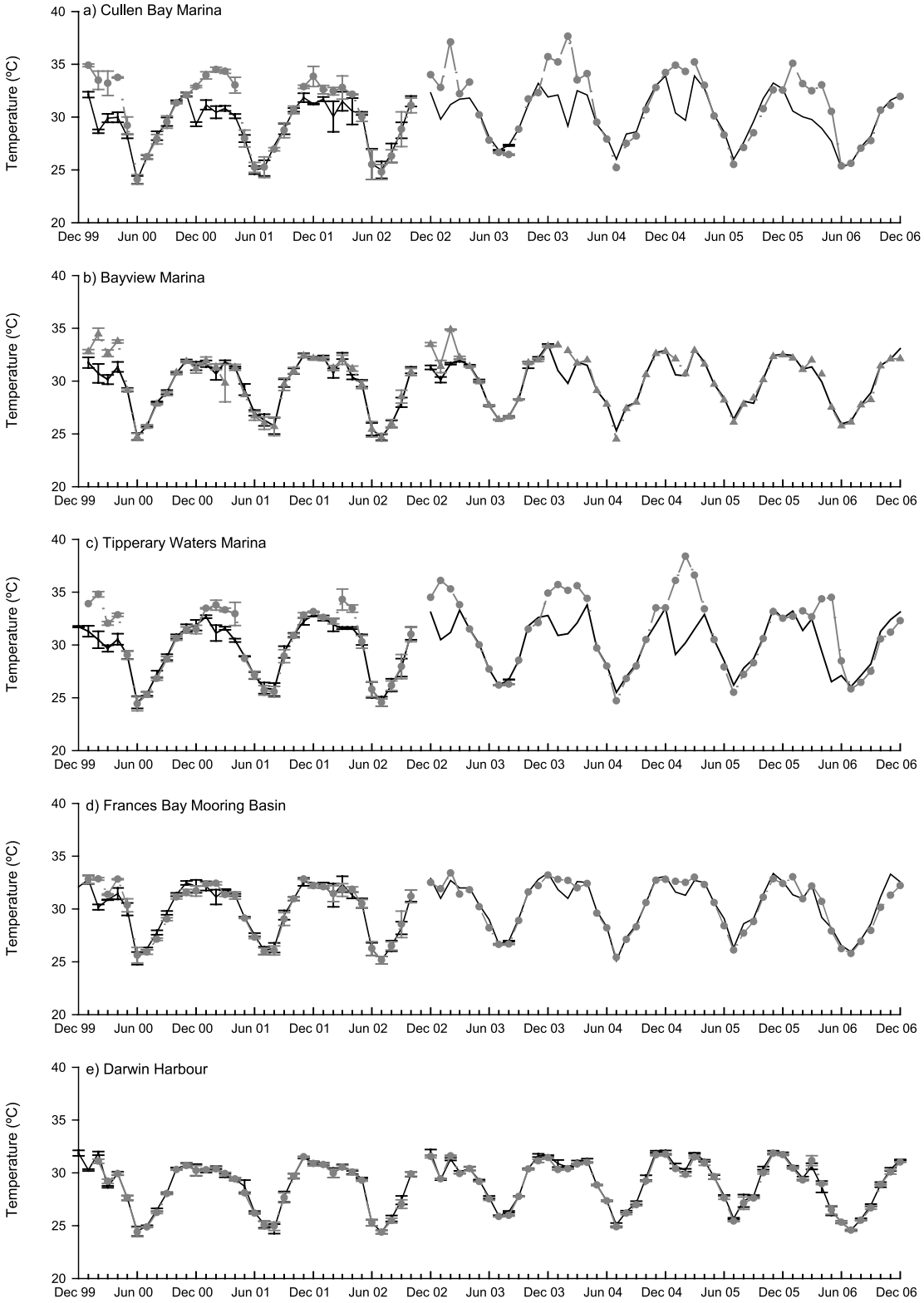

Figure 1. Temperatures (ºC, mean ± standard error) recorded at marina and open water sites of Darwin Harbour at 0.5 m (—) and 3.0 m (–●–) [Note - 2.0 m (–▲–) at Bayview Marina] depth between December 1999 and December 2006.

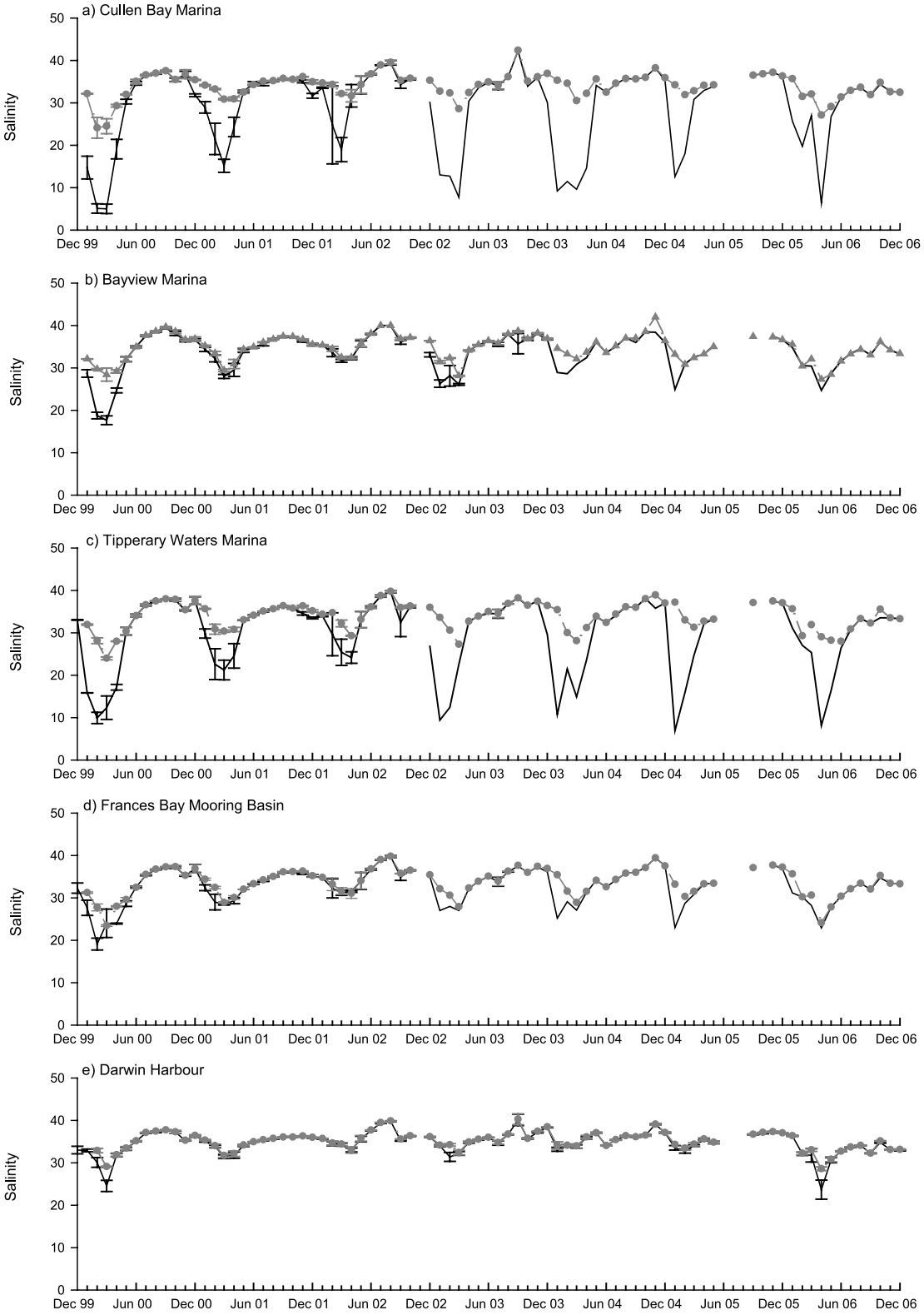

Figure 2. Salinity (PSS 78, mean ± standard error) recorded at marina and open water sites of Darwin Harbour at 0.5 m (—) and 3.0 m (–●–) [Note - (2.0 m (–▲–) at Bayview Marina] depth between December 1999 and December 2006.

Aquatic Pest Control

Prior to 1999, no noxious marine species was reported from the waters of Darwin Harbour. On 1 April, 1999 Darwin marinas were quarantined as a result of an extensive invasion by the exotic black-striped mussel (*Mytilopsis sallei*).

This bivalve has the potential to seriously impact on local marine biodiversity and threaten the social and economic benefits derived from the marine environment. Following the discovery, a rapid response by the NT Government successfully eradicated the species, at a cost exceeding $2.2m. 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, the APM unit was established. The issue of freshwater exotics also fell within the scope of the APM unit.

Only 18 months after the eradication of the black-striped mussel from Cullen Bay Marina, the species was again found in Darwin Harbour. In September 2000, dive surveys detected black-striped mussel on the hulls of two apprehended foreign fishing vessels, the Indonesian Type III Iceboats Hasil Jaya and Queen Nathalia. In consultation with the Australian Fisheries Management Authority (AFMA), both vessels were removed from Australian waters and returned to Indonesia. Intensive surveys in the following months failed to detect any further populations of black-striped mussels.

A population of Asian green mussels (*Perna viridis*) was discovered on the hull of an apprehended vessel during routine monitoring in November 2001. The infested vessel was destroyed following cooperation between the APM unit, AFMA and the Australian Quarantine and Inspection Service (AQIS).

In 2000, APM successfully eradicated two populations of exotic aquarium species: the jewel cichlid and Gambusia. The jewel cichlid (*Hemichromis bimaculatus*) is a prohibited import to Australia. This aquarium fish is a mouth-brooder capable of out-competing native fishes as it is a prolific breeder. It was eradicated from Racecourse Creek, Darwin. The creek was restocked with native fishes from a nearby waterway to assist with mosquito control.

Four established populations of exotic freshwater snails were eradicated in 2002. The snails were identified as the giant ramshorn aquarium snail (*Planorbarius corneus*) and *Lymnaea columella*, a snail that is a potential host for a parasitic liver fluke that affects cattle. Subsequent investigations revealed two further contained populations of these snails. It appears that movement of ornamental aquatic plants facilitated their spread.

No confirmed incursions of marine or freshwater pests were detected in 2003.

Two species of exotic freshwater snails were controlled during 2004. *Pseudosuccinea columella* (the liver fluke snail) and *Pomacea bridgesii* (the mystery snail) appear to have been introduced in association with the movement of pond and aquarium plants.

Routine vessel inspections and treatments conducted in 2004 resulted in the detection of a bivalve identified as a *Perna* species – potentially the marine pest, Asian green mussel. The bivalve was found in the pipe-work of a visiting yacht.

In 2005, both black-striped and Asian green mussels were again found in association with apprehended illegal foreign fishing vessels. Appropriate steps were taken to address the risk posed by the vessels. They were immediately destroyed and inspection regimes were amended in cooperation with AQIS and AFMA.

Also in 2005, a population of exotic aquarium fish, Platy (*Xiphophorus maculatus*), was eradicated from a storm water drainage network at Charles Darwin University. Wet season rains had the potential to spread this fish to

neighbouring Rapid Creek. Platies are tolerant of salt water and have the potential to compete with native species and impact on the ecosystem.

Current

Of the 13 marine pest reports received in 2006, 11 were of no concern and proved to be native or widely-distributed oceanic species. The remaining two, however, were of great concern.

In December 2006, black-striped mussel shells were found in the sea-strainer of a yacht during routine treatment of the vessel's internal seawater systems. The vessel was subsequently removed from the water at a local shipyard for inspection and cleaning.

In July 2006, a group of seven apprehended Indonesian Type III Iceboats were towed to Darwin Harbour. During dive inspections of the vessels' hulls, a large population of sexually mature black-striped mussels were found on the hull of one of the vessels and a small number of immature Asian green mussels were found on the hulls of another two vessels.

The vessels were immediately removed from the Harbour by AFMA and held at anchor outside port limits while discussions were held about how best to deal with the vessels. Over the following two weeks, in cooperation with AFMA, AQIS, the Darwin Port Corporation and the Museum and Art Gallery of the NT, all three vessels were treated using a novel method, resulting in the removal of the marine pest threat.

The three vessels were treated in succession by wrapping the hull of each vessel in a 'sheath' (Figure 3). Sodium hypochlorite was added in high concentrations to the water in the 'sheath'. The treatment continued until collected samples indicated that all individual mussels were dead. Following treatment, the vessels were held in Darwin Harbour until the next suitable high tide when they were destroyed.

Only one freshwater pest report was received in 2006. An established population of guppies (*Poecilia reticulata*), a popular small ornamental fish, was reported in Racecourse Creek. Guppies are an exotic fish which can compete with native species and impact on the ecosystem.

Attempts were made to eradicate the exotic pest fish during the dry season while water levels were low. Monitoring was planned for the 2006-07 wet season to determine if the eradication was successful.

Figure 3. Apprehended Indonesian Type III Iceboat being treated for marine pests

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. Therefore, it will be important to continue obtaining environmental information for habitats outside Darwin Harbour and find ways to expand aquatic (marine and freshwater) pest monitoring and surveillance activities.

Management/Governance

Management

Objective

The objective of APM is to minimise the opportunity for both the introduction and establishment of aquatic pest species in NT waters through a) the development of local protocols under the NT *Fisheries Act 1988* and b) the implementation of nationally consistent protocols.

History

The successful eradication of the black-striped mussel from Darwin waters in April 1999 initiated a series of events at both the local and national level.

A dedicated unit was established in NT Fisheries to assess and implement policies and strategies to minimise the recurrence of a similar potential ecological and economic disaster. At the same time, the Commonwealth initiated processes required to develop a national system for the prevention and management of marine pest incursions.

A risk-assessment based on voyage history, stops in international ports and vessel maintenance regimes identified two high risk categories of vessels frequenting NT waters: vessels entering Darwin marinas after traveling internationally and apprehended vessels. Vessels apprehended for illegal activities originate from, or have traveled through, 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.

Recreational 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 the continued presence of Asian green mussel (*Perna viridis*) in that port. The ease with which Asian green mussels may be transported to Darwin puts vessels from Cairns in the high risk category.

Marinas are recognised as high risk areas because they are frequented by high risk vessels. The marine organisms established in the marinas are subject to unnatural environmental stresses. Stressed native species do not compete effectively against exotic species, thereby increasing the chances for the establishment of aquatic pests.

Current issues

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

As a result of the construction of Alice to Darwin railway and an expansion in industrial development, an increase in international shipping is expected. Larger commercial vessels using the Port of Darwin carry tonnes of ballast water which could introduce potential marine pest species to the NT.

In addition, there is a need to educate the public 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. For example, native freshwater fish are more effective in the control of mosquitoes than Gambusia.

At the national level, the development of the National System for the Prevention and Management of Marine Pest Incursions (the National System) will largely address the paths of introduction for marine pest species such as vessels (recreational and commercial), aquaculture and port environments. The aquarium trade in marine species is also included in the National System, however, freshwater species fall outside its terms of reference.

Future plans

The National System is being developed by the National Introduced Marine Pest Coordination Group. Many elements of the National System are complete and have been endorsed by State/Territory and Commonwealth Governments. Planning for the implementation of the various elements is under way in consultation with industry groups. Implementation of the National System, including regulatory and non-regulatory components, is expected to be achieved by mid 2009. Implementation of the national system arrangements in coming years and the associated transition from current arrangements will impact on APM activities and will require appropriate planning and communication with affected stakeholders.

Compliance

Vessels intending to enter Darwin marinas are subject to an inspection before being permitted entry. With assistance from lockmasters, there has been a 100 per cent compliance. The entry requirements provide a basis for the development of national protocols to minimise the introduction of marine pest species into Australian waters.

In addition, vessels apprehended off the northern Australian coastline and destined for the Ports of Darwin and Gove are examined for the presence of aquatic pest species. Early in 2004 inspection protocols for apprehended vessels were reviewed in light of the information collected during the previous 12 months. The majority of vessels apprehended in 2003 were found to be very lightly fouled when inspected prior to entry to the Port of Darwin. Protocols were subsequently adjusted so that all Type III vessels were inspected inside the Port of Darwin. Changes to the protocols reduced the expense and inconvenience to AFMA, the Australian Defence Force (ADF), the Australian Customs Service (ACS) and AQIS without compromising the level of protection against the risk these vessels posed as potential sources of marine pests.

Further amendments to inspection protocols were made in 2005. In September, APM staff inspecting what remained of a vessel following destruction by burning detected a cluster of black-striped mussels on a propeller from a Type III Iceboat. This vessel had been inspected on its arrival in the Port of Darwin and cleared of marine pests. This discovery highlighted the risk from long detention of apprehended vessels which may harbour small, recently-settled mussel juveniles or larvae and the difficulty divers face in detecting organisms of such small size. Protocols were immediately amended to ensure a follow-up inspection of all Type III Iceboats one month after their arrival.

The first group of one month inspections was conducted in October 2005. During these inspections, a juvenile Asian green mussel was discovered. The individual's size was consistent with it being a recently-settled juvenile at the time of the initial inspection. These results justified the need for the new protocols. The vessel was subsequently destroyed by Commonwealth authorities.

Following the detection of marine pests on three apprehended vessels in July 2006, NT Fisheries discussed with AFMA and AQIS the issue of marine pest inspection protocols for apprehended vessels. The discussions resulted in the NT Government handing over responsibility for the inspection of apprehended vessels for marine pests to AQIS, as part of

the National System. Protocols for inspections were reviewed. All high risk vessels will now be inspected outside port limits by commercial divers contracted to AQIS.

In 2006, 153 pleasure craft and 42 high risk apprehended foreign fishing vessels were inspected (Figure 4). Figure 4 also highlights Darwin's appeal for tourists in the dry season. No such seasonal pattern is evident for apprehended vessels, as the number of apprehensions is influenced by operational factors.

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 ACS, ADF, AQIS and AFMA. Information from ongoing environmental monitoring is also reported to stakeholders through the departmental website and on request. Brochures outlining general marine pest information and vessel inspection protocols are distributed to stakeholders.

The general issue of aquatic pests has been presented in seminar forums and through articles in the popular media. These have targeted the general public and stakeholder groups such as commercial and recreational fishers, scuba divers, sailors, port operators, ship repair and maintenance facilities, naturalists and indigenous groups.

Regular reports (Fisheries Report series) to industry stakeholders associated with the aquatic resource monitoring program have continued. Electronic copies of these reports are available from the APM pages of the Fisheries website, along with other general information publications.

In 2006, the APM unit received 14 reported sightings of aquatic pest species, comprising 13 marine and one freshwater species. Reports were received by contact phone numbers which are been widely publicised to facilitate the reporting of aquatic pest sightings.

Prepared by

Helen Cribb – Program Coordinator, Aquatic Pest Management.

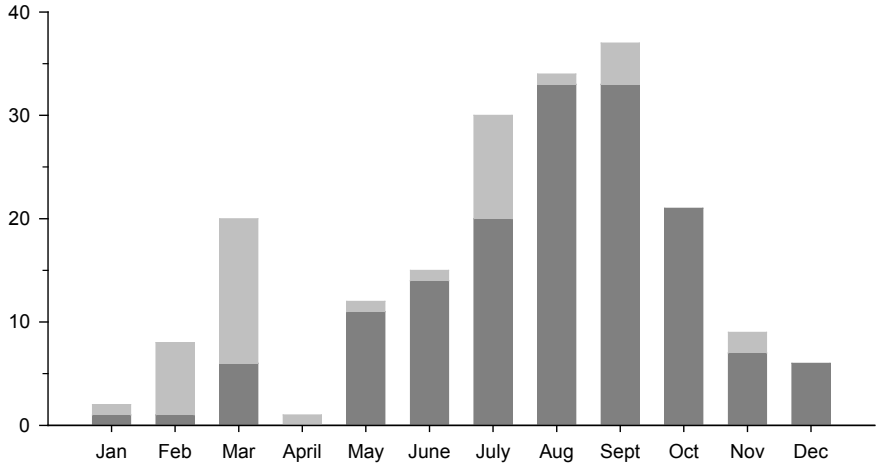

Figure 4: The total number of vessels inspected each month in 2006 (pleasure ; apprehended)

Licensing

Licensing Status Report 2006

The Fisheries Licensing Unit coordinates the issuing and renewal of licences and permits under Sections 11 and 15 of the *Fisheries Act 1988*. In 2006, 1017* separate licences and permits were issued to 905 parties. Details of the number of licences and permits issued by type, and the number of parties receiving the licences and permits are provided in Table 1.

Note* - 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.

Prepared by

Steve Wilmore – Senior Licensing Officer

Table 1. The number of licences and permits issued in 2006

Licence Type	Licence Count*	Party Count
A1 – Coastal Line Fishery Licence	56	50
A2 – Coastal Net Fishery Licence	14	13
A3 – Bait Net Fishery Licence	2	2
A4 – Spanish Mackerel Licence	18	17
A5 – Shark Fishery Licence	17	15
A6 – Demersal Fishery Licence	60	50
A7 – Barramundi Fishery Licence	24	23
A8 – Mud crab Fishery Licence	49	40
A9 – Mollusc Fishery Licence	1	1
A10 – Pearl oyster Fishery Licence	7	7
A12 – Aquarium Fishery/Display Licence	13	13
A13 – Trepang Fishery Licence	6	1
A15 – Restricted Bait Entitlement	127	104
A16 – Finfish Trawl Fishery Licence	1	1
A17 – Jigging Fishery Licence	1	1
A18 – Timor Reef Fishery Licence	12	12
A50 – Development Fishery – Coast Net	2	2
B1 – Fish Trader/Processor Licence	40	40
B2 – Fish Retailer Licence	305	294
C1 – Aquaculture Licence	16	16
C2 – Pearl Oyster Culture Licence	8	7
D1 – Aboriginal Coastal Licence	2	2
D2 – Fishing Tour Operator Licence	168	127
D3 – Aquarium Trader Licence	8	8
D4 – Net Licence	13	13
S16 – Permit	22	22
S17 – Special Permit	25	24
	1017	**905**

Appendices

Appendix 1: Glossary of Abbreviations

ACIAR	Australian Centre for International Agricultural Research
ACS	Australian Customs Service
ADF	Australian Defence Force
AFANT	Amateur Fishermen's Association of the NT
AFCC	Aboriginal Fisheries Consultative Committee
AFMA	Australian Fisheries Management Authority
AFZ	Australian Fishing Zone
APM	Aquatic Pest Management
AQIS	Australian Quarantine and Inspection Service
BFAC	Barramundi Fishery Advisory Committee
BVL	Berrimah Veterinary Laboratories
CI	Confidence Interval
CITES	Convention on International Trade in Endangered Species
CPUE	Catch per unit of effort
CRC	Cooperative Research Centre
DAC	Darwin Aquaculture Centre
DBIRD	Department of Business, Industry and Resource Development
DIPE	Department of Infrastructure, Planning and Environment
DEW	Department of Environment and Water Resources
DFMAC	Demersal Fishery Management Advisory Committee
EA	Environment Australia
EMP	Environmental Management Plan
EPA	Environment Protection Agency
EPBC	*Environment Protection and Biodiversity Conservation Act* (Commonwealth)
FRDC	Fisheries Research and Development Corporation
FTO	Fishing Tour Operator
FTOA	Fishing Tour Operator's Association
GIS	Geographic Information System
IUU	Illegal, Unregulated and Unreported
MACANT	Ministerial Advisory Committee on Aquaculture in the Northern Territory
MACRF	Ministerial Advisory Committee on Recreational Fishing
MCFAC	Mud Crab Fishery Advisory Committee
MOP	Mother of Pearl

MCFMP	Mud Crab Fishery Management Plan
MFES	Marine Fisheries and Enforcement Section
MOU	Memorandum of Understanding
MSE	Management Strategy Evaluation
NHT	Natural Heritage Trust
NPOA	National Plan of Action
NRIFS	National Recreational and Indigenous Fishing Survey
NRFSNT	National Recreational Fishing Survey: the Northern Territory
NRFS	National Recreational Fishing Survey
NTAC	NT Aquarium Committee
NTFDOC	NT Fisheries Development Opportunities Committee
NTFJA	NT Fisheries Joint Authority
NTGFIA	NT Guided Fishing Industry Association
NTSC	NT Seafood Council
ONLFMC	Offshore Net and Line Fishery Management Advisory Committee
OPSUNASR	Operational Plan for the Sustainable Use of Northern Australian Shark Resources
PFMES	Police Fisheries and Marine Enforcement Section
PIAC	Pearl Industry Advisory Committee
PL	Post-larvae
QDPIF	Queensland Department of Primary Industries and Fisheries
SMFMAC	Spanish Mackerel Fishery Management Advisory Committee
TRMAC	Timor Reef Management Advisory Committee
TRFAG	Timor Reef Fishery Assessment Group
VER	Viral encephalopathy and retinopathy
WTO	Wildlife Trade Operation

Appendix 2: Current Contact Details

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