STRATEGIC ASSESSMENT REPORT

NORTHERN PRAWN FISHERY

February 2003

Northern Prawn Fishery – Strategic Assessment Report

This assessment report for the Northern Prawn Fishery (NPF) has been prepared by AFMA in accordance with the Terms of Reference for the Strategic Assessment of the Northern Prawn Fishery (see Appendix I). It provides for assessing the fishery under both the strategic assessment and export of native wildlife provisions of the *Environment Protection and Biodiversity Conservation Act 1999*.

This Report comprises three parts:

Part I	**Overview**	describing the assessment process and providing background information on AFMA
Part II	**Description of the Fishery**	providing a detailed description of the Northern Prawn Fishery
Part III	**Environmental Assessment**	detailing the assessment for the Northern Prawn Fishery

Consultation

Prior to being finalised, the Terms of Reference for the Strategic Assessment of the Northern Prawn Fishery were released as a draft for a public comment period of 28 days.

A draft version of this assessment report was made available for public comment for a period of 28 days. AFMA and the Northern Prawn Fishery Assessment Group and the Management Advisory Committee have reviewed this report in light of all comments received. The AFMA Board Environment Committee has considered the final assessment report and it has been approved by the AFMA Board.

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Executive Summary

This Assessment Report for the Northern Prawn Fishery (NPF) has been developed as part of AFMA's obligations under the Environment Protection and Biodiversity Conservation Act 1999 which require strategic assessment reports for all Commonwealth fisheries, particularly those with an export component.

The report assesses the impacts of the NPF on target, byproduct and bycatch species and the broader marine environment. It is divided into three Parts:

Part I provides an overview of AFMA;

Part II provides a description of the NPF;

Part III provides an assessment of the management arrangements for this Fishery against the Commonwealth's Guidelines for assessing the ecologically sustainable management of fisheries.

The NPF is one of Australia's most mature and valuable trawl fisheries. An average of 8,500 tonnes of prawns are harvested annually with a production value of between $100 - $170 million. More than 90 percent of the catch is exported with Japan, China and other South-East Asian countries being the principal markets.

Located off Australia's northern coast, the fishery extends between Cape York Peninsula in Queensland to Cape Londonderry in Western Australia. The NPF has undergone major restructuring since the late 1980s which has seen the size of the commercial fleet reduced from 302 vessels to approximately 96 today.

The commercial catch also includes white banana, Indian banana, brown tiger, grooved tiger, giant tiger, blue endeavour, red endeavour, western king and red spot king prawns. Other species taken include bugs, scampi and squid. Banana prawn catches are thought to be influenced by environmental conditions, with high rainfall a key factor in many areas. During 2001, catches were extremely high but based on current information, are believed to be sustainable.

Brown and grooved tiger prawns have been classified as overfished for several years but work is underway to rebuild stocks. Fishing effort for tiger prawns has been significantly reduced in recent years. During 2002 AFMA has introduced new measures to reduce effort on brown tiger prawns by 40 percent and on grooved tiger prawns by 25 percent. This is expected to rebuild stocks to target levels by the end of 2006.

AFMA and industry, through the Northern Prawn Fishery Management Advisory Committee (NORMAC), have been extremely proactive in dealing with bycatch and ecosystem issues in the fishery. For many years NORMAC has made bycatch its highest research priority with more than $3.5 million of research and industry funds spent so far on developing and implementing appropriate bycatch reduction strategies. Measures include large area closures, the compulsory use of turtle excluder devices and bycatch reduction devices, and a ban on the take and retention of any products from sharks, rays and sawfish. Monitoring and collection of a reliable data set have also been key priorities for the fishery. In 2003 the NPF will commence an annual, independent data collection program. As well, a major industry campaign to improve data on bycatch will also begin. These initiatives, together with other management

controls, provide AFMA with a high degree of confidence that the fishery and the broader marine environment are being managed in a sustainable and precautionary manner.

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PART ONE

OVERVIEW

1 Assessment to meet the Commonwealth's environmental legislation requirements

Commonwealth managed fisheries are subject to the strategic assessment provisions of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Strategic assessment involves assessing all fishing activity under a Management Plan or policy rather than assessing each individual action or permit. The benefit of this approach is that it enables the cumulative impacts of a fishery to be considered and provides a level of certainty about what activities are permitted.

Once the assessment is complete, the Minister for the Environment and Heritage may then "accredit" the Management Plan or policy. He must then make a declaration under the EPBC Act that actions under the accredited Plan/policy do not require further impact assessment approval. The Management Plan and a notice of intent to make the declaration will be tabled in Parliament for a disallowance period of 15 sitting days.

In deciding whether to accredit a Plan, the Minister must be satisfied that the assessment report adequately addresses the Terms of Reference, and any modifications the Minister has recommended to the policy, Plan or program have been made.

The primary focus of the assessments is an evaluation against the Guidelines for the ecologically sustainable management of fisheries (the Guidelines), which are contained within the Terms of Reference (see Appendix I).

Following the amalgamation of the *Wildlife Protection (Regulation of Exports and Imports) Act 1982* into the EPBC Act, all Australian fisheries with an export component will also to be assessed against the Guidelines, before export permits are granted.

Accordingly, this report provides for assessment and decision making under both the strategic assessment and export of native wildlife provisions of the EPBC Act.

1.1 The Assessment Timetable

Under the strategic assessment provisions of the EPBC Act, the Australian Fisheries Management Authority (AFMA) must commence two thirds of the assessments by July 2003 and have all assessments commenced by July 2005. The native wildlife export provisions require all Australian fisheries with an export component to be assessed against the Guidelines for the Ecologically Sustainable Management of Fisheries by 1 December 2003, to enable exports to continue.

AFMA is aiming to complete assessments of all Commonwealth managed fisheries by 1 December 2003. Priority will be given to fisheries that are finalising Management Plans and those with a significant export component.

2 About AFMA

AFMA was established in February 1992 under the *Fisheries Administration Act 1991*. The legislative basis for AFMA's management of fisheries is the *Fisheries Management Act 1991*. These two pieces of legislation create the statutory authority model for fisheries management under which AFMA is responsible for the day-to-day management of fisheries. Broader fisheries policy and international negotiations are administered by a smaller group within the Department of Agriculture, Fisheries and Forestry – Australia (AFFA).

As a statutory authority, AFMA has been established as a specialist Commonwealth fisheries management agency, external to, but working closely with AFFA and strategically with the Minister with portfolio responsibility for fisheries.

Significant elements of the AFMA model include the organisation's day-to-day independence from the Minister; an expertise based Board; rights based management and a strong partnership approach with key stakeholders. Governing and guiding all of AFMA's activities are the legislative objectives contained under Section 6 of the *Fisheries Administration Act 1991* and Section 3 of the *Fisheries Management Act 1991* (see inside cover). These objectives provide a clear direction and focus for the organisation and a framework within which AFMA must function.

2.1 Managing Commonwealth Fisheries

The fisheries resources managed by AFMA are important community assets that support significant commercial fishing activity, recreational fishing and some subsistence and traditional fishing. These activities are of interest to a range of other stakeholders, including environmental groups, resource managers, researchers, and community groups.

AFMA maintains a firm commitment to managing Commonwealth fisheries resources for the benefit of the community as a whole. Co-operation with the community, industry, government and non-government agencies and others with an interest in the sustainable management of the Commonwealth's fisheries resources forms an integral part of AFMA's management.

AFMA has adopted policies of pursuing efficient harvesting regimes and providing positive market-based incentives for commercial fishers to enhance and conserve resources. A key mechanism is the provision of secure and transferable access rights (Statutory Fishing Rights) within statutory management plans for major commercial fisheries. AFMA also manages fisheries in accordance with management policies that are implemented through binding conditions on Fishing Permits. Management policies provide a level of certainty combined with the flexibility needed in the dynamic environment of fisheries management.

AFMA has a continuing role to play in managing fish stocks on the high seas. This role has expanded substantially following the signing and ratification of the United Nations Fish Stocks Agreement, which entered into force on 11 December 2001.

AFMA also has regard to a range of international obligations and agreements such as the United Nations Convention on the Law of the Sea, the Food and Agricultural Organisation of the United Nation's Code of Conduct for Responsible Fisheries and other environmental agreements such as the Convention on the International Trade in Endangered Species of Wild Fauna and Flora.

2.2 AFMA's Structure

Consistent with the statutory authority model and its key fisheries management responsibilities, AFMA's structure incorporates:

- **an eight member Board of Directors** responsible for overseeing AFMA's operations and making high level decisions on fisheries management matters. The Board is also responsible for setting the policy framework and ensuring that adequate resources and expertise are available to meet AFMA's legislative obligations. Board Directors are appointed on the basis of their skill and expertise in areas such as natural resource management, the fishing industry, finance, conservation and research. The Board is assisted by its Finance and Audit, Research and Environment Committees

- **a management team** comprising an Executive, Senior Managers and Managers, committed to providing clear and effective leadership and direction to other staff in the organisation.

- **a staff** of approximately 105 (including the management team) with responsibility for specific fisheries, operational and corporate functions within AFMA's Fisheries, Operations and Strategy and Planning Branches

- **Management Advisory Committees** – expertise-based committees established for each major Commonwealth fishery with membership typically including an independent Chairperson, an AFMA member, a research member, industry members and an environment/conservation member. Management Advisory Committees (MACs) may also include a broader range of interest groups, such as recreational fishers, charter boat operators and traditional fishers. MACs provide a forum for discussion of matters relevant to the fishery, facilitate the flow of information between stakeholders, and advise and make recommendations to the AFMA Board on the management of the fishery.

- **Fishery Assessment Groups** - established for each major fishery group or individual species, with membership drawn from fishery scientists, industry, fishery economists, management, conservation non-Government organisations, and recreational fishing and other interest groups. Fishery Assessment Groups (FAGs) synthesise biological, ecosystem and economic information on Commonwealth fisheries and coordinate, evaluate and regularly undertake fishery assessments in each fishery. FAGs report to the AFMA Board through the AFMA Board Research sub-Committee and MACs. Although the two groups work closely together, FAGs operate independently from MACs.

2.2.1 Relationship with Other Agencies

A significant component of AFMA's management approach is the close working relationship AFMA has established with both stakeholders and a number of other Commonwealth and State/Territory Government and non-Government agencies, including other resource managers, research providers and key interest groups. A schematic representation of AFMA's relationship with stakeholders and other agencies is presented in Figure 1.

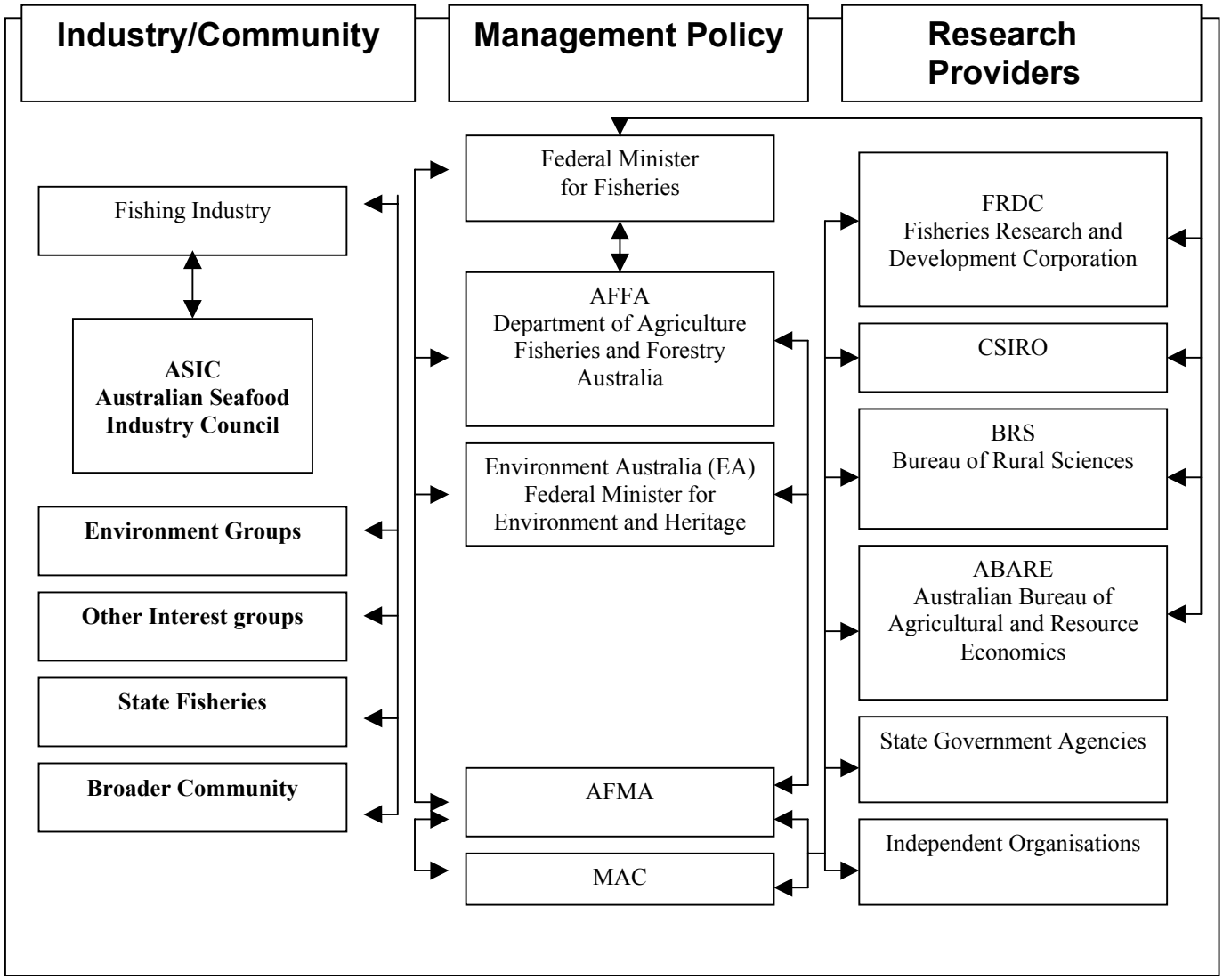

Figure 1: AFMA's relationship with other agencies

2.3 Accountability

AFMA's governing legislation provides AFMA with clear accountability to the Commonwealth fisheries Minister and the Parliament and, through them, the wider community.

The legislation requires that the Minister approve the AFMA Corporate Plan and Annual Operational Plan. AFMA must also submit an Annual Report to the Minister and the Parliament and provide a copy of that report to the peak industry body - the Australian Seafood Industry Council (ASIC). The AFMA Chair and Managing Director are required to report on AFMA's performance to the ASIC Executive and AFMA holds an annual public meeting to consult with industry, other stakeholders and the general public. The Minister must also formally accept each statutory management plan before it comes into effect. The Minister may also give directions to AFMA concerning the performance of its functions and the exercise of its powers and AFMA must comply with those directions.

Copies of AFMA's key accountability documents are available on the Authority's website at www.afma.gov.au.

In addition to specific legislative accountability provisions, AFMA has been subject to a number of external reviews and audits. AFMA's management effectiveness has been reviewed by the Australian National Audit Office (twice), a Senate Standing Committee (1993 and 2000) and a House of Representatives Standing Committee (1997). In response to these reviews, and as part of good corporate governance, AFMA has strengthened its planning, performance assessment and reporting arrangements. The strategic assessment process under the EPBC Act is also a process of review and audit.

Independent reviewer ACIL Pty Ltd reviewed AFMA's management advisory committees (MACs) in late 2000. The ACIL report highlighted concerns over a number of MAC and AFMA processes and practices, although strongly supporting the MAC concept and the contribution of MACs to Commonwealth fisheries management. These concerns were dealt with in a series of 31 recommendations, the majority of which have been adopted by the AFMA Board. The Board noted that actions had already been initiated to address some of the issues covered in the report but that further action will be required to implement the remaining agreed recommendations. AFMA is currently developing a timetable and plan for implementing these recommendations. A copy of the report is available on the AFMA website.

2.4 Consulting with Stakeholders

AFMA actively involves a wide range of key stakeholders in the process of developing and implementing fisheries management arrangements. This approach is supported by specific consultative processes that are embodied in the Authority's governing legislation and undertaken as part of good fisheries management practice.

AFMA's legislation specifies the consultative processes that AFMA must undertake with stakeholders when preparing plans of management. In particular, AFMA is required under Section 17 of the *Fisheries Management Act 1991* to maintain a register of interested persons who are to be notified of draft plans of management. The Act also requires AFMA to give public notice inviting persons and organisations to have their names and addresses entered on the register. Before formally accepting each statutory Management Plan, the Minister responsible for fisheries must be satisfied that adequate consultation has taken place and that AFMA has taken account of any representations received.

The Northern Prawn Fishery Management Advisory Committee (NORMAC) is the forum in which issues relating to the management of the fishery are discussed. NORMAC has an independent chair, an independent Executive Officer and membership including 5 industry members, an environment/conservation member, a scientific member and the AFMA manager of the fishery.

Numbers on Management Advisory Committee are restricted under the *Fisheries Management Act* 1991. Given the extremely low level of recreational take of prawns and the low level of indigenous take of prawns representatives from these groups have not been appointed to the Committee at this time.

AFMA also consults broadly when developing fisheries management policy. The manner in which consultation is undertaken depends on the nature and scope of the issues being considered. AFMA advertises the availability of documents through newspaper advertisements, AFMA News and/or mail outs to persons on various registers maintained by the Authority. In most cases, documents are available on the AFMA website or can be obtained directly from AFMA. AFMA also undertakes client surveys as a means of gathering information to assist AFMA measure its performance.

NORMAC participates or has participated in various community based groups in the region including:

- the Northern Gulf Resource Management Group. This group brings together community based groups, indigenous representatives, the various resource industries and shire councils to discuss issues in the region; and

- the Community Consultative Council which developed a multiple use strategic plan for the southern gulf of Carpentaria. The Council included community based groups and indigenous representatives.

2.5 Research in Commonwealth Fisheries

Dealing with scientific uncertainty is a key challenge in managing marine fisheries resources. Accordingly, AFMA puts a priority on fisheries research, stock assessments and in identifying strategies aimed at promoting the sustainable use of fisheries resources. AFMA's longer-term research directions and key research areas are set out in the Authority's Five Year Strategic Research Plan. Key fisheries also have their own Five Year Strategic Research Plans that outline priority research areas for the fishery.

AFMA's research function is overseen by the AFMA Research Committee (ARC), a six member committee drawn from AFMA's Board of Directors and executive management. The AFMA Research Committee is responsible for advising the AFMA Board and other Commonwealth agencies on research priorities and advising the AFMA Board on research policy and issues. The AFMA Research Committee also acts as the Commonwealth Fisheries Research Advisory Body, advising the Fisheries Research and Development Corporation on priorities and making recommendations about applications for research funding.

AFMA's approach to research involves close consultation with managers, fishers, researchers and others. This provides opportunities for stakeholders to have input into the research priority setting process through the Management Advisory Committees for each major AFMA managed fishery.

2.6 Fisheries and the Environment

The community interest in environment issues and strengthened environment legislation has increased AFMA's focus on its ecologically sustainable development objective. AFMA has expanded the resources within its Environment Section, which has resulted in a number of achievements in recent years. AFMA has completed Bycatch Action Plans for all major Commonwealth Fisheries, meeting a commitment in the Commonwealth Policy on Fisheries Bycatch.

AFMA has worked with conservation groups and industry to implement measures such as the mandatory use of turtle excluder devices and bycatch reduction devices in the NPF, and a strategy for managing incidental seal catch during winter fishing for blue grenadier in the South East Trawl Fishery. Additionally, an industry trial of underwater bait setting devices to reduce seabird bycatch in longline fisheries began in September 2001.

The AFMA Board is assisted by an Environment Committee, which provides advice on strategies to address environment and conservation issues, focusing on ecologically sustainable development, the precautionary principle and minimising the impact of fishing on non-target species. The Committee also provides advice on relevant environment related research and reviews key AFMA environment documents such as Bycatch Action Plans.

Membership of the Environment Committee includes representatives from AFMA, industry, science, a conservation NGO and the Commonwealth's environment agency; Environment Australia.

2.7 Funding Arrangements

2.7.1 Fisheries Management

The government established the current policy on fisheries management cost recovery in 1994 and AFMA has implemented this policy through levies on the commercial industry. The total cost of AFMA's operations is split between industry and Government (currently 40% and 60% respectively). The commercial fishing industry pays for costs directly attributed to fishing activity and the Government pays for activities that benefit the broader community as well as the industry.

In accordance with Government cost recovery policy, industry pays 100% of recoverable management costs. These include the running costs of Management Advisory Committees, licensing, AFMA's day-to-day fisheries management activities, developing and maintaining Management Plans and logbooks, and surveillance but not enforcement. Costs are recovered on a fishery by fishery basis with Management Advisory Committees playing an integral part in the preparation of annual budgets for each fishery.

2.7.2 Research

The following are the funding sources available to support fishery research:

- **AFMA Research Fund (ARF)** - consists of annual Commonwealth Government funding and is primarily used to conduct management related research including fishery and stock assessments, research in economically non-viable fisheries and research that does not generally fall within the established guidelines for funding by the Fisheries Research and Development Corporation.

- **MAC-initiated Research Funds (MIRF)** - raised through levies on the holders of fishing concessions and are maintained by AFMA for use, on the advice of MACs, for specific research in particular fisheries. AFMA currently maintains MIRF for 11 of its managed fisheries.

- **Fisheries Research and Development Corporation (FRDC) -** provides funding support for Commonwealth and State/Territory fisheries research programs. FRDC's revenue base is based on:

    - the Commonwealth Government providing unmatched funds equivalent to 0.5% of the average gross value of fisheries production (GVP) for the three preceding years

    - Commonwealth fishers provide contributions of 0.25% of GVP to the FRDCs funding base through mandatory fishing industry research levies, collected by AFMA in addition to any MIRF levies

    - State, Territory and aquaculturists also provide funding to FRDC at varying levels up to 0.25% of GVP

    - the Commonwealth Government matching contributions by state, territory and Commonwealth fishers and aquaculturists up to a maximum of 0.25% of GVP.

- **Fisheries Resource Research Fund (FRRF) -** AFFA administers funds for fisheries related research from the FRRF. The FRRF receives an annual Government appropriation and is an important source of research funding. Although the FRRF is managed by the Department of Agriculture, Fisheries and Forestry – Australia (AFFA), AFMA is consulted on expenditure from the FRRF by participating in an advisory committee that evaluates applications for funding. FRRF programs are intended to provide an agreed program of independent assessment of Commonwealth fisheries management performance, and support the development of new and improved policies for the management of Australia's fisheries.

- **Industry contributions to research** – in addition to financial contributions, industry often contributes in kind to research. This can include vessel time, provision of sampling equipment such as nets, crew time, observer coverage and in some instances the purchase of research equipment.

- **MOU agreement with FRDC** – industry contributes an additional $100,000 to FRDC over and above the FRDC levy of 0.25% for targeted NPF research programs.

- **Other Government Appropriation -** AFMA may also use its discretion to direct additional Government funding to research. In recent years, this type of discretionary funding has been used to partly fund the Integrated Scientific Monitoring Program for the South East Fishery. This is a very limited avenue, used only for agreed priorities not funded by any other means.

PART TWO

DESCRIPTION OF THE FISHERY

Geographical context

The Northern Prawn Fishery (NPF) occupies an area of 771,000 square kilometres off Australia's northern coast. The Fishery extends from the low water mark to the outer edge of the Australian fishing zone (AFZ) along approximately 6,000 kilometres of coastline between Cape York in Queensland and Cape Londonderry in Western Australia (see Figure 2).

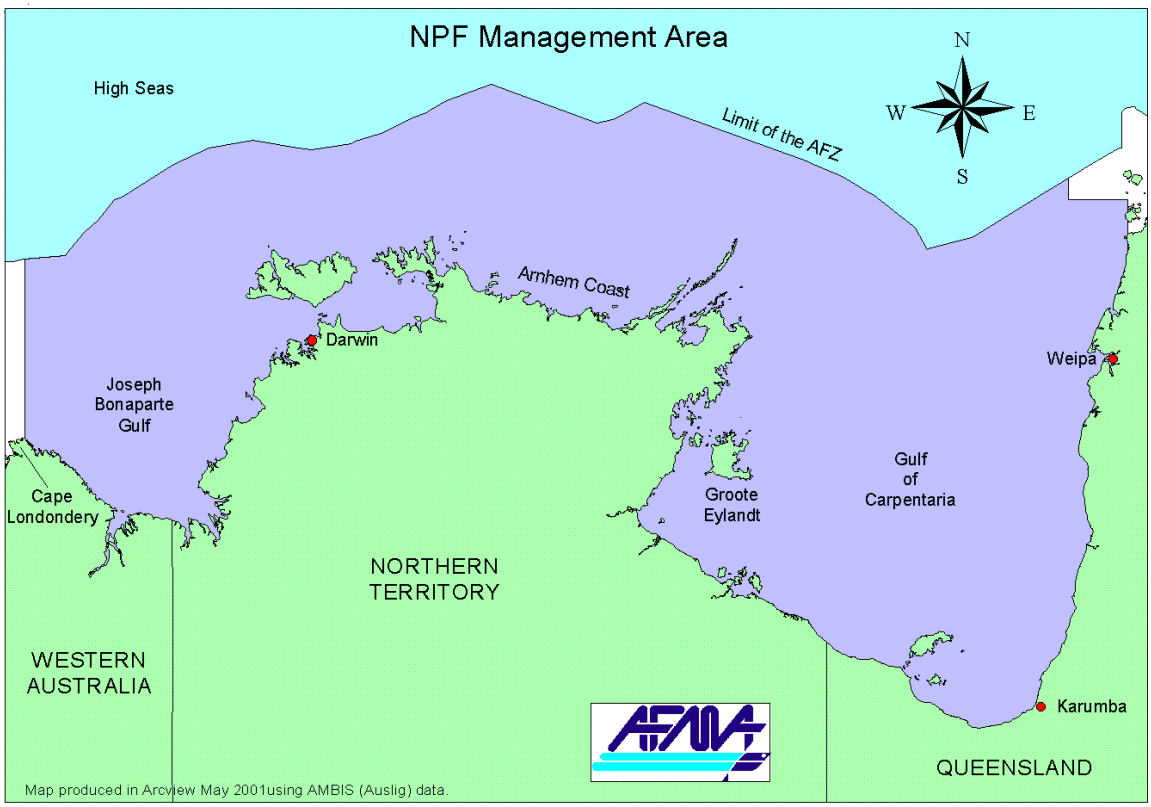

Figure 2 Location of the Northern Prawn Fishery

Under an Offshore Constitutional Settlement (OCS) agreement between the Commonwealth, Western Australia, Northern Territory and Queensland, originally signed in 1988, prawn trawling in the area of the NPF to low water mark is the responsibility of the Commonwealth through AFMA.

Data from the AFMA logbook data base indicates that fishing effort was reported from 273 grids (6 minute x 6 minute) when the fishery opened in 1973. Effort reached a maximum in 1989 when effort was reported in 1,407 grids and it has decreased since then to be reported from 811 grids in 2000, the most recent figures available. It is generally accepted that fishing effort was severely under-reported during the period 1970 to the early 1980's, when completion of logbooks was voluntary. Since the early 1980's logbook coverage of the fishery has been virtually 100%. There is an estimated 7281 grids in the area of the NPF.

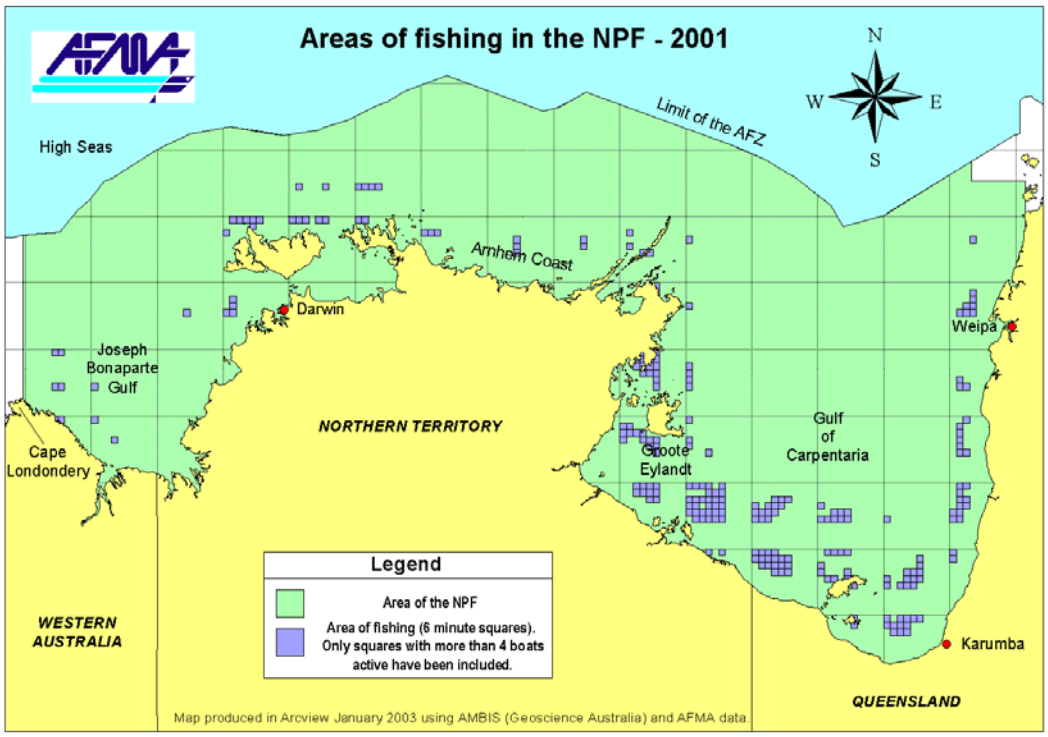

Figure 3: **Location of fishing in the NPF in 6 minute grids**
Note **For confidentiality reasons only grids with more than 4 boats are shown**

The principle reasons that much of the area of the NPF managed area is not trawled are:

- the permanent closure of areas such as all shallow water seagrass beds
- the unsuitability of areas to trawling due to large reef outcrops
- the low density of the target prawn species, (eg. central Gulf of Carpentaria).

There are also trawlable grounds closed to prawn trawling both seasonally (6.3% of total area) and permanently (2.1% of the total area). These areas include all known seagrass beds. The major trawl grounds are in the Gulf of Carpentaria and the area to the north and south-west of Darwin.

4 History

1960s The CSIRO identified the first commercial stocks of banana prawns by exploratory surveys in the Gulf of Carpentaria. Management was shared between Queensland, WA and Northern Territory, although it was minimal.

1970s The NPF grew rapidly as a commercial fishery after overcoming infrastructure problems such as a lack of suitable ports, refuelling and repair facilities, and the remoteness of the prawning grounds. The first consultative forum for the fishery, the Gulf of Carpentaria Prawn Advisory Committee, was established. Membership of the committee expanded to include more industry members and was renamed the Northern Prawn Fishery Advisory Committee. It later became the Northern Prawn Fishery Management Advisory Committee (NORMAC), which is still in place today and had its 52nd meeting in February 2002.

1977 A three year interim management plan (1977-79) for the fishery began on 1 January. The measures included a Declared Management Zone, a moratorium on licences, seasonal closures and log book requirements. Entry to the fishery was limited to 302 trawlers with entitlements to fish in the NPF.

1979 The 200 nautical mile Australian fishing zone was declared and foreign fishing boats were banned from the NPF.

1980 A new management plan took effect on 1 January 1980.

1984 Trawlers were 'unitised' in an effort to reduce capacity and control fishing effort and over-capitalisation. Each trawler with an entitlement to fish was issued with:

- Class A units (these became Class A SFRs under the 1995 Management Plan), which determined the hull volume (underdeck volume) and power of the engine used (eg. a boat with a hull volume of 75 units and engine power of 300 kW would require one Class B Unit and 375 Class A units to fish)
- one Class B unit (these became Class B SFRs under the 1995 Management Plan), which authorised the operation of a boat in the fishery
- Class C units (an entitlement to fish in the Joseph Bonaparte Gulf only)
- small trawlers that did not qualify for the Government ship building subsidy in place at the time were issued a minimum of 375 Class A units. A total of 133,269 Class A units were issued. Units were transferable and became the "currency" and the property right in the fishery.

1985 An industry initiated "buy-back" scheme was introduced to reduce the number of trawler licences in the fishery in response to declining tiger prawn stocks in the fishery. The scheme was industry-funded in addition to an initial government grant of $3 million. Around this time, a 'user pays' policy was adopted by the Government, requiring industry to pay levies for government management and research costs for the fishery. Levies, including those to fund the buy back scheme, were calculated based on the number of Class A units held. There were a total of 133,269 Class A units and 292 active Class B units attached to trawlers in the fishery.

1986 Researchers released figures which showed a serious decline in the numbers of tiger prawns entering the fishery.

1987 NORMAC agreed to a management package to reduce effort and fleet capacity with the aim of reducing the number of class A units from 118 000 to 70 000 by the start of the 1990 season. The package including increased levy contributions to boost the buy-back scheme. Gear restrictions were implemented to reduce fishing effort. Whilst not directly proportional to units held, an arbitrary two tiered gear restriction was imposed on trawlers, based on whether the trawlers were under or over 375 units. Trawlers under 375 Class A units were restricted to towing a maximum of twin 9 fathom nets and trawlers larger than 375 Class A units were restricted to towing a maximum of twin 14 fathom nets. A more restrictive boat replacement policy was implemented requiring any owner who decided to voluntarily replace a trawler of any size to forfeit one extra Class B Unit. For trawlers over 375 units, an equal number of Class A units to the total class unit holding of the replacement trawler also had to be forfeited.

1988 Jurisdiction over the NPF passed solely to the Commonwealth, under the Offshore Constitutional Settlement.

end 1989 20 810 Class A units, 45 Class B units, and nine C Class units were sold to the buy-back scheme. However, prawn stocks continued to decline and economic conditions remained poor in the fishery.

1990 NORMAC agreed to a further reduction in Class A units to achieve a target of 54,000 class A units by the beginning of the 1993 prawn season. This was to be achieved by an accelerated buy back scheme and a compulsory across-the-board proportionate surrender (forfeiture) of Class A units in 1993 to achieve the target if necessary. The accelerated buy back scheme was funded though a $5 million grant and a $40 million government guaranteed loan to be repaid by industry through levies.

1991-1992 The *Fisheries Management Act 1991* replaced the *Fisheries Act 1952* when AFMA was established. NORMAC initiated a review of the future management options for the fishery and developed a proposal to move to gear-based management.

1993 There was a compulsory reduction of Class A units of 30.76% on 1 April. This reduced the number of trawlers entitled to operate in the Fishery to 127, about half the number in the 1980s. Following the compulsory reduction, a number of other input restrictions - introduced in 1987 as interim measures to reduce fishing effort - were lifted. These included limits on net sizes although the two net restriction remained in place.

1995 A new plan of management was implemented and Statutory Fishing Rights (SFRs) for the NPF were issued under the *Fisheries Management Act 1991*. The new Management Plan provided commercial fishers in the NPF with SFRs based on their A and B Class units. The Plan was considered and approved under the *Environment Protection (Impact of Proposals) Act 1974.*

1997 NORMAC supported the proposal to move to gear-based management (i.e. headrope length). This proposal was developed following the review of the fisheries management options, which started in 1991.

1999 In November, the Minister accepted an amendment to the Management Plan, to give effect to gear-based management. The allocation of gear was based on an Independent Allocation Panel report. The amendment was tabled in Parliament and referred to the Rural and Regional Affairs and Transport Legislation Committee (RRTC) for consideration

2000 The RRTC endorsed the implementation of gear-based management and made a number of suggestions about the future monitoring of the fishery. Monitoring and research programs have been put in place in line with these recommendations. On 24 July, gear SFRs were issued and came into effect in the NPF (section 2.10 on Management Regimes contains more information on gear SFRs).

2001 The management plan was amended to allow the total gear pool to be set by determination. The gear SFR is set as an amount of headrope length, which can be varied depending on the status of prawn stocks.

2002 In 2002 further measures to reduce effort by 40% on tiger prawns were introduced. This was achieved by shortening the seasons and a further 25% reduction in the value of an SFR from 24 August 2002. This resulted in a reduction in Class B SFRs from 119 to 102. Only 96 trawlers operated in the Fishery in September 2002.

5 Operating methods

5.1 Seasons

The NPF has two open seasons when fishing is permitted. These generally fall between April/May to early June and between August and November. The 2001 season dates were:

- 1 April - 27 May (Banana Season)
- 4 August - 9 November (Tiger Season)

For 2002, the seasons were reduced and are:

- 1 April - 13 May (Banana Season)
- 1 September - 1 December (Tiger Season)

Most operators remain at sea for the entire season, unless trawlers experience mechanical problems requiring in-port repairs. Trawlers unload onto barges, or motherships, which usually meet the trawlers every two to three weeks. Trawling is banned during daylight hours during the tiger prawn season.

5.2 Trawlers and gear

The present management plan for the NPF allows up to 102 trawlers to operate in the fishery. Most of the NPF trawlers are purpose-built, steel hulled and range in length from 14 metres to 29 metres. The median age of vessels in the fleet is around 17 years. (Taylor & Dichmont 2000).

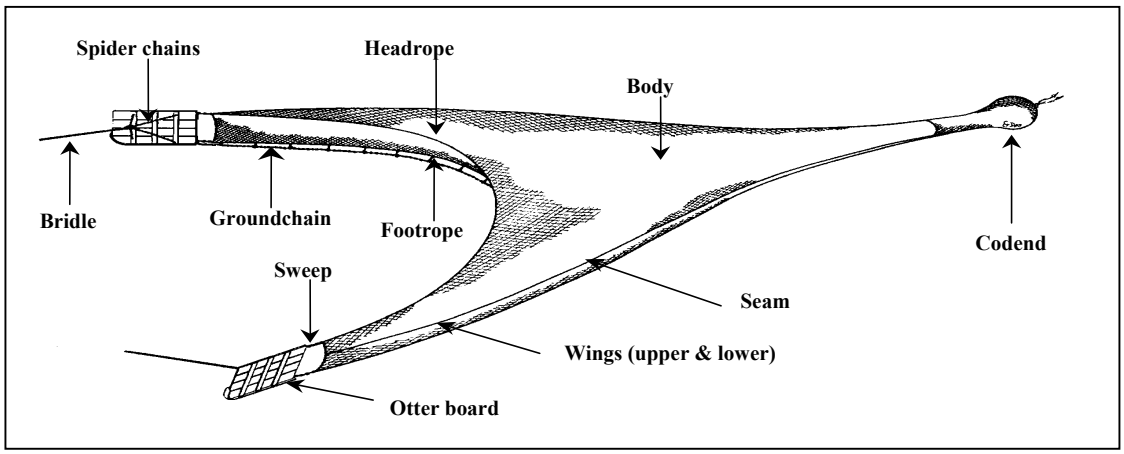

Figure 3: The typical components of an NPF prawn trawl (Illustration by G. Day, AMC)

All NPF trawlers have modern and sophisticated catch handling, packing and freezing capabilities as well as wet (brine) holding tanks. All use electronic aids such as colour echo sounders and Global Positioning Systems (GPS) (65% had differential GPS in 1999). Satellite phone and fax equipment is used by more than 95% of trawlers and 65% have introduced on-board computing facilities. All trawlers are required to have a Vessel Monitoring System (VMS).

Prawn trawling is an active fishing method that involves towing a conical-shaped net spread open by two steel or timber otter boards over the seabed (Figure 3). A ground chain skims over the seabed and stimulates prawns into the trawl mouth. The otter boards are located between the trawl and towing bridle and use hydrodynamic forces to spread the trawl open.

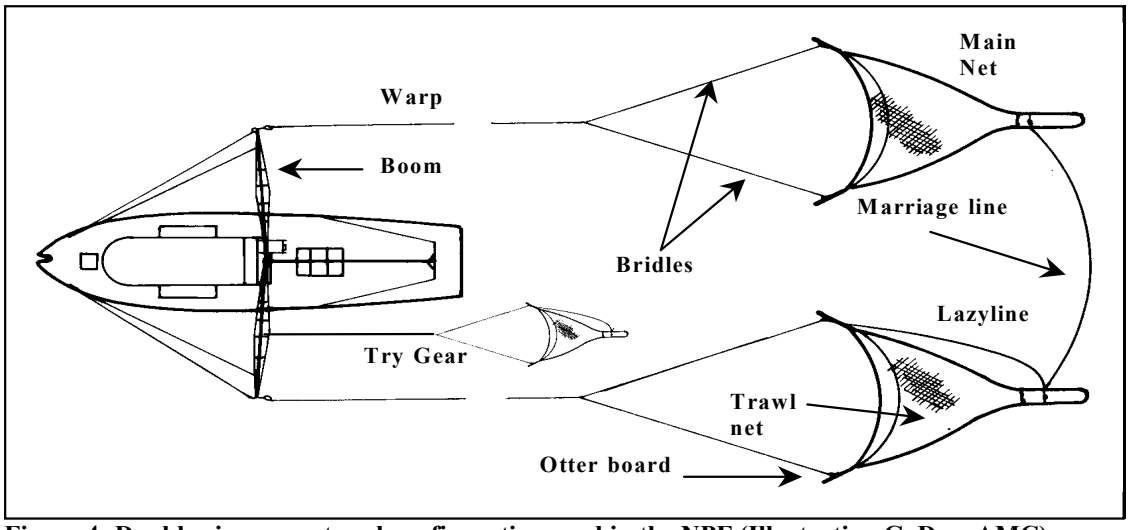

Figure 4: Double rig prawn trawl configuration used in the NPF (Illustration G. Day, AMC)

Note: Each trawl net is towed independently of the other. One pair of otter boards is used to spread each trawl and the try gear is towed independent of the main trawl nets. All vessels use try gear to sample prawn numbers on the seabed and to obtain an indication of catch rates. The try gear is towed separately either off the stern of the vessel or one of the two booms.

In the NPF, two nets are towed simultaneously in a double rig configuration (Figure 4). The nets are typically constructed from small mesh material. As the tapered trawl moves forward through the water, the catch is funnelled into the trailing end of the net and is retained in a mesh bag, or codend, which is constructed from a smaller mesh than the body of the trawl.

5.3 Turtle Excluder and Bycatch Reduction Devices

All trawl nets in the NPF are required by an AFMA Direction to have an approved Turtle Excluder Device (TED) and Bycatch Reduction Device (BRD) installed. A TED is a device fitted to a net that allows turtles and other larger animals to escape immediately after capture in the net. A BRD allows fish and other animals to escape from the net immediately after capture. These devices are usually fitted in or near the trawl codend (Figure 5). A complete description and specifications of approved TEDs and BRDs are in AFMA Direction: NPFD 60 (Appendix II).

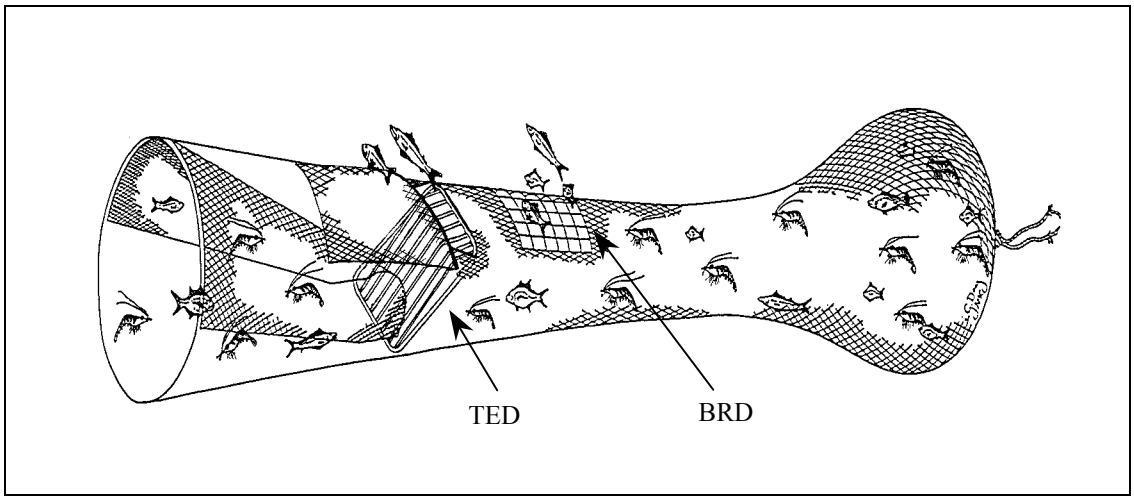

Figure 5: **Typical installation of a TED and a BRD in an NPF trawl codend. Pictured is a top opening TED called the NAFTED and a square mesh window BRD (Illustration by G. Day, AMC).**

5.4 Fishing Method

Fishing in the NPF can be broken into 6 steps:

1. Selection of fishing ground

Selection of fishing grounds is based on past fishing experience, use of try gear, trawler activity in the local area, lunar phase, tidal cycle, echo sounder information and bottom type. Spotter planes are deployed for finding banana prawns.

2. Deployment of trawl gear

The deployment of fishing gear involves releasing sufficient warp wire for the trawl to maintain contact with the seabed and allow the otter boards to spread the trawl open.

3. Trawling

The trawl is towed on the seabed for several hours when targeting tiger prawns and generally under one hour when targeting banana prawns. Operators trawl back and forth over an area of high prawn concentration detected with a try gear. Tow duration can range from a few minutes to several hours depending on the amount of prawn and bycatch caught by the try gear.

4. Retrieval of trawl gear

Winches are used to wind the warps back onto the trawler and the fishing gear is brought to the surface.

5. Emptying the codends

The codends are hauled onboard using lazylines, allowing the catch to be emptied (by untying the drawstrings of the codend) into a sorting tray. The codends are then retied, and shot over the side of the trawler for the next tow.

6. Streaming the gear

Streaming, or towing the gear at the surface, allows the operator to reposition the trawler over the intended trawling area ready for the next tow.

6 Key prawn target species

Target species are the most highly sought component of the catch taken in a fishery. The NPF is a multi-species fishery with nine species of prawns being targeted.

- White banana prawn *Penaeus merguiensis*
- Red-legged banana prawn *Penaeus indicus*
- Grooved tiger prawn *Penaeus semisulcatus*

- Brown tiger prawn *Penaeus esculentus*
- Blue endeavour prawn *Metapenaeus endeavouri*
- Red endeavour prawn *Metapenaeus ensis*
- Western king prawn *Metapenaeus latisulcatus*
- Red spot king prawn *Penaeus longistylus*
- Giant tiger prawn *Penaeus monodon*

The species fall into four general categories of banana, tiger, endeavour and king prawns. Individual species are not distinguished within those groups in the commercial catch. Extensive studies by CSIRO Marine Research, including commercial catch sampling and analysis of substrate composition, have shown that the adults of the two commercial species of tiger prawns have different spatial distributions. These are related to type of substrate and water depth. This has allowed the commercial catch category of tiger prawns to be approximately split between the two species according to the six-minute square grids.

A new analysis, Dichmont *et al* 2001, has updated the species split methodology and included the potential for species split shifts over time and area. In addition a project has been funded to collect species split data during 2002 and 2003 to re-validate the species split.

Banana prawns may be confidently split into the two component species much more easily. Red-legged banana prawns are caught almost exclusively in deep water (>45 metres) in JBG and white banana prawns elsewhere.

Three species - white banana prawns, brown tiger prawns and grooved tiger prawns - account for almost 80% of the total annual catch from the fishery. The remainder is made up mostly of endeavour prawns and red-legged banana prawns.

Prawn species reach a commercial size at six months, and can live for up to two years. Larger sizes bring the highest price. Growth rates vary considerably between species and sexes, with females generally growing faster and to a larger size than males.

Most species are sexually mature at six months, but fecundity increases with age. A twelve-month-old female can produce hundreds of thousands of eggs at a single spawning and may spawn more than once in a season. The eggs sink to the bottom after release, where they hatch into larvae within about 24 hours. Less than 1% of these offspring survive the two to four week planktonic larval phase to reach suitable coastal nursery habitats where they may settle. After one to three months on the nursery grounds, the young prawns move offshore onto the fishing grounds.

7 Supplementary species

This section covers species which are targeted on an opportunistic basis and not on a regular basis. While being the target of individual shots in the fishery they are considered to be more of a by-product of fishing in the NPF. In the remainder of this document they are considered under the by-product section.

7.1 Scampi

Scampi (*Metanephrops* species) is classified as a target species in the NPF. Scampi is found in the deep waters of the continental slope, from a depth of about 260 metres to about 500 metres (Wallner & Phillips, 1995). The deep habitat of scampi means it is only found in a couple of remote areas in the NPF, close to the outer edge of the Australian fishing zone.

Scampi is targeted during NPF prawn trawling closures. However, in the 13 years between 1987 and 1999, an average of only six NPF trawlers (less than 5% of the total NPF fleet) have targeted scampi each year. This is a result of the high cost associated with travel to and from the scampi grounds, and the restricted market opportunities for sale of the catch. Scampi catches in 2000 and 2001 were 5.5 tonnes and 3.8 tonnes respectively.

7.2 Squid

Since 1993, a small number of vessels in the NPF have been opportunistically targeting squid (a mixture of mitre squid, north-west pink squid and northern calamari *Sepioteuthis lessoniana*) during their normal prawn trawl operations. The primary

Location for this targeted catch in the NPF is the Gulf of Carpentaria with high catches being taken around Bombard Shoal, Mornington Island and the Vanderlin Islands. However, some of the relatively large quantities recorded from the Gulf of Carpentaria are the result of a larger number of trawlers taking smaller amounts as incidental bycatch.

The population structure of commercially harvested squid species is unknown. A genetic study undertaken in the early 1990s was unable to distinguish differences indicative of stock structure between samples taken from the Timor Sea, Gulf of Carpentaria, Townsville and Moreton Bay.

The amount of squid take is limited to the same amount of prawn take in the fishery. AFMA monitors the take of squid through the season and will put in place measures, particularly closed areas, should the catch of squid rise to more than 70% of the amount of prawns taken in the fishery. The value of the squid when compared with prawns is very low. Given this price differential it is unlikely that operators will move from targeting prawns as their principal species to taking squid.

Squid catches in the NPF over the past 5 years have ranged between 37 tonnes and 367 tonnes, with most coming predominantly from targeted squid fishing in the three regions of the Gulf of Carpentaria mentioned above and from some incidental catches.

As it was not compulsory to record retained species such as squid in the AFMA

logbooks until 1995, historical logbook data represent only the most conservative estimate of squid catches. With the co-operation of some industry operators that provided CSIRO with their own data, Manson (1996) has estimated that even in 1995 only about one half of the vessels landing squid recorded any catch, and of those that did, less than half of the total catch was recorded.

8 Byproduct

Byproduct refers to any part of the catch which is kept or sold by the fisher but which is not the target species. In the NPF there are a few bycatch species that are incidentally caught and are retained because of their commercial value. These include:

- two species of slipper lobster (bugs) (*Thenus indicus* and *Thenus orientalis*); also referred to as bay lobster are exploited in areas where prawns are targeted
- one species of scallop (*Amusium pleuronectes*); or delicate saucer scallops - taken incidentally in the NPF in coastal waters off the Northern Territory, from around Melville Island to west of Karumba and an area around Weipa. Approximately 40% of NPF trawlers retain their catch of saucer scallops for sale (Pender and Willing 1990). Trawlers target resting (post-spawning) or pre-spawning adults when meat yield and scallop condition are at their best (Joll 1989);
- some larger fish species.

Byproduct limits or measures are in place for the following species:

Species	Catch limit
all lethrinidae	10 whole fish in total per trip
Narrow barred Spanish mackerel (*Scomberomorus commerson*)	
Gold band snapper (*Pritipomoides multidens* and *P. typus*)	
all serranidae	
longtail tuna (*Thunnus tonggol*)	
broad barred Spanish mackerel (*Scomberomorus semifasciatus*)	
mud crabs (*Scylla* species)	10 in total per trip
ornate tropical rock lobster (*Panulirus ornatus*)	6 in total per trip
saddle tail snapper (*Lutjanus malabaricus*)	500 kgs in total from 1 January to 30 June; and 50 kgs in total from 1 July to 31 December
red snapper (*Lutjanus erythropterus*)	
red emperor (*Lutjanus sebae*)	
two species of bugs (*Thenus* species)	75 mm minimum carapace width

These bycatch limits are implemented through Directions made under section 25 of the Northern Prawn Fishery Management Plan 1995 (as amended).

Possession ban

Some of the following species may be caught in the Fishery and would have a commercial value. However, possession bans have been implemented, through Directions made under section 25 of the Northern Prawn Fishery Management Plan 1995 (as amended),.which means they cannot be retained.

Possession bans are in place for:

- all sharks, rays/skates, sawfish and all parts of these animals (eg fins)
- barramundi (*Lates calcarifer*)
- spotted grunter-bream (*Pomadasys kaakan*)
- blue salmon (*Eluetheronema tetradactylum*)
- threadfin salmon (*Polydactylus sp.)*
- black jewfish (*Protonibea diacanthus*)
- jewfish/jewel fish (*Nibea squamosa*)
- queenfish (*Scomberoides lysan* and *S. commersonianus*)
- trepang (Class Holothuroidea)
- pearl shell (*Pinctada* species*)*
- coral
- trochus.

9 Bycatch

The Commonwealth Policy defines bycatch as:

i. that part of a fisher's catch which is returned to the sea either because it has no commercial value or because regulations preclude it being retained; and

ii. that part of the "catch" that does not reach the deck of the fishing vessel but is affected by interaction with the fishing gear.

Specific measures aimed at substantially reducing bycatch are included under Guidelines 2.1.1-2.1.6 in Part 3 of this document. These include the mandatory use of TEDs and BRDs and a ban on retention of all shark products.

The bycatch consists mainly of small fish and crustacean species of negligible or extremely low monetary value. This bycatch is usually discarded, as it is not feasible to retain large volumes of low value bycatch in a fishery geared towards a high value, small volume frozen product.

Stobutzki *et al.* (2000) reports that 437 vertebrate species (fish and sharks, rays, and sawfishes) and 234 invertebrate species (eg. crabs, squid and scallops) were taken as

bycatch within the NPF and Torres Strait prawn trawl fisheries between the months of February and October of 1997. Of the 437 vertebrate species, 56 species of Elasmobranchs (sharks, rays and sawfishes) have been recorded in the bycatch of the NPF.

Five species of sea turtles, which are protected species, are occasionally caught in the fishery (Poiner and Harris 1996). Flatback Turtles (*Natator depressa*) are most commonly caught with lesser numbers of Olive Ridley turtles (*Lepidochelys olivacea*), Green Turtles (*Chelonia mydas*), Hawksbill Turtles (*Eretmocheyls imbricata*) and Loggerhead Turtles (*Caretta caretta*).

There are two known species of syngnathids incidentally caught in the NPF. These are *Haliichthys taeniophorus* and *Trachyrhamphus longirostris.* Other species are also caught but remain unidentified. Syngnathids are very rarely caught in the NPF (Stobutzki *et al.* 2000).

There are at least 16 species of sea snakes caught in the NPF, all of which are protected under the EPBC Act (Stobutzki *et al*. 2000).

10 Socio-economic environment

10.1 Value of the fishery

The NPF is the most valuable Commonwealth managed fishery (see Figure 6) and one of the most valuable fisheries in Australia. The gross value of production (GVP) of the fishery varies between $A105 – $A165 million annually, which can be attributed to the fluctuating annual catch, and the foreign exchange rate. The GVP for 1999-2000 was over $A107 million. While landings declined for the third successive year, the average unit price for prawns rose by an estimated 36% in 1999-2000. (ABARE, 2001).

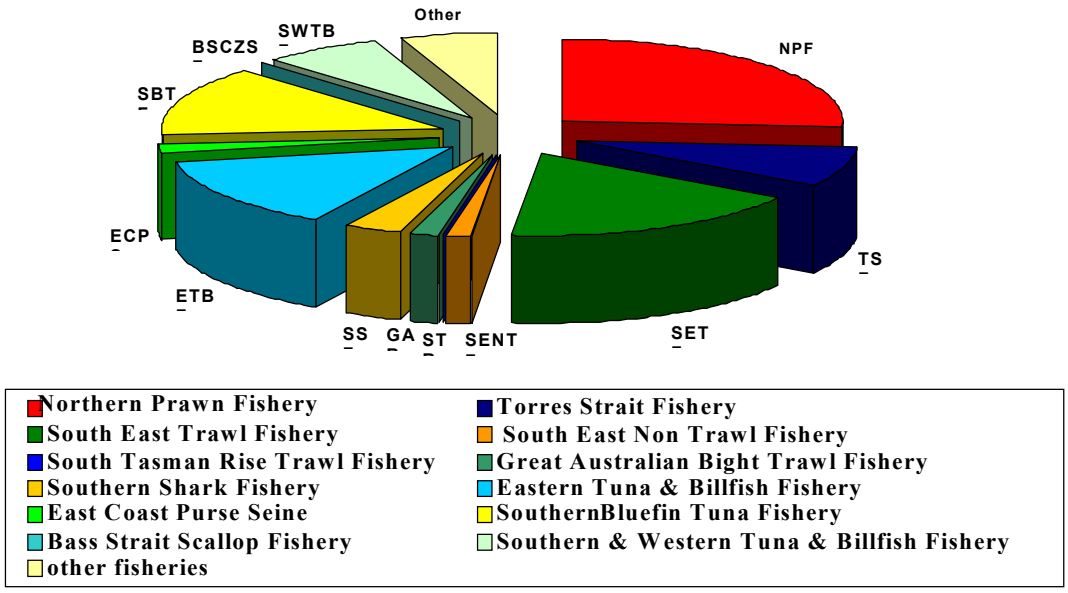

Figure 6: The value of Commonwealth fisheries during 1999-2000. (Source: Australian Fisheries Statistics 2000, ABARE 2001) Total Value: $412 749 000

Table 1 details the production levels of NPF-caught prawns and values obtained for species from 1997 – 2000.

Table 1: Northern Prawn Fishery production

	1998-99		1999-00		2000-01	
Species	**Tonnes**	**$'000**	**Tonnes**	**$'000**	**Tonnes**	**$'000**
Tiger	2 795	52 617	2 195	61 504	2 116	65 603
Banana	3 609	42 615	2 222	31 010	6 285	84 855
Endeavour	1 129	13 671	972	13 412	868	11 933
King	12	139	12	169	7	94
Other	6	32	3	36	6	34
Prawn total	7 550	109 104	5 404	106 130	9 282	162 519
Other species	437	2 173	202	1 232	469	2 149
Total	7 987	111 277	5 605	107 362	9 751	164 668

10.1.1 Export

More than 90% of the 5,605 tonnes of catch estimated for 1999-2000 was exported. The primary export market for NPF product is Japan and mainland China, with smaller quantities sold in Taiwan, Hong Kong, Europe and the USA.

10.2 Operators

As at 1 September 2002, there are 53,844 gear statutory fishing rights (SFRs) in the NPF divided among 54 trawler owners. These owners operate 96 trawlers, all of which have freezers and the capacity to remain at sea for extended periods of time. Four boats act as motherships and service the fleet, but are not entitled to fish. The majority of trawlers fish for the duration of the season (134 days during 2002). The home ports for NPF vessels include Brisbane, Cairns, Weipa, Karumba, Darwin and Fremantle.

Nearly 70% of owners in the fishery have entitlements to operate multiple trawlers. About 75% of the trawlers in the NPF are "dual-endorsed", ie: they hold an entitlement to operate in at least one, and in some cases up to nine, other fisheries. The total value of NPF gear SFRs is approximately A$350 million.

The normal number of crew on a trawler is five, though this number often increases by one or two during the short but busy banana prawn season. Between 500 and 800 persons may work in the fishery at any one time.

10.3 Other employment

Other commercial enterprises associated with the NPF fleet include the land-based fishing companies, agents and mothership operators, prawn buyers, processors and exporters, transport operators, shipyards and maintenance yards. In addition, there are service industries such as steel, aluminium and fibreglass fabricators, electronics, painting, engineering, refrigeration and victualling establishments. Many of these are labour intensive and so the fishery generates substantial economic benefits through employment and support industries.

10.3.1 Processing factories

Factories processing prawns from the NPF include A. Raptis & Sons, Moreton Bay Seafoods and Global Seafoods in southern Queensland, Markwell Pacific and Tweed Heads Fisheries in NSW, A. Raptis & Sons and Australian Bight Seafood in South Australia and the M G Kailis Group, N C Reid and WA Seafood Exporters in Western Australia. These companies produce mainly whole and headless prawns in frozen blocks for export markets.

10.4 Quality assurance and control

Australian seafood destined for export is subject to strict Commonwealth Government inspection, preparation and packaging standards, with processing facilities (including fishing boats) requiring certification by the Australian Quarantine Inspection Service (AQIS). Currently all NPF trawlers are registered by AQIS as export establishments.

10.5 Economic Assessments

The Australian Bureau of Agricultural and Resource Economics (ABARE) undertakes economic assessments of the NPF at regular intervals. The most recent covered the two financial years 1998/99 and 1999/2000 and was reported in the Australian Fisheries Surveys Report 2001. The assessment found that average receipts per trawler across the fishery decreased by almost 4% from 1998/99 to $970,000, following a significant drop in the harvest. The fall in receipts was tempered somewhat by higher per unit prawn prices in 1999/2000. During this time, costs per trawler fell marginally across the fishery. The average debt across the fishery fell by an estimated 4% to approximately $345 000 per boat in 1999/2000.

The key economic question about the management of any fishery is whether it results in the maximisation of resource rent. Resource rent is the long run excess of income from a fishery after fishing and management costs. However it is generally not possible to calculate resource rent, so a proxy measure – net return to the fishery – is calculated. The net returns to the NPF have been calculated by ABARE and reported in Australian Fisheries Surveys Report 2001. Real net returns for the Fishery fell by around 41% in 1999/2000 to an estimated $18.7 million (Figure 7).

ABARE produced a bioeconomic model of the NPF in 2001 to assess the economic impact of the amendment management plan. The model can be used to examine the potential impact of changes in management, prices or costs on both the profitability of the fishery and the structure of its fleet. The model draws on the biological relationships that are believed to exist within the NPF. The economic and institutional framework within the fishery was imposed on these biological relationships.

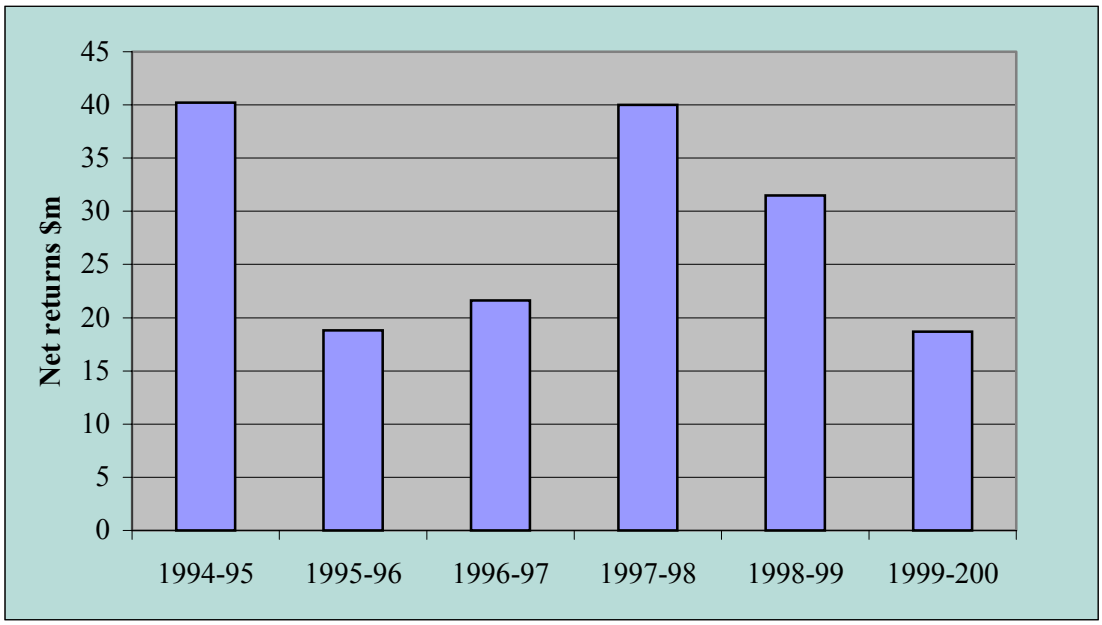

Figure 7 Real net returns to the Northern Prawn Fishery

11 Management regimes

The NPF is managed through a series of input controls, including limited entry to the fishery, gear restrictions, bycatch restrictions and system of seasonal, spatial and temporal closures.

The Northern Prawn Fishery Management Plan 1995 (as amended) sets out the management measures, objectives and performance criteria for the fishery (Appendix III). The Plan also provides for the fishery to be regulated by AFMA Directions and for implementation of a Bycatch Action Plan. An explanation of the Directions power can be found at sub-section 25 of the Management Plan and sub-section 17(5A) of the Act.

11.1 Statutory Fishing Rights

To fish in the NPF operators must hold Statutory Fishing Rights (SFRs), which control fishing capacity by placing limits on the numbers of trawlers and the amount of gear permitted in the fishery. There are two types of SFRs:

- a Class B SFR, which permits a boat to fish in the NPF; and
- a gear SFR, which limits the amount of net a fisher can use (from 24 August 2002 a gear SFR represents 7.5 centimetres of operational headrope and 8.625 centimetres of operational footrope).

Operators need Class B SFRs and the necessary amount of gear SFRs for the length of net they wish to use to operate in the fishery. There is a minimum holding of 100 gear SFRs[1] for each Class B SFR.

The total number of Class B SFRs in the fishery is 102. However, because of operators economic choices there are six Class B SFRs being held with the minimum (or near to minimum) number of gear SFRs and not active in the fishery. Hence, only 96 trawlers were active in the second season of 2002. There is no mechanism in the plan for Class B SFRs to be reactivated once falling below the minimum holdings.

There are 53,844 gear SFRs issued for the fishery.

The plan also allows for two other types of concessions to be granted:

- Scientific permits - these can be granted for a maximum period of six months to allow for research in the fishery including trials of different technologies in the fishery, for example the use of experimental TEDs; and
- Fishing permits - the management plan restricts the granting of fishing permits only to permit carrier vessels that tranship product at sea from fishing boats (known as motherships).

11.2 Seasons and Closures

The fishery has two open seasons where fishing is permitted. The seasons may vary but have generally fallen between April - May/early June and August – November. The 2002 seasons have been reduced in response to the most recent tiger prawn stock assessment and are from 1 April and 13 May and from 1 September to 1 December.

Closures of the fishery between seasons generally coincide with the spawning and recruitment phases of prawns to ensure individuals are at an acceptable size for harvesting. Shortening of the season has also been used as a method to reduce effort in the fishery. Other closures include permanent closure of seagrass beds and other sensitive habitats and seasonal closures of juvenile prawn stock habitat.

A daylight trawl closure during the spawning season aims to reduce the capture of gravid (pregnant) prawns, which are more likely to be caught during the day. A total of 2.1% of the fishery management area is subject to permanent closures, with 6.3% subject to seasonal closures.

Data from the AFMA logbook data base indicates that fishing effort was reported from 273 grids (6 minute x 6 minute) when the fishery opened in 1973. Effort reached a maximum in 1989 when effort was reported in 1,407 grids. It has decreased since then to be reported from 811 grids in 2000, the most recent figures available. It is generally accepted that fishing effort was severely under-reported during the period 1970 to the early 1980's. Since the early 1980's logbook coverage of the fishery has been virtually 100%. There is an estimated 7281 grids in the area of the NPF.

Seasons and closures in the fishery are implemented through a series of Directions made under section 25 of the Northern Prawn Fishery Management Plan 1995 (as

[1] There is some exception to this rule resulting from entitlements held at the time of the compulsory reduction in 1993. Details can be found at 24(3) of the Management Plan

amended). Closure-related Directions and maps of these closure areas are included in Appendix IV.

11.3 NORMAC

The Northern Prawn Fishery Management Advisory Committee (NORMAC) is the forum in which issues relating to the management of the fishery are discussed. NORMAC has an independent chair, an independent Executive Officer and membership including 5 industry members, an environment/conservation member, a scientific member and the AFMA manager of the fishery. The names of the current members of NORMAC are listed in Appendix V. A representative of the State/NT governments is a permanent observer to NORMAC. NORMAC meetings are generally open to anyone to attend. Annual public meetings, workshops, discussion papers and information circulars are used to promote discussion and understanding of the management of the NPF.

NORMAC has the following committees that deal with specific issues:

- Research and Environment Committee (REC)
- TED/BRD Committee
- Closures Committee
- Management Costs Committee

Working groups and specialist committees are also established from time to time to deal with specific issues.

NORMAC produces five-year Strategic Plans for consideration by the AFMA Board. The first Strategic Plan covered the period 1996-2001 and has been recently reviewed through a series of workshops. A copy of the Strategic Plan for the period 2001-2006 is included as Appendix VI.

The Plan contains five objectives and the detailed strategies for each of those objectives that AFMA and NORMAC intends to pursue over the period of the plan. The plan contains strategies and performance measures that will be reported against in NORMAC's annual report to AFMA, SFR holders and other stakeholders in the fishery.

11.4 Compliance and enforcement

AFMA co-ordinates compliance arrangements for Commonwealth fisheries. Specific compliance functions in the field are undertaken by State and Territory fisheries and police officers employed by AFMA on an agency basis. AFMA has developed a Memorandum of Understanding with each of the States and the Northern Territory which commits AFMA to sourcing compliance services from those States/Territory. Each Memorandum of Understanding is supported by defined Terms and Conditions which, among other things, specify State/Territory responsibilities.

AFMA also develops a Compliance Plan for each major Commonwealth fishery. As part of this process, AFMA assesses both the potential risks of non-compliance with management arrangements and the impact or consequence of a particular act of non-compliance on the integrity of those arrangements. Strategies to manage these risks are then identified and incorporated into the Compliance Plan. Details of compliance activity (commensurate with the perceived risk of non-compliance), performance measures and a proposed budget are also included in the Plan.

The Compliance Plans are translated into Service Level Agreements made with the States/Northern Territory. These Agreements detail specific compliance tasks to be undertaken by fisheries officers, the type and frequency of compliance activity, the area of activity, performance measures and the agreed costs of each activity. Service Standard Guidelines identify how each task will be undertaken.

Together, the Compliance Plans and the Service Level Agreements make up the Compliance Program for each fishery. In the Northern Prawn Fishery, the focus of the Compliance Program is to encourage operators to comply with management requirements, catch limits and allow for monitoring of protected species. A copy of the current Compliance Plan (for 2002-2003) is provided at Appendix VII. The key elements are described below. A summary of compliance activity and outcomes for the past twelve months is provides at Appendix VIII.

11.4.1 Integrated computer vessel monitoring system

All operators in the NPF are required to carry and operate an integrated computer vessel monitoring system. This system is a key tool in enforcing the many closures in place in the Fishery. In addition it:

- provides for a cost–effective way to monitor the start of the season, which also provides greater flexibility for fishers;
- assists AFMA in placing compliance resources where they are most effective; and
- provides information that allows fine scale scientific analysis of fishing patterns and activities.

11.4.2 At-sea Inspections

The Compliance Plan includes funding to carry out regular random vessel inspections on a minimum of 65 percent of the vessels in the fleet each year. This is combined with a program of aerial surveillance to deter operators from breaching rules and regulations. Timely, random vessel inspections enable fisheries officers to:

- check net lengths to ensure that operators are not exceeding their allocation;
- ensure that approved TEDs and BRDs are fitted to nets;
- check logbook and transhipment records; and
- inspect catch on board to ensure size regulations and bycatch limits are being met.

11.4.3 In-port measuring

This program is designed to maximise compliance with the management measures directed towards controlling the level of effort in the Fishery. All nets used in the Fishery are measured and a secure metal tag is affixed providing details of the measurement. This makes inspections of nets on board fishing vessels a faster and more efficient process.

11.4.4 Education

As part of its compliance approach AFMA seeks to educate operators about the rules and regulations that apply to the Fishery and the reasons why these have been implemented. This is achieved through:

- providing each operator and each vessel with an information handbook which is updated annually. The handbook sets out all of the closures, the bycatch limits and other requirements for the Fishery, together with information about Aboriginal sacred sites in the area, waste handling requirements and information provided by relevant State authorities.
- a series of annual skippers' briefings held in major ports just prior to the commencement of the fishing season. The program also provides operators with an opportunity to offer feedback to AFMA that can be fed into future planning processes for both compliance plans and fishery management.

12 Alternative management regimes

12.1 Output controls

The use of output controls (individual transferable quotas) to manage the NPF has been considered by NORMAC and AFMA in the past and rejected due to difficulties in accurately determining total annual catch and individual quotas, particularly for banana prawns. There is also the potential for high grading and dumping of lower value prawns.

12.2 Closure rules

ABARE recently conducted a study for the NPF with two objectives: (a) to develop a set of variable closure rules that could be used to expand management options in the NPF and (b) to improve understanding of the spatial dimension of fishing activity and catch in the fishery (Chapman et al. 2000).

Researchers developed a model of the NPF using biological models and adding statistically estimated behavioural equations to capture effort. Using ABARE survey data, returns from the fishery were calculated from estimates of the cost of fishing operations and prawn prices (by grade) that incorporated both annual and seasonal variability. The model was set in a stochastic optimisation framework that allowed optimal season closures to be determined for the fishery.

A comparison was made between the performance of two types of closure rules under different assumptions on the biological and behavioural equations in the model. The first rule was a fixed closing date and the second was a real time rule based on observable indicators of the current status of the fishery. The latter allows for flexible management of the fishery within the season. If stock levels appear to be low in a given year the season is closed earlier to allow prawn stocks to recover more quickly than would occur under a fixed closing date. Similarly, if stock levels appear to be higher than average in a given year the season can be extended to take advantage of this.

The uncertainty associated with surviving stocks and future recruitment reduces the effectiveness of most management options for the NPF. Variable closure rules, based on real time monitoring rules, may allow managers to preserve stocks when they appear to be low and exploit stocks during abundant seasons. However, the subsequent impact of reduced current catch on future stocks is highly variable. As a consequence, the benefits of establishing access rights based on real time performance measures may be limited.

Overall there were very few differences generated by the model simulations presented in the report. These results suggest that minor changes to the timing of season closures in the NPF, either using a fixed closure date rule or a CPUE based rule, are unlikely to result in a significant increase in economic returns.

The choice of equation used to represent the stock-recruitment relationship was found to have significant implications for the optimal setting of seasonal closures. If there is a weak relationship between surviving biomass in one year and recruits in the following year it further reduces the impact of changes to the length and timing of the fishing season. At the margin, the different management options considered are only able to capture a small percentage of the overall returns to the fishery.

When the stock-recruitment and CPUE relationships are known with certainty, altering the equation representing the relationship between surviving stocks and recruitment was found to have almost no impact on the optimal setting of season closures. However, when uncertainty about the relationship was introduced, differences in the underlying biological equations altered the optimal length and timing of the fishing season.

Given the existing understanding of the biological relationships within the fishery, differences in economic returns generated from the modelled changes to the closure rules applied across the whole of the fishery were found to be almost negligible. The potential for additional economic gains by allowing closures to occur at different times in different parts of the fishing grounds was therefore considered to be low.

12.3 Alternative methods of fishing

A project is currently being conducted by the Australian Institute of Marine Science (AIMS) with the aim of developing alternative technologies to allow the prawn trawl industry to meet present and future strict environmental standards at a reduced operating cost (FRDC project 2000/256). The project includes the trial of chemical attractants as a means to harvest penaeid prawn in pots.

The development of alternative methods could lead to a non-trawl fishery with minimum bycatch; open up new areas to harvesting which are unsuitable for trawling; and produce a less stressful method to collect broodstock *P. monodon* for the aquaculture sector. There would also be potential for the development of pot trap fisheries for other species of crustacea.

The objectives of the project are:

- to quantify the attraction and specificity of pheromones from crustacea in experimental environments
- to develop methods suitable for isolating and concentrating pheromones from crustacea, especially penaeid prawns
- to identify a mechanism for manufacturing a bait incorporating these novel attractants.

AFMA expects AIMS to submit the final report by December 2002.

13 Regional environment and activities

13.1 Description of the Environment

13.1.1 General

The tropical climate of northern Australia is influenced by the summer-winter monsoon cycle. Two other climatological factors also influence the NPF. These are the atmospheric circulation patterns across the Pacific giving rise to El Nino and La Nina events, and cyclone activity.

El Nino events result in widespread drought in northern and eastern Australia, whereas La Nina events bring higher than average rainfall, which in turn has been linked to higher than average banana prawn catches in the NPF (Vance et al., 1985 & 1998).

Cyclones have had a dramatic impact on the fishery in the past. Cyclone Tracey hit Darwin on Christmas eve, 1974 and cyclone Kathy on 22 March 1984, devastating the local fishing fleets. Cyclones have brought beneficial rain at times, but have also destroyed coastal seagrass beds, which are nursery areas for tiger prawns. In contrast

to most cyclones, cyclone Sandy travelled parallel to the coastline instead of crossing it. It hit at low tide and consequently destroyed the exposed seagrass beds, which have been slow to recover. This event has impacted on the local stocks of tiger prawn populations that rely on the seagrass beds as nursery areas for juveniles.

The average annual rainfall in the area of the NPF is 1200mm. Most rainfall is recorded between December and March with the dry season occurring from May to October. The average annual maximum temperature is 30°C and the minimum is 21°C (Bureau of Meteorology website).

13.1.2 Gulf of Carpentaria

75% of the fishing effort in the NPF occurs within the Gulf of Carpentaria. The Gulf is a relatively shallow body of water with a maximum depth of less than 70 metres, with most fishing occurring in depths of less than 40 metres.

The southern and eastern shores of the Gulf are characterised by mangrove-lined estuaries, which drain large areas of low-lying alluvial plains. The coastline of the western Gulf differs markedly from that of the east and south. Its proximity to the Arnhem Land escarpment make it a place of short rivers, smaller drainage basins and much less runoff into the Gulf (Somers 1994). It is characterised by extensive shallow water seagrass communities (Poiner et al. 1987).

Currents in the Gulf are dominated by tidal effects that create a net clockwise circulation, with limited exchange of Gulf water with the seas to the north (Church and Forbes 1981). Seasonal water temperatures range from 22 to 32°C inshore and from 25 to 31°C offshore (Somers 1994).

Sediments of the Gulf are divided into three zones: muddy inshore zone in sheltered embayments around river mouths, nearshore zone of relic deposits of diverse origin, and offshore depositional zone where suspended particles settle on the already present coarser sediments (Somers 1994).

13.1.3 Arnhem Coast

The Arnhem Land coast has many similar features to the Gulf of Carpentaria. One notable difference is the shelf gradient of the Arnhem Coast, which is much steeper than that of the Gulf. Fishing extends into offshore waters to around 70 metres deep. Sheltered embayments like those at Port Essington and Snake Bay are important nursery areas for this region of the NPF (Somers 1994).

13.1.4 Joseph Bonaparte Gulf

Joseph Bonaparte Gulf is subject to a much greater tidal range than the rest of the NPF. It is fed by the Ord and Victoria Rivers which are major river systems separated by stretches of low-profile shore backed by salt flats. Fishing extends offshore to depths of up to 85 metres (Somers 1994). Sediments are dominated inshore by biogenic gravels and sands grading to biogenic muds offshore.

For information on the bioregions (as determined by the Interim Marine and Coastal Regionalisation for Australia (IMCRA)) that occur within the NPF see Appendix IX.

13.2 Marine Protected Areas

In addition to management closures of the fishery there are a number of other areas protected by legislation located within the NPF. Most of these occur within areas that are already closed off to any fishing activity, are close to the shore and/or are part of terrestrial parks.

The only marine park in the NPF is the Cobourg Marine Park, which is located in the waters surrounding Cobourg Peninsula, approximately 220km north-east of Darwin. The Park occupies an area of approximately 229,000 hectares and is protected under NT legislation.

Cobourg Marine Park contains extensive live coral reefs and seagrass meadows, and is rich in marine life.

The conservation values of the Park are:

- the diversity of marine habitats
- the occurrence of live coral reefs and extensive seagrass meadows;
- the occurrence of breeding grounds for dugong, turtles and other marine life;
- the occurrence of critical habitat for a variety of marine animals;
- the occurrence of nursery areas for marine life in the form of a well-developed benthos;
- the presence of endangered species such as dugongs, turtles and the estuarine crocodile, *Crocodylus porosus.*

The Park also holds recreational, historical, educational and aboriginal values.

A management plan is currently being developed for Cobourg Marine Park. It is intended at this stage that the Park be managed as multiple use providing protection for marine biodiversity within the Park while allowing sustainable commercial and recreational use of the Park's resources. NPF vessels trawl in the northern portion of the Park. To ensure the interests of the NPF are taken into account when making management decisions for the Park, an AFMA representative is included as an observer on the Cobourg Fishery Management Area Advisory Committee (CFMAAC). This committee was established in January 1999 under the NT *Fisheries Act*.

Following consultation between the NT Government and fisheries stakeholders, an area of sea surrounding Cobourg Marine Park, but extending to the high water mark, has been declared by the NT Minister for Primary Industry and Fisheries under section 22a of the Fisheries Act to be a Fishery Management Area.

It is intended that fishing and any utilisation of aquatic resources within the Marine Park/Fishery Management Area be controlled under the Fisheries Act through Fishery Management Plans. Close consultation will be undertaken with the Commonwealth government over matters relating to the NPF.

The area of the NPF is encompassed in the area of the Northern Regional Marine Plan and preliminary work on the plan has been commenced by the National Oceans Office. There is an expectation that this will lead to further marine protected areas in the region.

13.3 Other Fisheries

13.3.1 Australian commercial fisheries

The NPF is one of many State and Commonwealth managed commercial fisheries located in northern Australia. Other fisheries that border the NPF or share common waters include some Commonwealth, WA, NT and Queensland fisheries:

Commonwealth fisheries

- Torres Strait Prawn Fishery (79 licences issued + 3 reserved for traditional inhabitants which are currently not being used)
- Eastern Tuna and Billfish Fishery (313 Fishing Permits issued)
- Western Tuna and Billfish Fishery (79 Fishing Permits have access to waters north of 34°S off the west coast).

WA fisheries - (number of licences issued as at 23 May 2001 unless otherwise stated)

- Kimberley Prawn Fishery (KPF) (134 licences but only 50 active in any one year)
- Kimberley Gillnet and Barramundi Fishery (7 licences)
- Northern Demersal Fishery (NDF) (11 licences but 7 boats operational at present)
- Spanish Mackerel Fishery (4 operators in the Kimberley area plus activity from the NDF boats and maybe some of the KPF boats – it is currently an open access fishery with other WA fishing boat licences potentially able to operate in it.

NT fisheries - (number of active licences as at 22 May 2001)

- Mud Crab Fishery (49 licences)
- Coastal Line Fishery (64 licences)
- Timor Reef Fishery (13 licences)
- Shark Fishery (21 licences)
- Demersal Fishery (60 licences)
- Spanish Mackerel (19 licences)
- Barramundi Fishery (26 licences)
- Trepang Fishery (6 licences)
- Coastal Net Fishery (14 licences)
- Squid Jigging Fishery (1 licence)
- Bait Net Fishery (3 licences)
- Mollusc Fishery (2 licences)
- Finfish Trawl Fishery (1 licence)
- Development fishery – Coast Net (5 licences)
- Development fishery – Jellyfish (1 licence)

Queensland fisheries - (number of licences issued as at 23 May 2001)

- Queensland Otter Trawl Fishery (560 licences)
- River Beam Trawl Fishery (40 licences)
- Gulf of Carpentaria Inshore Finfish (net) Fishery (100 licences)
- Queensland Tropical Inshore Finfish (net) Fishery (1020 licences)
- Crab Pot Fishery (890 licences)
- Queensland Harvest Fisheries (225 licences)
- Queensland Line Fishery (601 licences)
- Queensland Fisheries Joint Authority (line) (100 licences)
- Pearl Fishery (8 licences)
- Crayfish Fishery (30 licences)

Many NPF vessels are endorsed to operate in other fisheries as well as the NPF. Coordination between the jurisdictions for fishing in the area is provided through three forums:

1. Natural Resource Management Ministerial Council and Natural Resource Management Standing Committee;

2. The annual Northern Fisheries Managers Workshop; and

3. The inclusion of a permanent observer from the States/Territory on NORMAC.

13.3.2 International Commercial Fisheries

Until recently, Australian-flagged NPF vessels were able to fish in Indonesian waters, with many operating in Indonesia during and after the NPF season. This situation changed in early 2000, with only Indonesian-flagged trawlers now authorised to operate in Indonesian waters, making it difficult and expensive to operate trawlers in both areas. Most NPF operators restrict their fishing to the NPF only. This situation is similar for Papua New Guinea and other nations immediately north of Australia.

13.3.3 Recreational Fisheries

Recreational fishers are allowed to use hand-held seine or bait nets of restricted sizes for catching prawns in both Queensland and the Northern Territory. The NPF area is popular with recreational fishers targeting species other than prawns. Operators and management regard the impact of recreational fisheries on the NPF as insignificant.

13.3.4 Aquaculture

An OCS agreement exists between the Commonwealth, Northern Territory and Queensland governments, which permits licensed aquaculturalists to contract NPF-entitled operators to trawl for gravid prawns for use in the aquaculture industry.

13.4 Other regional activities

13.4.1 Tourism

There is a small but increasing tourism component in the NPF. Tourists to Darwin, Weipa and Karumba often display an interest in commercial fishing activities, including trawling, and may participate in recreational fishing within the NPF zone. In addition to recreational fishing for visitors, commercial fishing camps and eco-tourism are becoming popular and there are a growing number of isolated resorts established in coastal areas bordering the NPF.

13.4.2 Mining

There is presently no mining at sea in the NPF area although exploration for oil, gas, diamonds and gold is underway or proposed in Joseph Bonaparte Gulf and the Gulf of Carpentaria.

13.4.3 Shipping

There is considerable sea-borne transport of bulk commodities (especially bauxite, manganese, lead and zinc ore), live cattle and other general freight through some of the NPF fishing grounds. Supporting this transport in several locations along the coast are port infrastructures which indirectly benefit the NPF fishing industry by providing improved port facilities but which may also pose some risks to the fishery (eg. dredging and spoil dumping, transhipment of metal concentrate at designated Gulf of Carpentaria roadsteads, and ballast water and exotic pests).

NORMAC has expressed concern about the potential impact on the NPF of contamination of prawns and sediments from zinc dust and other potential spillages when transferring cargo at the designated Gulf of Carpentaria roadsteads. Of particular concern is the south-east Gulf roadstead used by Pasminco's mining operations, as trawling also occurs in this area.

In November 2000, NORMAC considered advice from the REC on issues surrounding the barging and trans-shipment of heavy metals from both the McArthur River Mine and Pasminco Mine in the western and south-eastern Gulf of Carpentaria. NORMAC resolved that monitoring should be undertaken to assess any impacts from the roadstead on the NPF, and that this monitoring should focus on the Pasminco operations. Monitoring began in 2001 and was jointly funded by NORMAC and Pasminco.

13.4.4 Others

Other users of the NPF include researchers and conservation groups, who carry out various types of scientific and non-scientific research; prawn aquaculture operators and recreationalists.

13.5 Indigenous Interests

13.5.1 Native Title

Although no exploitation of offshore prawns is carried out by Indigenous people in the NPF, there appears to be an Indigenous interest in other fishery resources within the NPF area. Consequently there are a number of native title claims over marine waters.

The 11 October 2001 decision in the Croker Island Sea case recognised native title rights in relation to the territorial sea. The decision also established the primacy of the public rights to fish and navigate, and the international law right of innocent passage over native title rights and interests. The claim area was the sea in the Croker Island off the Northern Territory, within the NPF management area but not extending beyond the limits of Australia's 12 nautical mile territorial sea. The decision gives native title holders non-exclusive rights, amongst others, to fish, hunt and gather for personal, domestic or non-commercial communal needs.

13.5.2 Aboriginal Land

Over 84% of the Northern Territory coastline including land down to the low water mark is owned by Aboriginal people. This land has been granted to Aboriginal people under the Commonwealth *Aboriginal Land Rights (Northern Territory) Act 1976.* A permit is required to go ashore on this land unless there is a genuine emergency at sea.

13.5.3 Closed Seas and Areas

There are presently two area closures under the *Northern Territory Aboriginal Land Act 1990*. These are the Milingimbi Crocodile Island and Glyde River area and the Castlereagh Bay/Howard Island area. A permit issued by the Parks and Wildlife Commission of the Northern Territory on behalf of the Cobourg Peninsula Sanctuary and Marine Park Board is required to enter Gurig National Park.

13.5.4 Sacred Sites

In the Northern Territory all places which are sacred or otherwise of significance according to Aboriginal tradition are protected under the *Land Rights Act* and the *Northern Territory Aboriginal Sacred Sites Act*. This means that sacred sites are protected whether or not they have been 'Declared', 'Registered' or otherwise brought to official attention.

Previously the Aboriginal Areas Protection Authority has received repeated complaints from traditional owners about breaches of the *Northern Territory Aboriginal Sacred Sites Act* by NPF trawlers anchoring in 'No Access' areas.

Each season AFMA provides operators with the Aboriginal Areas Protection Authority contact details and all operators are requested to find out in advance where sacred sites are located before commencing their operations and to ensure that their activities do not interfere with these sites.

14 Other impacts

14.1 Pollution

Pollution of the marine environment by ships of all types, including fishing vessels, is strictly controlled by the International Convention for the Prevention of Pollution from Ships (known as MARPOL 73/78). Australia is a signatory to this convention, which is now enforced in over 100 countries. The Australian Maritime Safety Authority administers the Convention and its regulations are implemented by Commonwealth and State/NT legislation.

Penalties for not complying with the law are up to $200,000 for individuals and $1 million for companies. The Australian MARPOL regulations apply to Australian fishing vessels wherever they are operating. Australian laws can be applied against foreign fishing vessels operating anywhere within Australia's exclusive economic zone.

Section 8.7 of the Code of Conduct for Responsible Fisheries (administered by the Food and Agriculture Organisation of the United Nations) also outlines measures to protect the aquatic environment.

14.1.1 Oil Pollution

The discharge of oily mixtures and disposal of used oil filters into the sea is prohibited. Vessels under 400 tons must comply with the discharge restrictions but are exempted from any specific shipboard equipment requirement. In most cases this means that oily residues must be stored onboard for disposal at onshore waste reception facilities. This includes diesel, hydraulic fluids, and bilge water with any concentration of oil.

The only allowable discharge of an oily mixture is where a discharge rate of 15 parts of oil to one million parts of water (15ppm) is achieved through oil filtering/separating equipment. All vessels over 400 tons are required to be fitted with this type of equipment which must also be approved to meet standards set by the International Maritime Organisation.

The NPF has seen considerable improvements in the management of hydrocarbons in fleets operations over recent years. Many vessels are fitted with waste oil and toilet tanks that can be pumped ashore at the end of each season. Other operators have avoided the need for these storage tanks by using synthetic oils to extend oil change intervals (some modern vessels require oil changes once each year, while in port).

Fuel & oil spillage kits are also becoming a common feature of many NPF vessels, as well as the implementation of health and safety training in the handling of oil, old nets and other waste.

14.1.2 Other Waste Disposal

Under MARPOL regulations, it is prohibited to dispose of plastics into the sea, and no other garbage may be discharged within 12 nautical miles of the nearest land. Most vessels retain all old netting, plastic and non-biodegradable waste on board for

unloading onto motherships or at ports.

Materials used at sea includes synthetic items such as trawl and fishing nets, synthetic rope, sheeting. "six pack" holders, fibreglass, strapping bands, plastic ice bags, oil filters, bait gaskets, paints, electrical/electronic, floats and disposable eating utensils

Regulations require fishing vessels to make every effort to retrieve all lost or damaged fishing gear. If fishing gear is lost, the operator must report the approximate position and reasons for the loss to the nearest port authority or the Australian Search and Rescue Centre in Canberra. This allows other vessels to look out for and retrieve the gear. Since the transition to gear SFRs took place, there is a requirement that all nets used by operators in the NPF be tagged with an identification code. This will assist in the identification of owners of lost gear.

14.1.3 Onboard garbage waste management

MARPOL 73/78 requires vessels over 400 tons to develop a waste management plan that contains procedures for collecting, storing, processing and disposal of garbage. Ships must be fitted with appropriate garbage handling equipment such as compacters or incinerators.

Vessels over 400 tons need to enter details of every garbage incineration or disposal in garbage record book. The record book and any receipt for using a waste reception facility in port must be kept for two years and be available for inspection by authorities

All vessels over of 12 metres or more in length are required to display placards setting out the disposal requirements of MARPOL 73/78.

14.1.4 Discarded Fishing Gear on Australia's Northern Beaches

'Ghost fishing' is a process where lost or discarded fishing gear continues to passively attract or capture marine life. It has become an issue of concern in many commercial fisheries worldwide. Lost fishing gear and gear scraps can effect marine life by ingestion and entanglement. Some species, particularly turtles, eat pieces of fishing floats and line and die from blocked or damaged digestive tracts (Laist 1995).

Concerns about fishing gear debris on Australia's remote northern beaches were raised by the Anindilyakwa Land Council, who represent the traditional interests of the Anindilyakwa speaking people who inhabit Groote Eylandt. In response to these concerns, AFMA and NORMAC initiated an intensive survey, which was funded by the NPF and carried out by members of the Angurugu community. Marine debris was collected from all accessible Groote Eylandt beaches over a seven month period beginning in December 1997.

Fishing gear related debris comprised the overwhelming majority of the debris on all beaches. Large marine debris densities were recorded on the north, east and south coasts of the island. The overall average debris density recorded was 1.098 kg km^{-1} (8.32 items km^{-1}). This weight was many times greater than any similar studies previously undertaken in Australia. Discarded trawl netting and gill netting fragments likely to have originated from Indonesian and Taiwanese fishers operating in the

Arafura and Timor Seas constituted the majority (84%) of the pollution, in terms of weight. 34% of the total number of items, but only seven percent of the overall weight of debris collected was identified as being similar to those materials used by Australian prawn operators.

PART THREE

ENVIRONMENTAL ASSESSMENT

Environment Australia, in conjunction with AFMA, developed the Guidelines for Assessing the Ecological Sustainability of Commercial Fisheries (the Guidelines), which consist of a series of guidelines under objectives and two overarching principles. In essence, the guidelines require that data collection, assessment and management responses in place for target and bycatch species and the broader environment are adequate to demonstrate that a commercial fishery is being managed in an ecologically sustainable manner. The Guidelines are a central component of the Terms of Reference for the Strategic Assessment of the Northern Prawn Fishery (Terms of Reference). The Terms of Reference and Guidelines are at Appendix I.

The Guidelines are addressed in relation to the NPF Fishery below.

15 Assessment of ecological sustainability

PRINCIPLE 1 A fishery must be conducted in a manner that does not lead to over-fishing, or for those stocks that are over-fished, the fishery must be conducted such that there is a high degree of probability the stock(s) will recover.

Objective 1 **The fishery shall be conducted at catch levels that maintain ecologically viable stock levels at an agreed point or range, with acceptable levels of probability.**

Information requirements

Guideline 1.1.1 **There is a reliable information collection system in place appropriate to the scale of the fishery. The level of data collection should be based upon an appropriate mix of fishery independent and dependent research and monitoring.**

A comprehensive data collection program has been established for the NPF to ensure reliable information is available on which to base management decisions. Information is maintained on all target prawn species taken in the NPF. The comprehensiveness of the program is a product of the high value of the fishery, the management needs of the fishery and the importance of stock assessment to determine the status of the target species.

The data collection program is based on logbooks that provide for catch data to be recorded daily onto logsheets by NPF operators. Processor records are obtained for

landings data which are used to verify the logbook catch.

Vessel gear details are also collected which tracks changes in gear and technology in the fishery. This information assists in stock assessments and research being undertaken on effort creep and fishing power studies.

This data forms the basis of the NPF's fishery dependent research program. Targeted fishery independent research is also undertaken in the NPF to capture data required for management not obtained from logbooks or associated fishery data collection programs. Figure 8 illustrates the comprehensive data collection and processing system in place for the NPF.

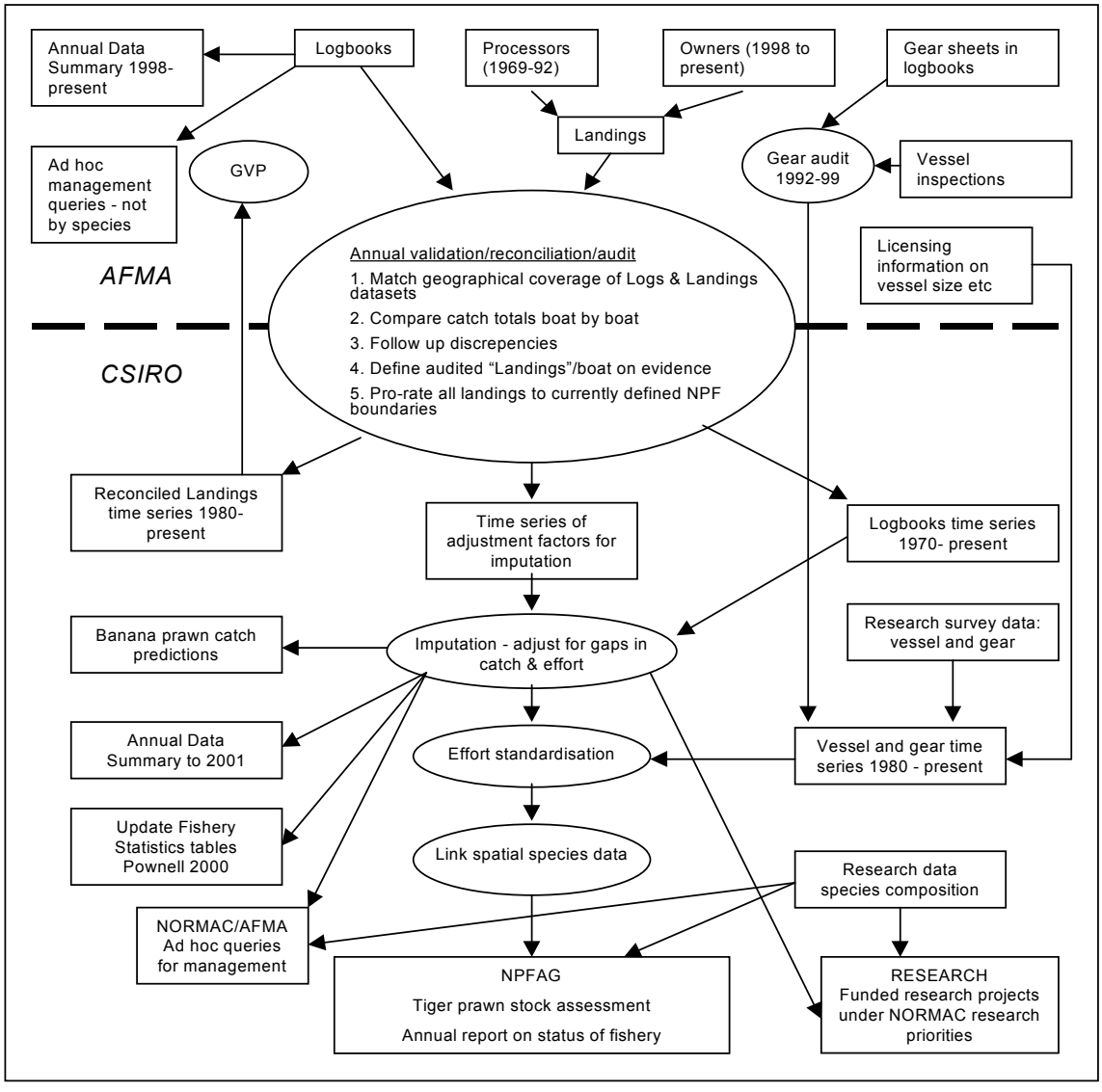

Figure 8. Sources of data for Northern Prawn Fishery, and some routine data processing pathways

(Source: CSIRO, May 2001)

Logbook program

The NPF logbook system was introduced in 1970 by AFMA's predecessor, the

Australian Fisheries Service. Regulation 32 of the *Fisheries Management Regulations* requires the logbook to be completed by all boats entitled to fish in the area of the NPF. Penalties apply to those responsible, if submission of logbook returns is not carried out according to the requirements. This includes giving false or misleading information. The penalties include fines of up to $27,500, or imprisonment for up to 12 months.

The logbook system includes a Daily Fishing Log–NP13, which is completed by skippers daily. The data obtained by logbooks includes the total catch weight of each target species, equipment used, hours trawled, the location of the greatest catch, and other information. Each NPF trawler has submitted a logbook record for every fishing day in the NPF since 1996.

The daily logsheet is forwarded to AFMA for entry into the Australian Fishing Zone Information System (AFZIS) database. The AFMA logbook section, with the assistance of CSIRO Marine Research, produces data summary reports drawing on information supplied by the daily log-sheets on a biannual basis. These reports contain catch and effort statistics by prawn species group, area, time and fishery, and are provided to all operators. The 2001 Data Summary Report is at Appendix X.

Data Verification

Data collected through the NPF logbook program is verified in the following ways:

- trawler owners complete landing reports to verify the logbook data, using a seasonal landing return sheet (Appendix XI), which includes information on the weights of prawns landed. In 2000, all but nine of the 121 trawler logbooks recorded catches within 10% of that recorded in the landing returns for each of the major prawn species groups. (bananas, tigers, endeavours and kings).
- information collected through logsheets is entered into the AFZIS database. The database is subject to validation to ensure the results fall within prescribed ranges.
- each skipper completes a transhipment record each time the trawler unloads product to a carrier boat (mothership). The unloading records are verified by the carrier boat operator. The data is used to verify logbook data.
- AFMA coordinates an at-sea logbook monitoring and enforcement program. Fisheries officers board at least 50% of the boats in the NPF each year and check catch on board against details in the logbook. During 2001, compliance officers boarded 95 trawlers. Two minor breaches were detected.

Data Reliability

The CSIRO have recently finalised a report ‘Accuracy of catch and effort data for the Northern Prawn Fishery’. The report concluded that annual landings in the NPF have been estimated reasonably accurately since 1980 by combining information from logbooks to supplement landed weights from prawn processing companies and trawler owners.

There have been periods during the early history of the fishery when not all operators provided logbook information. A detailed augmentation process is used to estimate the missing logbook information so that the total logbook catch corresponds to the landings. This information is needed for species specific stock assessments. A

detailed investigation of possible errors in this process has been investigated by Dichmont *et al* (2001) and found to be small.

The NPF has a long time series of data available for scientific analysis. CSIRO holds logbook data and annual reconciled landings since 1970. AFMA has had primary responsibility for collecting, collating and verifying the logbook and vessel register data since 1980. CSIRO has received annual updates from AFMA.

Research

The NPF was largely established through a research survey program carried out in the 1960s and research continues to be an integral part of the management decision making in the NPF. Research for the NPF is coordinated by the NPF Research and Environment Committee (NPFREC), who are responsible for developing the Five Year Strategic Research Plan for the fishery (Appendix XII contains the NPFREC terms of reference).

NORMAC takes into account the objectives of the *Fisheries Management Act 1991*, *Fisheries Administration Act 1991* and the NPF Strategic Plan 2001-2006 when evaluating research priorities for the NPF and producing the Five Year Research Plan. The Committee also takes into consideration other relevant government policies and their implications for management, and research into the fishery.

The first Research Plan was developed in 1997 and covers the period from 1997/98 to 2001/2002. The Research Plan outlines the Research Priority Areas for the fishery, which NORMAC reviews and updates annually. The research priorities for 2000/01 for the NPF are set out in the 2000/2001 NPF Five Year Research Plan and provide a guide to researchers on the needs of the fishery (Appendix XII).

Research projects are usually funded from several sources, the most important being the FRDC. The NPF industry contributes between $250 000 and $300 000 annually in the form of a compulsory levy to the FRDC (calculated as 0.25% of the gross value of production of the fishery). From 2001/2002, the industry has agreed to voluntarily increase its research levy to FRDC by $100 000 per year. In addition, the NPF industry contributes significant funds to support several projects that fall outside the normal funding cycle. These are known as Management Initiated Research Funds (MIRF). For 2002/03 NORMAC has agreed to an additional NPF MIRF contribution of in excess of $350,000.

Research agencies, particularly CSIRO Marine Research, also spend large amounts of their research funds on the NPF. Funds are also available from various research agencies and funds, which are detailed in Part 2 of this document.

Stock assessment continues to be a high research priority for the NPF. Researchers utilise the accurate logbook data available for the NPF. A summary of research ongoing and research completed since 1997 is included in the NPF Five Year Research Plan contained in Appendix XII.

Recent research (the last three years) includes studies into:

- spatial distribution of stocks (eg. Target Species Research project reference no. 5);

- population dynamics of prawn fisheries (eg. Target Species Research project reference no. 6);
- indices of recruitment and effective spawning for tiger prawn stocks (Target Species Research project reference no. 2).

A summary of these projects and other research projects for target, bycatch and other NPF research are provide in Attachment A.

Fisheries Independent Data

In August 2001, NORMAC and AFMA agreed that a fishery independent data collection program should be implemented for the fishery. To meet this requirement CSIRO has designed a survey.

The survey has two modules:

- a January survey which provides data for a fishery independent recruitment index for banana, tiger and endeavour prawns. This survey will be carried out annually; and
- a September survey which would provide information to examine any spatial contraction of the fishery and attempt to quantify changes in fishing power, one of the key areas of contention with the current model.

The survey program commenced in August 2002. While there is a long-term commitment to the carrying out these surveys, initially there will be a pilot year for each survey. After the completion of the pilot survey the data collected and methodology will be re-evaluated and a long-term design finalised.

Assessment

Guideline 1.1.2 **There is a robust assessment of the dynamics and status of the species/fishery and periodic review of the process and the data collected. Assessment should include a process to identify any reduction in biological diversity and/or reproductive capacity. Review should take place at regular intervals but at least every three years**

Guideline 1.1.5 **There is a sound estimate of the potential productivity of the fished stock/s and the proportion that could be harvested.**

The Northern Prawn Fishery Assessment Group (NPFAG) has responsibility for assessing the dynamics and status of NPF species. NPFAG comprises fishery scientists, industry members, fishery economists, and the AFMA NPF Manager. The assessment of the NPF is an ongoing process and is discussed at each meeting of the NPFAG (at least three times each year). The Terms of Reference for the NPFAG are provided in Appendix XIII.

The Group uses data from both logbooks and research in its stock assessment work, and bases much of its assessment on extensive modelling developed for the major species of prawn targeted in the NPF.

Results of the NPFAG's assessment process are published annually in NPF Fishery Assessment Reports. A copy of the 2000 report is included as Appendix XIV. These reports include analysis of previous and current stock assessments, implications of prawn stock assessments for management, the economic status of prawn stocks, environmental and ecological factors affecting prawn stocks and current and future research within the NPF.

The NPFAG currently monitors trends in overall catch, catch per boat and catch per unit of effective effort for target species. Persistent downward trends over three or more years in any of these parameters are investigated to determine whether there is a biological problem with stocks.

The strength of NPF stock assessments is based in the NPFAG's use of models, particularly those used to assess tiger prawns, which make up a significant percentage of the total prawn catch. Most of the models have shown that tiger prawns exhibit a strong stock-recruitment relationship. The models are peer reviewed regularly and include:

- Wang and Die model (1996)
- Haddon Model (2000)
- Modified Wang and Die model (2000)
- Dichmont and Punt model (2001)

A new banana prawn assessment has been developed by Vance *et al* (in prep).

A detailed description of the models is provided with the stock assessment reports contained in Appendix XIV.

Research into improved stock assessment techniques is given a high priority. The drive for continuous improvement has resulted in a move away from providing results as deterministic outcomes, to results of a stochastic nature that allows NORMAC and AFMA to more realistically consider uncertainty in future management decisions.

The Dichmont and Punt model (Application of a weekly delay-difference model to commercial catch and effort data for tiger prawns in Australia's Northern Prawn Fishery) replaces the previous Wang and Die and modified Wang and Die models for assessing tiger prawns.

The model and 2001 stock assessment of prawns has been independently reviewed by Dr Rick Deriso, an international stock assessment expert. Dr Deriso concluded in his review that the assessment is probably the most comprehensive of any prawn populations in the world. He added however that the assessment is based on limited data and some results exhibit a large degree of uncertainty however it is still reliable enough to use to make management decisions. Dr Deriso provided a series of recommendation to assist in improving the stock assessment and these are being worked through systematically with most having been implemented. Most importantly Dr Deriso recommended the survey to collect fishery independent data. This survey has been designed and will commence in late August 2002.

Stock Assessment summaries

Full assessment reports are contained in Appendix XIV.

Tiger Prawn Fishery

In the tiger prawn fishery, the management objective is Maximum Sustainable Yield (MSY). For management purposes this is broken down into the levels of spawning stock which produce maximum yields (S_{MSY}), and the level of fishing effort which produces maximum yields (E_{MSY}). Until 2001, the target reference point was S_{MSY}. The E_{MSY} was essentially treated as a limit below which serious remedial action had to take place.

In July 2001, the Northern Prawn Fishery Assessment Group (NPFAG) released its assessment of the state of tiger prawn stocks. The results of the assessment are detailed in the NPFAG report 'Status of tiger prawn stocks at the end of 2000' (Appendix XV) and a review of the NPFAG report 'A review of the 2001 assessment of tiger prawns in the Northern Prawn Fishery, Deriso, October 2001' (Appendix XVI).

The review by Deriso supported the general conclusion of NPFAG that current biomass of brown tiger prawns is well below abundance levels characteristic of the early 1970's and conclusively below levels (S_{MSY}) that support maximum sustainable yield (MSY). Current biomass of grooved tiger prawns is also likely below S_{MSY} abundance levels that support MSY, but not as depleted as the brown tiger prawn population. It was noted that Dr. Deriso had proposed that in accordance with world practice, E_{MSY} should be limit reference point, not a target.

The assessment of tiger prawn stocks 2000, based on the Dichmont and Punt model, was used for the assessment. In addition to providing estimates of (S_{MSY}) and (E_{MSY}), the new model provides information on how well those quantities were determined by estimating uncertainty associated with the analysis. Because of this uncertainty and the depleted status of the tiger prawn stocks, NORMAC in August 2001 agreed to rebuild brown and grooved tiger prawn stocks to S_{MSY} within 5 years (by the end of 2006). Furthermore, the MAC agreed to a new, more conservative target reference point: 'there is a 70+% chance that the spawner population at the end of 2006 will be above or at spawner level targets' (at present S_{MSY}). A framework for evaluating appropriate management strategies is being developed (Target species project No 7).

The 1999/2000 recruitment level for brown tiger prawns was the lowest on record. Recruitment of grooved tiger prawns showed a slight increase over 1998/99 levels, but remained well below the 10 year average. The assessment concluded that current levels of fishing effort were too high to confidently promote recovery of the species within ten years. Management measures to respond to the most recent assessment are detailed under guideline 1.1.7 and include a 25% reduction in gear and 13% decrease in the length of the fishing season.

Historical catch per unit effort (CPUE) data for the tiger prawn fishery is consistent with the assessment that both tiger prawn species are currently over-exploited. This is largely a result of particularly high levels of fishing effort that existed in the early to mid 1980s. NORMAC attempted to address this situation through a number of management responses, including the substantial effort reductions that occurred in the late 1980s and early 1990s. While this did not decrease effective fishing effort below E_{MSY} levels as desired, the extended temporal closure during the 1999 season was effective in cutting effort on both tiger prawn species.

Apart from fishing effort, another possible explanation for the failure of stocks over recent years is that recruitment had been influenced by environmental factors that affect larval dispersal and/or productivity in nursery areas. CSIRO research indicates that environmental variation does not have a significant effect on juvenile tiger prawn abundances in coastal nursery areas, except in extreme conditions such as severe cyclones. Juvenile numbers are mostly determined by offshore post larval recruitment. Further CSIRO research is attempting to establish the factors influencing offshore spawning and larval and post larval migrations (Target Species Research project no.2), and to identify the effective spawning area for each species.

Banana Prawn Fishery

The size of banana prawn stocks and the high inter-annual variability in catches is believed to be strongly linked to environmental factors, particularly the level of rainfall. In some areas the level of rainfall at certain times of the year and other environmental factors can explain over 80% of the variation in catches (Vance et al, 1985 and 1998).

The link to environmental factors has led to the application of stock prediction style assessments in the banana prawn stock assessment process. The environmental link is currently being tested in a project being conducted by the CSIRO (Target Species Research project reference no. 12). The research will also provide a new assessment of common banana prawn resources in the NPF and develop better predictive models to forecast the annual catch of banana prawns in future. The project is expected to be completed shortly.

The banana prawn fishery in the Gulf of Carpentaria was assessed as being fully exploited as early as 1974, based on yield-per-recruit model (Lucas *et al* 1979). Accordingly, there has been little increase in the nominal fishing effort directed at banana prawns since the early 1970s and the annual catches appear to be a reflection of annual recruitment.

Over the past 25 years, the estimated average annual yield from the banana prawn fishery has been about 4000 tonnes, ranging from 2000 tonnes to 14000 tonnes. Despite a small spatial expansion in the early 1980s with the discovery of red-legged banana prawns in Joseph Bonaparte Gulf (JBG) catches in the 1980s were on average lower than those of the 1970s.

There has been no change in the assessment of the white banana prawn fishery following the 1997, 1998 and 1999 seasons. This fishery is considered to be fully exploited and although there is no firm evidence of recruitment over-fishing, this possibility cannot be confidently discounted. AFMA funded a research project, started in 1999, to test this contention.

Preliminary results suggest that there may be an underlying stock-recruitment relationship in some regions of the NPF. The project is showing a relationship between the stock size in one year and subsequent recruitment in certain regions in the Gulf of Carpentaria.

The estimated MSY in banana prawns of about 3500 tonnes represents the median catch over the last 28 years (reference). The high year-to-year variation in catch appears to be linked to rainfall (Vance *et al.* 1985) but this has been questioned in the

light of the experience of recent years. For example, the low 1998 Gulf of Carpentaria catch of 2444 tonnes was below expectations created by the high rainfall during the 1997/98 wet season.

Similarly the 1999 catch in the Gulf of Carpentaria of about 2000 tonnes was well below the expected catch. Part of the large uncertainty in the predictions is due to the unusual patterns of rainfall in the southern Gulf of Carpentaria in recent years.

Both old and new banana prediction models underestimated the banana prawn catch substantially. The 2000/01 season was unusual with record high rainfall in December, then low rainfall in January and than very high rainfall in February in the western part of the Gulf of Carpentaria. At present the NPF may be experiencing climatic conditions unlike the model has ever had to deal with previously, and therefore cannot accurately predict catch levels.

During 1996, 1997 and 1998, CSIRO conducted research on the status of stocks of red-legged banana prawns in the JBG (Target Species Research project reference no.4).

The research involved tagging and releasing 18000 prawns during 1997-98 with the aim of improving estimates of growth and survival. With the collaboration of fishers, more than 1400 tags were returned and analysed. Preliminary analysis of this tagging experiment has provided the first estimates of mortality rates and biomass for red-legged banana prawns in Australia. Natural mortality rate was estimated at 4.5% per week, similar to the rate estimated for white banana prawns in the Gulf of Carpentaria. The estimate of recruitment for 1997 was three times as large as that in 1998. Fishing mortality was twice as high in 1997 as it was in 1998, because the high recruitment during 1997 in the JBG attracted the largest levels of effort since 1988.

With these results and the historic logbook data provided by industry, Die and Loneragan (1999) have estimated the average biomass and fishing mortality for the period 1980-98. These estimates were obtained for a number of different assumptions that could be made about the annual increase in fishing power, namely 0%, 2% or 5% per annum. More recent trends in stock size from 1993 to 1997 are, however, largely insensitive to the value of fishing power increase and suggest that the stock increased during that period to about 800 million prawns.

There are two alternative interpretations of these results:

- If effort creep in the fishery has been low, then population abundance would have fluctuated little (about 4500 million) for the period 1981-92. Since 1993 stocks would have tended to increase but also would have fluctuated considerably more than before, possibly due to changing environmental conditions
- If effort creep is equivalent to that of the tiger prawn fishery (and GPS possibly did have a major effect in this area), then stocks would have decreased in abundance by half between 1981 and 1992. Between 1993 and 1995 stocks would have increased as a result of decreases in effort brought about by the restructure and the displacement of effort to the Gulf of Carpentaria. Since 1996, stocks would have decreased again in the JBG possibly as a consequence of poor recruitment of tiger prawn stocks in the Gulf of Carpentaria which has subsequently led to a re-direction of effort back to the JBG.

Regardless of the effort creep scenario adopted, Die and Loneragan (1999) concluded that there is no evidence of recruitment overfishing in the JBG.

Endeavour Prawn Fishery

The total catch of endeavour prawns ranges from about 400 – 1,800 tonnes a year with the long term average being about 1,000 tonnes.

Relatively little is known about the biology of Endeavour prawn species and the status of the stocks. Park (1999) has studied the stock status and reproductive dynamics of Endeavour prawns in Albatross Bay using commercial logbooks from 1970-97 and research survey data from 1986-92.

Because the spawning stock recruitment relationship was linear, a biological reference point, $F_{rep,}$ was used in place of MSY to estimate the stock status. F_{rep} is defined as the fishing mortality associated with recruitment levels that would replace their parent stocks. The F_{rep} estimate for *M. endevouri* was 4502 boat-days, assuming a 3% annual increase in fishing power. This suggests the prawn population at present is underfished.

However, assuming a 5% annual increase in fishing power, the estimate is 787 boat-days, which suggests the population is severely overfished. This high sensitivity in F_{rep} for *M. endeavouri* may be due to the relatively small total annual catch. The estimated stock recruitment relationship suggests a 3% rate is more appropriate that a 5% rate.

The F_{rep} for *M. ensis* was closer to the present level of fishing effort for both 3% and 5% rates of annual increase in fishing power.

Guideline 1.1.3 The distribution and spatial structure of the stock(s) has been established and factored into management responses

Research carried out in the NPF over the past 25 years has enabled the distribution and spatial structure of the target species of prawns in the NPF to be established. For example, Target Species Research project reference no. 5 and Somers and Kirkwood, (1984) provide further information.

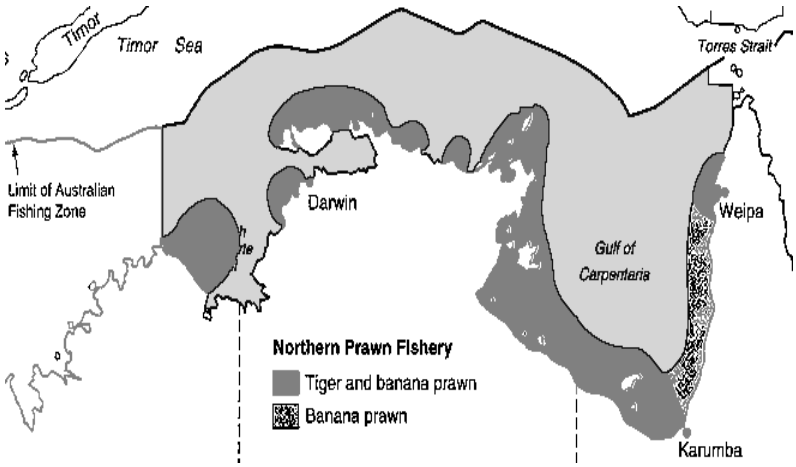

Figure 9 provides an overview of the location of banana and tiger prawns in the NPF.

Figure 9: Location of banana and tiger prawn stocks in the NPF.

Table 2 summarises the biological and spatial characteristics of the NPF target species.

Table 2: Biological and spatial characteristics of NPF target species

Scientific name Common name	Location in NPF	Spawning Migrate to fishing grounds	Age at maturity Max age (years)	Size at maturity Max size (cm)	Max weight (kg)
F. merguiensis White banana prawn	Gulf of Carpentaria: East, sth and west, Arnhem Land coast nth Fog Bay, Kimberley coast.	Spawn: March-May and Sept. – Nov. Migrate:May-July and Nov-Jan	0.5 1.5	2.6-3.4 CL/ 6CL	0.07
F. indicus Red-legged banana prawn	Joseph Bonaparte Gulf (JBG) Melville Island –Nth coast	All year	Unknown	Unknown 23TL	Unknown
P. semisulcatus Grooved tiger prawns	Gulf of Carpentaria: NE, West & Sth Arnhem Land coast off Melville Island, Port Essington, western JBG and Kimberley coast.	Spawn Aug-Oct and Jan-Feb. Migrate:Sept–Nov.	0.5 2	3 CL 5CL	0.09
P. esculentus Brown tiger prawn	Mornington Island, south-western Gulf of Carpentaria, Groote Eylandt, northern Arnhem Land coast.	Spawn year round. Peaks in Aug/Sept, occasionally March. Migrate: Nov-Jan.	0.5 2	2.6 CL 5.5 CL	0.09
M. endeavouri Blue endeavour prawns	Widespread. Mainly southern and western Gulf of Carpentaria.	Spawn year round but peaks Sept-Oct Migrate to fishing grounds Oct.-June.	0.5 / 1.5	1.8 / 4.7 CL	0.06
M. ensis Red Endeavour prawn	Melville Island, JBG, Weipa and western Gulf of Carpentaria	Spawn Oct.-Dec Migrate to fishing grounds Jan-June.	0.5/ 1.5	2.2 / 4.1 CL	0.06
M. latisulcatus Western king prawn	Southern and western Gulf of Carpentaria	Spawn in Sept and January-March. Remain in nursery areas 3 mths to 1 yr.	1-2/ 4	2.3-2.7 / 7.6 CL	Unknown
P. longistylus Red spot king prawns	Rare in the NPF.	Spawns in Gulf of Carpentaria June-September.	Unknown	2.4-3.3 CL/ 18 TL	Unknown
P. monodon Giant tiger prawn	Rare in the NPF, occasionally found in Albatross Bay and north Melville Island.	Spawn: peaks Aug-Nov and March-April. Migrate: when 80 mm long.	0.75/ Unknown	0.1 kg/ 33.6 TL	0.15

(adapted from Somers, 1994 and *Fishery Status Reports 1999* (BRS))

Extensive studies by CSIRO Marine Research, including commercial catch sampling and analysis of substrate composition, have shown that the adults of the two commercial species of tiger prawns have different spatial distributions. These are related to type of substrate and water depth. This has allowed the commercial catch category of tiger prawns to be approximately split between the two species according to the six-minute square grids.

With this more detailed information, stock assessments have been conducted separately for each species of tiger prawn. A new analysis, Dichmont *et al* 2001, has updated the species split methodology and included the potential for species split shifts over time and area. In addition a project has been funded to collect species split data during 2002 and 2003 to re-validate the species split.

Banana prawns may be confidently split into the two component species much more easily. Red-legged banana prawns are caught almost exclusively in deep water (>45 metres) in JBG and white banana prawns elsewhere.

At present information on the distribution and spatial structure of the stocks is not directly incorporated into the stock assessment process carried out by the NPFAG. A recent model developed by Dichmont *et al* have assessed the tiger prawn species by stock area with mixed success. The work is being addressed in a newly funded project to develop a fully spatial assessment model.

Each target species is subject to individual assessment, with results of this assessment influencing the type of management regime applied to the fishery by NORMAC. Where a threat to a species is identified action is taken to provide additional protection.

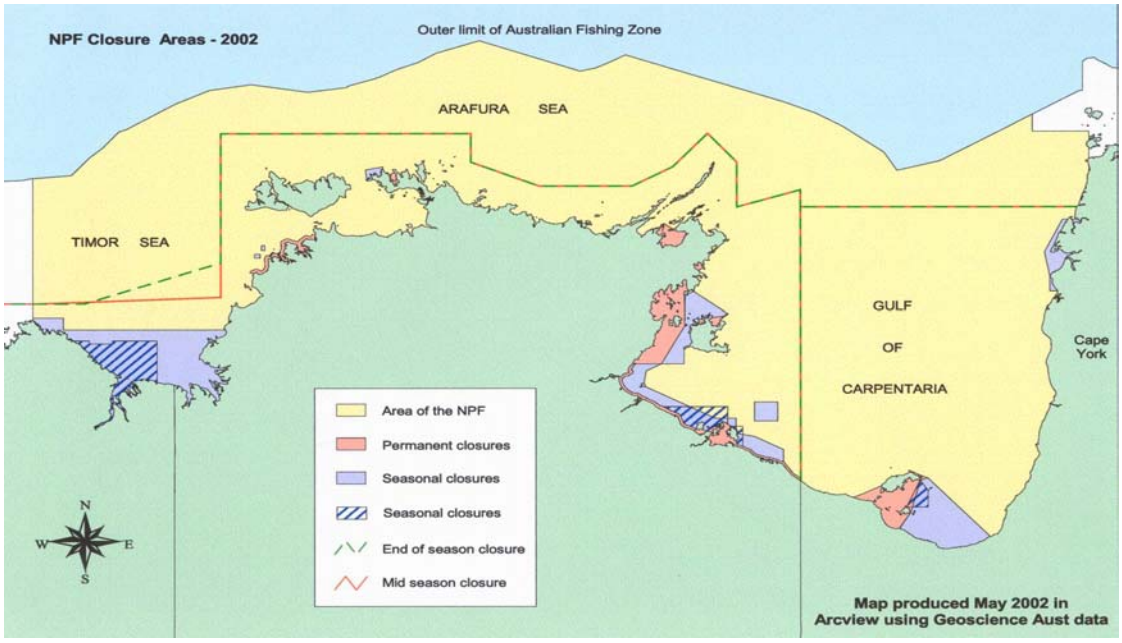

Figure 10: Northern Prawn fishery closure areas for 2002

A common management response to species threats, identified through spatial research and stock assessment, is to implement closures over areas of the fishery. Closures can be broadly categorised as either seasonal closures, area closures or daylight closures, and are implemented to limit both the effort in the fishery and prevent the take of juvenile prawns. Closures are also applied to protect nursery habitats such as seagrass beds. The map at Figure 10 shows the closures in place for 2002. More detailed maps of the closures in place for the fishery are included in Appendix IV.

A total of 2.1% of the total managed zone of the fishery is subject to permanent closures, while 6.3% is subject to seasonal closures. The decision to apply closures is often precautionary and based on anecdotal evidence supplied by operators. For example, if a large number of juvenile prawns have been caught in a certain area at a certain time of the year, NORMAC may decide to close the area to protect the juveniles.

Guideline 1.1.4 There are reliable estimates of all removals, including commercial (landings and discards), recreational and indigenous, from the fished stock. These estimates have been factored into stock assessments and target species catch levels.

The extensive catch data available through the NPF logbook program has enabled reliable estimates to be made of removals by commercial fishing. The reliability of these estimates is a result of AFMA's logbook verification process, where logbook data is validated against landing records for trawlers. In 2001, a further method of verification was implemented. Trawlers now complete transhipment documentation listing the quantity of all prawns and by-product unloaded. The person receiving the product certifies the documentation.

The commercial catch data is considered in the NPF stock assessment process, and applied to stock models to provide estimates on future catches of target species. These estimates are provided in the NPF Assessment Reports. There are no other commercial fisheries taking prawns in the area of the NPF. Catch statistics are outlined in the NPFAG's Fishery Assessment Reports, which detail catch tonnages of all target species for the respective year and compare these with previous years. Figure 11 and Table 3 shows the catch trends of the dominant NPF prawns caught over the past 32 years.

Discards of prawns are considered in the assessments. Discarding was more prevalent in the 1970's before freezer boats were operating in the fishery. Boats were landing prawns held in brine tanks and some prawn was discarded because of spoilage. Currently there is no evidence of systematic discarding. Discarding has been considered as a low risk by NPFAG as all boats have freezing capacity and the fishery is managed by input controls, therefore there is no economic incentive to discard catches. There is some anecdotal advice of very low levels of discarding during high catching banana prawn seasons where unusually high catches are taken.

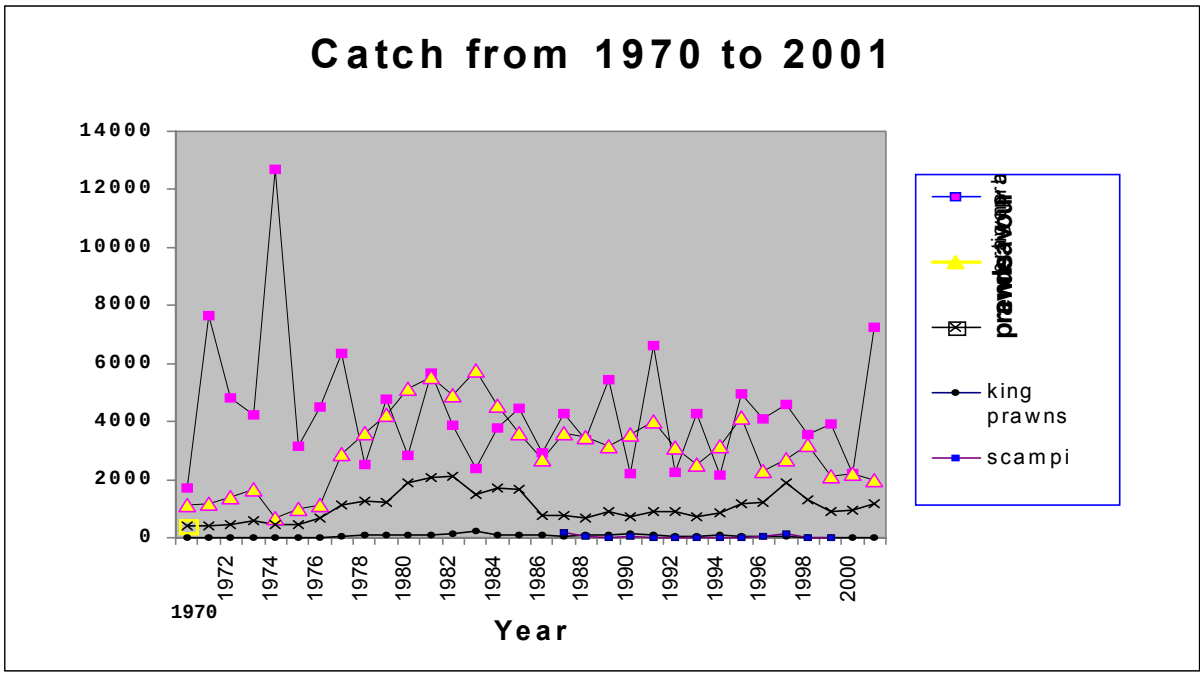

Figure 11: NPF Catch from 1970 to 2001 – (Source: Northern Prawn Fishery and Kimberley Prawn Fishery Data Summary 2001)

Table 3 Catch, effort and trawler numbers from 1970 to 2001

year	*banana prawns (tonnes)*	*Tiger Prawns (tonnes)*	*Endeavour prawns (tonnes)*	*king prawns (tonnes)*	*total prawns (tonnes)*	*number of trawlers*	*banana fishery effort (days)*	*tiger fishery effort (days)*
1970	1702	1138	417	0	3257	191	2041	5818
1971	7364	1183	400	0	8948	169	5571	6057
1972	4801	1380	472	0	6654	180	4327	7380
1973	4226	1672	594	0	6492	217	4917	7362
1974	12711	666	434	4	13815	196	7537	3439
1975	3160	973	444	6	4583	107	5361	6010
1976	4519	1118	675	5	6319	145	7238	6660
1977	6345	2900	1125	28	10398	193	7257	11673
1978	2535	3599	1240	82	7456	237	5569	18749
1979	4775	4218	1213	94	10300	240	7328	17791
'70-'79 average	*5214*	*1885*	*701*	*22*	*7822*	*188*	*5715*	*9094*
1980	2835	5124	1891	111	9964	269	8391	30594
1981	5672	5559	2073	95	13400	286	11524	31895
1982	3875	4891	2124	144	11036	271	8751	32956
1983	2382	5751	1488	207	9831	254	6856	34551
1984	3770	4525	1714	83	10095	252	5932	32447
1985	4469	3592	1671	77	9811	231	6946	26516
1986	2935	2682	748	85	6451	238	7132	26669
1987	4257	3617	772	65	8713	234	7954	22478
1988	3381	3458	669	81	7591	222	6655	26264
1989	5466	3173	909	85	9636	223	7439	27036
'80-'89 average	*3904*	*4237*	*1406*	*103*	*9653*	*248*	*7758*	*29141*

1990	2221	3550	735	128	6636	200	5044	25525
1991	6605	3987	879	81	11554	172	6515	20744
1992	2254	3084	880	47	6267	170	5132	21789
1993	4292	2515	733	35	7572	127	6299	16019
1994	2157	3162	872	72	6263	128	4955	18592
1995	4961	4125	1150	58	10294	125	4880	16834
1996	4078	2311	1235	41	7665	127	5525	16635
1997	4587	2694	1870	51	9202	129	5476	15385
1998	3569	3218	1322	20	8123	130	5301	18003
1999	3904	2136	885	21	6947	129	5639	12675
'90-'99 average	*3863*	*3078*	*1056*	*55*	*8052*	*144*	*5477*	*18220*
2000	2195	2190	958	13	5355	121	*3697*	*12736*
2001	**7245**	**1983**	**1157**	**4**	**10389**	**118**	***6247***	***10440***
'00-'01 average	*4720*	*2087*	*1058*	*9*	*7862*	*120*	*4972*	*11588*
'70-'01 average	4352	3005	1055	57	8469	188	6232	18366

Source: Annual reconciled landings figures and AFMA Logbook data.

The remoteness of the NPF restricts the level of recreational take from the NPF. The catch attributed to recreational fishers is negligible compared to the size of the commercial fishery, and the nature of recreational fishing in other Commonwealth fisheries. Unlike other Commonwealth fisheries, the NPF is not subject to tourism ventures that promote the recreational take of prawn species.

Management responses

Guideline 1.1.6 There are reference points (target and/or limit), that trigger management actions including a biological bottom line and/or a catch or effort upper limit beyond which the stock should not be taken

The NPFAG assesses the status of the NPF relative to these targets, and advises NORMAC on the effectiveness of different management strategies.

The long-term yield for the NPF is estimated to be about 8500 tonnes (4000 tonnes for banana prawns, 4000 tonnes for tiger prawns and 500 tonnes for other prawn species) (Taylor & Dichmont 2000). The white banana prawn stocks have been heavily exploited but appear to be more resilient than other species to the high level of exploitation. Nevertheless, this is being re-examined.

For several years now there has been evidence that the tiger prawn fishery is biologically over-exploited. Fishing effort levels on spawning tiger prawns are too high, so compromising subsequent recruitment to the fishery. The restructure of the fleet during 1987-93 significantly reduced the effort impact on tiger prawn stocks but not enough to allow these stocks to rebuild to their most productive levels.

In the tiger prawn fishery, the management objective is Maximum Sustainable Yield (MSY). For management purposes this is broken down into the levels of spawning stock which produce maximum yields (S_{MSY}), and the level of fishing effort which produces maximum yields (E_{MSY}). Until 2001, the target reference point was S_{MSY}. The E_{MSY} was essentially treated as a target rather than limit reference point until 1999/2000.

The review by Deriso supported the general conclusion of NPFAG that current biomass of brown tiger prawns is well below abundance levels characteristic of the early 1970's and conclusively below levels (S_{MSY}) that support MSY. Current biomass of grooved tiger prawns is also likely below S_{MSY} abundance levels that support MSY, but not as depleted as the brown tiger prawn population. It was noted that Dr. Deriso had proposed that in accordance with world practice, E_{MSY} should be the limit reference point, not a target.

In response, NORMAC in August 2001 agreed to rebuild brown and grooved tiger prawn stocks to S_{MSY} within 5 years (by the end of 2006). Furthermore, the MAC agreed to a new, more conservative target reference point that there is a 70+% chance that the spawner population after 2006 will be at or above S_{MSY}.

NORMAC has acknowledged that MSY is not the best type of target that may be available to the fishery. A successful proposal has been put forward by CSIRO for FRDC funding to assess options for alternative reference points and decision rules that may be applied under the new gear SFR-based management regime. The project aims to develop an alternative assessment models to complement, extend and correct, where necessary, existing assessment practices. The project also seeks to develop alternative management target and reference points together with the appropriate performance indicators. The objectives of the project are included in Target Species Research project reference no. 7.

It is unknown whether the current apparent failure of the tiger prawn stocks to recover in the Fishery is related to limited management options, serial depletion of stocks or to the use of the MSY and E_{MSY} management targets.

In species, such as prawns, whose dynamics are dominated by yearly recruitment variation, the MSY may well give a false expectation of stability. Management targets that relate to present conditions rather than to equilibrium conditions (eg. a target fishing mortality rate) may better serve intrinsically variable fisheries, such as prawns. However, reference points developed worldwide have concentrated on output controlled management systems.

The project is scheduled for completion in September 2003, at which time NORMAC and AFMA will consider implementing appropriate target and reference points.

Guideline 1.1.7 There are management strategies in place capable of controlling the level of take.

The NPF has a range of management strategies in place to control the level of take in the fishery. The strategies include a series of input controls that limit entry to the fishery, restrict gear (through issuing statutory fishing rights) and implementation of a system of seasonal, spatial and temporal closures, and bycatch restrictions. The *Northern Prawn Fishery Management Plan 1995* sets out the management measures as well as objectives and performance criteria for the fishery. The Management Plan was recently amended to enable the manager to quickly adjust the fishing effort in response to scientific advice.

Statutory Fishing Rights

Operators in the NPF must hold Statutory Fishing Rights (SFRs), which control

fishing capacity by placing limits on the numbers of boats and the amount of gear permitted in the fishery. There are two types of SFR:

- a class B SFR, which permits a boat to fish in the NPF;
- a gear SFR, which limits the amount of net a fisher can use; and

An operator needs a Class B SFR and the appropriate amount of gear SFRs for the length of net they wish to use to be able to participate in the fishery. There is a minimum holding of 100 gear SFRs[2] for each Class B SFR.

Seasons and Closures

In addition to limited entry and gear controls, the level of take in the NPF is effectively controlled by limiting fishing activity to two seasons and also by implementing a system of closures. The fishery has two open seasons where fishing is permitted. The seasons may vary but have generally fall between April - May/early June and August – November. The 2002 the seasons are:

1 April - 13 May (first season) and

1 September - 1 December (second season).

Closures of the fishery are designed to coincide with recruitment phases or to protect pre-spawning prawns and to ensure prawns are at a commercial size for harvesting. Shortening of the season has also been used as a method to reduce effort in the fishery.

Other closures include permanent closure of seagrass beds and other sensitive habitats and seasonal closures of juvenile prawn stock habitat. A daylight trawl closure during the spawning season aims to reduce the capture of gravid (pregnant) prawns. Closure-related Directions and maps of these closure areas included in Appendix IV. Closures, where necessary, can take effect in as little as three weeks or 24 hours in the case of an emergency.

Based on advice from NPFAG on the status of the fishery in relation to the spawning stock biomass and the level of effort, NORMAC makes recommendations to the Board on the need for the further reduction in fishing effort in the fishery.

If the level of take needs to be reduced this can be achieved by two mechanisms either separately or combined:

- a reduction in the amount of gear - the NPF Management Plan was recently amended to enable AFMA to reduce the total gear pool in the fishery through an AFMA direction rather than the lengthier process of amending the management plan. This will enable AFMA to respond quickly to management information such as changes in stock status.
- further closures - depending on which species requires additional protection further closures can be achieved through reductions in the seasons (as occurred in 1999 and 2000 and for 2002), area closures or temporal closures (eg reducing time available to fish each night). The use of VMS has been an effective means in ensuring compliance with closures.

[2] There is some exception to this rule resulting from entitlements held at the time of the compulsory reduction in 1992. Details can be found at 24(3) of the Management Plan

Guideline 1.1.8 Fishing is conducted in a manner that does not threaten stocks of by-product species. (Guidelines 1.1.1 to 1.1.7 should be applied to by-product species to an appropriate level)

A few species that are caught incidentally have commercial value and are retained and these species are referred to as by-product. By-product in the NPF consists mainly of small fish and crustacean species of negligible or extremely low monetary value.

By-product taken from the NPF includes:

- two species of slipper lobster (bugs) (*Thenus indicus* and *Thenus orientalis*);
- one species of scallop (*Amusium pleuronectes*);
- some larger fish species.

Byproduct taken in the NPF is recorded as part of the logbook program and the logsheets include provision for recording the species and quantity taken. The amount of by-product recorded is subject to verification by at-sea monitoring by enforcement officers and through recently introduced transhipment records. (Further details about the logbook program and its verification is detailed in the response to Guideline 1.1.1).

NORMAC has assigned a high priority to research into the composition of NPF byproduct due to the limited assessment that has taken place in the past. A recently funded FRDC project, 'Design, trial and implementation of an integrated long-term bycatch monitoring program' will enable CSIRO to collect data on byproduct and bycatch species.

Depending on the projects results, appropriate management measures will be implemented in response to the findings. The responses could include seasonal, temporal or spatial closures similar to those already implemented for the target species.

The combination of verified fisheries dependent data and independent data to be collected through the research project also will provide a reliable database on which to base further management decisions.

Management of byproduct is currently based on the NPF logbook records of the amount of byproduct taken from the NPF in the course of prawn fishing. There is, however, no data on Indigenous or recreational take of these species. Given the remote area of the fishery and the nature of these species, these catches are likely to be minor.

Management regimes have been implemented in the NPF to control the level of by-product taken from the fishery. Through the introduction of gear-based SFRs, fishing effort has been reduced, which is intended to minimise the impact on by-product species as well as the main target species.

Bugs

Moreton Bay lobsters or bugs (*Thenus indicus* and *T. orientalis*) are heavily exploited in areas where prawns are targeted. Evidence of overfishing comes from reduced catch rates and the average size of individuals caught (Kailola *et al*. 1993). To address this issue, NORMAC agreed to impose a size limit for bugs taken in the NPF based on the results of research into the biological parameters associated with yield optimisation (Courtney 2000). As of 1 April 2002:

- it is prohibited to take bugs that are less than 75 mm in carapace width
- it is prohibited to retain egg-bearing females (including egg-scrubbed females), regardless of size
- all bugs must be retained whole.

Scallops

Amusium pleuronectes, or delicate saucer scallops, are taken as bycatch of the NPF in coastal waters off the Northern Territory, from around Melville Island to west of Karumba and an area around Weipa. Approximately 40% of NPF trawlers retain their catch of saucer scallops for sale (Pender and Willing 1990). The fisheries target resting (post-spawning) or pre-spawning adults when meat yield and scallop condition are at their best (Joll 1989). Given the very low catch of these species it is considered to be ecologically sustainable.

Other target species

The fishery also targets some species on an opportunistic basis. These are squid species and scampi. As these species are not consistent target species they have been included under this guideline.

Squid

The primary location for the take of squid is the Gulf of Carpentaria with high catches being taken around Bombard Shoal, Mornington Island and the Vanderlin Islands. However, some of the relatively large quantities recorded are the result of a larger number of vessels taking smaller amounts as incidental bycatch.

The population structure of commercially harvested squid species in the NPF region remains unknown. A genetic study using allozyme electrophoresis undertaken in the early 1990s was unable to distinguish differences indicative of stock structure between samples of any species collected in the Timor Sea, Gulf, Townsville and Moreton Bay (Yeatman, 1993)

Under the terms of the Offshore Constitutional Settlement agreement between the Commonwealth and Queensland, the Northern Territory and Western Australia, the amount of squid take is limited to the same amount of prawn take in the fishery. AFMA monitors the take of squid through the season and will put in place measures, particularly closed areas, should the catch of squid rise to more than 70% of the amount of prawns taken in the fishery. There are times squid spawning aggregations are targeted at specific times and locations in the year.

Over the last two years, catches of squid for the whole of the NPF have been similar to the 292 tonnes recorded in AFMA logbooks for 1996. Catches reached 265 tonnes in 1997 and 262 tonnes in 1998, with most coming predominantly from targeted squid fishing in the three regions of the Gulf of Carpentaria mentioned above and from some incidental bycatch.

As it was not compulsory to record retained species such as squid in the AFMA logbooks until 1995, historical logbook data represent only the most conservative estimate of squid catches. With the co-operation of some industry operators that provided CSIRO with their own data, Manson (1996) has estimated that even in 1995 only about one half of the vessels landing squid recorded any catch, and of those that did, less than half of the total catch was recorded.

In 2001 logbooks recorded a squid catch of about 367 tonnes. This mainly came from a large aggregation near Mornington Island. One reason that there could be a higher recorded squid catch was the implementation of transhipment reports that have resulted in a more accurate estimate.

Given the nature of the squid capture and the paucity of information about squid stocks and catches, a formal assessment of squid may not be possible. NPFAG will be investigating other assessment and management methods for this species. Given the possible large range of the stock, to be effective any squid management will need to be carried out jointly with all of the relevant jurisdictions including Indonesia and East Timor.

Given the very broad range of squid and the relatively low catches taken in the NPF and in other jurisdictions the risk that the squid take is not sustainable is considered to be low.

Scampi

Scampi is taken from a deepwater area on the edge of the AFZ north of Melville Island. It is taken by vessels operating at times when the prawn grounds are subject to seasonal closures. Very little effort is applied to scampi each year. Boats visit the area for periods of between a couple of days and a couple of weeks.

The number of boats operating is generally between one and nine vessels. Given the distance offshore and the depth involved in fishing scampi many boats licensed for the NPF cannot assess this resource. Catches vary with the amount of effort that has been applied. The highest catch recorded was 273 tonnes but in recent years catches have remained under 20 tonnes. While gear limitations that apply in the NPF generally also apply to scampi fishing there are no other measures in place.

Given the very low catches of scampi and the small number of boats which take scampi it is considered to be ecologically sustainable.

Table 4 provides a summary of the catch of principal byproduct species and opportunistic target species taken in the NPF since 1997.

Year	Squid (kgs)	Scampi (kgs)	Bugs (kgs)		Saucer scallops (kgs)
			whole	tails	
1997	264,667	129,800	79,065	17,643	7,950
1998	261,937	18,200	88,517	23,352	14,599
1999	40,756	7,600	42,954	12,662	3,092
2000	37,368	5,500	54,337	12,210	6,935
2001	367,264	3,800	27,755	453	2,083

Table 4: NPF catch of principal byproduct and opportunistic target species (Source: NPF logbooks)

Guideline 1.1.9 The management response, considering uncertainties in the assessment and precautionary management actions, has a high chance of achieving the objective.

A series of strong management responses have been implemented to address issues which arise in the fishery, mostly recently a 25% reduction in gear in the fishery, time reductions, a change to the season dates and a ban on the take of sharks. This track record shows both industry's and AFMA's commitment to the sustainable management of the fishery.

NORMAC agreed that from 2002 and thereafter (annually) NORMAC will use the NPFAG accepted assessment model to estimate the performance of the previous years stock relative to spawner target levels. The agreed target is that there is a ≥70% chance that the spawner population at the end of 2006 will be above or at spawner target levels.

NORMAC will utilise the advice of the NPFAG (majority) to provide the advice to assess performance against the target. If the projection suggests that the agreed target will not be reached, NORMAC will recommend appropriate effort adjustment measures in the interim.

There are a number of other management responses aimed at sustainable management of the Fishery. These include:

- a high level of confidence in the data collection program which includes the verification of data.
- a survey to collect fishery independent data for use in stock assessments will be commenced in August 2002
- the precautionary nature of stock assessment which is regarded as world's best practice and has been subject to international review.
- a Plan of Management provides industry with a more secure access right (SFRs) which encourages economic, biological and ecologically responsible behaviour.

Objective 2. Where the fished stock(s) are below a defined reference point, the fishery will be managed to promote recovery to ecologically viable stock levels within nominated timeframes.

Management responses

Guideline 1.2.1 **A precautionary recovery strategy is in place specifying management actions, or staged management responses, which are linked to reference points. The recovery strategy should apply until the stock recovers, and should aim for recovery within a specific time period appropriate to the biology of the stock.** [3]

In July 2001, NPFAG released an assessment of the state of tiger prawn stocks at the end of 2000. The assessment results are detailed in the NPFAG report 'Status of tiger prawn stocks at the end of 2000' (Appendix XV) and a review of the NPFAG report 'A review of the 2001 assessment of tiger prawns in the Northern Prawn Fishery, Deriso, October 2001' (Appendix XVI).

Both reports conclude that the current biomass of brown tiger prawns is well below abundance levels characteristic of the early 1970s and conclusively below S_{MSY} levels that support MSY. Current biomass of grooved tiger prawns is also likely below S_{MSY} abundance levels that support MSY, but not as depleted as brown tiger prawns. Based on the reports conclusions, NORMAC agreed at its 51st meeting in August 2001 to rebuild brown and grooved tiger prawn stocks to S_{MSY} within 5 years (by the end of 2006) by significantly reducing fishing effort.

Guideline 1.2.2 **If the stock is estimated as being at or below the biological and/ or effort bottom line, management responses such as a zero targeted catch, temporary fishery closure or a 'whole of fishery' effort or quota reduction are implemented.**

Management measures to respond to the most recent assessment include a 25% reduction in gear and 13% decrease in the length of the fishing season. The fishing season timing has also been changed to ensure that brown tiger prawn stocks receive additional protection.

NORMAC developed a strategy comprising reduced fishing time and an across the board reduction in gear be implemented for the commencement of the 2002 tiger prawn fishing season to reduce fishing effort on both species of tiger prawns.

In 2002 the seasons are 1 April to 13 May (banana prawn season) and 1 September to 1 December (tiger prawn season).

Additional adjustment will be implemented through a 25% reduction in gear effective from 24 August 2002. The 25% reduction was based on the amount of gear to be

[3] Strategies require that recovery should take place within specified times with certain degrees of probability

used, not on the number of gear SFRs held ie. the amount of gear allocated to each gear SFR was reduced from 10 centimetres to 7.5 centimetres, rather than a reduction in the total number of gear units.

Using data provided by CSIRO on fishing power changes and seasonal effort patterns it was estimated that this package of measures would provide a reduction in the order of 43% on brown tiger prawns and 29% on grooved tiger prawns (assuming that ten boats left the fishery as a result of the reduction in gear). The stock assessment model was used to confirm that these reductions would have a greater than 70 percent chance of rebuilding tiger prawn stocks over the next five years.

Given that 18 boats have left the fishery between the first and second seasons in 2002 it is likely this reduction in effort on brown and grooved tiger prawns will have been achieved.

An annual in-season fishery independent survey was initiated in August 2002. The survey will be conducted across a subset of the NPF fishing grounds to estimate and monitor:

- prawn abundance in fished and non-fished areas;
- fishing power; and,
- other key biological data eg species split data.

PRINCIPLE 2 Fishing operations should be managed to minimise their impact on the structure, productivity, function and biological diversity of the ecosystem.

Objective 1 The fishery is conducted in a manner that does not threaten bycatch species.

Objective 2 The fishery is conducted in a manner that avoids mortality of, or injuries to, endangered, threatened or protected species and avoids or minimises impacts on threatened ecological communities.

The responses to objectives 1 & 2 have been combined as they both have the same or similar information requirements, assessment and management processes

There are no listed threatened ecological communities in the NPF area, and accordingly the following guidelines, which are specific to threatened ecological communities, are not applicable:

Guideline 2.2.3 There is an assessment of the impact of the fishery on threatened ecological communities.

Guideline 2.2.5 There are measures in place to avoid impact on threatened ecological communities.

Information requirements

Guideline 2.1.1 Reliable information, appropriate to the scale of the fishery, is collected on the composition and abundance of bycatch.

Guideline 2.2.1 Reliable information is collected on the interaction with endangered, threatened or protected species and threatened ecological communities.

Prior to the introduction of TEDs and BRDs, the level of bycatch in the NPF has ranged from 0-90% of the weight of any one shot (Pender and Willing 1989), dependant on gear set-up, the species being targeted and the location of the trawl. Bycatch in the NPF is mainly small fish and crustacean species of negligible or extremely low monetary value. This bycatch is usually discarded, as it is not feasible to retain large volumes of low value bycatch in a fishery that operates significant distances from markets.

Historically, the information on bycatch in the fishery has been based on logbooks and on-board research programs. To supplement this information a trained crew-based, on board observer program will be implemented for two years from April 2003.

Logbook program

The NPF logbook program requires operators to record bycatch species, including endangered, threatened and protected species. Comprehensive bycatch information is also included for the information of owners and skippers and to meet AFMA's obligations under cooperative memoranda of understanding with Queensland, the Northern Territory and Western Australia.

Since 1996 all operators have been required to record interactions with turtles in logbooks, including the number of turtles caught per day and the condition of the turtle when released. To assist in accurate recording of species and increasing the survival of turtles once returned to the sea, a turtle handling and identification guide has been included in all logbooks. Provision for reporting shark capture has also been included in the logbook.

In 1998 a specific page on TEDs and BRDs was included in the logbook for those operators trialing TEDs and BRDs, and is now required to be completed by all operators since TEDs and BRDs became compulsory on 15 April 2000. The page includes questions on the types of TEDs and BRDs used by the operators, the dimensions of the devices and comments on the effectiveness of the devices at reducing bycatch and maintaining prawn catch. Information on modifications made to the devices by the operator and any problems experienced with the gear is also sought.

In an updated logbook introduced to the fishery in April 2001 operators are also required to report the number of seasnakes and syngnathids caught and their condition when released. In addition operators are required to indicate whether they interacted with any other protected species and if so to complete a separate detailed wildlife and protected species information sheet in the logbook. A list of other protected species and wildlife is included in the logbook for information.

During 2002 AFMA and NORMAC, in consultation with Environment Australia, will be refining the wildlife and protected species reporting form to ensure it is consistent with the legislative requirements for reporting interactions with protected species and to streamline the reporting process.

Given the sheer number of species recorded as incidental bycatch in the fishery and problems in identifying each of the species, AFMA does not consider the use of fisher logbooks for the collection of data on all bycatch species a practical option. Consequently, the NPF has conducted numerous on board research programs to identify and quantify bycatch in the NPF.

Research programs

A recently released report entitled "Ecological Sustainability of Bycatch and Biodiversity in Prawn Trawl Fisheries" (Bycatch Research Project reference no.5) prepared by CSIRO and funded by FRDC provides substantial information on bycatch in the NPF, prior to the introduction of TEDs and BRDs.

The report indicates that the fishery interacts with a large number of species, some of which are caught frequently but most of which, while not necessarily being rare in existence, are rarely to very rarely caught in prawn trawls.

It is estimated that the fishery incidentally captures up to 56 species of elasmobranchs (sharks, rays and sawfishes). The CSIRO report suggests that Pristidae (sawfishes) and some Dasyatidae (rays) species should be a priority for research and management.

The report indicates that more then 450 vertebrate species (fish, turtles, seasnakes, sharks, rays and sawfishes) and 230 invertebrate species (eg. crabs, squid and scallops) may be incidentally caught in the fishery. Survival rates after capture are thought to be low for fish but high for many invertebrates.

Bycatch composition varies in the fishery depending on area, however the CSIRO report indicates that bycatch composition can be broadly grouped into two different regions in the fishery – a northern group (north of approximately 14°S) and a southern group (south of approximately 14°S). The northern region generally reflects the areas dominated by Penaeus semisulcatus catches and includes 'Melville', 'Cobourg', 'Weipa' and 'North Groote'. The southern region corresponds to the areas dominated by P. esculentus catches and includes 'South Groote', 'Vanderlins' and areas surrounding Mornington Island.

Teleosts (bony fish) averaged 72.9% and 63.2% of the weight of the bycatch in the research survey trawls and scientific observer trawls respectively, while elasmobranchs averaged 3.9% and 5.9% in the two surveys. Invertebrates made up on average 19.7% and 20% and the reptiles 0.3% and 0.98% of the research survey trawls and observer trawls respectively.

Validation

In 1989/90 CSIRO conducted a trained crew, on-board turtle monitoring program to estimate the capture and mortality of turtles in the fishery (Bycatch Research Project Reference No. 8).

Given the reductions in effort in the fishery since the early 1990s and significant changes to the management regime, a similar crew based on board monitoring program commenced in 1998 and will be completed in 2002 (Bycatch Research Project Reference No. 2). The results of the 1989/90 and preliminary results of 1998/2001 are presented below under Guideline 2.2.2.

As part of Bycatch Research Project reference no. 4, scientific and technical observers were placed on board vessels in the second half of the 2001 fishing season to assess the effectiveness of TEDs and BRDs.

An FRDC funded project entitled 'Assessment and improvement of BRDs and TEDs in the Northern Prawn Fishery' is being undertaken. The project involves at-sea testing of the performance of various TED and BRD designs and an economic assessment of TEDs and BRDs.

In 2000 and 2001 a gear specialist spent time on board NPF vessels to assist in the tuning of the TEDs. In the 2001 tiger prawn season (4 August – 9 November) five observers collected data from 23 vessels and around 1600 trawls. On vessels with an observer one net had the TED or BRD or both removed to enable catch changes to be detected. Data was collected on turtles, sharks, rays, seasnakes, other small bycatch, prawn catches and quality and byproduct. Information was also collected on factors that might influence the results such as gear characteristics, weather and time of day.

The preliminary results from this project confirm that TEDs are effectively reducing the catch of large animals (sharks, rays, turtles and sponges) in the NPF. It appears that the use of BRDs in reducing other bycatch has been less successful. The complete analysis will be available by early 2003.

Ongoing monitoring

An objective of Bycatch Research Project reference no. 5 was to develop cost effective, accurate and feasible methods of describing and monitoring prawn trawl bycatch. The results indicated that "as most species are rarely caught a sample of 10% of the total catch contains about half of the species in the catch and has an 80% sampling error for the rare species. The results suggest that it is probably not feasible to monitor to detect a 50% change in catch rate for the very rare species. However it may be possible to monitor more common species in one or two regions".

The report examined three types of methods for monitoring bycatch in the NPF: crew member observers; trained observers collections; and scientific surveys. Given the costs and benefits associated with each type of monitoring method the fishery has a monitoring strategy that incorporates a number of different methods, depending on the type of information required for different species.

On the basis of the successful crew-based, on board monitoring program to estimate the incidental capture of turtles in the fishery (Bycatch Research Project Reference No. 2), NORMAC is designing and trialing a similar program for protected species and other species of high conservation concern. The program will include training of crew in species identification, particularly protected species, and data requirements. The information will be used to validate logbook/protected species reporting form data across the fishery and an incentive scheme will be implemented to encourage adequate industry participation. The program will commence in April 2003.

Guideline 2.1.2 There is a risk analysis of the bycatch with respect to its vulnerability to fishing.

Guideline 2.2.2 There is an assessment of the impact of the fishery on endangered, threatened or protected species.

The objectives of the Bycatch Research Project reference No. 5 were to measure the impact of prawn trawling on the sustainability of important vertebrate bycatch species and to assess the effects of prawn trawling on the biodiversity of key fish and other vertebrate communities. Stock assessments for bycatch species in the NPF are inherently difficult because of the diversity of bycatch in the fishery, most species are rarely caught and there is limited knowledge on the biology of many of the species.

CSIRO with input from various stakeholders developed a set of criteria for examining the likely impact of trawling on vertebrate bycatch species and applied it to the NPF. In essence, the sustainability of species was considered relative to their susceptibility to capture and mortality in prawn trawls and their capacity to recover once depleted. The criteria used were:

- water column - the distribution of the species in the water column
- preferred habitat - primary habitat of a species overlapped with the habitat where trawling occurs

- survival – survival of bycatch species after capture in a trawl
- range – distribution of a species within the NPF
- day/night catchability – relative catch rate of species during night and day time trawling, given the ban on day time trawling for most of the fishing season.
- diet – whether the diet of the species would attract them to the trawl grounds and whether they feed within the area of the water column that is swept by a prawn trawl
- depth range – trawling mainly occurs at depths between 15m and 40m
- breeding – probability of breeding before capture
- maximum size – used as an estimate for the relative recovery rate for the species
- reproductive strategy – proxy for relative fecundity of a species
- removal rate – in general the higher the proportion of biomass removed the lower the ability of the population to recover.
- hermaphroditism – assumed hermaphroditic species generally have a lower capacity to recover
- mortality index – derived from the length frequency of a species and the von Bertelanffy growth parameters.

A conservative approach was adopted when applying specific ranking to species, for example where information was not available for a particular species or family the highest risk ranking was applied. The results in the report are based on scientific surveys and independent observers on commercial vessels prior to the compulsory introduction of TEDs and BRDs and as such the susceptibility of some species to capture are likely to be reduced through the use of TEDs and BRDs.

Teleosts

A total of 411 teleost species have been recorded in the fishery. The species ranked as the least sustainable are the ones most likely to be caught by prawn trawls. They are benthic or demersal, their habitat is soft sediment, their diet includes or can potentially include prawns, their recovery capacity is low, with a low estimate of total biomass and high removal rate. The species ranked most likely to be able to sustain trawling had a low susceptibility to capture by trawls and they are generally pelagic.

Elasmobranchs

As mentioned above, 56 species have been recorded in the NPF. The results suggest that Pristidae (sawfishes) and some Dasyatidae (ray) species should be a high priority for research and management as they are least likely to be able to sustain capture as bycatch. More information is needed on the basic biology of these species as well as their distribution, movement patterns and stock structure.

The compulsory introduction of TEDs should result in the exclusion of large individuals but the majority of individuals caught are <1000mm and the exclusion of these may be limited. Preliminary findings in the Bycatch Research Project reference no. 4, indicates a reduction in elasmobranch catch of around 80% with the use of TED/BRDs. The full results will be available in early 2003.

In recognition of the growing global concern over the conservation status of sharks, rays and sawfishes and the effects of fishing on their populations, the NPF industry, through NORMAC and AFMA, initiated a ban on the retention of any products from these species. The ban took effect from 1 February 2001. While the introduction of TEDs and BRDs is expected to dramatically reduce the incidental capture of large animals, some small sharks, rays and sawfishes may still be caught. NORMAC was concerned that there be no incentive, particularly given the high value of shark fin, to target juvenile sharks, rays and sawfishes. At the same time, the industry will be developing handling procedures for these species to assist in their survival once returned to the sea.

Sea snakes

The CSIRO report indicates that at least 13 of the 30 sea snake species occurring in Northern Australian waters are caught in the NPF. Mature female sea snakes were most commonly caught with very few juvenile sea snakes of most species being caught. The report states that based on the estimates of sea snake catch and biomass of each of the thirteen species caught in the fishery, that fishing mortality could be 5-6% per year.

On this basis the report concludes that catches of most sea snake species appear sustainable at current levels of fishing effort. Gulf of Carpentaria populations of two species of sea snake - the *Hydrophis pacificus* large headed sea snake and the *Disteira kingii* (spectacled sea snake) – appear susceptible to trawling and as such are a high priority for further study of trawl effects. TEDs and BRDS are considered to be very effective at reducing sea snake catches. The Bycatch Research project reference no. 4 (Assessment and improvement of BRDs and TEDs in the Northern Prawn Fishery) has collected further data on the effectiveness of TEDs and BRDs at excluding sea snakes and results will be available in early 2003.

Biodiversity of vertebrate bycatch communities

The project compared the biodiversity of vertebrate bycatch species between areas that are open to fishing and areas that have been protected from trawling for fifteen years. The report states that there was no consistent difference in the number, or catch rate of species between open and closed areas.

Turtles

The results of the 1989/90 survey (Bycatch Research project reference no. 8) indicated that over 5000 turtles were caught annually in the fishery. The estimates of the number caught and drowned in 1989 and 1990 are given in Table 5 below.

Table 5 Numbers of turtles estimated to have been caught and drowned in the NPF in 1989 and 1990 (Poiner and Harris 1996)

Year	1989	1990
Estimated no. caught	5503	5238
Estimated no. drowned	567	943
No. of trawlers	223	200

In 1998, FRDC funded a project to monitor the catch of sea turtles in the NPF (Bycatch Research project reference no. 2). Volunteer crew-members were trained in identification, tagging and data requirements, as well as best practice handling techniques to improve turtle survival. In addition, sawfish and sea snake capture information was collected.

From July 1998 to December 2000, 3413 boat days were monitored with the majority of turtles caught being flatbacks (60%, *Natador depressus*) and olive ridleys (27%, *Lepidochelys olivacea*) with small numbers of loggerheads (6%, *Caretta caretta*), greens (3%, Chelonia mydas) and hawksbills (3%, *Eretmochelys imbricata*).

The project results show that since TEDs were installed the catch of sea turtles is estimated to have fallen to 120 individuals per year. In addition, mortality is estimated to have decreased from close to 40% in earlier years to around 22% in recent years. The decrease in mortality may be attributed to the improvement in turtle handling techniques adopted by the fishers in the fleet. The small numbers of turtles that continue to be captured are taken primarily during the winching-up of the gear, a late stage in the fishing operation, and are presumed to survive due to the short time they are in the trawl.

A research project to assess the performance of TEDs in the first two weeks of the 2001 banana prawn season (Bycatch Research project reference No. 3) was undertaken. The study aimed through the removal of TEDs from one net to measure the impact of TEDs on catches of banana prawns and measure the incidence of turtle capture, and assess their condition and likely survival rates. Information on sea snake, saw shark, stingray and shark capture was also collected. The project included scientific and technical observers on board nine different vessels with a large proportion of the fleet also participating and filling in detailed log sheets.

Observers recorded trawl and catch data on nine boats. Each boat removed a TED from one net to allow catch comparisons between a standard net and a net fitted with a TED. The analysis of the logbook recorded by fishers and the observer data shows reasonably similar trends with a 5–10% reduction in prawn catch in nets fitted with TEDs. This was the first time that TEDs were used in the NPF banana prawn fishery.

A total of eight turtles were caught during this survey, and all were released alive. Four turtles were caught in the nets fitted with TEDs. These were caught ahead of the TED and released through the mouth of the net. The animals were lively and presumably caught on winch-up and had not had sufficient time to reach the TED and escape. The results are likely to improve in future seasons as fishers gain more experience in their use and operation, in much the same way that TED performance has been improved in the tiger prawn fishery in recent years

The observer data also indicates significant reductions in the incidental capture of saw fish and stingray and shovelnose rays. There was little significant difference on the observed boats recorded in the capture of sea snakes and sharks between the TED-on and TED-off nets. The fisher based data indicated a more significant number of turtles caught in the TED-off nets than the TED-on with little difference in the recorded sea snake catch.

Estimates of prawn loss between the observed and fisher provided data varied, with greater estimates of prawn loss in nets with TEDs provided by fishers. In general,

however, the results of the project indicated that TEDs have little impact on prawn catches in the banana prawn fishery and effectively exclude large animal bycatch including turtles. On this basis NORMAC recommended and the AFMA Board has approved the requirement for operators to use TEDs and BRDs throughout the entire fishing season including the banana prawn season.

Other Protected species

A number of species are protected under State and Commonwealth legislation. The following groups of species are protected under the EPBC Act:

- great white sharks
- grey nurse sharks
- sawfish
- turtles
- seabirds
- whales and other cetaceans
- seals
- syngnathids and solenostomids (including seahorses and pipefish)
- sea snakes
- dugongs.

Of these protected species, as mentioned above the NPF interacts frequently with turtles and seasnakes. The turtle species most commonly caught incidentally in the fishery is the flatback turtle (*Natator depressus*). The CSIRO report also indicates that syngnathids are very rarely caught in the fishery.

Large numbers of dolphins occur in the area of the NPF however, they are rarely caught and instead are known to actively feed on discards from vessels. In 2001 four dolphins were recorded as being captured. All of these were recorded as being caught in either the BRD or TED. Two dolphins were released alive, one was dead and the live status of the other was not recorded. In 2002 no dolphin captures were recorded.

Great white and grey nurse sharks are very rarely encountered in the area of the NPF (Last and Stevens 1994) and have not been caught during on board research programs.

No dugongs have been recorded as being taken by trawlers in the NPF. All known seagrass beds, the prime habitat of dugongs, are permanently closed to trawling. It is also generally acknowledged that, even in prawn fisheries that overlap dugong habitats, dugong catches are extremely rare. This has been attributed to the dugong's keen sense of hearing and awareness.

The remaining protected species are also not considered a bycatch issue in the NPF either because they do not occur in the region or are not likely to interact with the type of gear used in the fishery. The table at Appendix XVII shows all the species listed under the EPBC Act, and identifies which of the species interacts with the Fishery.

Guideline 2.1.3 **Measures are in place to avoid capture and mortality of bycatch species unless it is determined that the level of catch is sustainable (except in relation to endangered, threatened or protected species). Steps must be taken to develop suitable technology if none is available.**

Guideline 2.2.4 **There are measures in place to avoid capture and/or mortality of endangered, threatened or protected species.**

The NPF Bycatch Action Plan (BAP) provides the management framework for avoiding capture and mortality of bycatch species in the fishery, including endangered, threatened and protected species. NORMAC devised a BAP for the NPF in 1998, based on the Commonwealth Policy on Fisheries Bycatch prior to its release in June 2000. That BAP has now been reviewed and a revised draft BAP for the Fishery is included as Appendix XVIII. A draft background paper for the NPF BAP is included as Appendix XIX.

The core objectives of the Commonwealth Policy on Fisheries Bycatch are:

- to reduce bycatch
- to improve protection for vulnerable species
- to arrive at decisions on the acceptable extent of ecological impacts

The draft revised NPF BAP has the following aims:

1. eliminate to the greatest extent feasible the catch of:
    i. large animals such as turtles, sharks and stingrays
    ii. other protected species
    iii other species that may not be able to sustain impacts from the Fishery
2. reduce the overall amount of bycatch in the Fishery
3. provide protection for areas that are important habitat for vulnerable species of marine life.

One of the key bycatch management measures currently in the NPF is the compulsory requirement for all operators to use TEDs and BRDs. This requirement has been in place since 15 April 2000.

The primary objective of the compulsory introduction of TEDs is to reduce the number of turtles captured annually in prawn trawls in the NPF to approximately 5% of the average number estimated to have been caught by NPF trawlers in 1989 and 1990. TEDs have been successful in achieving this objective to date. However, to deal with the possibility that turtle captures may exceed the 5% limit set AFMA, in collaboration with NORMAC will develop a contingency plan that would be implemented. The introduction of TEDs has also had the effect of excluding other large animals such as sharks and rays from the trawl.

The compulsory introduction of TED/BRDs followed many years of research involving gear technologists, scientists and industry to develop effective devices (Bycatch Research project reference nos. 1, 6 and 7). This research had as a fundamental component, fisher extension workshops in all major NPF ports to discuss the design and installation of TED/BRDs with operators.

When introducing TED/BRDs to the fishery, NORMAC also funded a targeted education program that included:

- the production of a brochure outlining the legal specifications for TED/BRDs in simple language;
- a workshop for the makers of fishing gear to explain the specifications and regulations; and
- visits to every boat to explain the requirements to the skipper in person.

To ensure ongoing improvements in the design and effectiveness of TED/BRDs at reducing bycatch, research has been funded (Bycatch Research project reference no. 4) and scientific permits may be granted to those operators wishing to trial alternative TED/BRD designs. The scientific permit process includes independent at sea observations for assessment and validation.

Dr Chris Glass, an expert in fish behaviours and bycatch reduction from the Manomet Centre for Conservation Sciences in the United States participated in the workshop. The swimming behaviour and reaction to trawl nets of species of concern was recognised as an important issue which needs consideration in developing new designs. The workshop noted that the current BRD designs appeared to have limited effect in reducing bycatch of species not affected by the placement of TEDs in the net. Fishermen were encouraged to apply for permits to test new designs to improve the capacity.

In July 2000, the United States Department of State and National Marine Fisheries Service assessed the use of TEDs in the NPF and subsequently determined that the fishery has a regime of, at least, a similar standard to that implemented in US prawn fisheries. Following certification, US officials visited Australia to discuss the use and enforcement of TEDs in the NPF and to exchange technical information. On the basis of the visit the US reconfirmed its support for the use and enforcement of TEDs in the NPF.

In addition to the use of TEDs and BRDs, operators are not permitted to retain the following species:

- all sharks, rays/skates, sawfish and all parts of these animals (eg fins);
- Barramundi (*Lates calcarifer*);
- Spotted grunter-bream (*Pomadasys kaakan*);
- Blue salmon (*Eluetheronema tetradactylum*);
- Threadfin salmon (*Polydactylus sp.);*
- Black jewfish (*Protonibea diacanthus*);
- Jewfish/Jewel fish (*Nibea squamosa*);
- Queenfish (*Scomberoides lysan* and *S. commersonianus*);

- trepang (Class Holothuroidea);
- pearl shell (*Pinctada sp.);*
- coral; and
- trochus

The compulsory use of TEDs also has the effect of excluding some other large animals (such as sharks and rays) from the trawl. For example, preliminary monitoring of the effectiveness of TEDs in the NPF in the latter half of the 2000 fishing season indicated a reduction in elasmobranch catch of around 80%.

In recognition of the growing global concern over the conservation status of sharks, rays and sawfishes and the effects of fishing on their populations, the NPF industry, through NORMAC and AFMA, has initiated a ban on the retention of any products from these species. The ban took effect from 1 February 2001.

While the introduction of TEDs and BRDs is expected to dramatically reduce the incidental capture of large animals, some small sharks, rays and sawfishes may still be caught. As such the fishery was concerned that there be no incentive, particularly given the high value of shark fin, to target and retain juvenile sharks, rays and sawfishes. At the same time the industry will be developing handling procedures for these species to assist in their survival once returned to the sea.

The targeting methods of the fishery which includes primarily fishing at night, short shot duration when fishing during the day, and the use of a number of permanent and seasonal closures to protect seagrass areas, have assisted in minimising the impact of trawling in the NPF on turtle populations.

The report 'Ecological Sustainability of Bycatch and Biodiversity in Prawn Trawl Fisheries' (Stobutski et al 2000) provided valuable information on which to base further research. On the basis of a comprehensive assessment of different bycatch monitoring strategies, a data collection, monitoring and validation program for the NPF has been established to help ensure the objectives of this Plan are being met.

Protected species as well as other species that may be a concern and the general volume of bycatch and physical impacts of trawling in the Fishery all require monitoring. In September 2003 a crew-based observer monitoring program will be implemented to collect data on the total amount of bycatch, protected species and high risk species.

The purpose of the monitoring project is to ensure that the Fishery is meeting its reporting requirements, particularly in terms of protected species, and that the data are validated. The project will seek to validate the risk assessment of bycatch species which were identified as high risk in previous research and to provide a broader understanding about the impact of the Fishery on general bycatch species.

Guideline 2.1.4 An indicator group of bycatch species is monitored.

Guideline 2.1.5 There are decision rules that trigger additional management measures when there are significant perturbations in the indicator species numbers.

One of the key actions in the draft Bycatch Action Plan for the NPF is to monitor bycatch in the fishery. The focus of the monitoring will be on protected species and species that have been identified as high risk, through the formal risk assessment undertaken by CSIRO (Bycatch Research project reference no. 5).

The report identified a number of bycatch species which were least likely to be sustainable to capture. The species were bronze catfish, smooth-headed catfish, catfish, narrow-lined toadfish, dragonet, short-spined porcupine fish, long-tailed catfish, shoulderspot wrasse, blotched jawfish, conger eel, slender cardinal fish, checkered lizardfish and big-eyed lizardfish.

The ranking of the species was based on attributes of their biology that effect the likelihood of their capture and also the ability of species to recover once their population is decreased. Where information was not known, information from other members in the family was used or a conservative ranking. Consequently, many of the species with the lowest ranking are ones about which very little is known.

The results in the report suggest that the catches of some species are less likely to be sustainable than others. Future research will focus on monitoring the species that were shown least likely to be sustainable to validate this assessment.

The results indicate that "as most species are rarely caught, a sample of 10% of the total catch contains about half of the species in the catch and has an 80% sampling error for the rare species. The results suggest that it is probably not feasible to monitor to detect a 50% change in the catch rate for the very rare species. However it may be possible to monitor more common species in one or two regions".

NORMAC is designing a program for monitoring protected species and species of conservation concern, including species identified as being at high risk of capture. The trial will be based on the successful crew-based, on-board monitoring program to estimate the incidental capture of turtles in the Fishery. The program will commence in April 2003.

Before the program commences, the crew will be trained in species identification, particularly protected species, and data requirements. The design of the program will also include the means of assessing the information collected and validation and verification. The information will be used to validate logbook/protected species reporting form data across the fishery.

Scientific research programs will continue to be used in the fishery to gain a broader understanding about the impact of the fishery on general bycatch species.

The Fishery conducts on-going monitoring of the effectiveness of TEDs and BRDs and additional management measures will be considered if they are assessed as not being as effective as expected. The additional measures may include, but not necessarily be restricted to time and area closures to trawling of those areas in which

there are high catch rates.

The objective of the introductions of TEDs was to reduce the number of turtles captured annually in the fishery to about 5% of the number estimated (5370) to have been captured in the NPF in 1989 and 1990 (Poiner and Harris, 1996). This means a maximum catch of about 268 turtles. If turtle catch exceeds this level, then further measures will be considered. Since TEDs were installed the catch of sea turtles is estimated to have fallen to 120 individuals per year. In addition, mortality is estimated to have decreased from close to 40% in earlier years to around 22% in recent years.

Guidelines 2.1.6 & 2.2.6 **The management response, considering uncertainties in the assessment and precautionary management actions, has a high chance of achieving the objective.**

AFMA and NORMAC have introduced stringent measures throughout the fishery to avoid the incidental capture of bycatch species. The compulsory use of TEDs and BRDs has already shown substantial reductions in the incidental capture of large animals such as turtles, sawfish, sharks and rays. The introduction of these measures was underpinned by extensive research which continues to be undertaken to monitor whether the objectives of bycatch reduction are being achieved.

Support from the industry has been and will continue to be fundamental to the successful ongoing use of TEDs and BRDs. The fishery has committed in the NPF BAP to examining the utility of other bycatch reduction measures should monitoring of bycatch and effectiveness of TEDs and BRDs indicate a need for further measures to be introduced to the fishery. This approach has a high chance of ensuring that the mortality or injury to protected species is avoided and that bycatch species in general are not threatened.

Objective 3. The fishery is conducted in a manner that minimises the impact of fishing operations on the ecosystem generally.

Guideline 2.3.1 **Information appropriate for the analysis in 2.3.2 is collated and/or collected covering the fisheries impact on the ecosystem and environment generally.**

Guideline 2.3.2 **Information is collected and a risk analysis, appropriate to the scale of the fishery and its potential impacts, is conducted into the susceptibility of each of the following ecosystem components to the fishery.**

1.Impacts on ecological communities

- **Benthic communities**
- **Ecologically related, associated or dependent species**
- **Water column communities**

2. Impacts on food chains

- **structure**
- **productivity/flows**

3. Impacts on the physical environment

- **physical habitat**
- **water quality**

A substantial amount of information on the Northern Australian environment has been collected through various research projects. The information collected in the Fishery is extremely accurate in terms of:

- recording the spatial and temporal distribution of fishing effort over the history of the fishery; recent studies have provided estimates of effort distribution at very fine spatial scales ($\leq$1 nautical mile)
- the quantification of the target species catch.

Information on the environment of the NPF has been or is currently being collected through various research projects. The key sources of relevant data are:

- mapping and monitoring the seagrass communities of the Gulf of Carpentaria (Poiner *et al*. 1987, 1989, 1993);
- fish trawl, benthic dredge and sediment grab samples collected at 107 sites across the Gulf of Carpentaria, both within and outside prawn trawling grounds (Blaber *et al*. 1994; Long and Poiner 1994; Long *et al*. 1995);
- prawn trawl (411 sites) and benthic dredge surveys primarily within the prawn trawling grounds (Stobutzki *et al*. 2000);
- environmental information on tides, wind stress, wave height, chlorophyll, turbidity, sediment, temperatures, salinity, oxygen, phosphate, silica, nitrate, depth and acoustic data is available to varying degrees throughout the area of the fishery;
- detailed diet information on numerous fish, sharks and rays (Brewer et al. 1989; 1991; Salini et al. 1994);
- the ongoing CSIRO/FRDC Project (2000/160): Surrogates I - Predictors, impacts, management and conservation of the benthic biodiversity of the Northern Prawn Fishery. This project will be completed in October 2002.

There are several large projects planned to start in 2002/03 that will collect data on the environment of the NPF and the impacts of fishing. These include:

- CSIRO/FRDC/MIRF- Effects of trawling on animals and plants living on and in soft sediment seabed
- CSIRO/FRDC - Design, trial and implementation of an integrated long-term bycatch monitoring program in the NPF
- CSIRO/FRDC/AFMA/MIRF - Designing and implementing an integrated monitoring program for the NPF optimising costs and benefits

Impacts on ecological communities

Benthic communities

Aside from the capture of species during trawling, disturbance and mortality of the benthic communities is likely to be the main impact due to prawn trawls. This is due to the otter boards and groundchains' contact with the seabed. As the trawl net is towed through the water, the groundchains skim over the seabed stimulating prawns into the mouth of the trawl. Operators usually rig these chains for light seabed contact to avoid the capture of large rocks and other debris that will damage the nets.

The patterns of trawling in the NPF show that trawlers avoid large reef outcrops. However, they do trawl over hard seabed capable of supporting attached animals. Some areas, such as north of Mornington Island, presumably support a large biomass of sponges as large catches of these fauna in prawn nets are not uncommon.

The managed area of the NPF covers a large area, encompassing at least three broad/major epibenthic assemblage types within the Gulf of Carpentaria. One includes the shallow water regions (<15 m deep) around the periphery of the Gulf; which includes all the seagrass beds in the region (Poiner *et al*. 1987). The seagrass communities in this shallow water assemblage type were recognised as potentially sensitive to trawling impacts and are closed to trawling in the NPF (since 1983). In deeper water, Long et al. (1995) distinguished two assemblages

1) along the eastern and southeastern margins of the Gulf of Carpentaria located in predominantly sandy sediments and comprised mainly of sessile suspension-feeding sponges, zoantharians, pennatulaceans, bivalves and ascidians; and
2) located in the muddier sediments in the central and western Gulf and comprised mainly of deposit-feeding spantagoids and sand dollars.

The impact of the NPF on benthic communities will be a function of the removal/mortality rate per trawl, the intensity of trawl effort communities are exposed to, their ability to recover between trawls, and also on the location of trawling in relation to where the vulnerable seabed communities live.

Data from the AFMA logbook data base indicates that fishing effort was reported from 273 grids (6 minute x 6 minute) when the fishery opened in 1973. Effort reached a maximum in 1989 when effort was reported in 1,407 grids and has decreased since then to be reported from 811 grids in 2000, the most recent figures available. It is generally accepted that fishing effort was severely under-reported during the period 1970 to the early 1980's. Since the early 1980's logbook coverage of the fishery is virtually 100%. There is an estimated 7281 grids in the area of the NPF.

The principle reasons that much of the area of the NPF managed area is not trawled are:

- the permanent closure of areas such as all shallow water seagrass beds
- the unsuitability of areas to trawling due to large reef outcrops
- the low density of the target prawn species, (eg. central Gulf of Carpentaria).

In the NPF area exposed, benthic communities are exposed to the impacts of trawling for less than 5 months of the year due to seasonal closures. The trawled area peaked in the mid 1980s but since then has been declining as shown in Figure 12.

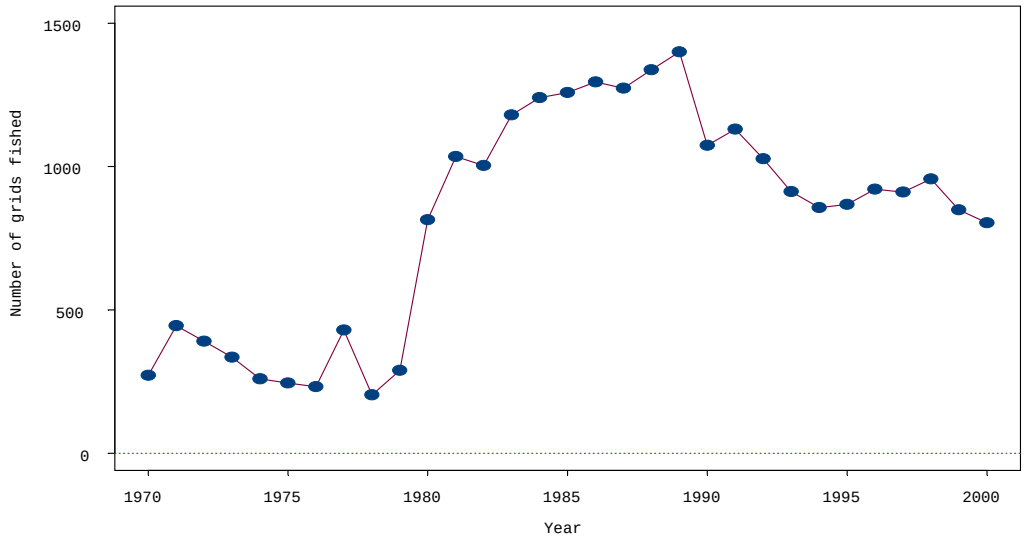

Figure 12. Total number of 6 x 6 grids fished in the NPF (Data from AFMA logbook database). Note: (1) A number of grids reported as being fished actually overlie land; these have been excluded in this figure. (2) It is generally accepted that fishing effort was severely under-reported during the period 1970 to the early 1980's; we have made no attempt to correct for this in this figure.

Management measures to decrease fishing effort on prawns are a major driver of this reduction but it is having the parallel effect of lessening the spatial extent of impact on the seabed fauna (see Surrogates Project below).

In the areas trawled, the level of exposure of the benthic communities is likely to be variable spatially and temporally due to the locally aggregated nature of the trawling. Recent CSIRO research has shown that NPF operators target aggregations of tiger prawns, repeatedly trawling areas of high catch. Operators in the NPF record fishing effort on a scale of six nautical mile grids but much of the seabed within those grids is trawled only once, or not trawled at all. Therefore, trawling may only be directly impacting a small area within most of the grids with recorded effort (Die *et al*. 2001). The impact of trawling on benthic communities will vary throughout the area of the fishery depending on the effort distribution.

Studies by CSIRO and QDPI in the Great Barrier Reef (GBR) region examined the impact of trawling on benthic communities, and primarily those in soft sediment, inter-reefal areas with patchy benthic structure. On average, a single pass by a prawn trawl was estimated to remove 10 - 15% of the animals attached to the seabed in the trawl pathway (Poiner *et al*. 1998).

Although the depletion rates are low, repeated trawling over the same ground will result in significant depletion. The depletion rates estimated for the northern GBR would result in a loss of 50% of the sessile benthos vulnerable to prawn trawling after 5 to 7 trawls and 75% after 10 to 14 trawls on the same ground. The recovery rate of these benthic organisms is unknown but studies in the GBR are attempting to provide estimates. The research suggests that in moderately trawled areas, there has probably been a shift away from highly vulnerable, slow growing species to more resistant, fast-growing species.

Surrogates project

Results from the ongoing Surrogates I Project (CSIRO/FRDC Project No. 2000/160 - Surrogates I - Predictors, impacts, management and conservation of the benthic biodiversity of the Northern Prawn Fishery will be relevant to the impacts of fishing on benthic communities. This project is due for completion in October 2002.

Fine Scale Distribution of Trawl Effort

Commercial fishing logs record trawl activity on a 6 x 6 nautical mile grid. Since 1999, all trawlers in the NPF have been required to carry a satellite-based VMS that records the exact position of each trawler at time intervals decided by AFMA. In the Surrogates project, the data for August, September and October 2000 were analysed and used to partition trawl effort into 1 nautical mile grid squares. This showed that trawl effort is highly aggregated and that in many cases only part of a 6 nautical mile grid square is fished. Trawl effort is concentrated into high yield areas. The consequence of this pattern is that the area that is actually fished is smaller than indicated by an analysis of the number of 6 nautical mile grids fished.

Distribution of biota

The present data sets on the benthic fauna of the NPF are highly biased towards the deeper Gulf of Carpentaria. There is limited data for the shallower (<20m) fringes of the Gulf except for the distribution of seagrass communities and no data for JBG or for the top end north of Arnhem Land.

The NPF has been divided into 15 bioregions under the Commonwealth IMCRA. The information available for each IMCRA bioregion was insufficient for a description of the benthic biota. For four regions there are no prawn trawl, fish trawl or dredge samples at all. Many of the others are inadequately sampled, for example 10 bioregions have less than 10 benthic dredge samples.

The analyses of the benthic fauna of the Gulf of Carpentaria showed a strong relationship between its composition and sediments – the higher the mud content, the lower the biodiversity. This relationship was extended with acoustic data that gave information on the hardness of the seabed. Low acoustic roughness and low biodiversity are related.

Comparing Gulf of Carpentaria data from different sampling gears – dredge, prawn trawl and fish trawl – showed that estimates of biodiversity depend on the sampling gear since they collect different components of the fauna.

An area with high infauna biodiversity may not necessarily have a high fish biodiversity. The epifauna (sampled by a dredge) of the trawl grounds is different to that of the central Gulf of Carpentaria. This is an important finding since it indicates that the lack of trawling in the central Gulf of Carpentaria does not mean that fauna on the trawl grounds is being protected simply by the distribution of trawling. However, the targeted fishing found with respect to the VMS monitoring does indicate that there are substantial areas of the ‘trawl grounds’ that are not trawled.

Impacts of trawling

The trawl impacts model developed for the Queensland East Coast trawl fishery was used to estimate the impact of various management regimes on the seabed fauna in selected parts of the NPF. The model showed that reduction in effort resulted in gradual recovery of the seabed in depleted areas – those previously exposed to high fishing effort.

- an instantaneous reduction in effort by 25% (the management measure applied in 2002) had similar outcomes to a reduction over 5 years
- as expected, a 50% reduction over 5 years resulted in greater relative biomass of benthos, more grids exceeded 20% of initial biomass and there was a higher median biomass
- groups that were impacted the most were gastropods and echinoids. Asteroids were impacted the least
- medium effort grids showed the greatest responses to changes in effort

Sustainability

In order to complement earlier work on the sustainability of teleosts and elasmobranchs (Stobutzki 2000, 2001), a semi-quantitative evaluation of the sustainability of the benthic invertebrates was undertaken.

The following twelve taxa were identified as the most sustainable:

- Pectinids (bivalve), Venerids (bivalve), Xenophorids (gastropod), Holothuroids, Mactrids (bivalve), Corystids (crab), Gonoplacids (crab), Cardiids (bivalve), Pagurids (hermit crab), Portunids (crab), Scyllarids (bug), Asteroids.

The twelve least sustainable taxa identified were:

- Soft corals, Bryozoans, Echinoids, Octopods, Olivids (gastropod), Palinurids (lobster), Parthenopids (pea crab), Pennatulids (sea pen), Sepiolids (cephalopod) Solemyids (bivalve), Solenids (bivalve), Teuthoids (squid).

It is important to bear in mind that these sustainability estimates refer to animals on the trawl grounds; in many cases there may be substantial off-ground populations that are not directly affected by trawling. Echinoids are a good example, while they appear to have low sustainability with respect to trawling, there are substantial populations off the trawl grounds. An earlier dredge survey of the Gulf of Carpentaria found that spatangoid echinoids were the dominant taxon in terms of biomass.

Impacts on food chains, ecologically related species and water column communities

The NPF may impact food chains through

- the removal of the target prawn species and byproduct species;
- through the capture of bycatch species; and
- the reintroduction of discard species.

In terms of the removal of target prawn species the prawn predators are likely to be the most significant group of ecologically related species. The CSIRO has done substantial work in the area of food chains and in particular, predation on commercial prawns in the NPF (Brewer *et al*. 1989; 1991; Salini *et al.* 1994).

Juvenile prawns are preyed upon in estuaries by queenfish (*Scomberoides spp*), catfish (*Arius spp*), barramundi (*Lates calcarifer*) and king threadfin (*Polydactylus sheridani*) amongst others (Kailola *et al*. 1993). The barramundi and king threadfin are targeted by inshore gillnet fisheries in Queensland and Northern Territory waters. The relative impact of these target finfish fisheries on these finfish populations, in comparison to the NPF's removal of prawns would be difficult to assess.

In a study of the feeding ecology of predatory fishes in the Gulf of Carpentaria, Brewer *et al*. 1991 found that penaeids were the first or second most important prey item by dry weight in 14 of the 34 penaeid-eating fish species, and in 12 species by frequency of occurrence. Larger fish ate larger penaeids of mainly commercially important species, while smaller fishes ate smaller mainly non-commercial species. The fishes with the strongest predation impact on commercially important penaeids were blue-spot trevally and four species of elasmobranchs. Table 6 shows the main predators of the adult prawns (Brewer *et al*. 1991; Salini *et al*. 1994).

Target prawn species	**Main predators**
White banana prawn (*Fenneropenaeus merguiensis*)	Blue-spot trevally (*Caranx bucculentus*) and Whitecheek shark (*Carcharhinus dussumieri),* Milk shark (*Rhizoprionodon acutus),*Grey Reef shark *(Carcharhinus amblyrhynchos)* and Black-spotted Whipray (*Himantura toshi).*
Brown tiger prawn (*Penaeus esculentus*)	Squid (*Loligidae*), cuttlefish (*Sepia* spp) and a variety of demersal fish.
Endeavour prawns (Metapenaeus endeavouri and M. ensis)	Squid (*Loligidae*), cuttlefish (*Sepia spp*) and a variety of demersal fish.
King prawns (*Melicertus latisulcatus* and *M. longistylus*)	Numerous juvenile and adult fishes including tailor (*Pomatomus saltatrix*), cobbler (*Cnidoglanis macrocephalus*), mulloway (*Argyrosomus hololepidotus*), black bream (*Acanthopagrus butcheri*).

Table 6 : Main predators of adult prawns

Prawns are only seasonally available to predators and their abundance shows high natural variation (Somers 1994). These characteristics would suggest that prawn predators would need to be flexible in their diet. The impact of the removal of prawns on the predator species therefore, may be less than if the predators were more specialised or targeted prey with low natural variation.

The impact of the removal of bycatch species on the food chains has not been assessed but the CSIRO/MAFRI/BRS project "Ecological risk assessment for

Commonwealth fisheries" will consider the broader ecological impacts of the Fishery and will identify any sustainability risks for food chains. In general the majority of bycatch species, particularly those caught in large numbers, occupy low trophic levels (eg. planktivores, herbivores or small carnivores). These lower trophic levels are generally characterised by high biomass, variability and turnover rates.

There is also likely to be more redundancy in these trophic levels, ie. numerous species occupying a given trophic level. These factors may lessen the trophic impact of the NPF. Additionally, the fishery occurs for less than six months of the year and an estimated 25% of the managed area. This means there are significant temporal and spatial refuges available for species, which would reduce the impact of the fishery.

The reintroduction of discards is the other impact the NPF may have on food chains. The majority of NPF discarded bycatch is fish (75% by weight, Stobutzki *et al*. 2001) that have low survival. Studies have shown that floating discards are scavenged by dolphins, sharks and birds, the latter only during daylight hours (Hill and Wassenberg 1990, Wassenberg and Hill 1989). Discards that sink are scavenged midwater but little is known about this and by benthic scavengers, including crabs, on the seafloor.

Discards from prawn trawling are spread over large areas, as trawlers are moving while discarding. Poiner *et al*. 1998 provide a rough estimate of NPF discards at 1.2g/m^2 over the six month trawling season (this was based on 30,000 tonnes per annum in the NPF (Pender and Willing 1989), over a fishery area of 24,720 km^2.

Poiner *et al*. 1998 also provide general predictions about the likely indirect impacts of discarding, which are summarised in Table 7.

Scavenger Group	**Distance of daily scavenging activity**	**Impact on populations relative to trawling intensity**
Seabird species that take discards	Tens of kilometres	Possible even in lightly fished areas because of ability to forage widely – but foraging only occurs during daylight
Dolphins and sharks	Kilometres	Possible in areas of regular trawling because they can concentrate in these areas
Small fish and invertebrates on the seabed	Tens of metres	Likely only in areas of regular trawling.

Table 7. The three groups of scavengers of trawler discards and the possibility of their populations being affected by scavenging (Poiner *et al.* 1998)

The research on the GBR has identified a possible impact of trawling on populations of Crested Terns (Poiner *et al*. 1998). However, birds scavenge during daylight hours and so the impact of the predominantly night fishing in the NPF may be less. The more restricted scavenging range of dolphins and sharks suggests that impacts would only be expected in populations that forage in areas of high fishing intensity.

The small benthic fish and invertebrates that range over restricted distances are probably not affected by discards as their opportunity to feed on them is limited. In areas of concentrated trawling, however, the amount of discards in a given area may be sufficient to increase significantly the amount of food available to individuals.

The possible impact of the NPF on water column communities, other than through discarding addressed above or physical changes to the water addressed below, is likely to be limited due to benthic nature of the fishery.

Impacts on the physical environment

Fishing activities have the potential to impact the physical environment: the sediment, water or atmosphere. In the NPF the most likely impacts on the physical environment would be through changes to:

- sediment or substrate due to trawling activities, and
- water quality due to introduction of debris, biological wastes.

Benthic trawling in the NPF has the potential disturb the upper sediment layers and resuspend sediment into the water column. However, the shallow nature of the NPF, the frequency of storms and cyclones and the high river discharge in some regions would suggest the sediment in this region is reasonably mobile. There is also bioturbation from organisms that live or feed on and in the sediment. In comparison to these natural impacts on the sediment, trawl impacts may be minimal.

Potential impacts on water quality from the NPF would be through the discarding of bycatch (discussed previously), pollution or biological wastes. Operators are required to retain any plastic waste and dispose of this waste when the vessel returns to port. Operators are required to comply with MARPOL legislation designed to minimise any impacts on water quality through pollution.

The CSIRO/MAFRI/BRS project "Ecological risk assessment for Commonwealth fisheries" will consider the broader ecological impacts of the NPF.

Guideline 2.3.3 Management actions are in place to ensure significant damage to ecosystems does not arise from the impacts described in 2.3.1.

In a few fisheries, environmentally friendly fish trawls have been developed to fish above the seabed to avoid damage to sessile animals. Prawns, however, live close to the seabed and so prawn trawls have to be rigged to skim the seabed. To date, there has been no technical improvement that would reduce the impact of trawls on sessile seabed animals such as sponges. The most effective measure to date is the reduction in frequency and amount of seabed that is trawled.

There has been a major reduction in effort both in number of boats and in the length of the season in the NPF in recent years. Since 1990 the number of boat-days in the Fishery has reduced by around 46% from over 30,000 boat-days to 16,687 boat-days in 2001. In terms of hours trawled, effort has fallen from 339,977 hours in 1990 to 171,504 hours in 2001.

Further measures to reduce effort by 40% on tiger prawns were introduced in 2002. This is being achieved through shortening of the fishing seasons and a further 25% reduction in the value of an SFR from 24 August 2002. Operators wishing to retain their current net sizes will need to acquire 25% more gear SFRs from the existing SFR pool. A further reduction in the number class B SFRs in the Fishery from 119 to 102, with only 96 vessels entering the fishery for the 2002 tiger prawn season occurred as a result.

The effort reductions have been primarily implemented to protect tiger prawn stocks. However the reductions in fishing effort on target species have resulted in a reduction in the total amount of bycatch and discards, and a reduction in the impact of fishing operations on benthos.

The increased fishing efficiency (effort creep), using electronic aids, such as colour echo sounders and GPS linked to plotters, is concentrating trawling with some areas being fished more frequently but with other areas being excluded or being seldom fished. The NPF has a number of management measures that are designed primarily to protect the target stock but also reduce overall effort in the fishery that would have ecosystem benefits. Some of these measures, and other factors include:

- seasonal and permanent closures, including all known seagrass beds
- the low proportion of the fishery trawled (approximately 14% of the fishery area)
- the reduction in effort over time
- the environment is highly diverse (as evidenced by the scale and composition of bycatch) and subject to natural fluctuations and disturbance ie. the shallow depths affected by cyclones, and high tidal range
- ecosystem damage reduced by spatial changes in the fishery over time

Guideline 2.3.4 There are decision rules that trigger further management responses when monitoring detects impacts on selected ecosystem indicators beyond a pre-determined level, or where action is indicated by application of the precautionary approach.

To monitor the extent of trawling on benthic communities operators are required to report the location of trawls in their logbooks. All vessels in the fishery are required to use a VMS, which provides a means of reporting and validating this information. The monitoring, using logbook and VMS data, will be undertaken by NORMAC and the extent of trawling will be reported annually and include changes over time.

NORMAC will encourage and seek funding for a study on the impacts of trawling on soft sediment fauna in the NPF and will undertake a vulnerability assessment of benthic species and communities, similar to the CSIRO Bycatch Species project. A workshop will be held in February 2003, to discuss the issue of physical impacts and more specifically to develop vulnerability criteria.

The current draft Bycatch Action Plan for the Fishery includes a strategy and actions to manage the physical impacts of the fishery including to:

- continue the current permanent closures of critical fisheries habitat for the NPF,

such as seagrass beds; and

- initiate research to conduct a vulnerability assessment on species and habitat resulting from the impacts of trawling and implement new closed areas where required.

The NORMAC Closures Committee meets annually to review closure arrangements in place and to consider proposals to provide additional protection to identified sensitive areas. The information collected in the monitoring and both the Closures and Research and Environment subcommittees of NORMAC will consider validation program. The Surrogates project currently being undertaken by CSIRO will also identify the areas being trawled and the type of communities in which trawling is occurring.

Guideline 2.3.5 The management response, considering uncertainties in the assessment and precautionary management actions, has a high chance of achieving the objective.

NPF industry, NORMAC and AFMA have along history of commitment to the sustainable management of the fishery and the marine ecosystem. The fishery also has an excellent record of incorporating the results of research into the management of the fishery in a timely manner. In the Strategic Plan 2001 – 2006 there is a commitment to achieve a comprehensive, adequate representative system of Marine Protected Areas in the NPF.

Considerable funds have been directed towards ecosystem management and it continues to be high research priority. The ongoing CSIRO/FRDC Project (2000/160): Surrogates I - Predictors, impacts, management and conservation of the benthic biodiversity of the Northern Prawn Fishery aims to:

- assess the potential of physical, research and fishery data to classify benthic species assemblages within the NPF
- develop maps of benthic species assemblages, fine–scale patterns of trawling intensity and the untrawlable grounds for key areas in the NPF
- assess the sampling strategies required to extend the coverage of data on benthic species assemblages and untrawlable grounds in the NPF
- apply the existing CSIRO/GBRMPA East Coast Trawl Fishery management scenario evaluation model to evaluate the impacts of trawling on benthic species assemblages under a number of likely scenarios for several regions of the NPF
- develop a planning tool that will assist in identifying different reserve configurations to achieve specified biodiversity and other environmental targets, while maximising the value of the commercial fishery

The project was completed in October 2002 and the report will be available early in 2003. The results on identifying different ecosystems, and modelling different management scenarios, will provide information for the selection process of Marine Protected Areas in the NPF and on potential management strategies for conserving biodiversity values. The project will also provide information on methods for assessing the effectiveness of Marine Protected Areas for conserving biodiversity.

There are several large projects planned to start in 2002/03 that will collect data on the environment of the NPF and the impacts of fishing. These include:

- Effects of trawling on animals and plants living on and in soft sediment seabed
- Design, trial and implementation of an integrated long-term bycatch monitoring program in the NPF
- Designing and implementing an integrated monitoring program for the NPF optimising costs and benefits

All the projects will provide valuable data on which to which to make sound decisions on managing the impact of fishing on the ecosystem and environment generally.

16 GLOSSARY

Access right: A right to carry out specified fishing activities.

Australian fishing zone (AFZ): Waters adjacent to Australia and its external territories (excluding Torres Strait and the Antarctic Territories) which extend from defined baselines to 200 nautical miles seawards, but not including coastal and excepted waters. Agreed boundaries apply where these zones intersect the 200 nautical miles zones of other nations. Within the AFZ, Australia exercises jurisdiction over all fishing by Australian and foreign boats.

Bellyrope: Rope sewn longitudinally into the side panel of a high opening trawl to transfer netting strain onto the top of the otter board.

Bilateral Agreement: This is a Government-to-Government agreement between Australia and another nation allowing vessels of that nation to fish within the AFZ.

Body: Section of the net between the bosom and the codend.

Booms: Steel/aluminium structures up to 12metres outboard of the vessel's centre line from which the trawl is towed.

Bosom: Central part of nets where the frame line is normal to the direction of tow.

Bridles: Wire rope connecting the otter boards and sleds to towing warps.

Codend: A netting bag connected to the aft end of the trawl to collect the catch during the tow.

Demersal fish: Fish that are normally caught on the seabed.

Demersal trawl: Trawl gear designed to work on or near the seabed. Such gear is used to take demersal species of fish and prawns.

Drop Chain: Length of chain (≈ 150 millimetres) connecting the footrope to the ground chain at approximately 1metre intervals. The resulting gap between the footrope and the ground chain allows less mobile benthic creatures and objects to pass beneath the trawl. Also referred to as drops or droppers.

Fishing capacity: The amount of fishing effort that a fishing boat, or a fleet of fishing boats, could exert if utilised to its/their full potential.

Fishing concession: A Statutory Fishing Right, or a Fishing Permit or a Foreign Fishing Boat Licence granted under the provisions of the Fisheries Management Act 1991

Fishing Permit: A Fishing Permit is a type of fishing concession granted under Section 32 of the Fisheries Management Act 1991 to a person and authorising the use of a specified Australian boat by that person, or a person acting on that person's behalf, for fishing in a specified area of the AFZ or a specified fishery for specified species using specified equipment.

Fleet: A fleet is defined as an organisation operating (or having entitlements to operate) two or more boats.

Fly wires: Wire connecting the headrope of a trawl to the bridle approximately 10 – 20 metres from the otter board.

Footrope: Lower frame line to which netting is connected to in a trawl. Also referred to as the fishing line or footline.

Ground Chains: Chain of similar length to the footrope that skims across the seabed to stimulate prawns into the trawl.

Ground Gear: That part of the net along the footrope that is likely to contact the sea floor. The ground gear can include; drop chains, ground chains, tickler chains and mudropes.

Hanging: Method for attaching the tapered netting sections of headrope and footrope of the trawl to their respective frame lines.

Headrope: Upper frame line to which netting is connected in a trawl. Also referred to as the headline.

Input controls: Restrictions placed on the amount of effort input into a fishery eg by restricting types and size of fishing gear and boats and the amount of fishing time.

Lazy line: Rope permanently connected to the codend to allow it to be hauled on board the vessel.

Leadahead: Where the headrope is forward of the footrope to form an over hanging sheet of netting. Leadahead is designed to prevent prawn from escaping over the headrope when they react to the ground chain.

Limited entry: Management arrangements whereby only a fixed number of vessels are allowed to fish in a particular fishery. New operators may only gain access to the fishery by purchasing an existing right.

Logrope: A length of small diameter rope attached vertically to the wingend between the headrope and footrope to provide support and strengthen the wingend.

Marriage line: Small diameter rope, connecting all lazy lines. This rope, being near the stern of the vessel when the gear is hauled, is easily recovered to provide access to all lazy lines.

Net: The net, or trawl, consists of a netting bag hung between two frame lines. The lower frame line also includes the ground gear; usually a ground chain connected by drop chains.

Nominal Mesh Size: Another input control that regulates trawl gear are restrictions on the mesh size that can be used in the construction of the net. Nominal mesh size is usually meshed as the distance between the centres of opposing sheetbend knots when the mesh is pulled taut.

Offshore Constitutional Settlement (OCS): An agreement between the State(s)/Territory and the Commonwealth whereby the State or the Commonwealth (or in some cases a Joint Authority) is given jurisdiction for a particular fishery occurring in both coastal waters and the AFZ. When no OCS agreement has been reached the fishery remains under the jurisdiction of the State out to 3 nautical miles, and the Commonwealth from 3 to 200 nautical miles.

Output controls: Restrictions imposed on the quantity of fish that can be taken from a fishery within a specified period of time. This can be by either a competitive total allowable catch (TAC) or a TAC allocated to participants as individual transferable quotas (ITQs).

Otter board: Steel or timber door between the net and towing bridle which is set at an angle of attack to the tow direction designed to generate a lateral hydrodynamic force (shear) to spread open a trawl.

Pelagic fish: Fish that are normally caught on the sea surface or in the water column.

Seam: The product of joining two panels of net together along the length of the trawl from wingend to codend, The panel seamed together are usually the top and bottom panels, or with a side panels in between if required.

Side Panel: Longitudinal panel of netting incorporated into the side of the trawl to allow for the degree of vertical separation between the headrope. This produces a net that has two seams down each side (4 seam net).

Skirt: A cylindrical cover over the codend of similar material and circumference to reduce wear on the codend. The skirt may also be sealed over the codend using a drawstring to prevent catch loss.

Spread: Is the lateral distance that the headrope spans while the gear is working. Spread is often expressed as a percentage of total headrope length and is termed the spread ratio.

Sweep: Length of wire between the net and otter boards.

Taper: A combination of meshes cuts at various angles in the netting to shape a panel of netting.

Tickler Chain: Chain of smaller diameter and shorter length attached to the ground chain that travels across the sea floor ahead of the ground chain to provoke an earlier reaction by prawns in an attempt to increase catch rates.

Torres Strait Protected Zone: A region of the Torres Strait, established under the Torres Strait Treaty, in which Australia and Papua New Guinea each exercise sovereign jurisdiction for fish and sedentary species on their agreed sides of jurisdiction lines.

Torres Strait Protected Zone Joint Authority: An Authority comprising the Commonwealth Minister for Resources (Chairperson) and the Queensland Minister for Primary Industry. The Authority is responsible for monitoring the condition of the jointly managed fisheries and for the formulation of policies and plans for their management.

Torres Strait Treaty: The Treaty between Australia and Papua New Guinea concerned with sovereignty, management and maritime boundaries in the area between the two countries and the protection of the way of life and livelihood of traditional inhabitants and the marine environment.

Warp: Main towing wire.

Wing: Panels of netting forward of the trawl bosom extending to the otter boards.

Wingend: The forward or leading edge of the wing between the upper and lower frame lines. The wingend is usually strengthened by the addition of a logrope.

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19 ACRONYMS

ABARE	Australian Bureau of Agricultural and Resource Economics
AFMA	Australian Fisheries Management Authority
AFFA	Department of Agriculture, Fisheries and Forestry - Australia
AFZ	Australian fishing zone
AFZIS	Australian Fishing Zone Information System
AIMS	Australian Institute of Marine Science
ALC	Automatic Location Communicator
AMC	Australian Maritime College
AQIS	Australian Quarantine and Inspection Service
ARC	AFMA Research Committee
ARF	AFMA Research Fund
ASIC	Australian Seafood Industry Council
BAP	Bycatch Action Plan
BRD	Bycatch Reduction Device
BRS	Bureau of Rural Sciences
CPUE	Catch per unit effort
CSIRO	Commonwealth Scientific and Industrial Research Organisation
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
FAG	Fishery Assessment Group
FRDC	Fisheries Research and Development Corporation
FRRF	Fisheries Resource Research Fund
GBR	Great Barrier Reef
GPS	Global Positioning System
GVP	Gross value of production
IMCRA	Interim Marine and Coastal Regionalisation for Australia
JBG	Joseph Bonaparte Gulf
MAC	Management Advisory Committee
MARPOL	Marine pollution
MIRF	Management Advisory Committee Initiated Research Fund
MSY	Maximum Sustainable Yield
NORMAC	Northern Prawn Fishery Management Advisory Committee
NPF	Northern Prawn Fishery
NPFAG	Northern Prawn Fishery Assessment Group
OCS	Offshore Constitutional Settlement
SFR	Statutory Fishing Right
TED	Turtle Excluder Device
VMS	Vessel monitoring system

20 SUMMARY OF RESEARCH 1996 – 2001

1.1 TARGET SPECIES RESEARCH PROJECTS

Target Species Research project reference no. 1

An economic assessment of applying ecologically sustainable development principles to fisheries management: the case of the Northern Prawn Fishery. ABARE, FRRF 97/9592 ($141 432) 2000

Summary

Implications of alternate management instruments for the sustainability of target stocks, the commercial fishery and the marine environment were examined in this report. The sustainable management of the marine environment is discussed, with consideration of the impacts that management of the commercial fishery may have on the marine environment. The sustainability of the principal commercial prawn species is examined in the light of alternative measure to control fishing efforts. The feasibility of monitoring and adjusting fishing restriction in real time in response to the observed state of stocks is also investigated. Where appropriate, moving images show the temporal and spatial pattern of fishing and are used to assess the likely effects of different management options.

Target Species Research project reference no. 2

Die D, Loneragan N, Haywood M, Vance D, Manson F, Taylor B, Bishop J Indices of recruitment and effective spawning for tiger prawns stocks in the Northern Prawn Fishery CSIRO, FRDC ($972 283) 1995-1998

Non Technical Summary

This study was conducted to improve understanding of the relationship between the spawning stock and recruitment in the Tiger Prawn Fishery and aimed to better understand the reasons why tiger prawns did not recover from recruitment overfishing after drastic effort reductions in the late 1980s.

Electronic maps were developed that identify where trawling occurs and the areas which are untrawlable due to the type of substrate. The maps showed that fishing effort and untrawlable grounds are distributed unevenly throughout the NPF. The fishers tend to search for aggregations of tiger prawns early in the night. Once an area of higher catch has been located, the vessel targets that same area for the remainder of the night. As a result, some of the fishing ground is trawled several times in the same night but nearby areas may not be trawled. This information is essential for understanding seasonal and historical changes in the efficiency of trawling.

A simulation model of the currents in the Gulf of Carpentaria and the behaviour of larval prawns was developed. The model was used to predict the offshore spawning regions from which larvae could be expected to reach the seagrass nursery areas along the coast. The model shows that there are large gaps between these effective spawning areas and this suggests limited mixing of tiger prawn larvae within the Gulf of Carpentaria.

Logbook data was used to examine trends in the spatial extent of the fishery. Although the total area fished has been decreasing since 1983, the area searched continued to increase until 1987. Areas of high catch have remained unchanged throughout the history of the Fishery. The area currently fished has contributed to the majority of the historical catches, but in the early 1980s only 60% of the total catch came from this area. Some areas that were fished in the 1980s are not fished today - some because they are now inside trawl closures, but others because of low catch rates.

Commercial count data provided by skippers in their logbooks is accurate and was used to identify the location and seasonal pattern of recruitment of small prawns onto the fishing grounds. Many of the areas located as recruitment areas are on the edges of current area closures, supporting the hypothesis that these closures are protecting pre-recruits from harvesting. The analyses suggest that October/November tiger prawn catch rates of the 20-30 count category may be a good predictor of recruitment of tiger prawns in the following fishing season.

The analyses of logbook, plotter and larval advection data have led us to propose a new stock structure for tiger prawns inside the Gulf of Carpentaria. Seven new stock areas have been defined: some contain a stock of both grooved and brown tiger prawns, and others contain a stock of only one of these species. It is likely that other stock areas occur outside the Gulf of Carpentaria.

Spawning/stock recruitment relationships (SRR) have been defined at two spatial scales; firstly at an NPF-wide scale and secondly at each of the regional stock levels of the Gulf of Carpentaria. At the NPF-wide scale, the model suggests a strong influence of spawning stock on recruitment, and also increased recruitment, independent of the spawning stock, every 3 to 4 years. At regional scales the influence of spawning on recruitment is less apparent.

However, simple biomass dynamic models suggest that, from 1993 to 1998, tiger prawn stocks in the Gulf of Carpentaria remained below the levels required to produce maximum sustainable yield, thus implying that these stocks were overfished. Similarly, standardised fishing effort for that same period remains above the fishing effort required to achieve maximum sustainable yield, thus implying that overfishing continued to occur. Spatial analysis suggests that there are differences in the levels of overfishing between regional stocks.

The assessments seem to confirm the perceptions of some members of the fishing industry who have suggested that the tiger prawn stocks in the Groote Eylandt region have not recovered from the overfishing that occurred in the early 1980s. They also suggest that the stocks in the Vanderlin and Mornington Island areas were further depleted during the later 1980s as the fishing fleet fished more in these areas in response to the depletion of the stocks around Groote Eylandt.

At smaller spatial scales our research has shown that fishing is highly aggregated. This reflects differences in the abundance of prawns and the type of bottom present within the fishing grounds. We believe that this knowledge will be critical in supporting the establishment of marine protected areas in northern Australia. To make this information more useful, however, we will need to quantify fishing impacts on prawn populations and benthic habitat at these small scales. This will require further research to characterise the reasons for these aggregations and the relationship between bottom type

and benthic habitat.

In summary, this project has confirmed that tiger prawn stocks remain overfished at both a large (NPF-wide) scale and a regional scale. This implies that for NORMAC to put in place management measures that will recover the stocks from their overfished state, these measures will have to be effective in all regions of the fishery.

Target Species Research project reference no. 3

N. Loneragan, D.J. Die, G.M. Kailis, R. Watson, N. Preston Developing and assessing techniques for enhancing tropical Australian prawn fisheries and the feasibility of enhancing the brown tiger prawn (*Penaeus esculentus*) fishery in Exmouth Gulf CSIRO, MG Kailis Company, FRDC ($6 943) 1998-1999 (Stage 1)

Non-Technical Summary

The prawn trawl fishery in Exmouth Gulf, Western Australia, harvests a mixture of penaeid prawns. Catches of the high value, brown tiger prawn *Penaeus esculentus* comprised about 36% of the annual catch in the 1990s. However, annual catches of tiger prawns are now about half the level they were in the 1970s and fluctuate markedly, from about 200 to 680 t. These changes in catch create uncertainty in the supply of prawns for export markets and force fishing and processing operators to have excess capacity to deal with good years. Managers, fishing industry and researchers are considering the option of enhancing the natural recruitment of brown tiger prawns by releasing juveniles in wild nursery areas to reduce natural fluctuations and increase the average annual catch.

This collaborative project (CSIRO, Fisheries WA, MG Kailis Group of Companies) assessed the feasibility of stock enhancement of tiger prawns in Exmouth Gulf by:

- developing a bioeconomic model
- examining the risks of changes in the genetic composition and introducing disease to the wild population of tiger prawns, and
- identifying further work that would be needed before stock enhancement should proceed.

This is the first of several stages that may lead to stock enhancement of tiger prawns in Exmouth Gulf. The project was initiated through a workshop of all project participants in Perth in July 1998.

Bioeconomic model

A bioeconomic model was developed in EXCEL to make it accessible to managers and industry. This model contains independent modules (linked worksheets) for the hatchery, production, nursery and fishery. The results from the model suggest that a release of 7 million juvenile prawns (1g) would increase catches of brown tiger prawns by about 100 t and that the median marginal revenue for this level of enhancement would be $1.2M (range = $0.8M to $1.7M). The marginal revenue was affected mainly by variation in prawn prices and secondarily by the densities used to grow juvenile prawns. The variation in prawn prices should be considered a risk in any future enhancement project. The uncertainty about the best densities for producing juvenile prawns and the production environment (ie. ponds or raceways) is an important area for future research and development. A further source of uncertainty in the model is the

survival rates of prawns and how they vary at different stages of the enhancement (eg. survival during transport and release, whether survival is density-dependent in the nursery).

The median difference between production costs and the median marginal revenue was about $540,000. This cannot be interpreted as strict profit because the model did not include all capital costs and because it used some assumptions that may not be realistic (e.g. 100% survival of juveniles during harvest and release). Sensitivity analysis showed that provided the mortality associated with the harvest, transport and release of juvenile prawns is less than 30%, the enhancement has a greater than 90% chance of still being profitable. Although the model did not include the costs of monitoring, the current results indicate how much can be spent on capital and monitoring for enhancement to be profitable. The predictions of the current model therefore represent "best-case" scenarios for stock enhancement and would be refined, as new information becomes available. The model also provides a rigorous framework for evaluating the possible success of other enhancement projects.

Nursery habitats

Participants at the stock enhancement workshop recognised that little was known about the nursery habitats of brown tiger prawns in Exmouth Gulf, the dynamics of juvenile prawns in the nurseries, and predation rates on them. This information is needed to develop the best release strategies to ensure the success of a stock enhancement.

Risks of affecting the gene pool and introducing disease through stock enhancement

The risks of affecting the genetic composition of the wild stocks from the stock enhancement of penaeid prawns were discussed by a panel of industry representatives, research scientists, research managers and policy managers at the FRDC sponsored workshop on "Genetics in the Aquaculture Industry" held in Perth in October 1998. In this case the risks were considered low and recommendations were made for minimising the genetic risks. These were:

- determine the genetic structure of the wild population prior to stock-enhancement
- use only broodstock from the target population selected for enhancement
- randomly collect broodstock (to avoid family groups)
- trace individual families through rearing using genetic markers
- release the same number of individuals from each of the captive-bred families
- monitor the effects of the release using molecular methods (e.g. microsatellite DNA markers)

The risks of introducing disease into the wild population were also considered at the stock enhancement workshop and in further discussions with Dr Brian Jones of Agriculture WA. The protocols for assessing diseases in prawns have been developed as a part of the Fisheries WA program on Disease and Hatchery testing and a component of the "Tropical Prawn Diseases" project (FRDC 98/212). Any juvenile prawns produced for stock enhancement would be tested for disease using these protocols.

Conclusions

The bioeconomic model has shown that the stock enhancement of tiger prawns in

Exmouth Gulf can be profitable. However, further information is needed on the production of juvenile prawns and the survival of juveniles during the release (i.e. harvest, transport, release), to make better predictions about the likely success of an enhancement.

The technology for the production, harvest, transport and release of juvenile prawns needs to be developed. Further information is also needed on the nursery habitats of the juvenile prawns to develop release strategies that give the maximum chance of a successful enhancement.

These information needs are the basis for a three year FRDC project "Developing techniques for enhancing prawn fisheries, with a focus on brown tiger prawns (*Penaeus esculentus*) in Exmouth Gulf" (FRDC 1999/222), which is the second stage in the overall plan for the stock enhancement of tiger prawns in Exmouth Gulf. If the results of Stage 2 are favourable, it would be followed by trial stock enhancements (Stage 3, 1 to 2 million juveniles) and a commercial scale enhancement (Stage 4, 7 to 10 million juveniles) that would attempt to increase the commercial catch by at least 100 t.

Target Species Research project reference no. 4

Loneragan NR Kenyon RA, Die DJ, Pendrey RC, Taylor B The impact of changes in fishing patterns on red-legged banana prawns (*Penaeus indicus*) in the Joseph Bonaparte Gulf CSIRO, FRDC ($55 014) 1996-1997

Summary

Tagging did not affect either the growth or survival of *Penaeus indicus* under laboratory conditions. The results of this study show that a large scale field tag/release experiment in Joseph Bonaparte Gulf (JBG) should be feasible.

There was no difference in growth or mortality between the tagged and control prawns. Growth of all prawns was higher in the large 5000 l tanks than in the much smaller 50 l tanks. The mortality of both tagged and control prawns was higher in small tanks than large tanks. Female *P. indicus* grow faster than males.

A prototype release cage was developed and tested under calm conditions in shallow water, the release mechanism activated successfully and the prawns left the cage. However, under extreme conditions in JBG the cage was less successful. The release cage reached depths greater than 60 m, however, upon retrieval, some prawns remained in the release cage to within 3 m of the surface.

Tagging in JBG would be very dependent on weather. It would be impossible to tag and release prawns under the conditions that the cage was tested. An improved release cage design is currently being developed.

Logbook data were used to examine effort patterns in the JBG during different seasonal closures. In the early years of the fishery (1981-84), effort was concentrated at the end of the year (September-December), in 1985-86 effort was more in the middle (June-September), whereas in recent years (1988-1995) effort peaks in May and June.

Length frequency data and data on the maturity of red-legged banana prawns collected by Rik Buckworth of NT Fisheries were analysed to estimate parameters of growth and reproduction, and estimate the seasonal pattern of recruitment to the fishery. The

estimates of growth rate were unreliable and as a consequence best estimates were obtained from the literature for *P. merguiensis*. The seasonal pattern of recruitment from the length frequency data suggests that most prawns recruit to the fishery between February and April. However, no length frequency data are available for the months between December and February.

The yield, value of the catch and egg production were estimated for different seasonal patterns of effort using a per-recruit model (SIMSYS). The results from this model show that both yield and value can vary by as much as 15% depending on the pattern of effort. However, the results of the model were sensitive to the estimates of growth and mortality, which highlights the need to obtain better estimates of these parameters.

Target Species Research project reference no. 5

Vance D, Kenyon R, Taylor B Growth, mortality, movements and nursery habitats of red-legged banana prawns (*Penaeus indicus*) in the Joseph Bonaparte Gulf CSIRO, FRDC ($850 541) 1996- 2000

Summary of ongoing work

1. Estimates of natural and fishing mortality and growth rates for the red-legged banana prawn in the Joseph Bonaparte Gulf.

About 1016 tonnes of red-legged banana prawns were caught in JBG in 1997, while about 261 tonnes were caught in 1998. The population estimates from our tag-release-recapture experiments reflect the fishery catch. We estimate the population was 65 million prawns in 1997 and 20 million in 1998. During 1997, about one tagged prawn was taken per tonne of catch, while during 1998, two to three tagged prawns were taken per tonne of catch.

Using the data from 1997, we estimated the natural mortality of red-legged banana prawns to be about 5% per week (M = 0.11), similar to the common banana prawn, *P. merguiensis*, in the Gulf of Carpentaria.

Analysis of our model showed that some aspects of the tag-release experiment including the size of the prawn (in 1997 only), sex of the prawn (not a strong effect), time of release and date of release affected prawn survival. The tag type, tagger, reward paid and location of release had no effect on prawn survival.

An analysis of growth parameters has been undertaken. Fits to the tagging data show that there were significant differences in growth between sexes, but not between years. Our model showed that P. indicus grew at a greater rate at 50 days of age (males - 1.42 mm wk^{-1}; females – 1.53 mm wk^{-1}) than later at 100 days (males – 0.82 mm wk^{-1}; females – 1.09 mm wk^{-1}) and 150 days of age (males - 0.48 mm wk^{-1}; females – 0.77 mm wk^{-1}).

2. The distribution of juvenile red-legged banana prawns in coastal Joseph Bonaparte Gulf and the most important habitats used.

Juvenile red-legged banana prawns (*P. indicus*) are found predominantly in the eastern JBG (>90% of all banana prawns in the Fitzmaurice, Victoria and Keep Rivers) and Cambridge Gulf (>73% of all banana prawns). They are found in high abundances (>1000 m^{-2}) in some small creeks and gutters at low tide. The western JBG (Berkeley and King George Rivers and many small creeks) have similar high abundances of

banana prawns, but they are predominantly *P. merguiensis* (>90%). This shows that the distribution of the two species is quite separate and distinct.

Juvenile *P. indicus* are found associated with mangrove-lined mudbanks in estuaries and rivers, similar habitats to those identified for *P. merguiensis* in the Gulf of Carpentaria. Repeated trawls among different riverine habitats in close proximity showed that *P. indicus* are most abundant in small side-creeks and gutters, compared to large creeks and riversand are found in very low numbers around mid-river mudbanks and channels.

3. Mapping of the juvenile nursery habitats on the ArcVIEW and ArcINFO GIS database

The Australian Land Information Group (AUSLIG) electronic map data were incorporated into a JBG GIS. Three potential juvenile red-legged banana prawn habitat types – mangroves, salt-flats and land-subject-to-inundation - were identified from these data and mapped. The area of each habitat and the linear extent of the habitat/water interface of likely habitats of *P. indicus* have been calculated. The abundances of juvenile P. indicus have been incorporated into the GIS, and relationships between prawn abundance and habitat have been investigated. No distinct relationship was found between prawn abundance and any aspect of habitat.

4. Other aspects of GIS that have been investigated

We used 3 methods (topographical data, aerial photography and Landsat Thematic Mapper satellite imagery) to estimate the area and linear extent of juvenile banana prawn habitats (mangroves and salt-flats) in the Berkeley River and Lyne River in JBG.

AUSLIG topographical dataset is digitised from topographical maps at a scale of 1:250,000, and includes such features as mangroves, salt-lats, land subject to inundation, and rivers. Black and white aerial photographs were obtained from the WA Department of Conservation and Land Management (CALM). These were classified to provide a coverage of mangroves and salt-flats. Landsat TM satellite imagery was purchased, and used to classify the mangroves and salt-flats.

For each method, the area and linear extent of each type of habitat was calculated and compared among methods to gauge the best method to use to estimate habitat. The results show that, at this scale, the aerial photographs provide the most accurate estimates of both area and linear extent of habitats, as verified by ground-truthing, while the topographical data was the least accurate. Landsat TM imagery gives good estimates of the area of habitats, but underestimates the linear extents. The differences in the estimates are attributed to differences in the resolution of each of the methods. The mangroves of the JBG region typically form narrow fringes that can be detected only at a high resolution. While aerial photographs give the most accurate results for individual river systems, Landsat TM imagery and topographical data can be useful tools in broader-scale studies.

5. Other findings

Freshwater discharge from the Ord River Irrigation Scheme affects the distribution of *P. indicus* and *P. merguiensis* in the Ord River. The all-year-round discharge from the irrigation scheme lowers the salinity in the Ord River. At low tide, the salinity is 0-5 ppt just upstream from its confluence with Cambridge Gulf. The abundance of juvenile banana prawns at sites in the Ord River was low to non-existent, and much lower than

in comparable rivers and sites flowing into Cambridge Gulf that we sampled at the same time. We stopped travelling up the Ord to sample as there were no prawns at several sites and the water was fresh.

Changes to river flows (i.e. inputs of fresh water) elsewhere in the JBG system may have an affect of reducing the estuarine habitat available to juvenile prawns and other estuarine fauna.

Target Species Research project reference no. 6

Yougan Wang, D. Die, N. Ellis Estimation of population parameters for Australian prawn fisheries CSIRO, FRDC ($69 524) 1995-1998

Non-technical summary

One of the main objectives of fisheries management is to ensure the sustainability of fished stocks. To reach this objective scientists have to adequately assess the status of fished populations with quantitative models of the fishery systems. Most of these models require estimates of population parameters such as growth rates, mortality rates and catchability (the proportion of the population caught by a single vessel each day). Most of these parameters are unique for each stock; unfortunately they are not easily estimated because marine organisms are inherently difficult to observe and study. Estimation is generally done through statistical analysis of catch data, either from the fishery or from research surveys.

Tropical prawns are fast growing organisms that reach maturity in a few months and tend to be predated upon or caught before they reach a year of age. Prawns are also animals for which age can not be easily determined because they have no hard structures that are retained through their life. As a result age cannot be estimated and can be inferred only indirectly from their size. The combination of a short life-span and the inability to age individuals is a major difficulty in developing estimation methods for populations of tropical prawns. This is especially the case for those parameters that are time dependent (such as mortality and growth rates).

This document reports on two years of work devoted to developing new statistical methods for the estimation of population parameters in tropical prawn fisheries. The work was divided into five components:

1. Review of current methods of estimating growth and mortality rates
2. Development of new methods for the estimation of growth and mortality rates
3. Development of a method for the estimation of size-specific mortality rates
4. Study of the dynamics of prawn aggregations
5. Estimating the effects of effort and aggregation dynamics on catchability

In the review of current methods we investigated three models that use length frequency data to estimate growth and mortality. The first two of these methods ignore differences in size for individuals of the same age and assume all prawns recruit at the same time. As a consequence these methods provide substantially biased estimates of population parameters. The last method considered did accommodate different sizes at age and gave unbiased results. This last method, however, provided very uncertain estimates, with large confidence limits suggesting that estimates were accurate but not precise.

This review concluded that it was imperative to develop new methods, more appropriate for the life history and fishery characteristics of tropical prawn fisheries.

A new method was then developed for estimation of mortality rates and growth parameters from length frequency data by incorporating individual growth variability within the model. The method is flexible enough to accommodate for different recruitment patterns, length-specific gear selectivity and varying fishing effort over time. This method is statistically robust and was tested with data for grooved tiger prawns from Northern Australia.

All the methods mentioned above make the fundamental assumption that the natural mortality rate does not change with the age or size of the prawn. We used data for common banana prawns to show this assumption is certainly not correct for juvenile prawns. We found considerable changes in the natural mortality of juvenile prawns, from 40% mortality per week for the smallest juveniles (4mm carapace length) to only 5% mortality per week for the larger ones (12mm carapace length). This suggests that there is a need to revise the evidence for size-independence of natural mortality rates for larger prawns.

Schooling is a well-known behavioural trait in fish but it is less common in prawns. In Australia, there is at least one group of prawns that form dense schools, the banana prawns. Other prawn species aggregate but in much smaller densities. We have used logbook data to describe the dynamics of prawn schools. We found that the apparent biomass of schooling banana prawns decreases due to fishing more rapidly than that of non-schooling banana prawns. This implies that the density and catchability of banana prawn stocks decreases as the season progresses. This possibly invalidates earlier assessments of banana prawn stocks, which assumed catchability was constant throughout the season.

At larger spatial scales we examined the relation between the effects of non-random distribution of fishing effort and abundance. Models used to analyse the catch and effort data from the Northern Prawn Fishery suggest that there has been an increase in catchability due to the reduction in abundance of tiger prawns and the tendency of tiger prawns to aggregate.

In conclusion this project has made substantial progress in developing appropriate methods for parameter estimation for tropical prawn stocks. Some of these methods have been successfully used to show that previous estimates of growth parameters, mortality rates, and catchability may have been subject to substantial bias or relied on untenable assumptions. This research has therefore contributed to correct such estimates at the same time as providing a set of new statistical tools that can be used for other Australian prawn stocks.

Target Species Research project reference no. 7

Dichmont C Risk analysis and sustainability indicators for prawn stocks in the Northern Prawn Fishery CSIRO, FRDC ($226 524) 1998-2000

Objectives

1. To assess the probability that current NPF prawn stocks are being fished at sustainable levels (as defined by performance indicators of stock status developed by NORMAC) by carrying out a risk analysis.

2. To predict the performance of future NPF management alternatives by comparing predicted stock parameters against NORMAC's performance indicators of stock status.

Target Species Research project reference no. 8

Haddon M. Spatial and seasonal stock dynamics of northern Tiger Prawns using fine-scale commercial catch-effort data. Tasmanian Aquaculture and Fisheries Institute, FRDC ($80 915) 1999-2000

Objectives

1. Determine whether the spatial and temporal scales of fleet behaviour bias the interpretation of the tiger prawn stock dynamics when analysed by a non-equilibrium stock-production model
2. Prepare NPFAG Working Papers that will include full descriptions of the model structure, data analyses and potential management implications
3. Communicate to the Northern Prawn Fleet and industry the results of the analyses in a format such that the implications become clear to everyone and that permits comments and criticisms by industry members

Target Species Research project reference no. 9

Hill B, Gooday P, Haywood M Developing surrogates for species assemblages, assessing the impacts of trawling and modelling the performance of spatial closures in the Northern Prawn Fishery CSIRO, FRDC, ABARE, EA, ($550 591) 2000–2002

Objectives

1. Assess the potential of physical, research and fishery data to classify benthic assemblages within the NPF
2. Develop maps of benthic species assemblages, fine-scale patterns of trawling intensity and the untrawlable grounds for key areas in the NPF
3. Assess the sampling strategies required to extend the coverage of data on benthic species assemblages and untrawlable grounds in the NPF
4. Apply the existing CSIRO/GBRMPA East Coast Trawl Fishery management scenario evaluation model to evaluate the impacts of trawling on benthic species assemblages under a number of likely scenarios for several regions of the NPF
5. Develop a planning tool that will assist in identifying different reserve configurations to achieve specified biodiversity and other environmental targets, while maximising the value of the commercial fishery.

Target Species Research project reference no. 10

Loneragan N Developing techniques for enhancing prawn fisheries, leading to experimental releases of juvenile brown tiger prawns (*Penaeus esculentus*) in Exmouth Gulf CSIRO (Division of Marine Research and Division of Tropical Agriculture, MG Kailis Group of Companies, Fisheries WA, FRDC) ($128 850) 1999-2002 (Stage II)

Objectives

1. Minimise the costs of producing large numbers of juvenile prawns through research

on techniques to intensively grow larvae to juvenile prawns (1 g), and developing methods of harvest, transport and release

2. Maximise the possibility of the success of releasing juvenile prawns in the environment by surveying the critical nursery habitats of brown tiger prawns in Exmouth Gulf (including the juvenile prawns and their predators)
3. Ensure that the cost and success of prawn enhancement can be rigorously evaluated by developing release protocols and monitoring strategies, and by refining the bioeconomic model developed in Stage 1
4. Minimise the risks of large changes in the genetic composition of the tiger prawn stocks and introducing disease to the wild population.

Target Species Research project reference no. 11

Vance D and Pendry B, The definition of effective spawning stocks of commercial tiger prawns in the Northern Prawn Fishery and king prawns in the Eastern King Prawn Fishery: behaviour of post-larval prawns CSIRO, FRDC ($449 168) 1997-2000

Objectives

1. Measure the critical vertical migration behaviour of postlarval tiger and king prawns that determines their inshore advection patterns.
2. Incorporate this behaviour into hydrodynamic models to accurately estimate the effective spawning stocks of tiger and king prawns.

Target Species Research project reference no. 12

Die, D, Dichmont C, Bishop J, Taylor B, Hall N, and Die D, Management of common banana prawn stocks of the Gulf of Carpentaria: separating the effects of fishing from those of the environment CSIRO, FRDC ($108 019) 1999-2000

Objectives

Review the influence of the environment and fishing on the long-term catch of banana prawns.

Provide a new assessment of the status of common banana prawn resources in the NPF. Obtain better predictive models to forecast the annual catch of banana prawns.

BYCATCH RESEARCH PROJECTS

Bycatch Research project reference no. 1

Robins J *et al.* Effects-of-trawling subprogram: commercialisation of bycatch reduction strategies and devices in northern Australian prawn trawl fisheries QDPI, AMC, Qld and NPF Industry ($473 688) 1996-1999

Edited draft of non-technical summary

The project aimed to inform, develop and encourage the use of turtle excluder devices (TEDs) and bycatch reduction devices (BRDs) by working collaboratively with the prawn trawling industry of northern Australia. The project also examined the possibility of modifying the headline height of trawl nets to reduce bycatch. We used several strategies to disseminate the relevant information about TEDs and BRDs.

Methods included:

1 Informal, hands-on workshops at ports throughout northern Australia, these demonstrated the various gears available
2 Attending industry meetings and informally visiting the wharves to discuss gear with fishers
3 Distribution of dedicated bycatch newsletters and videos summarising TED and BRD issues
4 Loans to skippers of TEDs and BRDs custom-built to suit individual needs
5 At-sea assistance with testing of TEDs and BRDs
6 An incentive award, the Prawn Trawling Innovation and Adoption Award to recognise the contribution of individuals within the northern Australian trawl industry to the development and adoption of TEDs and BRDs.

Tangible outcomes included face-to-face contact by project staff with about 30% of the prawn trawl operators in the Queensland East Coast Trawl Fishery and about 60% in the NPF. Over 400 fishers, net makers, conservationists and other industry personnel, attended TED and BRD workshops. 68 TEDs and 13 BRDs were lent to commercial fishers. Supervised field tests of TEDs and BRDs occurred on 37 vessels. Research staff spent over 418 days in the field, and recorded performance data on over 828 tows during which a TED or BRD was fitted to a trawl net.

TEDs were very effective at excluding sea turtles and other large animals. In total, 14 turtles were caught in standard nets, while two turtles were caught in TED-equipped nets (ie. the net was winched in with the turtle positioned at the base of the grid). Generalisations about the effects of TEDs on prawn catches were difficult to make, because of variable results.

A reduction in prawn catch of between 4% and 10% occurred during many of the supervised at-sea testing of TEDs. However, prawn catch rates were maintained or increased (average 7%) during several supervised TED tests. On some vessels, prawn loss in the TED equipped net was excessive (eg. 50%), but could be attributed to a particular cause such as shallow grid angle. On other vessels, excessive prawn loss occurred (eg. 29%), no obvious cause could be found.

BRDs had a varied effect on unwanted fish bycatch. Exclusion rates depended on the design of the BRD, the composition and quantity of bycatch, and whether trawling was undertaken during the day or night. In most cases, bycatch reduction averaged about 20% during night trawling and about 40% during day trawling. The data collected suggested that BRDs had little impact on prawn catches.

The recipients of the Prawn Trawling Innovation and Adoption were John Olsen in 1997 and Garry Anderson in 1998. Both recipients actively promoted TED and BRD use amongst their fellow fishers and were ambassadors for progress industry had made in reducing unwanted bycatch.

Results from the multi-level beam trawl work suggested that about 96% of most commercial prawn species and 90% of bycatch entered the trawl within 600mm of the seabed. This suggests that the majority of the unwanted bycatch lives close to the seabed like prawns. As such, the potential for reducing bycatch simply by reducing the headline height of the trawl seems to be poor.

Many fish species demonstrated strong upward escape responses to the approach of the trawl and the strategic placement of BRDs in the top panel of the trawl might be required to exclude these species successfully.

Less tangible outcomes of the project were the exchange of knowledge and information between project staff and individuals within the trawl industry. Information distributed by the project provided an important starting point for the manufacture and use of TEDs and BRDs by fishers and net makers of northern Australia. First-hand experience using TEDs and BRDs led many individuals to begin developing their own designs. Providing fishers with information that would allow them to understand the underlying principles of fish exclusion assisted this.

Less than 2% of the Queensland East Coast Trawl fleet used BRDs, and only two vessels (out of 920) regularly used TEDs when the project began in 1996. A similar situation prevailed in the NPF. No NPF vessels were known to regularly use TEDs in the NPF in 1996, but 7 vessels were known to have tested a TED previously. TEDs and BRDs were not commercially available and the skipper or owner of the vessel made most of the devices in use.

A wide variety of TED and BRD designs are now commercially available from at least 20 commercial suppliers in ports throughout northern Australia. From the beginning 2000, TEDs and BRDs were compulsory in all NPF trawlers. While the project targeted otter trawl operations, the concepts and designs for fish exclusion from trawl nets have been utilised by several operators in beam trawl fleet of the Queensland East Coast. This is an example of the change in industry attitudes towards bycatch reduction amongst many trawl fishers.

This project clearly demonstrated that a focused extension program can effectively raise the awareness of the fishing industry to sensitive issues, such as sea turtle bycatch, and encourage the use of "environmentally friendly" fishing practices. It also clearly demonstrated that the provision of research and extension information does not necessarily cause or induce all industry operators to change their practices.

Bycatch Research project reference no. 2

Robins C, Poiner I Monitoring the catch of turtles in the Northern Prawn Fishery BRS, CSIRO ($162 274) 1998–2000

Objectives

1 To collect detailed baseline information on the species composition, catch and mortality rates of sea turtles captured incidentally by the Northern Prawn Fishery in 1998 and 1999.

To use these results to:

- Measure the impact of the 1988/92 restructure, and predict the impact of the proposed effort adjustment package (199899) and the introduction of bycatch reduction devices (BRDs) into the NPF on the incidental catch of sea turtles
- Improve the current AFMA logbook monitoring of turtle bycatch in the NPF.

Bycatch Research project reference no. 3

Eayrs S An assessment of TED performance in the banana prawn fishery, Gulf of Carpentaria AMC, AFMA ($54 210) 2001

Objectives (NB this project was deferred to 2001 because of poor banana prawns catches in 2000)

1. To measure turtle catch rates in a standard trawl whilst target fishing for banana prawns.
2. To assess the condition of turtles caught during short tows and provide a first order estimate of likely survival rates.
3. To measure the effect of TEDs on banana prawn catches. (Effect of BRDs on prawn catches will also be assessed depending on the number of operators willing to participate in this study and the number of observers available).

Bycatch Research project reference no. 4

Stobutzki I *et al* Assessment and improvement of BRDs and TEDs in the NPF: a co-operative approach by fishers, scientists, fisheries technologists, economists and conservationists. CSIRO, WA Seafood Exporters Pty Ltd, A. Raptis and Sons, Veejay Fisheries Pty Ltd, Tiger Fisheries, Newfishing Australia Pty Ltd, Latitude Fisheries Pty Ltd, Gulf Net Mending Company, Australian Trawl Net Company, Austfish Pty Ltd, Traffic Oceania, ARJ Investments Pty Ltd, Australian Maritime College, Fisheries Economics Research and Management Specialists (FERM), FRDC ($1 165 233) 2000-2002

Objectives

1. To optimise the performance of approved BRDs and TEDs on NPF vessels
2. To identify the factors influencing the performance of BRDs and TEDs
3. To measure any change in catch rates of total unwanted bycatch and in particular, selected charismatic or vulnerable bycatch species, due to the use of BRDs and TEDs
4. To measure any changes in catches of commercially important prawns and retained byproduct species due to the use of BRDs and TEDs
5. To assess the economic costs and benefits to industry of the use of BRDs and TEDs
6. To establish a protocol for the ongoing development and testing of new BRDs and TEDs

Bycatch Research project reference no. 5

Stobutzki I, Blaber S, Brewer D, Fry G, Heales D, Jones P, Miller M, Milton D, Salini J, Van der Velde T, Wang Y, Wassenberg T, Dredge M, Courtney T, Chilcott J, Eayrs S Effects-of-trawling subprogram: ecological sustainability of bycatch and biodiversity in prawn trawl fisheries CSIRO, QDPI, AMC, FRDC ($1 477 390) 1996-1999

Edited draft of summary of final report

This project covered bycatch issues in the NPF, the Torres Strait Prawn Fishery and the Queensland Banana Prawn Fishery. This edited summary deals only with the NPF.

1) Description of the bycatch of the NPF

Areas of high trawl effort were sampled by scientific surveys and by an observer on commercial boats to describe the bycatch. The bycatch was very diverse; 390 species of fish, 47 species of elasmobranchs (sharks, rays and sawfishes) and 234 invertebrate taxa were recorded.

Fish species made up about 73% of the bycatch weight. Because most fish die after capture, most bycatch does not survive trawling. Three families, Bathysauridae (lizardfish or grinners), Leiognathidae (pony fishes) and Nemipteridae (monocled bream), made up 41% of the weight. Most of the fish species were rare. The bycatch differed across the areas of the fisheries and with time of year. NPF fishing areas can be divided into two on the basis of the bycatch composition. These two regions were dominated by different species of prawn and both should be included in any bycatch monitoring program

2) To assess the impact of trawling on the sustainability of vertebrate bycatch species

Stock assessments for bycatch species are not feasible because bycatch is very diverse and little is known about the biology of most species. Hence, we developed an approach to examine the likely impact of trawling on vertebrate bycatch species and applied this to the NPF. Two overriding characteristics determine the sustainability of bycatch species: the susceptibility of a species to capture and mortality in a prawn trawl (susceptibility) and the capacity of a species to recover once depleted (recovery). A number of biological criteria were assessed for each characteristic. Species were ranked on each characteristic and the ranking reflects their ability to resist fishing pressure and therefore their priority for management, monitoring and research. The fishes, elasmobranchs (sharks, rays and sawfishes) and sea snakes were dealt with separately due to taxonomic and biological differences.

Since the 1980's, 411 fish species have been recorded in NPF bycatch and on average the fishery removes about 6% of their total biomass annually. Thirteen species, from four families ranked as high priority for management, monitoring and research; these are the least likely to be sustainable. They are highly susceptibility to trawls because they are benthic or demersal, their main habitat is soft sediments and their diet may include prawns. Their recovery capacity is low. In applying this process we have highlighted important gaps in current knowledge of bycatch species but the ranking must be used with caution. Future research should be aimed at developing a greater understanding of the biology of species and their distribution in the region of the fishery.

The biology of elasmobranchs makes them more susceptible to overfishing than bony fishes because they are long lived, slow growing, reach maturity at a later age and have few young. Fifty-six species of elasmobranchs have been recorded in the bycatch of the NPF and the average estimated removal by the fishery is 14% of the total biomass. Most are dead when landed on deck (56%) and survival is lower for smaller individuals.

Twenty-seven species are the least sustainable, including stingrays (Dasyatidae), sawfishes (Pristidae), angel sharks (Squatinidae), zebra sharks (Stegastomatidae), shovelnose rays (Rhinobatidae) and nurse sharks (Ginglymostomatidae). They are all bottom dwellers, which increases their susceptibility to capture. Research focusing on

these high priority species is vital to ensure their long term sustainability.

We need to know more about the basic biology, distribution, movement patterns and stock structure of these species. The introduction of compulsory Turtle Excluder Devices (TEDs) and BRDs in 2000 will result in the exclusion only of large elasmobranchs. Most elasmobranchs caught by trawlers are small and would fit through the bars of the TED and be caught.

The biology of sea snakes also makes them more susceptible to overfishing than bony fishes. Thirteen species of sea snake are caught in the NPF. About 49% of sea snakes caught in trawls die. Most snakes caught are mature. Our estimates of sea snake catch and biomass of each species indicate that fishing mortality could be 5-6% per year, which appears sustainable for all but 2 species, Hydrophis *pacificus* (Large headed sea snake) and *Disteira kingii* (spectacled sea snake). In the Gulf of Carpentaria, these two species should receive high priority for further study on the effects of trawling. TEDs and BRDs appear effective at reducing sea snake catch (Brewer et al. 1998).

3) To assess the effects of prawn trawling on the biodiversity of vertebrate bycatch communities

The vertebrate bycatch community was compared between areas open to trawling and areas that have been protected for 15 years in the western Gulf of Carpentaria. If trawling had a large impact on biodiversity we would expect to see fewer species, lower catch rates and smaller individuals in the open areas. This was not the case; there was no consistent difference in the number of species between open and closed areas or in catch rates between open and closed areas. In general, the mean size of species was greater in the open areas. Although the results were equivocal with respect to the impact of trawling on biodiversity, this does not imply that trawling has no impact. Any differences between open and closed areas may be reduced by the low commercial effort in the open area, aggregated trawling, possible illegal trawling in the closure, and the mobility of species. This combined with high natural variation may obscure any impacts of trawling.

4) To develop cost-effective, accurate and feasible methods of describing and monitoring bycatch.

We carried out studies of sampling and monitoring methods to assist management. Most species are rare, and a sample of 10% of the catch of a single trawl contains about half of the species in the catch and has an 80% sampling error for the rare species. This sample size is the minimum recommended for monitoring. The results suggest that it is not feasible to monitor at a level that will detect a 50% change in catch rate for all taxa, including rare species. However, it may be possible to monitor more common species. The high level of variation in bycatch is contributed to by factors such as moon phase and should be taken into account when developing monitoring programs.

We compared three methods for monitoring NPF bycatch: crew-member observers; trained observer collections; and scientific surveys. The fishery-dependent strategies are the least costly and the best for monitoring rare species. However, crew-member observers cannot collect data on all bycatch without affecting fishing operations. In addition there is a real problem of identification of species, this is difficult given the large number of species in the bycatch. Scientific surveys are most costly, but provide reliable, accurate and immediately available data. They are also the only method of

collecting data on bycatch in unfished areas.

The design of a monitoring program will depend on the specific objectives. However, any monitoring program should aim to collect information on a suite of bycatch species and be able to detect changes in populations that may be at unsustainable levels. Other features of a monitoring program are also defined in the report. A monitoring program will be critical to assess whether the bycatch is sustainable or not.

Conclusions

Managing the sustainability of the bycatch is a significant challenge because of the high diversity of the bycatch of these tropical prawn fisheries and the fact that most species are rare. There are clearly some species that are more susceptible to trawling and are unlikely to recover if they are depleted; these species are the least likely to be sustainable. Future research and management should concentrate on these species. The development of a monitoring program for bycatch is not straightforward; the available methods differ in aspects such as data accuracy, reliability and cost. This project provides guidelines that can be used in the development of a monitoring program.

Bycatch Research Project reference no. 6

Blaber S Effects of trawl design on bycatch and benthos in prawn and finfish fisheries. CSIRO ($804 801) 1993-1996

Summary

As part of the project three inclined grids (Super Shooter, Nordmøre grid and AusTED) were tested. All three proved to be extremely effective in excluding large animals such as sea turtles, large sharks and large rays. Table 1 shows the effectiveness of TEDs during two research cruises in the NPF. They were also effective in excluding some of the unwanted small fish catch, especially when used in combination with other BRDs such as a fisheye or square-mesh window.

Cruise dates	Net type	No. of shots	No. of turtles
February 1995	TED net	52	1[1]
	Other[2]	172	15
October 1995	TED net	125	0
	Other[2]	51	11

[1]. Turtle in belly of net – insufficient time to find escape opening
[2]. Net without TED including those with BRDs fitted.

The ability of the inclined grids to catch prawns also varied. The Super Shooter showed the best prawn retention, only losing between 2% and 12% of prawns. The higher rates of prawn loss (>2%) were associated either with early trials or the use of the Super Shooter in combination with a fisheye and poor weather. The Super Shooter also performed well in areas where the other inclined grids may have clogged with sponges or other large objects. The Nordmøre grid lost substantial numbers of prawns, but it was considered that modifications could greatly improve its performance. The AusTED lost 22% of prawns but had much better results in other trials during a Queensland Department of Primary Industries and Fisheries (QDPIF) and Northern Territory

Department of Primary Industries and Fisheries (NTDPIF) project.

Bycatch Research Project Reference no. 7

Dredge M Development and application of AusTED in the Australian trawl industry Queensland Department of Primary Industries ($536 000) 1993–1996

Summary

Part of the objectives of this project was the further development of the AusTED design to maximise prawn catches whilst further reducing bycatch and develop a library of bycatch reduction equipment and literature which can be made available to industry for eduction and trial purposes.

As part of the project the AusTED and AusTEDII were trialed in various trawl grounds both in the NPF and the Queensland East Coast Trawl Fishery, under various conditions. The project report states that 'the results from AusTED II trials and the informal trials with commercial fishers lead us to conclude that in many situations any BRD will need to be individually tuned to suit the particular trawling conditions. The variation in the results demonstrates that caution needs to be taken when interpreting the performance results of a BRD outside the season or location in which the original work was conducted.

Bycatch Research Project Reference no. 8

NPF Bycatch Extension AFMA, NPF Industry ($13 125) 2000

Objective:

1. Educate and inform fishermen and gear manufacturers on bycatch issues in the NPF.

OTHER NPF RESEARCH PROJECTS

Other NPF Research project reference no. 1

Bishop J, Sterling D Survey of Technology utilised in the Northern Prawn Fishery CSIRO, DJ Sterling Trawl services, NPF industry, AFMA Research Fund ($14 000) 1998-1999

Summary

The survey aimed to establish a sound basis for tracking of changes in fishing power in the NPF by collecting data on key aspects of configuration of all vessels in the NPF. As vessels are reconfigured, or new technology is adopted by a fleet, changes in fishing efficiency follow.

Methods

All owners of statutory fishing rights in the NPF were requested to take part, and interviews were completed with representatives of 92% of the fleet of 1998. Half (55%) of the interviews were with single boat owners, a third (34%) were with owners of 3 or 4 boats, and the remaining 10% were with representatives of companies with more than 10 boats. Most (78%) of those interviewed were owners or managers, and the other 12% were skippers or fleet engineers. A third (31%) of the interviews were conducted on board, and the remainder were conducted in an office or elsewhere.

Opinions about the importance of some factors in relation to fishing performance

Try nets, plotters and echo sounders were rated as having the greatest impact on fishing performance, followed by engine power, communication equipment and GPS error. Otterboard size, net size and vessel dimensions were rated as having some impact, while radar and stabilisers were rated as having low impact.

Engineering performance of the vessel

Median rated engine power in the fleet was 300kw (interquartile [iq] range 272-336). According to the opinions of interviewees, over a third of the surveyed vessels (38%) had motors that could potentially produce more power than stated on the SFR register, (iq range 45-100 kw more). Median prop diameter was 1.52 m (iq range 1.5-1.7).

Bollard pull (the maximum thrust capability of a vessel while held stationary) was estimated by a deterministic engineering prediction model (Prawn Trawl Performance Prediction Model, (PTPPM, Sterling DJ 1996) for a subset of the vessels from rated power, reported propeller diameter, maximum trawling rpm, operating trawling rpm, and rated rpm. Median estimated bollard pull in the fleet was 5523 kgwt (iq range 5023-6312).

Characteristics of fishing gear that affect fishing efficiency

Median twine thickness was 36 ply (iq range 30-36); knotless netting was currently used in 7% of tiger prawn nets and none of banana prawn nets and none used spectra netting; Bison no 9 were the most common boards; median headrope length was 28 fathoms (iq range 24-28); and most common body taper was 1P4B (reported by 49% of vessels. Swept area performance was calculated for a subset of vessels by the PTPPM based on trawl gear specifications, calculated bollard pull.

Assuming a tiger prawn fishing night was 12 hours, and each vessel fished for tiger prawns for 138 nights in 1998), the median swept area per vessel per night was 2.3 square kilometres (iq range 2.0-2.5) and the median swept area per vessel for the year in 1998 was 319 square kilometres (iq range 281-341). Note that these estimates of swept area do not take into account any degree of retrawling over the same grounds.

Innovations with potential to improve catch efficiency of the trawl design

These included groundgear type (all had Texas); Stainless steel groundline (used on 88% of vessels); square mesh codend (no vessels); codend mesh size (median 50mm, iq range 47.6-50.8). Information relevant to bycatch reduction was also collected.

Innovations with potential to improve targeting ability of the vessel and crew and possibly trawling time

These included differential GPS (currently 65% of vessels with active DGPS mode), automated try gear (on board 3% of vessels); communications improvements (currently satellite phone 97%; personal Computer linked to email facilities 42%). The most common plotter type was non-PC based (Furuno or JRC, 75%); autopilot was linked to GPS on board 19% of vessels.

Other NPF Research project reference no. 2

Holland P, Gooday P, Shafron W, Ha W, Lim-Applegate H Australian Fisheries Surveys Report 1999: Northern prawn fishery survey results (note that the Report includes other Commonwealth Fisheries) ABARE (Cost not available) 1998-1999

Summary

Following higher per unit prawn prices in 1997-98, average receipts per boat across the fishery increased by almost $170,000 in 1997-98 to over $1.1 million per boat

Costs per boat are estimated to have increased by 6% across the fishery in 1997-98. Cost increases were heaviest for boats with less than 375 A SFR

Estimated average boat business profit across the fleet increased to $256,300 in 1997-98 from just under $135,000 in 1996-97

Average debt across the fishery is estimated to have declined slightly in 1997-98 to $416,000 per boat. The boat business equity ratio for 1997-98 was 87%.

Net returns to the fishery (excluding any changes to stocks) rose from an estimated $14 million in 1996-97 to around $30 million in 1997-98

Other NPF Research project reference no. 3

Johnson A, Cowell S, Loneragan N, Dews G, Poiner I. Sustainable development of Tropical Australia: R&D for Management of Land, Water and Marine Resources CSIRO, LWRRDC, FRDC ($16 148) 1998

A full report was published by Land and Water Resources Research and Development Corporation as LWRRDC Occasional Paper 05/99. Only the objectives of the study are given here.

Objectives

1. Undertake a data and information review that:
2. Develop a metadatabase for available regional data
3. Determine information needed to support management
4. Outline planned development(s)
5. Summarise current legislative, jurisdictional and institutional boundaries documenting the scales of management needed 5. summarise existing planning processes 6. identifies the key aquatic resources and key attachment areas
6. Document the activities, skills and resources of the research providers
7. Consider the spatial extent of a potential study(s)
8. Develop research proposal(s) aimed at supporting the sustainable development of land, water and marine resources in tropical Australia
9. Consider ways of approaching an integrated multidisciplinary study(s) and identify potential obstacles and risks to research projects.

Other NPF Research project reference no. 4

Dichmont C A new approach to fishing power analysis and its application in the Northern Prawn Fishery CSIRO, AFMA Research Funds, FRRF, AMC, Curtin University ($354 873) 1999-2001

Objectives

1. Improve present knowledge on engine power performance, effective fishing time and catch efficiency
2. Validate the Prawn Trawl Performance Prediction Model against engineering performance information
3. Produce a comprehensive effort effectiveness model that combines engineering concepts and statistical methodology incorporating results from 1 to 2 above and analysing data on catch, effort, vessel configuration and technology on board from 1974 to present
4. Improve estimates of changes in fishing power in the Northern Prawn fishery by making them more reliable and justifiable
5. Reassess the status of stocks in the light of changes in estimates of fishing power
6. In consultation with management bodies, investigate possible management strategies to control fishing effort and its effects on sustainability and the industry

Other NPF Research project reference no. 5

Slattery S Electronic cooking end point determination and the effectiveness of alternate cooking methods for crustacea QDPI, FRDC ($32 146) 1998-2000

Objectives

1. To develop a device which will determine endpoint of cooking for crustacea by:
   (a) determining crustacean protease deactivation temperature curves
   (b) developing a durable sensor for measuring the thermal centre of the crustacea
2. To confirm that protease deactivation as the endpoint for cooking, as determined by the above device, is effective by:
   (a) on site trials of several species, sizes and cooking rates
   (b) effects on possible melanosis development, sensory and textural quality, and yield
3. To Evaluate alternate cooking/processing conditions for prawns
4. To produce 10 prototype devices for demonstration in commercial trials.
5. To extend results to industry through workshops, publications and media.

Other NPF Research project reference no. 6

Sterling D (DJ Sterling Trawl Gear Services) Effort Creep Review NPF Industry ($1840) 2000

Objective

1. Provide a qualitative analysis of all potential effort creep scenarios in the NPF

Other NPF Research project reference no. 7

Willoughby C. Australian Prawn Industry Code of Practice. FRDC, APPA, NPF Industry ($219 581) 1999-2001

Objectives

1. The project will provide the basis for a Quality Management System for the Australian sea-caught prawn industry by:
2. reviewing, validating and updating the Code of Practice to ensure it establishes an agreed set of standards across the industry, applicable and achievable in all fisheries, covering boats and shore-based processing operations and all markets
3. establishing a training regime by creating a core of trainers to implement a 'train the trainer' program so that trawler crews and shore-based processing staff thoroughly understand the requirements and their responsibilities in catching and processing the product, with a support network to provide assistance and advice; assistance with development of Food Safety Plans and adoption of ISO 9002 standards will also be provided where requested.
4. developing a third party auditable certification quality management system based on the industry quality standards in the Code of Practice; a single audit will incorporate quality and regulatory standards – AQIS, State and ANZFA requirements and be agreed by all regulatory authorities
5. ensuring that the quality management system is capable of modular expansion to incorporate standards for Occupational Health and Safety, environmental protection and sustainable trawling.

Other NPF Research project reference no. 8

Flexible seasonal restrictions in the Northern Prawn Fishery ABARE, FRRF ($85 521) 2000

Objectives:

1. Develop a set of variable closure rules that could be used to expand management options in the Northern Prawn Fishery.
2. Contribute to improved economic reporting of the Northern Prawn Fishery.
3. Improve understanding of the spatial dimension of fishing activity and catch in the Northern Prawn Fishery.

Other NPF Research project reference no. 9

Northern Prawn Fishery Assessment Group report 2000/2001 CSIRO, AFMA ($99 014). 2000-2001

Other NPF Research project reference no. 10

Economic impact of the Northern Prawn Fishery Amendment Management Plan ABARE, FRRF ($85 475) 2000-2001

Objectives:

1. To assess the economic impact of the Northern Prawn Fishery Amendment Management Plan on the NPF fleet:

- through time;
- by operator sub-group; and
- under a number of alternative harvest strategies, stock recruitment relationships, assumptions regarding effort creep and other relevant economic variables.

Other NPF Research project reference no. 11

Monitoring the impact of the Northern Prawn Fishery Amendment Management Plan ABARE, FRRF ($49 117) 2000-2001

Objective:

1. To monitor the economic impact of the Northern Prawn Fishery Amendment Management Plan 1999 on shore and offshore based activities.

Other NPF Research project reference no. 12

Die, D. Accuracy of catch and effort estimates in the Northern Prawn Fishery CSIRO/AFMA ($42 000) 1998

Objective:

1. To enhance catch and effort data collected by AFMA for the purpose of stock assessment of the NPF.

Other NPF Research project reference no. 13

Development of a genetic method to estimate effective spawner numbers in the NPF and Qld tiger prawn (SPIRT). QDPI, AFMA ($30 000) 2001

Other NPF Research project reference no. 14

Proposal to survey technology utilisation in the NPF fleet CSIRO, NPF Industry ($14 506) 2001

Other NPF Research project reference no. 15

Hall, M The development of manufactured attractants as a means to harvest prawns specifically. Australian Institute of Marine Science ($304 920)

Objectives:

1. To quantify the attraction and specificity of pheromones from crustacea in experimental environments.
2. To develop methods suitable for isolating and concentrating pheromones from crustacea, especially penaeid prawns
3. To identify a mechanism for manufacturing a bait incorporating these novel attractants.
