Northern Territory Government
Department of Business, Industry & Resource Development

NORTHERN TERRITORY STRATEGIC PLAN FOR FISHERIES RESEARCH AND DEVELOPMENT 2002 to 2006

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in Regional and Remote Communities in the Commercial Seafood Industry

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FOREWORD

In 1998 the then Department of Primary Industry and Fisheries requested the Northern Territory Fisheries Research Advisory Board (NT FRAB) to provide a strategic plan for Northern Territory fisheries R&D. The NT FRAB submitted an application to the Fisheries Research and Development Corporation (FRDC) to fund a consultant to prepare this plan. FRDC approved the application and the Plan was completed in early 1999.

Since the original Plan was published in 1999 there have been significant changes in NT Government directions and priorities that required the Plan be updated. In addition, a number of projects in the 1999 original have been completed, modified or abandoned making the Plan out of date in a number of aspects. As part of the revision of that Plan, these changes have been tabulated and any management action or other outcomes from them listed.

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The revised Plan will be available in two formats: a complete edition published on the NT Department of Business, Industry and Resource Development (DBIRD) web site (http://www.nt.gov.au/dbird/dpif/)and a printed summary hard copy version.

It is intended that the Plan on the web site will be a living document that will be updated annually. The printed summary will not be reprinted annually but will be revised and reprinted every two to three years.

This revised Plan was prepared by Mr R J Slack-Smith for the Northern Territory Fisheries Research Advisory Board. Funding was provided by the Fisheries Research and Development Corporation.

Members of the professional and recreational fishing industries and the staff of the NT Fisheries Group, have all provided essential input during preparation of the document. Special thanks go to Mr Iain Smith, Executive Director of the NT Seafood Council (NTSC)and Mr John Harrison, Executive Director of the Amateur Fishermen's Association of the Northern Territory (AFANT).

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Executive Director
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STRATEGIC PLAN FOR NORTHERN TERRITORY FISHERIES RESEARCH AND DEVELOPMENT

1 OVERVIEW OF NT FISHERIES AND AQUACULTURE INDUSTRIES

The Territory's fisheries comprise commercial (wildcatch, fishing tour operators and aquaculture) and recreational and traditional sectors. All have played a significant role in the development of the Territory and they continue to contribute to diversified regional economic growth. The fish resources in waters adjacent to the Northern Territory are characterised by a large variety of species of relatively low abundance. Many of these species have a high growth rate and are short lived (8 - 15 yrs). Conversely, recent research has shown that growth rates in some of the NT commercial species, mainly demersal snappers, are unexpectedly low and reach a considerable age (> 25 yrs).

In spite of major advances in stock assessment methodology during the last decade, significant fisheries collapses have occurred in other parts of the world. In response, the NT Government and its fishery stakeholders have adopted conservative approaches to fisheries utilisation. This approach has sought to minimise the possibility of fishery collapse whilst maximising the optimal utilisation of the stocks.

Prawns and pearl culture make up the majority of the gross value of production (GVP) of Northern Territory fisheries. However, a number of other species are very important to the local economy, some of which still may be under-utilised.

The annual value of production from the commercial fisheries sector is between $100M and $110M for the wildcatch sector (prawn catches included) over $55M for aquaculture. However, the multiplier effects to the community (usually a factor of 3 or more for commercial fishing) of this production is considerable. In 2002 some $600M was invested in licences, vessels and equipment and approximately 1,440 people were employed directly in the seafood industry, generating wages of about $180M annually.

The overall annual expenditure on recreational fishing in the NT is conservatively estimated to be at least $30M per year (Coleman, 1998)[1]. The value of recreational fishing to the Territory is difficult to estimate as it contains qualitative social and cultural elements as well as quantitative commercial outcomes through Fishing Tour Operators (FTOs). Improved ways of measuring the social value of recreational fishing and its real value to the community were recently discussed by Hundloe (2002). In addition, there is little information on fishing by indigenous communities; this is being addressed in the 2000 National Recreational Fishing Survey.

Due to the diversity of stakeholders and interest groups, there are different and often conflicting policies and directions that the Government needs to consider, when deciding its strategic directions for managing the conservation and utilisation of aquatic resources. For example, the values of recreational fishing need to be balanced against the use for

[1] Please note that because of the differences in calculation methodology, no comparisons or inferences should be drawn regarding the relative values of the recreational and other sectors to the NT.

commercial fishing; the differing requirements of Aboriginal communities for aquatic resources in their ceremonial, recreational and commercial needs; and the potential conflicts between stakeholders in the same fishery. Fisheries R&D must provide the managing agency with information on which to ensure that the natural resources involved are conserved, that conflict between stakeholders is minimised and that the resources are optimally utilised.

Thus, fisheries management, research and development priorities must be set in close consultation with the stakeholders in the various fisheries and aquatic resources involved. Apart from the Fishery Advisory Committees (FAC's), this consultation also occurs through a number of formal and informal channels.

Before R&D strategic priorities can be set, the objectives and expected outcomes for the management and/or development of utilisation and conservation of the aquatic resources needs to be clear and understood by stakeholders.

The function of this revised Plan is to ensure that, within the resources available in the NT for fisheries R&D, the biological and technical advice needed for managing and conserving its fisheries is optimised.

Summaries of R&D progress since the adoption of the original Plan in 1998 are provided in Tables 1 to 7 and 11 to 17 (see 3 below).

2 LEGISLATIVE BASIS FOR THE STRATEGIC R&D PLAN

The legislative basis for the management and conservation of fisheries and fish resources resides in the NT *Fisheries Act* 1988 which is an Act "*to provide for the regulation, conservation and management of fisheries and fishery resources so as to maintain their sustainable utilisation, to regulate the sale and processing of fish and aquatic life, and for related purposes*". Subordinate to the Act are Fisheries Regulations that provide for declaration of the various fisheries and how these are administered. The Act also makes provision for the declaration of Management Plans which provide specific management for major fisheries and waters.

To achieve the objectives of the Act, relevant information needs to be gathered on the Territory's aquatic resources. The role of this Strategic R&D Plan is to ensure that the gathering of this information has been planned with priorities agreed by both stakeholders and Government.

3 STRATEGIC DIRECTIONS FOR NT FISHERIES RESEARCH & DEVELOPMENT

Background

The 1998 R&D objectives for NT fisheries were based on the 1995 NT Government Future Directions document and identified the following principal outcomes:

- Sustainable Harvesting of Fish and Other Aquatic Resources
- Conservation of aquatic Biodiversity and Implementation of Ecosystem Management of Aquatic Resources
- Optimum Utilisation of Fish and Aquatic Resources
- Growth of the aquaculture Industry

The progress, outcomes and management action of each of the fishery resources or activities considered in the 1998 Plan have been summarised in Tables 1 to 7 and 11 to 17. These Tables were prepared by listing the Planned Outcomes, Specific R&D Outputs, Projects and Planned Durations from the original Plan, then evaluating the current status of each project and any management action or other outcomes that may have occurred.

Also there have been significant changes in NT Government directions and priorities since 1998 that now require:

- Greater emphasis on recreational fishing.
- Increased prominence being given to aquaculture development, both large and small scale.
- Increased pressure for research on habitat and biodiversity conservation.
- The requirement to report on all aspects of ecologically sustainable development (ESD) and to take account of its principles in managing Territory fisheries.
- Creation of business partnerships between traditional owners and the private sector arising from the growth of both core and emerging industries in the Territory.
- Increased emphasis on regional development.

With respect to ESD, account must be taken of the Conceptual Framework for the Ecologically Sustainable Development of Australia Fisheries ratified in 2001. The core objectives for sustainable fisheries are seen to be:

- Protection of biodiversity and maintenance of essential ecological processes.
- Provision of effective legal, institutional and economic frameworks for ecologically sustainable development.
- Enhancement of individual and community well-being by following a path of economic development that safeguards the welfare of current and future generations.

The current agreed Vision for the Department of Business, Industry and Resource Development is ***to provide profitable and sustainable primary industries in the Northern Territory***.

Based on the above vision, fisheries legislation, the above changes in Government policy, the recent NT Government policy statement entitled 'Vision for a Stronger Territory' and

consultation with stakeholders, the principal outcomes for NT fisheries have been increased and now include:

- SUSTAINABLE HARVESTING OF FISH AND OTHER AQUATIC RESOURCES
- CONSERVATION OF AQUATIC BIODIVERSITY AND IMPLEMENTATION OF ECOSYSTEM MANAGEMENT OF AQUATIC RESOURCES
- OPTIMUM UTILISATION OF FISH AND AQUATIC RESOURCES
- GROWTH OF THE AQUACULTURE INDUSTRY
- *DEVELOPMENT AND MANAGEMENT OF RECREATIONAL FISHING*[#]
- *CONTROL OF AQUATIC PESTS*[#]
- *DEVELOPMENT OF APPROPRIATE APPROACHES FOR DEVELOPMENT OF REGIONAL AND REMOTE COMMUNITIES*[#]

Details of the above principal outcomes and the programs to achieve them by 2006 are given below.

4 DETAILED STRATEGIC PROGRAM FOR THE NEXT 5 YEARS

The 2002 to 2006 R&D program for each major fishery or fisheries activity needs to take into account the strategic outcomes outlined in Section 3 above. The program to address these outcomes for each fishery and activity is represented diagrammatically in Figures 1a to 19a. The information shown in each column of these diagrams is:

1. **COLUMN 1** - this column identifies the general category of the fishery or activity involved (eg, wild harvest, aquaculture, technology, etc), where appropriate, the principal species involved and the degree of stakeholder utilisation.

2. **PRINCIPAL OUTCOMES** - these are the principal outcomes identified above, ie, *Sustainable Harvesting of Fish and other Aquatic Resources*; *Growth of the Aquaculture Industry; Protection of Aquatic Biodiversity and Implementation of Aquatic Ecosystem Management*; etc. Optimum Utilisation [of Fish and other Aquatic Resources] principally picks up the development aspects of the Territory's R&D Plan.

3. **SPECIFIC R&D OUTPUTS** - these are identified under each principal outcome and, where possible, have been standardised across the fisheries or activities considered. For example, a specific outcome under principal outcomes for all fisheries is economic viability; by-catch is considered under *Protection of biodiversity*, etc.

4. **PROJECTS** - the R&D programs and projects identified are listed with the priority of each project indicated by square brackets [ ] after each. H = High; M = Medium; and, L = Low.

5. **FUNDING SOURCE** - three categories of funding sources are used:

   - NT Government Funded;
   - Externally funded (ie. Funded from sources external to the NT Government); and
   - Not yet funded.

[#] New

6. **TIMETABLE** - this is a graphical representation of the timetable for each program and project from 1999 to 2003.

In terms of fishery resource utilisation or for considering the R&D future priorities, there are three distinct utilisation categories, ie,

- Commercial industry,
- Recreational fishing, and
- Traditional fishing and indigenous usage.

In the examination of specific R&D outcomes, it is valuable to assign the levels of usage by these categories for each sub-program. The levels are shown in a table contained in the FISHERY/ACTIVITY column in the R&D Strategic Plan tables .

When assessing R&D priorities, FRDC identifies both 'attractiveness' and 'feasibility' for projects. In this context, **Attractiveness** includes factors such as status of the fishery, potential benefits to stakeholders, conformity with Government policy, costs of implementing the results, and the incremental contribution to the overall of knowledge of the fishery. **Feasibility** is whether the project will succeed and whether its results will be adopted.

R&D directions for each fishery and fisheries activity were based on the recommendations from the Fishery Advisory Committees (FAC's), discussions and submissions from stakeholder groups and individual stakeholders; Fisheries Group analyses and NT Government policy.

In addition, results and progress from the projects formulated in the original 1999 Plan and tabulated for each of the fisheries and activities that were evaluated and any management action or actual outcomes listed in separate tables.

Attainment of the specific R&D outputs set out in this Plan will ensure rational and sustainable growth of the Territory's fishing and aquaculture industries for the benefit of all stakeholders.

5 SUSTAINABLE HARVESTING OF FISH AND OTHER AQUATIC RESOURCES

Description

Harvesting of fish and other aquatic resources can only be sustainable if the long-term rate of harvest does not exceed the long-term rate of replacement to the stock(s). The information required to ensure adherence to this truism is complex, inherently imprecise and often expensive to collect. Research on the status of fish populations and their levels of sustainable utilisation provides fishery managers and stakeholders with information on which to base management decisions. To be truly effective, the objectives of any investigations must be very clear and focussed. In the current climate of diminishing R&D resources, a strict prioritisation and triage process should be applied to ensure that the most pressing potential, actual and solvable problems relating to the utilisation of aquatic resources are addressed.

The essential information required for ensuring sustainability of utilised fish populations is their capacity to maintain replacement levels. To assess this capacity in the context of potential management strategies for each fishery, reliable stock assessment methods and accurate relevant data are required. These data include: catch and effort distribution and spatial dynamics from commercial logbooks; fishing tour operator (FTO) logbooks; comprehensive information from other sectors such as recreational fishers (The 2000 National Recreational Fishing Survey) and Aboriginal communities; population abundance/harvest rate surveys; and, relevant data on basic biology, such as growth, reproduction rates, behaviour, and biomass. The models applied must provide reliable quantitative information on stock productivity; mortality rates, exploitation rates; and analysis and an understanding of fishery operations. Advice on managing the target aquatic resources flows from these analyses.

Advice on sustainable utilisation is also provided to the public and commercial, recreational and Indigenous fisheries sectors through extension and information services.

Planned Outputs to 2006

Although there is a need to manage the whole ecosystems containing the harvested species, the R&D outputs planned for sustainable harvesting of major fishery and other aquatic resources are targeted at providing the best available advice to fishery managers on current levels of utilisation and on future levels that will not allow over-fishing to occur.

Major outcomes include:

- Production of stock assessment reports accepted by major client groups for the target fisheries resources. These should focus on sustainability indicators, particularly estimates of utilisation rates and/or sustainable catch levels;
- Regular reporting of research outputs to stakeholders; and
- Consistency of research outputs with the stated R&D priorities.

The risks of not addressing these R&D objectives on sustainable harvesting include:

- sub-optimal outcomes, with substantial potential negative economic and social impacts through over-harvesting of stocks; and

- inadequate information available for the Division to evaluate proposals and inquiries from clients, lobby groups, etc.

6 EVALUATION OF PRINCIPAL NORTHERN TERRITORY FISHERY RESOURCES

As part of this revision of the Northern Territory R&D Strategic Plan, an evaluation of important fishery resources has been undertaken. This somewhat different approach from the original Plan was adopted to take account of the effects that all stakeholders are having on the resource; an important pre-condition to determining the key strategic R&D that will be required on each in the coming years to address the principal outcomes set out above.

6.1 BARRAMUNDI FISHERY RESOURCES (see Figures 1 & 1a)

Overall, barramundi (*Lates calcarifer*) stocks in the NT appear to be in a very healthy condition. The 2000/2001 commercial landing from the whole fishery was reported to be 1,388t (964t of barramundi alone). Based on FISHCOUNT 1995 results the retained recreational catch has been tentatively estimated to be at least 300t while the indigenous take is as yet not quantified. The 2000 National Recreational Fishing Survey will provide more accurate estimates of the latter two sectors. Whilst harvesting still seem to be at acceptable levels, the recent sharp increase in the commercial landings and apparent increase in recreational utilisation, may be placing the stocks at the upper level for their sustainable exploitation, at least in some of the more heavily recreationally fished river systems such as the Mary and Daly rivers.

Thus, there is still a need to monitor the status of whole NT Barramundi resource, including the high recreational use areas like the Mary and Daly Rivers, the commercial fishery and areas where there is no commercial harvesting (eg River watch and BARRAwatch programs). To do this data sets from the various programs must be linked and considered jointly.

Also, the species is biologically very complex with several unknowns of some management importance to be addressed. In view of the importance of barramundi to recreational and commercial fishing, research and monitoring barramundi stocks should continue, as well as provision of realistic yearly stock assessments across the Northern Territory. Barramundi R&D is currently covered by several separate projects.

Sustainable Harvesting.

Continuing annual reports on the status of the NT barramundi stocks, including sustainability indicators to provide ongoing information on rational management of the stocks.

Projects:

- Annual monitoring of the NT barramundi populations with an emphasis on the Mary River through trends in catch and effort data from commercial returns and other sources such as annual closed area depletion sampling (BARRACADE) and analysis of data from tag returns;

- Continue investigations of methodologies for studying more complex issues of barramundi biology with a view to developing external funding applications. Key projects should include:
  - Assessment of cryptic mortality and stress physiology of barramundi caught and released by anglers.
  - Pilot study for monitoring of the barramundi populations in the Victoria and Roper Rivers (BARRAwatch)
  - Continued collection of data from areas where commercial harvesting is not occurring to monitor population trends.
  - Targeted consequential tagging or gene tagging to determine exploitation rate.
  - Assessment of effectiveness of stocking in Manton Dam.
  - Assessment of crocodile predation on barramundi.

Protection Of Biodiversity.

Projects

- Provision of information on amounts and identity of bycatch from both commercial and recreational fishing

Optimum Utilisation.

Projects

(See also Recreational Fishing, Development of further participation by Aboriginal People in Regional and Remote Communities in the Commercial Seafood Industry and Coastal Line sub-programs)

TABLE 1. EVALUATION OF R&D PROGRESS SINCE 1998

WILD HARVEST FISHERIES - BARRAMUNDI FISHERY

PLANNED OUTCOMES	SPECIFIC R&D OUTPUTS	INITIAL PROJECTS	PLANNED DURATION	2002 EVALUATION	MANAGEMENT ACTION OR ACTUAL OUTCOME
SUSTAINABLE HARVESTING	Reports on the status of NT stocks of barramundi. These reports will include sustainability indicators.	- Assessment of barramundi stocks using: analysis of catch & effort trends; depletion experiments (mainly in the Corroboree Billabong); sampling of migrating recruits; and, analysis of data from tag returns.	1999-2003	Monitoring of NT barramundi populations with an emphasis on the Mary River has continued using: trends in catch and effort data from commercial returns and annual closed area depletion sampling and analysis of data from tag returns.	The results of this monitoring has provided the Fisheries Group with information that the barramundi stocks are not under threat.
		- Assess the impact of saline intrusion and of saline intrusion controls on barramundi in the Mary R. wetlands.	1999-2002	Project will be completed in December 2002.	The need for spillways in SWI control bunds has been reinforced by the land holders and environment managers.
		- Assess the effects of crocodile predation, cryptic mortality and movement of fish in tidal areas on resource estimates.	1999-2003	Cryptic mortality study commenced in July 2002 but effects of crocodile predation not yet commenced.	The effects of crocodile predation has not been followed up but funding has been obtained to study cryptic mortality.
		- Assess survival of Manton Dam stocked fish.	2000-2001	Up to 2002, not carried out.	Funding not available for this study.
		- Participation in The 2000 National Recreational Fishing Survey.	2000-2002	See Environment and Habitat sub-program.	Analysis of data continuing.
PROTECTION OF BIODIVERSITY	Provision of information on the by-catch from commercial and recreational barramundi fishing.	The effects of commercial barramundi fishing on protected biota such as dugongs, turtles, etc (See also Table -- Habitat and Environment).	1999-2002	Report on protected species prepared.	Protected Species Information Sheet – Dugongs published.
OPTIMUM UTILISATION	Determination of the economic benefits of impoundment stocking and value of recreational fishing experience.	- The value of the recreational fishing experience (addressed nationally by Hudloe *et al.*) - Analysis and quantification of stakeholder competition for the NT barramundi resource.	1999-2003	"Is my Fish Worth More than your Fish" published by Hudloe in July	This publication addresses the the value of fisheries to the various sectors.

FIGURE 1a. STAKEHOLDER PARTICIPATION, R&D OUTCOMES, PROJECTS AND TIMETABLE FOR THE BARRAMUNDI FISHERY.

WILD HARVEST	PLANNED OUTCOMES	SPECIFIC R&D OUTPUTS	PROJECTS	FUNDING SOURCES			TIMETABLE (Years)				
				N	E	Y	02	03	04	05	06

BARRAMUNDI FISHERY	SUSTAINABLE HARVESTING	Annual reports on the status on the NT barramundi stocks, including sustainability indicators.	- Monitoring trends in barramundi catch and effort from commercial returns and other sources [H].
			- Investigating barramundi biology including:
			  - Assessment of cryptic mortality and stress physiology of barramundi caught and released by anglers [H].
			  - Collection of data from areas where commercial harvesting is not occurring [M].
			- Assess effectiveness of stocking of Manton Dam [M].
			- Assess crocodile predation [M].
				X
				X
				X
					X	X
						X					

	PROTECTION OF BIODIVERSITY	Provision of information on amounts and identity of bycatch from both commercial and recreational fishing.	- Monitor commercial fishing operations to document by-catch as well as targeted catch [M].			X					
	OPTIMUM UTILISATION	Basis for valuation of the social benefit associated with recreational barramundi fishing provided. Optimum distribution of fishing effort between stakeholders found. (See also Recreational Fishing and Coastal Net & line sub-programs)	- Based on valuation of recreational fishing experience and commercial landed values, determine best possible distribution of effort between stakeholders [H]. (See also Recreational Fishing and Coastal Net and Line sub-programs)			X					

STAKEHOLDER UTILISATION	
COMMERCIAL INDUSTRY	H
RECREATIONAL FISHING	H
TRADITIONAL USAGE	H

KEY:

H = HIGHLY IMPORTANT
M = MEDIUM IMPORTANCE
L = LOW IMPORTANCE
NIL = NO UTILISATION

Project Priority: H = High; M = Medium; L = Low

N = NT Funded; E = Externally funded; Y = Yet to be funded

6.2 MUD CRAB FISHERY RESOURCES (see Figures 2 & 2a)

Mud crab (*Scylla serrata)* is the basis for the most valuable commercial, wild-harvest fishery in the Northern Territory, with the landing valued at over $10 million in 2000/2001. The fishery fosters high participation from both commercial and recreational fishers , and is also an important food source for indigenous Australians. Assessments based on CPUE data alone are uninformative as commercial fishing practices promote hyperstability in catch per unit of effort (Walters, 1996). Exploitation rates for the fishery were estimated to be as high as 70%.

Following the submission of the detailed study on the NT mud crab population and the fishery on it by Ian Knuckey in 1998, future research directions for the fishery were proposed at a workshop held in Darwin in May 1999. This workshop was attended by government and industry representatives from WA and QLD as well as from the NT. The three principal research strategies were endorsed:

- Relative productivity of mud crab habitat;
- Stock abundance indicators; and
- Spatial differences in population reproductive characteristics.

New assessment methodology based on the relationship between mud crab habitat and mud crab density has commenced under a FRDC funded project entitled "Methods for estimation of mud crab abundance and habitat across northern Australia". The output from this project is showing considerable promise. Collection of data to address stock abundance indicators has continued.

The specific R&D outputs for the NT Mud crab stocks are:

Sustainable Harvesting.

In view of the high harvesting rate on year one recruits, it is necessary to closely monitor the NT mud crab population for signs of over-harvesting, especially in areas of high fishing intensity. Research indicated that the Fishing Mortality (F) for mud crabs it high and that the annual Exploitation Rate (E) is in the vicinity of 70 to 90%. These high rates are normally compensated by high fecundity and growth rates but if environmental factors should lower these rates the population may fall. However, research has indicated that natural mortality (M) in unfished stocks is also in the vicinity of 80%. It is important that monitoring of this fishery continue so that real trends in stock size and exploitation rate can be rapidly identified and measures taken to correct them.

Projects

- Continued monitoring the status of the NT mud crab fishery with an emphasis on four commercially harvested areas using commercial, recreational and indigenous (where available) catch, effort, size frequency data as well as area depletion experiments as required;
- Validation of commercial catch data;
- Annual evaluation of sustainable catch levels for the mud crab stocks;

- Continue development of fishery independent methods to estimate stock abundance including a juvenile pre-recruit index; and
- Finalise mapping of Northern Territory critical mud crab habitat by completing the remaining Arnhem Land component.

Protection of Biodiversity

Due to the selectivity of the crab pots used in this fishery, there is little bycatch. However, there is a need to quantify this bycatch and determine whether its capture is affecting biodiversity. Further information on legal bait fishing with nets associated with the commercial fishery, in areas where it is permitted, needs to be collected.

Project

1. Study of bycatch from pots and bait nets.

Optimum Utilisation

From a commercial viewpoint, the industry Code of Practice, introduced in 2001, has reduced mortality during post-harvest handling and transport of crabs. There will be a further refinement of these Practices in the near future.

There in also a requirement to determine the proportion of the overall catch being taken by recreational and indigenous fishers. This information will available through The 2000 National Recreational Fishing Survey and future recreational and indigenous fishing surveys.

TABLE 2. EVALUATION OF PROGRESS SINCE 1998

WILD HARVEST FISHERIES - MUD CRAB FISHERY

PLANNED OUTCOMES	SPECIFIC R&D OUTPUTS	PROJECTS	PLANNED DURATION	2002 EVALUATION	MANAGEMENT ACTION OR ACTUAL OUTCOME
SUSTAINABLE HARVESTING	Fishery assessment reports on the status of NT stocks of mud crabs. These reports will include sustainability indicators.	Monitoring of the commercial catch, fishing effort and size composition	1999-2003	Continued	Population monitoring has shown that although exploitation rate is high there is currently no indication of over harvesting.
		Genetic identification of the NT stock distribution	1999-2001	Completed	Distinct populations with two species have been identified across northern Australia.
		Tagging study for spawning behaviour and movement during spawning;	1999-2001	Combined with following project	
		Density estimate experiments to determine stock size & identification and quantification of mud crab habitats utilising satellite imagery, aerial photography, etc.	2000-2002	Continuing	Although not yet completed, these projects are already providing value information on stock size and distribution.
PROTECTION OF BIODIVERSITY	There are no relevant by-catch problems with the mud crab fishery although nets for obtaining bait in some areas may have a small by-catch.	Nil		N/A	There are no relevant biodiversity issues associated with this fishery.
OPTIMUM UTILISATION	Determination of the contribution of indigenous and recreational sectors to the overall exploitation of mud crab stocks.	The catch from the recreational and indigenous sectors will be calculated from The 2000 National Recreational Fishing Survey data and information on allocation and usage between stakeholders investigated.	2000-2002	Continuing	The 2000 National Recreational Fishing Survey data is currently being analysed.

FIGURE 2a. STAKEHOLDER PARTICIPATION, R&D OUTCOMES, PROJECTS AND TIMETABLE FOR THE MUD CRAB FISHERY

MUD CRAB & MINOR FISHERIES	PLANNED OUTCOMES	SPECIFIC R&D OUTPUTS	PROJECTS	FUNDING SOURCES			TIMETABLE (Years)				
				N	E	Y	02	03	04	05	06
MUD CRAB FISHERY	SUSTAINABLE HARVESTING	Fishery assessment reports on the status of NT stocks of mud crabs. These reports will include sustainability indicators.	- Continued monitoring the status of the NT mud crab fishery with an emphasis on three commercially harvested areas using commercial, recreational and indigenous (where available) catch, effort, size frequency data as well as area depletion experiments as required [H]; - Annual evaluation of sustainable catch levels for the mud crab stocks [H]; - Complete FRDC project on mapping mud crab habitats [H]. - Develop pre-recruit index [H]	X X X X	X						
	PROTECTION OF BIODIVERSITY	Due to the selectivity of the crab pots used in this fishery, there is little bycatch. However, there is a need to quantify this bycatch and determine whether its capture in affecting biodiversity. The effects of bait fishing associated with the commercial fishery also needs to be addressed.	- Study of bycatch from pots and bait nets [H].			X					
	OPTIMUM UTILISATION	The industry code of conduct requires further refinement, particularly in the area of reducing mortality during post-harvest handling and transport of crabs. Also further attention is needed for producing 'Safe Seafood' grading for export. Determination of the proportion of the overall catch being taken by recreational and indigenous fishers. This information will available through FISHCOUNT 2000 and future recreational and indigenous fishing surveys. Development of the fishery in areas currently not being fished (off Aboriginal land, areas with large tidal range, etc) requires further investigation.	- Reduction of post-harvest mortality due to handling and transport [M]. - See recreational fishing. - Investigated development potential of areas not currently being fished [M - L].	X	X	X X					

STAKEHOLDER UTILISATION	
COMMERCIAL INDUSTRY	H
RECREATIONAL FISHING	M
TRADITIONAL USAGE	M

KEY:

H = HIGHLY IMPORTANT
M = MEDIUM IMPORTANCE
L = LOW IMPORTANCE
NIL = NO UTILISATION

Project Priority: H = High; M = Medium; L = Low

N = NT Funded; E = Externally funded; Y = Yet to be funded

6.3 COASTAL LINE FISHERY RESOURCES (see Figure 3 & 3a)

Even excluding the major species such as barramundi, mud crab and several minor species (eg, trepang, marine aquarium fish, some species of sharks, etc), the NT coastal zone is very important to many fisheries stakeholders. It is a major resource for the recreational, fishing tour operators, commercial coastal line and indigenous fishers and important for ecotourism operators. The best use strategy for these resources will depend on the balance of its social and economic values with resource sustainability and any environment degradation that may be caused by its use. There are many species involved (eg jewfish, snappers, emperors, cods, etc), each with their own biological characteristics, making management of the zone as a whole complex and often expensive.

Commercial coastal line fishery catch for 2000/2001 was 166 tonnes and was principally five species (black jewfish, golden snapper, , tricky snapper, stripy and redfish). This was an increase of 56% from 1999, which was attributed almost wholly to an increase in the black jewfish catch. FISHCOUNT 1995 estimated that the total recreational catch in 1995 was 690 tonnes of which approximately one third was black jewfish. A preliminary fishery assessment conducted by Professor Carl Walters in 1996 indicated that the sustainable yield of coastal species was in the range of 100-1,000 tonnes per annum. However, it must be noted that this estimate was based on only a small amount of information. If the recreational catch has not increased since 1995 the combined total estimated harvest for coastal species would be around 850 tonnes. This estimate is very near Professor Walter's upper boundary of 1000 tonnes.

Concerns over possible localised excessive harvesting of coastal finfish resulted in the commencement of the Coastal Fishery Research Project in 1995. Monitoring and research of this fishery was terminated in October 2000 due to budgetary restraints. A considerable amount of biological information on the five most important species was collected during the operation of the project. This information is being processed as time and resources permit.

An important finding from the initial work indicated that golden snapper are long-lived (to 25 years) and mature at a much larger size than expected. A positive and major outcome of this finding was the addition of golden snapper as a managed species by the Territory Government.

While total golden snapper catches have remain constant there is anecdotal evidence suggesting localised depletions in some areas. Increasing catches and target fishing evident for black jewfish and high exploitation of spawning aggregations may render the stocks unsustainable.

In addition to the Coastal Line fishery, there are small Coastal Net and Bait fisheries. As these fisheries only took about 30 to 40 tonnes over 2001 and 2002 they were not considered to be sources of significant harvesting of the coastal resources. Mud crab fishery licences have endorsements to use small bait nets in some coastal areas.

In view of the above, re-commencement of research on coastal fisheries is considered a high priority for the next 5 years.

Sustainable Harvesting.

In view of the expanding use of the coastal fishery resources, it is necessary to provide biological information needed for rational management of the stocks.

Projects

- Review biological data collected and when analyses completed identify further data requirements and resources required to complete the research project and publish the results.
- Continue collection of the commercial catch and effort information needed for ongoing monitoring of the stocks.
- Continue collection of information on coastal recreational fishing, including through The 2000 National Recreational Fishing Survey and later continuations of FISHCOUNT.
- Re-commence collection of biological data on the major species, especially black jewfish and golden snapper.
- Develop methods to monitor the impact of fishing on spawning aggregations.

Protection Of Biodiversity

In view of the heavy fishing pressure on the coastal fish stocks in certain areas, the amount of by-catch taken by commercial and recreational fishers needs to be identified and quantified.

Projects

- Identification and quantification of by-catch taken by commercial and recreational fishers.

Optimum Utilisation

The central problem is one of resource allocation between alternative uses and users with recreational fishers taking about six times the commercial catch. Apart from sustainability issues, the problems associated with stakeholder interaction and resource allocation, are key problems for this fishery.

Projects

- The commercial component of the fishery needs projects in the areas of gear development to assist in its further development.
- Investigation of the effects of cryptic mortality.
- Investigation of the effects of fishing aggregating species.

TABLE 3. EVALUATION OF R&D PROGRESS SINCE 1998

WILD HARVEST FISHERIES - COASTAL LINE FISHERY

PLANNED OUTCOMES	SPECIFIC R&D OUTPUTS	PROJECTS	DURATION	2002 EVALUATION	MANAGEMENT ACTION OR ACTUAL OUTCOME
SUSTAINABLE HARVESTING	Reports on the status of NT stocks of coastal fish species. These reports will include sustainability indicators for the principal species.	Collection and analysis of biological data,.	1999-2002	Project suspended in 2000 due to a lack of funding.	As the coastal line fish resources are very important to both the recreational and commercial sectors, the suspension of action on this project should be lifted.
		Analysis of logbooks from commercial fishers and fishing tour operators.	1999-2002	Report completed.	Copies of report sent to commercial operators.
		Tagging program to determine movement and exploitation rates	1999-2001	Work suspended.	See above.
		Analysis of the 2000 National Recreational Fishing Survey data on recreational & indigenous fishing	1999-2001	To be completed.	The report on the 2000 National Recreational Fishing Survey is due for completion in late 2002.
		Review of the multi-species modeling options for the fishery.	1999-2001	Work suspended.	There was some progress on this modeling from the Prof. Walters. Workshops.
PROTECTION OF BIODIVERSITY	Report provided on the composition of catch from principal sectors	Monitoring program for the coastal line fishery to determine catch composition and spatial distribution of species.	1999-2002	Work suspended.	See above
OPTIMUM UTILISATION	Recreational fishing access optimised and appropriate commercial gear developed.	There is also a need to optimise recreational access to the resource. The commercial component of these fisheries need projects in the areas of gear development and marketing to assist in their further development.	2000-2002	Work suspended. Not commenced.	See above

FIGURE 3a. STAKEHOLDER PARTICIPATION, R&D OUTCOMES, PROJECTS AND TIMETABLE FOR THE COASTAL LINE FISHERY

WILD HARVEST	PLANNED OUTCOMES	SPECIFIC R&D OUTPUTS	PROJECTS	FUNDING SOURCES			TIMETABLE (Years)				
				N	E	Y	02	03	04	05	06
COASTAL LINE FISHERY	SUSTAINABLE HARVESTING	Reports on the status of NT stocks of coastal fish species. These reports will include sustainability indicators for the principal species.	- Complete the analysis and publish the results of data already collected [H]. - Continue collection of the commercial catch and effort information needed for ongoing monitoring of the stocks [H]. - Continue collecting information on coastal recreational fishing, including through The 2000 National Recreational Fishing Survey and its later continuations [H]. - Re-commence collection of biological data on the major species, especially black jewfish and golden snapper [M]. - Assess methods for assessing the effects of fishing aggregating species [H]	X X	X	X X X					
	PROTECTION OF BIODIVERSITY	A large number of species are taken in these fisheries, some of which could be considered as by-catch. Report provided on the composition of catch from principal sectors	- Identification and quantification of by-catch taken by commercial and recreational fishers [M].			X					
	OPTIMUM UTILISATION	Apart from sustainability issues, the problems associated with stakeholder interaction and resource allocation, are key utilisation problems for this fishery. Optimum economic and social benefits from this resource examined.	- The recreational component of the coastal line fishery is about 6x the commercial catch. There is already some conflict between stakeholders for the resource. There is also a need to optimise recreational access to the resource [M]. - The commercial component of these fisheries need projects in the areas of gear development and marketing to assist in their further development [M]. - Investigation of catch and release for estimating cryptic mortality [L].			X X X					

STAKEHOLDER UTILISATION	
COMMERCIAL INDUSTRY	M
RECREATIONAL FISHING	H
TRADITIONAL USAGE	H

KEY:
H = HIGHLY IMPORTANT
M = MEDIUM IMPORTANCE
L = LOW IMPORTANCE
NIL = NO UTILISATION

Project Priority: H = High; M = Medium; L = Low

N = NT Funded; E = Externally funded; Y = Yet to be funded

6.4 SPANISH MACKEREL RESOURCES (Figures 4 and 4a)

The general biology of Spanish mackerel is well known and Northern Territory research has been directed at obtaining information pertinent to the management of the fishery and confirming information obtained on the species from other areas.

Sampling of commercial catches and detailed logbooks have provided information for assessment, confirmed growth relationships established from other Australian stocks; and, defined local reproductive characteristics. The current Fisheries Research and Development Corporation project *The Stock Structure of Northern and Western Australian Mackerel* will set the appropriate geographic scale for managing mackerel stocks by indicating boundaries and defining the levels of interchange between stocks.

Modelling has been used extensively for this fishery to maximise the use of available information. Dynamics models have provided a basic guide to research approaches by summarising the current understanding of the stock. However, one of the most important results from this modelling has been to reveal the extent of uncertainty about current population levels or harvest rates.

As this species is highly aggregative it is not amenable to trawl or gillnet survey. Clear signals on harvest rates or abundance are unlikely to come from the fishery in terms of catch rates unless overfishing is marked. It is critical for confident management of the stocks that an improved method(s) for monitoring harvest rates become available.

Some specific work should be carried out to address improvement of information used in the models. Daily, spatially referenced logbook data for professional sectors (Commercial harvest fishers and Fishing Tour Operators) and improved compliance with the cooperative catch information program are highly desirable.

Harvest rates could be monitored using an innovative bulk tagging methodology being developed by the Fisheries Group and recently funded by FRDC.

Though probably not as effective as tagging, mean size can also be used to track harvest rates. For this reason, monitoring of catch rates and size and age composition of the catch should also continue and its collection is included in the daily logbooks.

Sustainable Harvesting.

As with all fisheries, sustainability depends on keeping the harvest rate at a level that will not exceed recruitment. The projects for Spanish mackerel for the next five years will address this issue.

Projects

- Collation of fishery information and providing up-to-date descriptions of the NT narrow-barred Spanish mackerel.
- Development of methodology for mark-recapture of Spanish mackerel, including bulk tagging methodology and recreational tagging protocols, in the collaborative FRDC

project GENETAG: Genetic mark-recapture for real-time harvest rate monitoring. Pilot studies in northern Australia
- Use of stock assessment and population models and effort dynamics to identify the potential of the fishery and provide information necessary for the rational management of the fishery.

Protection Of Biodiversity

To ensure that biodiversity is conserved and ecological management is implemented it is necessary to define the trophic relationships between mackerel and its environment. From an ecological viewpoint, description of diet and its associations is important.

Projects

As the fishery only uses lines, habitat damage is not a significant factor. However, to provide information for EA evaluations, by-catch information should be collected.

- Information on diet of Spanish mackerel and bycatch to be collected during onboard monitoring.
- Opportunistic collection of biological information on other pelagic species.

Optimum Utilisation

While the stock size and resilience is being defined, there is also a need to gather information on the harvest levels of the commercial, recreational and indigenous sectors.

There may be a need for market research to investigate reasons for market prices not reflecting the high eating quality, storage and health attributes of Spanish mackerel.

Projects

- Calculation of the catch from the recreational fishery using The 2000 National Recreational Fishing Survey and investigation of competition between stakeholders.
- Market research to investigate reasons for market prices not reflecting the high eating quality, storage and health attributes of Spanish mackerel.

TABLE 4. EVALUATION OF R&D PROGRESS SINCE 1998

WILD HARVEST FISHERIES - SPANISH MACKEREL FISHERY

PLANNED OUTCOMES	SPECIFIC R&D OUTPUTS	PROJECTS	DURATION	2002 EVALUATION	MANAGEMENT ACTION OR ACTUAL OUTCOME
SUSTAINABLE HARVESTING	Fishery assessment reports on the status of NT stocks of Spanish mackerel .These reports will include sustainability indicators.	Monitoring of commercial catch and fishing effort.	1999-2002	Continuing.	Monitoring has shown no evidence of over harvesting and that the current management of this fishery is adequate.
		Stock discrimination study and determination of stock movement and exchange.	1999-2001	Completed	Several distinct stocks identified off northern Australia with minimal exchange between them.
		Determination of sustainability indicators.	1999-2001	Continuing.	Indicator models still being developed.
		Electrophoretic identification of Mackerel species.	1999-2000	Not carried out due to funding constraints	No further action planned for this project.
		Review the appropriateness of a tagging program to determine movement & exploitation rates.	1999-2000	New project funded by FRDC to develop methods for the bulk mark-recapture of Spanish mackerel, using genetic tagging technology.	The new tagging technology and the fishery models being developed to analyse the results should have wide application in this and other fisheries.
PROTECTION OF BIODIVERSITY	Other than protection of the stocks from over-exploitation, there does not appear to be any need for projects aimed at protecting biodiversity.	Log books will be needed to monitor levels of any by-catch	1999-2002	Log book data collected.	Logbook data still being analysed.
OPTIMUM UTILISATION	Contribution of recreational fishing to the overall exploitation of Spanish mackerel determined.	The catch from the recreational fishery calculated from 2000 National Recreational Fishing Survey	2000-2002	2000 National Recreational Fishing Survey proceeding.	2000 National Recreational Fishing Survey data still being analysed.

FIGURE 4a. STAKEHOLDER PARTICIPATION, R&D OUTCOMES, PROJECTS AND TIMETABLE FOR THE SPANISH MACKEREL FISHERY

[FISHERY/ ACTIVITY]	PLANNED OUTCOMES	SPECIFIC R&D OUTPUTS	PROJECTS	FUNDING SOURCES			TIMETABLE (Years)				
				N	E	Y	02	03	04	05	06
SPANISH MACKEREL	SUSTAINABLE HARVESTING	Fishery assessment reports on the status of the NT stocks of Spanish mackerel, including sustainability indicators. New tagging methodology developed and applied to improve accuracy of stock modelling.	- Provision of up-to-date descriptions of the NT Spanish mackerel stocks [H]. - Development of methodology for mark-recapture of Spanish mackerel, including bulk tagging methodology and recreational tagging protocols, in the collaborative FRDC project GENETAG [H]. - Provide information for the management of the fishery Using stock assessment, effort dynamics and population models to identify the potential of the fishery [M]. - Pilot investigation of the value of morphometric information in monitoring the mackerel fishery [L].	X X X	X X	X					
	PROTECTION OF BIODIVERSITY	The trophic relationships between mackerel and its environment defined, including description of diet and its associations. Non-target catch documented.	- Information on diet of Spanish mackerel and by-catch to be collected during onboard monitoring [M]. - Opportunistic collection of biological information on other pelagic species [M].	X X							
	OPTIMUM UTILISATION	Information on the harvest levels of the commercial, recreational and indigenous sectors gathered. Market research completed on why prices do not reflecting the high eating quality, storage and health attributes of Spanish mackerel. Development of genetic testing protocols to allow rapid testing of specific identity of landed mackerel fillet	- Collection of information on recreational and indigenous harvest (see The 2000 National Recreational Fishing Survey) [M] - Project to be formulated by industry [L]. - Project to be formulated. [L]	X	X	X X					

STAKEHOLDER UTILISATION	
COMMERCIAL INDUSTRY	H
RECREATIONAL FISHING	M
TRADITIONAL USAGE	M

KEY:

H = HIGHLY IMPORTANT
M = MEDIUM IMPORTANCE
L = LOW IMPORTANCE
NIL = NO UTILISATION

Project Priority: H = High; M = Medium; L = Low

N = NT Funded; E = Externally funded; Y = Yet to be funded

6.5 SHARK FISHERY RESOURCES (Figures 6 and 6a)

The key target species in this fishery are the blacktip sharks (*Carcharhinus tilsoni and C. sorrah*), and grey mackerel (*Scomberomorus semifasciatus*) with a number of other sharks and finfish being landed or taken as by-catch. The target shark species were about 35% of the total landings in 2001. The annual landings of blacktip sharks from the NT Shark Fishery for the past 6 licensing years has varied between 500 and 800 tonnes with a decline in the catch per unit of effort (CPUE) being noted over this period. A number of factors may have contributed to this decline.

Although assessments of the northern shark resources over the last decade have indicated that there may be a relatively large population of sharks off northern Australia, it has also suggested that only a small amount can be sustainably harvested each year (6-7% of the net vulnerable component). This is supported by a substantial decline in CPUE since the ending of foreign operations in the mid 1980's. This decline may be due to either or both, an unaccounted removal of about 1500 tonnes/yr from the stock by foreign fishing in the Arafura Sea but outside the AFZ and/or a slow depletion of inshore stocks without being replenished by migration from offshore stocks. The NT fishery is presently based almost entirely on these inshore stocks.

In view of the considerable uncertainty in stock responses to fishing as shown by recent studies, as well as the slow growth rate of sharks, late age of sexual maturity and low fecundity of the species involved, a conservative approach to management of the shark fishery has been adopted by the NT.

The Territory has not carried out any dedicated research on the shark fishery in recent years and in view of the observed declining CPUE, consideration should be given to re-activating assessment studies.

Sustainable Harvesting.

The key recommendation from the 1997 shark assessment workshop was the establishment of a cooperative program with commercial fishers to provide a 'fishery independent' index of stock trends along the Territory coast and the Gulf of Carpenteria. The workshop also strongly recommended that a concerted effort be made to obtain fishery statistics from foreign fisheries operating in the Arafura Sea north of the AFZ. Reducing the uncertainty in assessments and predictions is the key to ensuring sustainable harvesting for this stock/fishery. A further important element in reducing this uncertainty is obtaining a more accurate assessment of the quantities and species of shark bycatch from other commercial and recreational fisheries.

Projects

- Continue analysis and refinement of catch and effort information from fishers logs. This should aim at recording data for the individual species involved.
- Continue attempts to obtain shark fishery information from fishing fleets operating in the Arafura Sea but outside the AFZ.
- Participation in the collaborative FRDC funding project ' *Northern Australian sharks and rays: the sustainability of target and bycatch species, phase 2'.*

- Investigate the feasibility of a further tagging study to specifically examine onshore/offshore migration of blacktip sharks.
- Investigate a rapid assessment project for grey mackerel and develop and test of monitoring protocols.

Protection Of Biodiversity

The key elements in protecting the biodiversity of the shark resources in the NT are determining the species and quantity of retained and incidental bycatch and any important effect that the fishery may be having on the species composition of elasmobranches and other aquatic species.

Projects

- Participate in the FRDC funding project ' *Northern Australian sharks and rays: the sustainability of target and bycatch species, phase 2'* (see above).
- Collection of bycatch data from commercial fishers.

Optimum Utilisation

Although there may be some market development needed for the shark catch, the principal aspect of optimum utilisation requiring attention is an assessment of the quantity of commercial sharks outside the current fishing areas. At the present time there is no significant recreational fishery developed for sharks, similar to other Australian states.

Projects

- Assess the need of a food safety plan for the NT shark fishery.
- Examine potential markets and utilisation of by-catch species.

TABLE 5. EVALUATION OF R&D PROGRESS SINCE 1998

WILD HARVEST FISHERIES – SHARK FISHERY

PLANNED OUTCOMES	SPECIFIC R&D OUTPUTS	PROJECTS	PLANNED DURATION	2002 EVALUATION	MANAGEMENT ACTION OR ACTUAL OUTCOME
SUSTAINABLE HARVESTING	Fishery assessment reports on the status of NT stocks of commercial sharks and grey mackerel. These reports to include sustainability indicators.	Collation and reporting on existing data.	1999-2000	Completed in 2000.	Preliminary analysis of this data has not shown any indications of over harvesting.
		Review of logbook program and implementation of an at sea monitoring program to improve data quality and type	1999-2002	Reported for action in 2001. Development of a tagging program planned.	Logbook program revised and changes implemented.
		Investigate effects of fisheries in jurisdictions and by-catch in Australian waters are having on northern shark populations.	1999-2001	Only planning carried out.	FRDC funded project '*Northern Australian sharks and rays: the sustainability of target and bycatch species, phase 2*' from 2002 until 2005.
PROTECTION OF BIODIVERSITY	Quantity and composition of commercial sharks taken in other fisheries assessed, including target and non-target species taken by pelagic nets and longlines.	Identification of species in the commercial catch (a CSIRO project).	1999-2001	See FRDC funded project above.	See FRDC project above .
OPTIMUM UTILISATION	Interaction between commercial and recreational fishing established.	No projects developed	?	No progress reported.	This output was not considered necessary.
	Shark market value maximised, including markets for shark and shark parts.	Development of markets for shark parts not traditionally sold.	1999-2002	Commercial fishers have been developing these markets.	Commercial fishers should continue to develop these markets.

FIGURE 5a. STAKEHOLDER PARTICIPATION, R&D OUTCOMES, PROJECTS AND TIMETABLE FOR THE SHARK FISHERY

WILD HARVEST	PLANNED OUTCOMES	SPECIFIC R&D OUTPUTS	PROJECTS	FUNDING SOURCES			TIMETABLE (Years)				
				N	E	Y	02	03	04	05	06
SHARKS AND GREY MACKEREL	SUSTAINABLE HARVESTING	Fishery assessment reports on the status of the fishery indicating uncertainty of assessments and predictions, and processes by which uncertainty may be reduced. These reports contain sustainability indicators.	- Continue analysis and refinement of catch and effort information from fishers logs including, when available, information from fleets operating outside the AFZ [H]. - Participate in the FRDC funded project *'Northern Australian sharks and rays: the sustainability of target and bycatch species, phase 2'* [H]. - Investigate feasibility of tagging to monitor harvest rates and to examine onshore/ offshore migration of blacktip sharks [M]. - Investigate a rapid assessment project for grey mackerel and develop and test monitoring protocols [M].	X	X	X X X					
	PROTECTION OF BIODIVERSITY	Species and quantity of retained and incidental bycatch determined and any important effects that the fishery may be having on the species composition of elasmobranches and other aquatic species.	- Participate in FRDC funded project *'Northern Australian sharks and rays: the sustainability of target and by-catch species, phase 2'* (see above). - Collection of bycatch data from commercial fishers [M].		X	X X					
	OPTIMUM UTILISATION	The economics and profitability of the commercial shark fishery assessed by the commercial industry, including assessment of current and potential market improvements.	- Assess the need of a food safety plan for the NT shark fishery [M]. - Examine potential markets and utilisation of by-catch species [M].			X X					

STAKEHOLDER UTILISATION	
COMMERCIAL INDUSTRY	H
RECREATIONAL FISHING	L
TRADITIONAL USAGE	H

KEY:
H = HIGHLY IMPORTANT
M = MEDIUM IMPORTANCE
L = LOW IMPORTANCE
NIL = NO UTILISATION

Project Priority: H = High; M = Medium; L = Low

N = NT Funded; E = Externally funded; Y = Yet to be funded

6.6 OFFSHORE SNAPPER RESOURCES

These resources contribute to three separate licensed commercial fisheries; the Timor Reef Fishery, the Demersal Fishery and the Finfish Trawl Fishery. The majority of the catch in the Timor Reef Fishery constitutes goldband and sharp toothed snappers, while ruby emperor and red snapper predominate in the Demersal and Finfish Trawl fisheries.

The snapper resources in the Arafura and Timor Seas have been studied by trawling surveys and other biological projects since the late 1980's. These resources were harvested by Taiwanese, Japanese and Thais fishers from the early 1970's until foreign fishing in the AFZ was terminated in 1990. The peak catch (all species combined) was 10,000 tones in 1983 from the Arafura Sea. The landings from all NT based offshore fisheries in 2000/2001 was about 1650 tonnes. There is only a single licence issued in the Finfish Trawl Fishery but its landing was about 1,000 tones in 2000 and 2001. The catch from the portion of the resource outside the AFZ was not known but considered to be considerable.

Several estimates have been made of the snapper resource and its sustainability, the most recent being a sustainable annual harvest of 1,500 tonnes of snappers from the Arafura Sea. This estimate was based on recorded slow growth rate of tropical snappers and the assumption that the stock prior the commencement of harvesting was in the order of 50,000 tonnes. The yield estimates for the Timor Box ranged from 3,000 to 20,000 tonnes or more. This assumed a high level of mixing of the stock in the AFZ and waters to the north in East Timor and Indonesia. Refinement of these estimates will only be possible when further information is available on the degree of mixing across the AFZ, accurate information on catch and fishing effort across the whole area of the resource and on fishery independent surveys of the stocks.

Overall, it appears that the resources in the Timor Reef are reaching full sustainable harvesting level but the stocks from other areas appear to be well below their sustainable limits.

The future R&D of the offshore snapper resources was discussed at a joint industry/government workshop held in 2000 to:

- Examine factors affecting the profitability of the demersal fishery, including fishery economics, marketing requirements, fishery and environment interactions and alternative fishing techniques;
- Increase industry awareness of the factors influencing economic viability; and,
- Develop a strategic R&D plan.

Although there has been a shift in emphasis since the 2000 Workshop, its generally agreed outcomes were:

- That the line and trap fishery for offshore snappers is likely to develop close to Darwin due to reduced profitability for fish taken from more distant grounds;
- Exploratory fishing trials using traps and longlines/trot lines may encourage further investment in the industry;
- International markets offer considerable potential in the short to medium term
- An improved understanding of how environmental condition influence variations in catch rates may help in planning how to overcome these variations; and,

- Assessing the performance of various alternative fishing gears on remote areas for improving catch rates and offsetting lower prices received for frozen product.

6.6.1 TIMOR REEF FISHERY (Figures 6 and 6a)

Sustainable Harvesting.

The research objectives for this fishery are to determine the sustainability yield indicators and to provide further biological and population parameter information in goldband and sharp toothed snapper for incorporation into stock assessment models. In the longer term, to monitor sustainability of the harvested stock. There is also a need to develop joint initiatives with adjacent domestic and international (Indonesia and East Timor) management agencies for collection and analysis of data to improve the understanding of the stocks and the reliability of the sustainability estimates.

Projects

- Continue monitoring of catch and effort information provided by fishers.
- Completion of project on biological parameters (growth, F, M, recruitment, etc).
- Participate in joint projects, especially those that will assist in providing data on the harvesting regimes of stocks north of the AFZ and on migration between Australian waters and waters north of the AFZ in the Arafura and Timor Seas.

Protection Of Biodiversity

There is a need to continue assessment of the levels of by-catch taken by traps and line fishing in this fishery. The recent trend for fishers to concentrate on using traps in this fishery may necessitate projects to assess possible damage to reefs by traps.

Project

- Collection of information on by-catch through logbooks and regular onboard monitoring fish catches by Fisheries Group staff.

Optimum Utilisation

There is no interaction between commercial and recreational stakeholders due to no recreational activity in the area of this fishery.

Projects

- Studies to determine any relationship between water temperature, schooling and migration and the effects on abundance of environmental influences such as the El Ninõ and La Nina events.

TABLE 6. EVALUATION OF R&D PROGRESS SINCE 1998

WILD HARVEST FISHERIES - TIMOR REEF FISHERY

PLANNED OUTCOMES	SPECIFIC R&D OUTPUTS	PROJECTS	DURATION	2002 EVALUATION	MANAGEMENT ACTION OR ACTUAL OUTCOMES
SUSTAINABLE HARVESTING	Fishery assessment reports on the status of NT stocks of *Pristipomoides spp.* These reports will include sustainability indicators.	Fishing power survey to enable standardisation of CPUE.	1999-2001	Completed.	Accuracy of stock assessment has been improved.
		Collection & analysis of length at maturity and age data.	1999-2002	Continuing.	A collaborative ACIAR funded funded project with NT, CSIRO and Indonesia was initiated in 1999. This has focused on goldband snapper and red snappers (stocks off northern Australia, eastern Indonesia, and East Timor).
		Obtain data on catches from Indonesian waters in the Arafura and Timor Seas to improve stock estimates.	1999-2003	Data not obtained up to June 2002 but attempts continuing.	
		Determination of stock structure off northern Australia.	2000-2003	Continuing.	
		Barotrauma experiments to provide data for tagging & migration experiments.	1999-2001	Funded by FRDC or NT was not obtained.	Project was not carried out.
PROTECTION OF BIODIVERSITY	As the fishery is using lines and traps, the by-catch and habitat damage is not regarded as significant.	Data on the level of by-catch in the snapper fishery to be collected through log books.	1998-2002	Continuing.	Continuing but as the fishery is using lines and traps, the by-catch and habitat damage is not regarded as significant..
OPTIMUM UTILISATION	There is no interaction between commercial and recreational stakeholders due to little or no recreational activity on the principal harvested species. Investigation of the economic performance of the Timor Reef fishery.	Development of a management strategy of waters between NT, QLD, WA and Indonesia.	1999-2002	Continuing.	See collaborative project above.
		Annual update of the economic performance of the industry.	1999-2002	Continuing.	Reports presented to industry and Government.
		Influence of offshore oil and gas development on catches and catch rates.	1999-2001	Not carried out due to lack of resources.	Although oil and gas development may influence catches and catch rates, short resources have not allowed the study to proceed.
		Effects of environmental influences such as the El Ninõ and La Nina events in fishery profitability.	2000-2002	Not carried out up until 2002.	Project planned to proceed from 2002 onwards.

FIGURE 6a. STAKEHOLDER PARTICIPATION, R&D OUTCOMES, PROJECTS AND TIMETABLE FOR THE TIMOR REEF FISHERY

WILD HARVEST	PLANNED OUTCOMES	SPECIFIC R&D OUTPUTS	PROJECTS	FUNDING SOURCES			TIMETABLE (Years)				
				N	E	Y	02	03	04	05	06
TIMOR REEF FISHERY	SUSTAINABLE HARVESTING	Fishery assessment reports on the status of NT stocks of *Pristipomoides spp.* These reports include sustainability indicators.	- Continue monitoring of catch and effort information provided by fishers [H]. - Completion of project on biological parameters (growth, F, M, recruitment, etc) [M]. - Participate in joint projects, especially those that will assist in providing data on the harvesting regimes of stocks north of the AFZ and on migration between Australian waters and waters north of the AFZ in the Arafura and Timor Seas [H].	X X	X						
	PROTECTION OF BIODIVERSITY	Other than protection of the stocks from over-exploitation, there does not appear to be any need for projects aimed at protecting biodiversity. As the fishery is targeted at using lines and traps, the by-catch and habitat damage is not regarded as significant.	- Data on the level of by-catch in the snapper fishery will continue to be collected through log books [M].	X							
	OPTIMUM UTILISATION	There is no interaction between commercial and recreational stakeholders due to no recreational activity in this fishery.	- Annual updates of the economic performance of the industry including the effects of environmental influences such as the El Ninõ and La Nina events in fishery profitability [M].	X							

STAKEHOLDER UTILISATION	
COMMERCIAL INDUSTRY	H
RECREATIONAL FISHING	Nil
TRADITIONAL USAGE	Nil

KEY:

H = HIGHLY IMPORTANT
M = MEDIUM IMPORTANCE
L = LOW IMPORTANCE
NIL = NO UTILISATION

Project Priority: H = High; M = Medium; L = Low

N = NT Funded; E = Externally funded; Y = Yet to be funded

6.6.2 DEMERSAL FISHERY (Figures 7 and 7a)

Sustainable Harvesting

The R&D objectives for this resource relate to refining its stock and sustainability estimates and to the further development of the demersal fishery.

Projects

- Continue monitoring of catch and effort information from Territory, State and international sources.
- Continuation of project on biological parameters (growth, F, M, recruitment, etc) of the target species.
- Participate in joint projects, especially those that will assist in providing data on the harvesting regimes of stocks north of the AFZ and on snapper migration between Australian waters and waters north of the AFZ in the Arafura and Timor Seas.

Protection Of Biodiversity

Other than protection of the stocks from over-fishing, there does not appear to be a need for projects aimed at protecting biodiversity unless there is an expansion of the trawl fishery. If this should occur, then projects to assess potential damage to the demersal environment would need to be developed. It should be noted that the single demersal trawl licence currently issued uses the environmentally friendly "Julie-Anne" trawl.

Optimum Utilisation

The development of the demersal fishery is progressing at a pace consummate with business economics and market development. It appears that several more vessels may enter the fishery over the next two years.

Projects

- Investigation of alternative fishing method(s), including longlines, trot lines and the use of automatic baiting machines;
- Studies to determine any relationship between water temperature, schooling and migration and the effects of environmental influences such as the El Ninõ and La Nina events.

6.6.3 DEMERSAL TRAWL FISHERY

The catch taken by the single fisher in the Fishery is regularly monitored but to date there has been no dedicated research on the fishery. In view of the significant catch by the operator, about 1,000t per year, an increase in research on this part of the demersal stocks should be considered.

TABLE 7. EVALUATION OF R&D PROGRESS SINCE 1998

WILD HARVEST FISHERIES - DEMERSAL FISHERIES

PLANNED OUTCOMES	SPECIFIC R&D OUTPUTS	PROJECTS	DURATION	2002 EVALUATION	MANAGEMENT ACTION OR ACTUAL OUTCOME
SUSTAINABLE HARVESTING	Fishery assessment reports on the status of NT stocks of red snappers .These reports will include sustainability indicators.	Analysis of existing data/samples in DBIRD.	1999-2001	Continuing	Analysis will continue under the ACIAR project (see below).
		Stock discrimination study	1999-2001	Not done	New joint ACIAR funded project to provide this information is planned. to commence in 2002. This is a with D BIRD, CSIRO and RIMF (Indonesia) participating.
		Obtain data on catches in adjacent national & international waters	2000-2002	Not done.	
		Barotrauma experiments.	1999-2002	Funding from FRDC or NT was not obtained.	Project was not carried out.
PROTECTION OF BIODIVERSITY	Damage from the single demersal trawl, traps and lines is minimal.	Initial studies of species diversity to be carried out on log book data.	1999 2002	No action until 2002	Possibly to be picked up under the ACIAR project.
OPTIMUM UTILISATION	There is minimal interaction between commercial and recreational stakeholders. A sustainable economic viable fishery developed.	Workshop to assess red snapper fishery opportunities and the effects of environmental influences on fishery profitability;	2000	Completed	Provided some information on opportunities but further is required.
		Gear trials to determine economical fishing method(s) .	2000-2003	Completed	Further trials may be needed.
		Biological studies to determine any relationship between water temperature, schooling and migration.	1999-2003	No action until 2002	New project being planned by DBIRD.
		Development of an effective marketing strategy to facilitate adequate returns from the fishery	1999-2002	No action until 2002	Commercial industry will now address this aspect.
		Monitoring program to assess fishery performance	1999-2003	No action until 2002	Commercial industry do not consider this a priority project.

FIGURE 7a. STAKEHOLDER PARTICIPATION, R&D OUTCOMES, PROJECTS AND TIMETABLE FOR THE DEMERSAL FISHERY

WILD HARVEST	PLANNED OUTCOMES	SPECIFIC R&D OUTPUTS	PROJECTS	FUNDING SOURCES			TIMETABLE (Years)				
				N	E	Y	02	03	04	05	06
DEMERSAL FISHERY	SUSTAINABLE HARVESTING	Fishery assessment report on the status of the NT stocks of red snappers. These report include sustainability indicators.	- Analysis of existing data/samples in DBIRD [H]; - Stock discrimination study [L]; - Obtain data on catches in adjacent national and international waters; [M] .	X	X	X					
	PROTECTION OF BIODIVERSITY	Other than protection of the stocks from over-fishing, there does not appear to be a need for projects aimed at protecting biodiversity unless there is an expansion of the trawl fishery. The single demersal trawl licence currently issued uses the environmentally friendly "Julie-Anne" trawl.	Only needed if the fishery becomes significant and the trawl fishery expands. Initial studies on species diversity can be carried out from log book data.								
	OPTIMUM UTILISATION	A sustainable economic fishery developed. Commercial fishing trial carried out. A sustainable marketing system developed.	- Desktop modeling to determine the likely success of alternative fishing method(s), including longlines, traps, trot lines, and automatic baiting machines [H]. - Commercial fishing and marketing trials in locations identified by fishers [H]. - Studies to determine any relationship between water temperature, schooling and migration; [M]. - Development of an effective marketing strategy to facilitate adequate returns from the fishery [L].	X		X X X					

STAKEHOLDER UTILISATION	
COMMERCIAL INDUSTRY	L
RECREATIONAL FISHING	L
TRADITIONAL USAGE	L

KEY:
H = HIGHLY IMPORTANT
M = MEDIUM IMPORTANCE
L = LOW IMPORTANCE
NIL = NO UTILISATION

Project Priority: H = High; M = Medium; L = Low

N = NT Funded; E = Externally funded; Y = Yet to be funded

6.7 TREPANG RESOURCES (Figure 9)

Although a fishery for trepang (also known as *bêche-de-mer*) by Macassan trepangers occurred for about four centuries on the Northern Territory coast, the industry ceased in the early part of the 20th century. However, due to dwindling supplies of trepang from other parts of the world and a resultant increase in trepang prices, the fishery has again become commercially viable in northern Australia and is now a significant Territory fishery.

The sudden collapse of trepang fisheries throughout the Pacific suggests a large fraction of the stock can be removed by fishing, and that recruitment is dependent on adult density over small local scales. The collapses suggest that either that larval transport is usually quite limited, and/or that an Allee effect is in action. (An Allee effect is depensatory recruitment at low spawner densities, and can occur where, for example, juveniles rely on adults for protection from predation in some way).

This resource was not covered in the original R&D Plan as limited financial and human resources did not allowed the Fisheries Group to mount specific studies on the trepang population(s). However, logbook information continued to be collected.

Contract research on sustainable harvesting of trepang by the Parks and Wildlife Commission of the NT, funded by Environment Australia, was conducted on the Coburg Peninsular and Arnhem Land coasts. A draft report on this work has now been completed.

To provide information on the time and spatial dynamics of fishery operations at different scales, fishery data on catches and effort also should be collected on fine scales (eg daily spatially-referenced records of catch numbers and weight). It must be emphasised, however, that logbook data alone are not likely to provide answers to the real management questions.

Sustainable Harvesting.

As pointed out above, the key to providing sustainable harvesting of trepang is to having reliable information on recruitment and migration rates to establish the periods needed to replenish fished areas.

Projects

- Continue detailed catch and effort monitoring program.
- Seek resources to further study the replenishment rates for fisher areas.
- Development of a trepang aquaculture sector.

Protection Of Biodiversity

There is almost no bycatch taken during collecting operations for trepang.

Optimum Utilisation

Optimum utilisation of the trepang resources relates to the replenishment rates of areas fished and these seems to be little to be done in the question of processing and value adding.

FIGURE 8a. STAKEHOLDER PARTICIPATION, R&D OUTCOMES, PROJECTS AND TIMETABLE FOR THE TREPANG FISHERY

WILD HARVEST	PLANNED OUTCOMES	SPECIFIC R&D OUTPUTS	PROJECTS	FUNDING SOURCES			TIMETABLE (Years)				
				N	E	Y	02	03	04	05	06
TREPANG (Sandfish, Black teat fish, White Teat Fish, etc)	**SUSTAINABLE HARVESTING**	Reliable information obtained on recruitment and migration rates to establish the periods needed to replenish fished areas.	- Continue detailed catch and effort monitoring program [H]. - Study on replenishment rates for fished areas [M].	X		X					
	PROTECTION OF BIODIVERSITY	There is almost no bycatch taken during collecting operations for trepang.	No projects.								
	OPTIMUM UTILISATION	Optimum utilisation of the trepang resources relates to the replenishment rates of areas fished. The question of processing and value adding does not need addressing.	No Projects.								

STAKEHOLDER UTILISATION	
COMMERCIAL INDUSTRY	H
RECREATIONAL FISHING	Nil
TRADITIONAL USAGE	L

KEY:
H = HIGHLY IMPORTANT
M = MEDIUM IMPORTANCE
L = LOW IMPORTANCE
NIL = NO UTILISATION

Project Priority: H = High; M = Medium; L = Low

N = NT Funded; E = Externally funded; Y = Yet to be funded

6.8 NATIVE AQUARIUM FISH RESOURCES (Figure 10a)

In 1993 the Northern Territory Aquarium Fishing Industry was worth in excess of $270,000. Of this value, the greater proportion comprised either marine or exotic species. By 1998 the value of the native freshwater component alone had reached $273,000, rising from less than $100,000 in 1993/94. The 1998 value of the total industry was estimated to be between $600,000 and $700,000. Export of live native freshwater and marine aquarium fish, including corals, was undoubtedly a significant contributor to this increase. This Fishery provides a valuable part of the income of the small operators involved.

The major areas utilised for the commercial collection of native freshwater fish are the streams and creeks in the proximity to Darwin.

Sustainable Harvesting.

The aims in managing this fishery are to: ensure that the harvesting is carried out in accordance with the principles of Ecologically Sustainable Development (ESD) and Fisheries Ecosystem Management (FEM), and to harvest the resource in a manner that will not jeopardise the conservation and long term sustainability of the species utilised. These species do not include those under legislative protection.

Meaningful research (biological, ecological and population knowledge) on each of the large number of species involved in this industry would be very expensive and far outweigh the value of the industry. Logbook records from the industry will be closely monitored for completeness and accuracy by the Fisheries Group, thus providing a more reliable index of any significant changes in catch and catch per effort. If any downward trends are observed, funding should be sought as a matter of urgency for research to address these trends.

Projects

- Maintain a monitoring regime based on daily logbooks for licensees, providing validation of these logbooks where possible, and facilitation of any additional data collection and research needed to manage the species involved; and
- If sufficient data is available, develop models to achieve rational harvesting of the resource using catch, effort, available biological data, and any other relevant parameters.

Protection Of Biodiversity

The level of recreational utilisation was not available but it is anticipated that the 2000 National Recreational Fishing Survey will provide further information on recreational utilisation of native freshwater fish for aquarium use.

In general, commercial collectors are well equipped and mobile but are limited by distance, accessibility and season. Over 70% of the Northern Territory is not readily accessible to aquarium fish fishers.

Although no Northern Territory native aquatic aquarium fish are considered to be in danger of extinction, endangered, or vulnerable, the Territory Government has adopted a

conservative approach to their management. If utilisation does result in falling population numbers, research may be needed for management measures such as imposition of size limits; limiting the amount of effort allowed; closure of certain river systems; and encouragement of captive breeding programs for native freshwater fish.

Optimum Utilisation

Although the Recreational Fishing Assessment Survey FISHCOUNT 1995 did not specifically target aquarium fish, it did provide detailed data on recreational fishing in the Territory. The 2000 National Recreational Fishing Survey will provide further information of the utilisation of native freshwater fish for recreational aquarium purposes.

No projects are needed at this time.

FIGURE 9a. STAKEHOLDER PARTICIPATION, R&D OUTCOMES, PROJECTS AND TIMETABLE FOR NATIVE AQUARIUM FISH FISHERY.

WILD HARVEST	PLANNED OUTCOMES	SPECIFIC R&D OUTPUTS	PROJECTS	FUNDING SOURCES			TIMETABLE (Years)				
				N	E	Y	02	03	04	05	06
NATIVE AQUARIUM FISH **(Freshwater & marine)**	**SUSTAINABLE HARVESTING**	Harvesting is carried out in accordance with the principles of ecologically sustainable development (ESD) and fisheries ecosystem management (FEM), and ensuring that harvesting will not jeopardise the conservation and long term sustainability of the species utilised.	- Maintain a monitoring regime based on daily logbooks for licensees, providing validation of these logbooks where possible, and facilitation of any additional data collection and research needed to manage the species involved [H]. - If sufficient data is available, develop models to achieve rational harvesting of the resource using catch, effort, available biological data, and any other relevant parameters [L].	X		X					
	PROTECTION OF BIODIVERSITY	A conservative approach to management of Northern Territory aquarium fish adopted.	Projects to comply with EA requirements for management will need to be considered.								
	OPTIMUM UTILISATION	There is currently no obvious need for R&D in this area. FISHCOUNT 2000 may provide further information of the utilisation of native freshwater fish for recreational aquarium purposes.	No projects.								

STAKEHOLDER UTILISATION	
COMMERCIAL INDUSTRY	H
RECREATIONAL FISHING	M
TRADITIONAL USAGE	L

KEY:
H = HIGHLY IMPORTANT
M = MEDIUM IMPORTANCE
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Project Priority: H = High; M = Medium; L = Low

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6.9 DEVELOPMENTAL FISHERIES (figure 11)

The Northern Territory Fisheries Development Opportunities Committee (NTFDOC) was established in 1999 to advise the Director and the Minister on the priorities for development opportunities. These include sustainable utilisation of aquatic resources within the Northern Territory in line with Environmentally Sustainable Development (ESD) principles. Particular account is taken of commercial fisheries that are not subject to formal management arrangements (ie, developmental fisheries under NT jurisdiction) and of trials with fishing vessels or fishing gear in fisheries under formal management arrangements. Developmental Fisheries projects are funded from external sources, usually by the proponents or in some cases organisations such as FRDC. Conditions may be placed on the permit or licence for the proponents to fund Fisheries Group observers during fishing operations.

Potential projects include:

- Development of a squid fishery;
- Capture of bait fish in offshore waters;
- Development of a jellyfish fishery;
- Development of a blue swimmer crab fishery;
- Development of sponge culture off Aboriginal communities; and
- Development of inshore net resources (eg, mullet, blue salmon, garfish, etc.).

FIGURE 10a. STAKEHOLDER PARTICIPATION, R&D OUTCOMES, PROJECTS AND TIMETABLE FOR DEVELOPMENTAL FISHERIES.

WILD HARVEST	PLANNED OUTCOMES	SPECIFIC R&D OUTPUTS	PROJECTS	FUNDING SOURCES			TIMETABLE (Years)				
				N	E	Y	02	03	04	05	06
DEVELOPMENT FISHERIES	SUSTAINABLE HARVESTING	Sustainable utilisation of NT aquatic resources in line with environmentally sustainable development (ESD) principles. Particular account taken of commercial fisheries that are not subject to formal management arrangements (ie, developmental fisheries under NT jurisdiction) and of trials with fishing vessels or fishing gear in fisheries under formal management arrangements.	Potential projects include: - Development of a squid fishery; - Capture of bait fish in offshore waters; - Development of a jellyfish fishery; - Development of a blue swimmer crab fishery; - Development of sponge culture; - Development of inshore net resources (eg, mullet, blue salmon, garfish, etc.).			X X X X X X					
	PROTECTION OF BIODIVERSITY	Environmentally sustainable development (ESD) principles maintained.	No projects.								
	OPTIMUM UTILISATION	Commercial fisheries not subject to formal management arrangements (ie, developmental fisheries under NT jurisdiction) addressed and trials with fishing vessels or fishing gear in fisheries under formal management arrangements carried out.	No projects.								

STAKEHOLDER UTILISATION	
COMMERCIAL INDUSTRY	
RECREATIONAL FISHING	
TRADITIONAL USAGE	

KEY:

H = HIGHLY IMPORTANT
M = MEDIUM IMPORTANCE
L = LOW IMPORTANCE
NIL = NO UTILISATION

Project Priority: H = High; M = Medium; L = Low

N = NT Funded; E = Externally funded; Y = Yet to be funded

7 GROWTH OF THE AQUACULTURE INDUSTRY

Description

In recent years the value of NT aquaculture production averaged about $50M from Pearl Oyster culture with the value of production from seafood farming industry over 1 million dollars. The seafood farming industry is considered to have a strong potential and its value should grow to about $40M industry over the next 10 years. This growth will be mainly from prawns and barramundi. To achieve this production the issue of access to suitable aquaculture lands must be resolved and utilisation of sites on Aboriginal and Crown Land clarified.

- Strategic directions for aquaculture R&D were set out during 1999 in "*Into the Blue*", the NT Aquaculture Development Plan. These followed the *National Strategy on Aquaculture in Australia* (1994, 1997) particularly including the elements to:

- ensure industry participation in priority setting;
- encourage collaborative research projects, both within Australia and internationally;
- encourage industry participation in research projects; and
- encourage commercialisation of R&D outcomes.

In March 2001 the Territory Government convened an aquaculture industry workshop to identify the extension needs of industry and examine the role that industry can play in R&D. The workshop identified the goals and issues that the industry expects government to address. Principal research and extension goals and priorities agreed for the principal aquaculture industries were:

- **Pearling**
  Health and disease management including prevention, diagnostics and disease response planning.

- **Fish**
  Research - including pond management, national genetic improvement program and improved farming systems.
  Extension - including support and enhancement of pathology services.

- **Prawns**
  Research - industry driven and appropriate

- **Red claw**
  Access to selectively bred stock
  Commercial scale comparison of Queensland with local stocks
  Identification on sites for farming

- **Algae**
  Disease control

In addition, industry wide issues such as health services, effective communication and industry focussed R&D were addressed. The Territory Aquaculture Development Advisory Committee (TADAC) assists in the identification of key research areas for aquaculture.

The principal R&D outcomes for growth of the NT aquaculture industry are:

- **Sustainable growth of existing industries; and**

- **Development of new sustainable industries.**

Planned Outputs by 2006

- Sea cage aquaculture for barramundi developed and profitably operating and additional barramundi farms developed;
- Preliminary work on the culture of reef fish such as barramundi cod (*Cromileptes altivelis*) and possibly cobia (*Rachycentron canadum*);
- Larval and nursery culture systems for mud crab available for commercialisation;
- Commercial grow-out of mud crabs in both pond and mangrove enclosures;
- Regular supply of *Penaeus monodon* broodstock available to NT prawn hatcheries;
- Development of several new prawn farms;
- Monitoring of interstate research on closing the breeding cycle of *P. monodon* in ponds;
- Pearl oyster histology atlas completed and, if necessary revised;
- Diagnostic service for aquaculture and fisheries continued;
- Development of a commercial scale redclaw farm;
- Assessment of local redclaw strains for farming; and
- Development of trepang culture.

In addition to the above, there is a need to take account of;

- The genetic and ecological effects that aquaculture bred fish may have on wild populations if they escape from farms; and
- The environmental impacts of aquaculture.

7.1 MOLLUSC AQUACULTURE (see Figures 11 and 11a)

"Into the Blue" identified R&D on issues of generic interest, such as disease control and biofouling as important to the pearling industry.

The 1999 Strategic Plan for Fisheries R&D identified projects on :

- Production of a Pearl Oyster Industry Development Plan
- Monitoring of pearl oyster health.
- Investigation of pearl oyster diseases and the production of pearl oyster histology atlas
- Investigation of biofouling of cultured pearl shells and
- Investigation of pearl oyster physiology and farm management.

However, the 2001 Industry Workshop on Aquaculture only identified pearl shell health and disease management as important. This included disease prevention, diagnostics and response planning. The pearl farmers considered that the remaining projects in pearl culture were their responsibility .

While the 1999 Plan also identified projects on exploration of the feasibility of farming edible oysters and on the feasibility of farming tropical abalone in the NT, neither species is currently given priority status.

TABLE 11. EVALUATION OF R&D PROGRESS SINCE 1998

AQUACULTURE - MOLLUSC AQUACULTURE

PLANNED OUTCOMES	SPECIFIC R&D OUTPUTS	PROJECTS	DURATION	2002 EVALUATION	MANAGEMENT ACTION OR ACTUAL OUTCOMES
SUSTAINABLE GROWTH OF EXISTING INDUSTRIES	A Pearl Oyster Industry Development Plan produced. Health service provided for the pearl oyster culture industry. Economic efficiency of pearl culture farming improved.	Production of a Pearl Oyster Industry Development Plan.	1999-2000	No action until 2002	Plan to be completed in consultation with industry.
		Production of pearl oyster histology atlas.	1999-2000	completed in 2002/2003	Used in assessing health of pearl oysters.
		Monitoring of pearl oyster health.	1999-2003	Ongoing	Ongoing as required.
		Investigation of pearl oyster diseases.	1999-2003	Ongoing	Ongoing as required.
		Investigation of biofouling of cultured pearl shells	2000-2003	Not continued	Industry is now addressing this problem.
		Investigation of pearl oyster physiology and farm management.	2000-2003	Not continued	Industry now addressing this
DEVELOPMENT OF NEW SUSTAINABLE INDUSTRIES	Report on feasibility of edible oyster farming in the NT. Report on feasibility of tropical abalone aquaculture in the NT.	Explore the feasibility of farming edible oysters in the NT.	1999-2000	Not continued due to lack of resources.	Project on oyster farming off Aboriginal land under consideration.
		Explore the feasibility of farming tropical abalone in the NT	2000-2001	Not continued due to lack of resources.	Project not considered a priority.

FIGURE 11a. STAKEHOLDER PARTICIPATION, R&D OUTCOMES, PROJECTS AND TIMETABLE FOR MOLLUSC AQUACULTURE.

AQUACULTURE	PLANNED OUTCOMES	SPECIFIC R&D OUTPUTS	PROJECTS	FUNDING SOURCES			TIMETABLE (Years)				
				N	E	Y	02	03	04	05	06
MOLLUSC AQUACULTURE	SUSTAINABLE GROWTH OF EXISTING INDUSTRIES	Health service provided for the pearl oyster culture industry.	- Monitoring of pearl oyster health and investigation of pearl oyster diseases [H].	X	X		—	—	—	—	—
	DEVELOPMENT OF NEW SUSTAINABLE INDUSTRIES	Report on the feasibility of farming edible tropical oysters.	- The feasibility of farming edible tropical oysters [L].			X			—	—	—

STAKEHOLDER UTILISATION	
COMMERCIAL INDUSTRY	H
RECREATIONAL FISHING	Nil
TRADITIONAL USAGE	L

KEY:

H = HIGHLY IMPORTANT
M = MEDIUM IMPORTANCE
L = LOW IMPORTANCE
NIL = NO UTILISATION

Project Priority: H = High; M = Medium; L = Low

N = NT Funded; E = Externally funded; Y = Yet to be funded

7.2 FISH AQUACULTURE (see Figures 12 and 12a)

The fish aquaculture research identified by the 2001 Industry Workshop referred mainly to barramundi and included pond management, co-ordination of research applications, national genetic improvement program and improvement of farming systems. It also identified the need for support and enhancement of pathology services.

Currently, fish aquaculture in the NT is based solely on barramundi using pond and sea cage culture. It is anticipated that this will develop into a significant industry within the next few years. Industry have identified disease control, feed development and pond management as key R&D areas.

Development of tropical fin fish aquaculture has received priority from the NT Aquaculture Branch, using the systems already developed for golden snapper as a model. High value species such as barramundi cod, cobia, coral trout and grouper could be addressed.

However, industry policy states that unless an industry partner works with the NT Government Aquaculture scientists and is willing to take the research through to commercialisation, research on new species should not be commenced.

The NT DBIRD has made a strategic alliance with the Gondol Research Institute for Mariculture in Bali. Areas of proposed collaboration include developing production systems for high value finfish, fish pathology and the use of copepods as live feed and the environmental impacts of fish aquaculture.

Sea Cage Culture

It has been shown that Barramundi (*Lates calcarifer*) can be grown to 3 kg in less than 1.5 years using sea-cages. It been has also shown that finfish farming on the NT coast is achievable with current technology. Also new technology to further deal with strong currents and high ambient and water temperatures found in the NT is evolving.

The following R&D constraints have been identified by the industry:

Development

- Designing affordable sea cages to use in the high currents, temperature, corrosion, etc. found in the NT.
- Development of processing/value adding facilities in Darwin including more reliable freight services.
- Water quality that will allow year round hatchery production of fingerlings.
- Development of feeding technology to use in high current and turbidity conditions.

Research

- Assessment of the viability of local Cobia (*Rachycentron canadum*) and some species of tunas as an aquaculture species. The market potential of these species should be assessed as a preliminary to any research.

TABLE 12. EVALUATION OF R&D PROGRESS SINCE 1998

AQUACULTURE - FISH AQUACULTURE

PLANNED OUTCOMES	SPECIFIC R&D OUTPUTS	PROJECTS	DURATION	2002 EVALUATION	MANAGEMENT ACTION OR ACTUAL OUTCOMES
SUSTAINABLE GROWTH OF EXISTING INDUSTRIES	A barramundi aquaculture industry plan produced.	Production of a barramundi aquaculture Industry Development Plan.	1999-2000	Plan completed.	Plan used for further development of the barramundi aquaculture industry.
	Operation of a semi-commercial barramundi hatchery to support industry development	Production of barramundi larvae and fingerlings for sale and stocking of enclosed waters	1999-2003	Marine Harvest and other barramundi farmers being provided with larvae and juvenile barramundi on a commercial basis. Excess used to stock dams for recreational fishing.	Barramundi cage culture and pond culture developing on a commercial basis.
		Stocking of Manton Dam.	1999-2002	Annual stocking carried out.	Value of artificial stocking being assessed.
DEVELOPMENT OF NEW SUSTAINABLE INDUSTRIES	Reports on the technical and economic feasibility of farming new tropical aquatic species (barramundi cod; cobia, etc).	Investigate potential for aquaculture of high value tropical species, such as barramundi cod and possibly cobia.	1999-2002	Project currently on hold for 2002-03	Broodstock handling and disease management work undertaken. A few spawnings completed.
		Develop copepod feed technology for larval fish;	1999-2002	Project on hold	Technology being used in tropical reef fish aquaculture project.
		Develop larval rearing techniques, growout protocols and growout feeds for tropical species for tropical species	1999-2002	Not started	To be used in the tropical reef fish culture project.

FIGURE 12a. STAKEHOLDER PARTICIPATION, R&D OUTCOMES, PROJECTS AND TIMETABLE FOR FISH AQUACULTURE.

AQUACULTURE	PLANNED OUTCOMES	SPECIFIC R&D OUTPUTS	PROJECTS	FUNDING SOURCES			TIMETABLE (Years)				
				N	E	Y	02	03	04	05	06
FISH AQUACULTURE	**SUSTAINABLE GROWTH OF EXISTING INDUSTRIES**	Operation of a commercial hatchery to support and encourage barramundi grow-out industry and provision of research facilities for other species.	- Production of a barramundi aquaculture Industry Development Plan [H]. - Production of barramundi larvae and fingerlings for sale [H]. - R&D on viral, bacterial and parasite challenges to farmed barramundi [H]	X X X	X		—	—			
	DEVELOPMENT OF NEW SUSTAINABLE INDUSTRIES	Report on the technical feasibility of farming barramundi cod and cobia. Reports on the economic feasibility of production of barramundi cod and cobia.	- Investigate potential for aquaculture of barramundi cod [M]. - Assessment of the economic feasibility of cobia [L]. - Develop broodstock holding techniques [L]. - Develop larval rearing techniques [H]. - Develop and refine copepod feed technology for larval fish [H]. - Develop growout protocols and feeds [H].	X		X		—			

STAKEHOLDER UTILISATION	
COMMERCIAL INDUSTRY	H
RECREATIONAL FISHING	Nil
TRADITIONAL USAGE	L

KEY:
H = HIGHLY IMPORTANT
M = MEDIUM IMPORTANCE
L = LOW IMPORTANCE
NIL = NO UTILISATION

Project Priority: H = High; M = Medium; L = Low

N = NT Funded; E = Externally funded; Y = Yet to be funded

7.3 CRUSTACEAN AQUACULTURE (see Figures 13 and 13a)

Into the Blue identified further development of crustacean aquaculture as an important issue. It specifically identified prawn aquaculture as an emerging industry sector with significant latent potential. However, this potential has been constrained by native title issues. At present the lack of a reliable supply of brood stock is seen as a major bottleneck the industry's development. Mud crab aquaculture was identified as approaching commercialisation but there is currently no industry partner in the NT to commercialise these results with the notable exception of Aboriginal groups.

In 2003 about 80 ha of prawn ponds will produce over 225 tonnes of prawns valued at over 3.75 million dollars. Indigenous groups are actively involved in this production, and other coastal communities are showing interest. The strategy is to initially build the industry and its infrastructure support base in the Darwin area around viable and sustainable prawn farms. Such localised initial development close to Darwin will allow for training and industry expansion to more remote areas of the NT. Growth of the industry results in employment opportunities to skilled as well as unskilled workers, and to full time as well as part time job seekers. Every one hundred tonnes of prawns produced provides full time employment for at least 6 people, as well as part time work for up to 10 others in harvesting, processing and packing.

R&D priorities for the prawn farming sector must recognise that prawn farming is relatively high risk business enterprise. To this end, the priority is to mitigate risk while at the same time assisting the growth of the industry.

R&D priorities for NT prawn farming are to:

- Ensure regular supply of disease free *P monodon* broodstock , both sea caught and raised from pond reared prawns;
- Investigate alternate prawn species and single sex or sterile prawns;
- Initiate brood stock selection of pond grown animals to produce superior prawn strains; and
- To maintain up to date information data bases on all aspects of prawn farming including diseases and communicate this information to the NT Industry.

R&D priorities for prawn research need to be considered from a national, as well as a local perspective, so that local farmers can derive benefit from work being undertaken on behalf of the National Prawn Farmers Association.

Alternate areas to Queensland need to be developed for a reliable and continuous supply of *P. monodon* broodstock needs, eg. Nickol Bay (WA) and sites within the NT. Restriction on capture of *P. monodon* from within the Northern Prawn Fishery needs to be further addressed. Also, local prawn farmers need to further develop hatchery production of nauplii to supply NT farms.

Research on producing a closed life cycle for *P. monodon* in ponds is currently being carried out by CSIRO, AIMS and QDPI. The NT supports this research.

The Darwin Aquaculture Centre has made good progress in commercialising larval and juvenile production of mud crabs (*Scylla serrata*) in a joint project with QDPI with funding by FRDC. This project is due for completion in 2004. The continuation of this project will depend on the commercial viability of raising mud crab to marketable size and industry development needs.

Towards the end of this current project, it is planned to assess the business and economic viability of mud crab aquaculture in the NT, using the information provided by the current project. Any further mud crab aquaculture work would address strategic and business issues that have been identified.

Although tropical rock lobster was identified by *Into the Blue* as a species for future feasibility studies, it has not yet been given any priority consideration by the NT. A national program on rock lobster aquaculture is currently funded by FRDC but this does not include the Northern Territory.

The 2001 NT Aquaculture Industry Workshop identified R&D priorities for redclaw aquaculture. This included access to selectively bred stock from Queensland, assessment of Territory versus Queensland stock and case management style extension services. A pilot farm being developed to industry best practice standards at Bachelor will enable economic assessment of the redclaw industry under Territory conditions to be undertaken.

TABLE 13. EVALUATION OF R&D PROGRESS SINCE 1998

AQUACULTURE

CRUSTACEAN AQUACULTURE

PLANNED OUTCOMES	SPECIFIC R&D OUTPUTS	PROJECTS	DURATION	2002 EVALUATION	MANAGEMENT ACTION OR ACTUAL OUTCOMES
SUSTAINABLE GROWTH OF EXISTING INDUSTRIES	Prawn Aquaculture Development Plan produced. Assistance provided to local industry to develop & maintain a viable & sustainable prawn aquaculture industry.	Production of a Prawn Aquaculture Development Plan.	1999-2000	No action until 2002.	Production of Plan abandoned.
		Sustainable *Penaeus monodon* (Tiger prawn) populations for broodstock supply.	1999-2002	Negotiating with AFMA and WA for access to resource in the NPF and the WA coast.	Project given high priority by prawn farmers and NT Government.
		Ensure reliable supply of locally produced *Penaeus monodon* larvae.	1999-2003	Project still under consideration.	Research being carried out in QLD but costs currently too high for a NT project.
		Investigation of feasibility of local production of feeds suitable for NT prawn farming.	2000-2001	No action until 2002.	Project not considered viable.
		Create and keep current a database on cultured prawn diseases and parasites.	2000-2003	Continuing.	Activity to be continued.
DEVELOPMENT OF NEW SUSTAINABLE INDUSTRIES	A Mud Crab Aquaculture Development Plan produced. A technology package for a mud crab production system produced for transfer to industry. Report on the feasibility of tropical rock lobster aquaculture in the NT produced.	Production of a Mud Crab Aquaculture development Plan;	1999-2000	No action until 2002.	Will form part of the technology package below.
		Development of a technology package for a mud crab production system for transfer to industry;	1999-2001	FRDC funded, NT and QLD project still in progress. This project will establish broodstock holding, larval culture and juvenile production techniques for the mud crab *Scylla serrata*.	A technology package for a mud crab production system to be developed for transfer to industry including assessment of commercial viability.
		Undertake national & international collaborative nutrition & extension work with ACIAR, FRDC, QDPI, UVP & SEAFDEC.	1999-2002	Completed.	Final reports under preparation.
		Feasibility studies on the development of viable and sustainable tropical rock lobster aquaculture.	1999-2000	Not carried out.	Tropical rock lobster aquaculture given a low priority.

FIGURE 13a. STAKEHOLDER PARTICIPATION, R&D OUTCOMES, PROJECTS AND TIMETABLE FOR CRUSTACEAN AQUACULTURE.

AQUACULTURE	PLANNED OUTCOMES	SPECIFIC R&D OUTPUTS	PROJECTS	FUNDING SOURCES			TIMETABLE (Years)				
				N	E	Y	02	03	04	05	06
CRUSTACEAN AQUACULTURE	SUSTAINABLE GROWTH OF EXISTING INDUSTRIES	Assistance provided to local industry to develop & maintain a viable & sustainable prawn aquaculture industry. Access to prawn broodstock in NT waters to support prawn farming development obtained.	- Provide reliable, sustainable and disease free supply of *Penaeus monodon* (Black Tiger Prawn) for broodstock [H]. - Investigate alternative prawn aquaculture species[M]. - Initiate brood stock selection of pond grown animals to produce superior prawn strains [M]. - Create and keep current a database on cultured prawn diseases and parasites [M].			X X X X					
	DEVELOPMENT OF NEW SUSTAINABLE INDUSTRIES	A technology package for a mud crab production system produced for transfer to industry. Assist in on-farm redclaw growout research.	- Development of a technology package for a mud crab production system for transfer to industry including assessment of commercial viability [H]; - Undertake national & international collaborative work on mud crab aquaculture with QDPI, and industry partners. In the future collaboration with Indonesia. - Comparison of local with interstate redclaw stocks.	X X	X X	 X					

STAKEHOLDER UTILISATION	
COMMERCIAL INDUSTRY	H
RECREATIONAL FISHING	Nil
TRADITIONAL USAGE	M

KEY:

H = HIGHLY IMPORTANT
M = MEDIUM IMPORTANCE
L = LOW IMPORTANCE
NIL = NO UTILISATION

Project Priority: H = High; M = Medium; L = Low

N = NT Funded; E = Externally funded; Y = Yet to be funded

7.4 AQUACULTURE INDUSTRY SUPPORT (see Figures 14 and 14a)

The 1999 Strategic R&D Plan identified the provision of a specialist aquaculture health and pathology service as a priority for sustainable growth of the industry. This was reinforced by the 2001 Industry Workshop. The Territory government responded by appointing a veterinarian to manage Aquatic Health matters for the Department. An additional veterinarian has been employed to provide additional support to the aquaculture sector. It is estimated that 20-30% of the entire veterinary laboratory's work is aquaculture related. This includes: bacteriology; virology; and, pathology. It is anticipated that the level of aquaculture related work will expand as the industry grows. To meet the future needs of industry this is likely to include an increasing R&D and training components

To assist the promotion of aquaculture in the Northern Territory, identification of suitable sites around the coast is continuing, including development of GIS solutions for different areas. This work has clear goals to assist in identifying opportunities for Aboriginal, as well as, main stream aquaculture activities.

TABLE 14. EVALUATION OF R&D PROGRESS SINCE 1998

AQUACULTURE - AQUACULTURE INDUSTRY SUPPORT

PLANNED OUTCOMES	SPECIFIC R&D OUTPUTS	PROJECTS	DURATION	2002 EVALUATION	MANAGEMENT ACTION OR ACTUAL OUTCOMES
SUSTAINABLE GROWTH OF EXISTING INDUSTRIES	A specialist aquaculture pathology service provided to the aquaculture industry. A general advisory service to industry is also provided.	Work plan to be provided following the appointment of the pathologist.	1999-2003	John Humphrey was appointed as specialist aquaculture pathologist in 1999.	A specialised diagnostic health service provided for aquaculture and fisheries that undertakes R&D on aquaculture health to support the development of the aquaculture industry and provides information and advice to all aquaculture stakeholders on all quarantine and health.
DEVELOPMENT OF NEW SUSTAINABLE INDUSTRIES	Production of regional aquaculture plans to ensure that adequate areas suitable for aquaculture are set aside in an integrated coastal management system for the NT. Facilitation of aquaculture projects that have Aboriginal involvement or interest. Cost-benefit analyses provided for aquaculture projects.	Development of regional aquaculture plans.	1999-2002	An aquaculture planner was appointed in 2000.	An aquaculture planning service provided to support aquaculture development. This service mainly identifies suitable sites. It also promotes and encourages aquaculture development both within the NT and at a national/international level.
		Development of an aquaculture extension service for Aboriginal communities.	1999-2004	Aquaculture Extension Service provided to the aquaculture industry.	Aquaculture extension to Aboriginal communities needs further attention.
		Development and refinement of cost-benefit models for the significant aquaculture sectors.	1999-2003	There was little development of these models.	Cost-benefit models little used in aquaculture development proposals.

FIGURE 14a. STAKEHOLDER PARTICIPATION, R&D OUTCOMES, PROJECTS AND TIMETABLE FOR AQUACULTURE INDUSTRY SUPPORT.

AQUACULTURE	PLANNED OUTCOMES	SPECIFIC R&D OUTPUTS	PROJECTS	FUNDING SOURCES			TIMETABLE (Years)				
				N	E	Y	02	03	04	05	06
AQUACULTURE INDUSTRY SUPPORT	SUSTAINABLE GROWTH OF EXISTING INDUSTRIES	Regional aquaculture plans produced ensuring that adequate areas suitable for aquaculture are set aside in an integrated coastal management system for the NT.	A specialised diagnostic health service provided for aquaculture and fisheries that undertakes R&D on aquaculture health to support the development of the aquaculture industry and provides information and advice to all aquaculture stakeholders on all quarantine and health issues [H].	X							
	DEVELOPMENT OF NEW SUSTAINABLE INDUSTRIES	Production of regional aquaculture plans to ensure that adequate areas suitable for aquaculture are set aside in an integrated coastal management system for the NT.	Development of an aquaculture planning service provided to support aquaculture development. This service mainly identifies suitable sites. It also promotes and encourages aquaculture development both within the NT and at a national/ international level [H].	X							
		Facilitation of aquaculture projects that have Aboriginal involvement or interest.	Development of an aquaculture extension service for Aboriginal communities [M].	X		X					
		Cost-benefit analysis models provided for aquaculture projects.	Development and refinement of cost-benefit models for the significant aquaculture sectors [M].			X					

STAKEHOLDER UTILISATION	
COMMERCIAL INDUSTRY	H
RECREATIONAL FISHING	Nil
TRADITIONAL USAGE	M

KEY:

H = HIGHLY IMPORTANT
M = MEDIUM IMPORTANCE
L = LOW IMPORTANCE
NIL = NO UTILISATION

Project Priority: H = High; M = Medium; L = Low

N = NT Funded; E = Externally funded; Y = Yet to be funded

8 DEVELOPMENT OF RECREATIONAL FISHING (Figures 15 and 15a)

Description

Recreational fishing has long been an important part of the Northern Territory's social fabric and continues to develop into a thriving industry with a local high participation rate and a growing tourism element. This attraction is also complemented by enjoyment of pristine wilderness areas and its resident wildlife.

The 1995 Department of Primary Industry and Fisheries (now the Department of Business, Industry and resource Development - DBIRD) survey showed 35% of the non-indigenous population go fishing in the NT annually. Over 6% of all visitors to the NT fish at least once during their stay.

A National Recreational Fishing Survey commenced in 2000 to collect similar data from the whole of Australia, including fishing by Indigenous groups. It is planned to repeat this survey every five years.

The Top End's population is predicted to increase significantly in the next few decades with proportionately increased impacts on target recreational species; these must be managed within the principles of ecologically sustainable development. This may require tighter controls being placed on recreational fishers and/or measures to spread the effort into new areas. Opening up new areas in partnership with indigenous land holders, pastoralists and others will create opportunity to ease the pressure on fish stocks in areas of high populations.

A key factor in the management of recreational fishing effort in the Territory is the need to assess the status and exploitation levels of the various aquatic species involved. To this end, continuation of research aimed at assessing the coastal fish stocks is considered to be of high priority. Also the quantity of recreational catch from the barramundi, mackerel and mud crab stocks must be quantified and included in the stock evaluations on the species.

Although the Fisheries Group of DBIRD has the primary role in planning, developing and managing all fisheries activities, there are several other Government agencies which have an interest in recreational fishing R&D, including: Territory Parks and Wildlife Commission (biodiversity issues) and the Department of Lands, Planning and Environment (planning and environment approvals).

The role of R&D in the development and management of recreational fishing is addressed in consultation with all stakeholders. This occurs principally through the Amateur Fishermen's Association of the NT (AFANT) and various fishery management advisory committees (FMAC's) which comprise a cross section of representative stakeholders.

There are about 150 licensed fishing tour operators (FTO) in the Territory who provide fishing services to more than 12,000 local and visiting clients each year. The most recent annual summary of logbook data collected from FTO clients revealed a total catch of 75,847 fish by their clients, of which 53,304 (70.3%) were released. The total included 22,926 barramundi, 20,188 (88%), of which were released.

Planned Outputs by 2006

The principal outputs for recreational fishing R&D include:

- NT portion of The 2000 National Recreational Fishing Survey and the National Indigenous Fishing Survey;
- Emphasis on coastal fisheries research increased (see Coastal Line Fishery Sub-Program);
- Emphasis on determining the rates of cryptic mortality (see barramundi sub-program)
- Assessment of the various recreationally important fish stocks assisted through projects such as the AFANT Angler Diary Program, BarraWatch and monitoring of recreational fishing competitions;
- Report on potential for increasing recreational fishing opportunities through improved access and fish stocking finalised;
- Report finalised on the effectiveness of possession limits and size limits for recreational fishers;
- Analysis completed of the impact of FTO's on NT fish stocks and recreational fishers generally;
- Recreational catches continue to be included in the stock evaluations of species such as coastal species, barramundi, Spanish mackerel and mud crabs;
- Assess recreational fishing options for Darwin River Dam, eg, the use of electric motors only, etc;
- Develop a program to assess the social value of recreational fishing;
- Promote recreational fishing contributions to the Fisheries Research and Development Corporation (FRDC); and,
- Planning of the next national recreational fishing survey due to commence in 2005.

TABLE 15. EVALUATION OF R&D PROGRESS SINCE 1998

RECREATIONAL FISHING

PLANNED OUTCOMES	SPECIFIC R&D OUTPUTS	PROJECTS	DURATION	2002 EVALUATION	MANAGEMENT ACTION OR ACTUAL OUTCOME
SUSTAINABLE HARVESTING	Biology and resource assessment of the species involved is largely covered by the sub-programs on other fisheries and species. The major future project for this sub-program will be its participation in The 2000 National Recreational Fishing Survey as part of the core development team.	National survey of non-commercial fishing.	2000-2002	National Recreational Fishing Survey and Indigenous Fishing Survey in Northern Australia nearing completion.	When completed, this survey will provide important information on which to base future development of recreational fishing.
		Spatial delineation of recreational fishing effort in Darwin Harbour and Shoal Bay.	2000-2002	Not carried out due to lack of resources.	Not to be continued.
		A voluntary logbook/ monitoring project to better quantify catches of individual species.	1999-2003	AFANT Angler Diary Program, BarraWatch and ongoing monitoring of fishing competitions.	Is providing useful information for fishery analyses.
PROTECTION OF BIODIVERSITY	Quantification of target and associated recreational species in specific areas to ensure that aquatic biodiversity of the NT is not endangered.	Identification of discarded and/or released by-catch made from the 2000 National Recreational Fishing Survey.	2000-2003	To be completed from the 2000 National Recreational Fishing Survey data.	To be completed by late 2002.
OPTIMUM UTILISATION	Catch of recreationally important species is distributed between stakeholders to provide the optimum economic and social benefits. Fishing Tour Operators (FTOs) ventures providing adequate service to visiting and local recreational fishers.	Preparation of a Recreational Fishing Industry Development Plan.	1999-2000	Drafted.	Draft Completed.
		Participation in The 2000 National Recreational Fishing Survey.	2000-2002	Occurred.	Ongoing.
		To be discussed with FTOs and relevant NT Government agencies prior to project formulation.	2000-2002	Still to be implemented.	Still to be implemented.

FIGURE 15a. STAKEHOLDER PARTICIPATION, R&D OUTCOMES, PROJECTS AND TIMETABLE FOR RECREATIONAL FISHING

RECREATIONAL FISHING	PLANNED OUTCOMES	SPECIFIC R&D OUTPUTS	PROJECTS	FUNDING SOURCES			TIMETABLE (Years)				
				N	E	Y	02	03	04	05	06
RECREATIONAL FISHING RESEARCH & DEVELOPMENT	SUSTAINABLE HARVESTING	Biology and resource assessment of the species involved is largely covered by the sub-programs on other fisheries and species. Participated in FISHCOUNT 2000 as part of the core development team.	- NT portion of the 2000 National Recreational Fishing Survey and the National Indigenous Fishing Survey [H]; - Assist assessment of fish stocks through the Angler Diary Program, BarraWatch and monitoring of fishing competitions [M]; - Report finalised on effectiveness of bag and size limits for recreational fishers [M]; - Inclusion of recreational catches included in the stock evaluations of species such as barramundi, Spanish mackerel and mud crabs [H]. - Development and conduct of 2005 National Survey [H].	X X X X X	X						
	PROTECTION OF BIODIVERSITY	Quantification of target and associated recreational species in specific areas to ensure that aquatic biodiversity of the NT is not endangered.	Identification of discarded and/or released by-catch from data collected during the 2000 National Recreational Fishing Survey [M].	X							
	OPTIMUM UTILISATION	Catch of recreationally important species is distributed between the commercial, indigenous and recreational sectors so as to provide the optimum economic and social benefits to the NT community. Fishing Tour Operators (FTOs) ventures providing adequate service to visiting and local recreational fishers.	- Analysis of the impact of FTOs on NT fish stocks and recreational fishers [M].	X							

STAKEHOLDER UTILISATION	
COMMERCIAL INDUSTRY	H
RECREATIONAL FISHING	H
TRADITIONAL USAGE	M

KEY:

H = HIGHLY IMPORTANT
M = MEDIUM IMPORTANCE
L = LOW IMPORTANCE
NIL = NO UTILISATION

Project Priority: H = High; M = Medium; L = Low

N = NT Funded; E = Externally funded; Y = Yet to be funded

9 ENVIRONMENT, HABITAT AND CONSERVATION OF AQUATIC BIODIVERSITY (Figures 16 and 16a)

Description

All Australian State, Federal and Territory Governments now recognise biodiversity conservation as part of the wider issue of ecosystem management. Recent Commonwealth legislation now requires that all aquatic species to be exported must be cleared for compliance with ESD objectives set out under that legislation. The Fisheries Group contributes to the protection of the Territory's aquatic ecosystems and biodiversity by providing R&D advice on aquatic populations and environments. This advice is often in collaboration with other NT Government instrumentalities such as the Territory Parks and Wildlife Commission, the NT Museums and Art Gallery, Power/Water, the Department of Infrastructure, Planning and Environment, etc. The Fisheries Group contributes through:

- Ensuring that species to be exported comply with ESD principles;
- Assessment of proposals for developments and modifications to the aquatic environment;
- Declaration of marine parks, refugia, etc and assessment of their potential impacts on fisheries stakeholders;
- Identifying threats to biodiversity from over-utilisation of aquatic resources and implementation of management measures to alleviate them;
- Minimising threats represented by commercial and recreational fishing to biodiversity by the introduction / translocation of exotic species;
- Minimising the opportunity for the introduction of exotic marine species through inspection of internationally travelled vessels and maintenance of a early warning monitoring program; and,
- Providing an emergency response capability to respond to the detection of exotic freshwater, estuarine and marine species

Research advice on potential threats to ecosystems and biodiversity must be formulated in collaboration with industry, planning and development agencies, and environmental protection agencies. The Fisheries Group will remain in the forefront of providing biological advice on the environmental and habitat impacts of fisheries development proposals.

Planned Outputs by 2006

The principal outputs for fishery related R&D on the protection of ecosystems and biodiversity include:

- Assessment of NT harvested species for ESD compliance prior to export;
- Risk based assessments of the probable impacts and/or benefits of proposed fisheries protected areas; and
- Major client groups awareness and acceptance of environmental and biodiversity issues.

Export of the Territory's aquatic species could be disrupted if ESD compliance is not obtained from Environment Australia. If advice on threats to biodiversity by development proposals is not provided, or if this advice is not heeded, there is a strong possibility that there will be losses of biodiversity, reduced environmental quality and damaged fish habitat.

The consequences will be loss of fish production, possibly with substantial economic and social impacts.

The 2006 NT Government target for ecologically sustainable use and protection of resources is that the set legislative requirements are met for the development and protection of the resources on which NT fisheries depend.

TABLE 16. EVALUATION OF R&D PROGRESS SINCE 1998

ENVIRONMENT AND HABITAT

PLANNED OUTCOMES	SPECIFIC R&D OUTPUTS	PROJECTS	DURATION	2002 EVALUATION	MANAGEMENT ACTION OR ACTUAL OUTCOME
CONSERVATION OF AQUATIC BIODIVERSITY	Threats to stocks of utilised fish and aquatic life assessed. By-catch from commercial fishing operations minimised.	Investigation of introduction of exotic aquatic pests in ballast water and on vessel hulls, as required.	1999-2004	A new program, Aquatic Pest Management, was set up in 1999 to cover this activity. It consists of two projects, "Monitoring & Public Education" and "Vessel Inspection Program". The objectives of these projects are: To develop and implement management strategies designed to minimise the introduction of aquatic marine pest species to protect biological diversity, aquaculture, commercial and recreational fisheries, tourism and port interests.	The program has had success in eradication of exotic marine pests from Darwin marinas.
		See projects in the individual fishery & activity groups.	1999-2003	See projects in the individual fishery & activity groups.	See projects in the individual fishery & activity groups.
PROTECTION OF AQUATIC HABITATS	- Status of coastal and estuarine fishery habitats assessed and any necessary protection implemented.	Relationship between mangroves and fish productivity.	1999-2002	New project to examine the role that mangroves play in the trophic relationships of species that depend upon them, and the effect of mangroves on the survival of these species.	Should provide important information on the role of mangroves in fisheries productivity.
		Assessment of need for aquatic reserves and MPAs.	1999-2002	New project to develop and manage the fisheries component of marine parks in the Northern Territory in line with the ANZECC TFMPA guidelines.	Important in the development and management of marine parks.
		Development of Cobourg Fishery and Cobourg Area Management Plans.	1999-2001	Continuing.	Continuing.

FIGURE 16a. ENVIRONMENT AND HABITAT R&D OUTCOMES, PROJECTS AND TIMETABLE.

ENVIRONMENT & HABITAT	PLANNED OUTCOMES	SPECIFIC R&D OUTPUTS	PROJECTS	FUNDING SOURCES			TIMETABLE (Years)				
				N	E	Y	02	03	04	05	06
X ENVIRONMENT AND HABITAT	CONSERVATION OF AQUATIC BIODIVERSITY	Threats to stocks of utilised fish and aquatic life assessed. By-catch from commercial fishing operations minimised.	- See new sub-program shown in Figure 18 - Control of Aquatic Pests - See projects in the individual fishery and activity groups	X X	X X	X X	—	—	—	—	—
	PROTECTION OF AQUATIC HABITATS	Status of coastal and estuarine fishery habitats assessed and any necessary protection implemented.	- Examine role that mangroves play in the trophic relationships of species that depend upon them, and the effect of mangroves on the survival of these species [H]. - Use trophic models to summarise food webs and ecosystem relationships within the mangrove community [M]. - Planning of Marine Parks to develop and manage the fisheries component of marine parks in the Northern Territory in line with the ANZECC TFMPA guidelines [M]. - Manage the Northern Territory marine parks and refugia[M].	X X X X	X X		—	—	—	—	

STAKEHOLDER UTILISATION	
COMMERCIAL INDUSTRY	H
RECREATIONAL FISHING	H
TRADITIONAL USAGE	H

KEY:

H = HIGHLY IMPORTANT
M = MEDIUM IMPORTANCE
L = LOW IMPORTANCE
NIL = NO UTILISATION

Project Priority: H = High; M = Medium; L = Low

N = NT Funded; E = Externally funded; Y = Yet to be funded

10 OPTIMUM UTILISATION OF FISH AND AQUATIC RESOURCES (Figure 17)

Description

Within the limits of the sustainability of each fishery, this planned outcome seeks to:

- Equitable allocation of fisheries resources between stakeholders;
- Identification and documentation of potential areas of economic development of commercial fishing, fish processing, marketing and aquaculture;
- Identification of new fisheries and new or improved fishing methods for optimising utilisation; and,
- fisheries extension and training for the NT.

Outcomes that increase profitability by increasing unit price of product and/or decreasing production costs are also included. In the area of recreational fishing, optimum utilisation activities include: improved access to fishing areas; advice on ways to improve the social and cultural experience of recreational fishing; as well as documentation of the potential for further development of the Fishing Tour Operator business. Advice on acceptable allocation of fish and aquatic life resources between competing stakeholders and provision of appropriate extension, training and education to non-Aboriginal and Aboriginal stakeholders are also important in achieving this outcome.

The commercial harvesting industry will assume the major responsibility for achieving these outcomes.

Planned Outputs by 2006

The outputs of R&D advice on optimal utilisation of NT fisheries include:

- Promote of business partnerships between Aboriginal traditional owners and the private sector.
- Identification and prioritisation of commercial, aquaculture and recreational fishery opportunities;
- Effective extension services developed for commercial and recreational fisheries and Aboriginal communities; and
- Client acceptance of resource allocations made after consideration of relevant matters raised during stakeholder consultation.

TABLE 17. EVALUATION OF R&D PROGRESS SINCE 1998

FISHERIES TECHNOLOGY - SEAFOOD INDUSTRY DEVELOPMENT

PLANNED OUTCOMES	SPECIFIC R&D OUTPUTS	PROJECTS	DURATION	2002 EVALUATION	MANAGEMENT ACTION OR ACTUAL OUTCOME
SUSTAINABLE HARVESTING	Exploratory fishing carried out for under-utilised NT fish resources.	Projects to address the outcomes of this sub-program are contained in the appropriate individual fisheries.	1999 - 2002	Exploratory fishing projects considered by the NT Fisheries Development Opportunities Committee.	Exploratory fishing projects are considered by the NT Fisheries Development Opportunities Committee
PROTECTION OF BIODIVERSITY	Research and development on by-catch reduction carried out.	None current.		None current.	No current NT work in this area.
OPTIMUM UTILISATION	Development of new or modified gear technology for the fishing industry, as required. Improved product handling and marketing. Economic services provided to Government and the stakeholders, as required	In most cases projects under this outcome are contained in the projects for the various individual sub-programs.	1999-2003	(See Sustainable Harvesting above)	
		- Assistance in the development of a Quality Assurance (QA) program for the NT fishing industry.	1999-2003	QA practices currently being implemented by industry as they are identified.	QA best practices advice being provided by industry specialists and Government.
		- Economic analyses of the NT fishing industry and of fisheries research directions, as required.	1999-2003	Not carried out.	Not a high priority by industry.

11 CONTROL OF AQUATIC PESTS

Description

In November 1999 the Aquatic Pest Management (APM) unit was officially established within the Department of Business, Industry and Resource Development (previously Primary Industry and Fisheries) to provide the Territory with a aquatic pest monitoring and risk mitigation capability. The roles of the Aquatic Pest Management Unit are to:

- Establish a comprehensive biological monitoring program to detect any further introductions of aquatic pests to the Northern Territory;
- Observe the recovery of Darwin marinas and monitor the establishment of biofouling in the new Bayview Marina Estate;
- Coordinate vessel inspections of internationally travelled vessels entering marinas and other high risk vessels for aquatic pests;
- Protect Northern Territory inland waters by preventing the establishment of aquatic pest species; and
- Raise public awareness relating to the sources and impacts of aquatic pest species on the environment and economy, and how best to prevent aquatic pest introductions.

An extensive monitoring program commenced in May 1999 as a sentinel for introduced marine pest species and document the recovery of Darwin's marinas following chemical treatment for black-striped mussel. In December 1999 twelve months of nutrient level monitoring was commenced to measure phosphorous, nitrogen and algae levels. The information was compiled into a final report to the Coast & Clean Seas program titled "Integrated monitoring of water quality and biodiversity in Darwin Harbour and its marinas". An underwater photographic and visual fouling community survey was also commenced. Monitoring of marine pest species using artificial settlement surfaces in the Gove Harbour area was also commenced.

A vessel inspection program monitoring fouling on vessels entering Darwin Harbour from overseas was also commenced. At least two non-endemic species of bivalve of concern as a potential marine pest: the Asian Green Mussel (*Perna viridis*) and the black-striped mussel (*Mytilopsis sallei*)have been found.

The fouling fauna associated with apprehended foreign fishing and refugee vessels are also being monitored. Inspection of apprehended vessels outside of Port Limits will continue until sufficient data is collected to enable the development of a risk assessment protocol which will reduce the requirement for all apprehended FFVs and SIEV s to be inspected prior to their entry to the Port of Darwin.

At a national level, tabling of the joint report by the Standing Committee on Conservation, the Standing Committee on Fisheries and the Aquaculture National Taskforce on the Prevention and Management of Marine Pest Incursions, resulted in the establishment of the National Introduced Marine Pests Coordination Group (NIMPCG). This Group is responsible for formalising cost-sharing arrangements for marine pest emergency responses and setting the policy framework within which supporting bodies such as the industry body AIMPAC (Australian Introduced Marine Pest Advisory Council), the Technical Research

and Advisory Group and the Consultative Committee on Introduced Marine Pest Emergencies (CCIMPE) - are to operate.

The APM unit has been active in the eradication of feral freshwater fish populations which have most likely developed from either aquarium releases or the overflow of backyard ponds. In December 2000 an extensive population of the prohibited jewel cichlid (*H. bimaculatus*) was eradicated from Racecourse Creek. The biomass of the aquatic pest was ten times that of the native fish, and the diversity of native species was significantly reduced. Similarly populations of the inappropriately named mosquito fish (*Gambusia* species) were eradicated from backyard ponds and Illparpa Swamp in Alice Springs where all other native freshwater fish species had been displaced. The waterways were restocked with native freshwater species from nearby waterways to assist in the control of mosquito numbers.

Planned Outputs for 2006

The primary outputs from aquatic pest management include:

- Inventory of native fouling species in Darwin and Gove Harbours and the Groote Eylandt area;
- Removal of exotic species populations;
- Inventory of the high risk vectors for introducing and translocating exotic species;
- Risk based management of vectors to minimise the opportunity for introduction or translocation of exotic species;
- Liaison with the aquarium and garden supply industry to promote the value of freshwater fish species as alternative aquarium species and effective mosquito control options; and
- maintenance of client and stakeholder group awareness regarding the undesirable impacts associated with reduced biodiversity as a consequence of the introduction of exotic species.

FIGURE 18a. STAKEHOLDER PARTICIPATION, R&D OUTCOMES, PROJECTS AND TIMETABLE FOR CONTROL OF AQUATIC PESTS

AQUATIC PESTS	PLANNED OUTCOMES	SPECIFIC R&D OUTPUTS	PROJECTS	FUNDING SOURCES			TIMETABLE (Years)				
				N	E	Y	02	03	04	05	06
CONTROL OF AQUATIC PESTS	FISHERY RESOURCE PROTECTION	Risk of harm to marine fishery related resources minimised, including destruction of any infestations.	- Inventory of native fouling species in Darwin and Gove Harbours and the Groote Eylandt area [M].	X			—	—	—		
			- Inventory of the high risk vectors introducing and translocating exotic species [H].	X			—	—	—	—	
		Risk of harm to freshwater fishery related resources minimised, including destruction of any infestations.	- Risk based management of vectors to minimise the opportunity for introduction or translocation of exotic species [M].	X			—	—	—	—	—
			- maintenance of client and stakeholder group awareness regarding the undesirable impacts associated with reduced biodiversity as a consequence of the introduction of exotic species [M].	X			—	—	—	—	—
	AQUATIC ENVIRONMENT PROTECTION	Establishment of aquatic pest species in Northern Territory inland waters prevented.	- Monitoring and destruction of any exotic and/or pest freshwater species in NT waters [M].	X			—	—	—	—	—

STAKEHOLDER UTILISATION	
COMMERCIAL INDUSTRY	H
RECREATIONAL FISHING	H
TRADITIONAL USAGE	H

KEY:

H = HIGHLY IMPORTANT
M = MEDIUM IMPORTANCE
L = LOW IMPORTANCE
NIL = NO UTILISATION

Project Priority: H = High; M = Medium; L = Low

N = NT Funded; E = Externally funded; Y = Yet to be funded

11 DEVELOPMENT OF FURTHER PARTICIPATION BY ABORIGINAL PEOPLE IN REGIONAL AND REMOTE COMMUNITIES IN THE COMMERCIAL SEAFOOD INDUSTRY(Figure 19)

Description

As 84% of the NT coastline is Aboriginal land, there is potential for Aboriginal people to become active participants within the seafood industry. There has been a history of attempts to develop fishing ventures with coastal Aboriginal communities since the mid 1960's and until the present time none of these attempts has resulted in viable or sustained ventures. These failure may well be the result of projects that are inappropriate for the Aboriginal culture or these has been no real feeling of ownership by the communities. Not withstanding, there are strong indications that fishing and aquaculture ventures based on resources off Aboriginal land and conforming with Aboriginal culture are gaining support in the communities. In addition, there are also remote non-indigenous communities that would benefit from local appropriate fisheries development projects.

Examples of such projects include an application to FRDC for a sponge farming project, the Sefrettings barramundi sea cage project at Port Hurd on Bathurst Island, mullet and milk fish netting trials n Elcho Island, etc. The ongoing consultative process between the Fisheries Group, the Police Marine and Fisheries Enforcement Unit, and where and when appropriate, NTSC, AFANT and NTU with Aboriginal representatives and groups assists in the development of a larger Aboriginal involvement in the seafood industry.

Planned Outputs by 2006

The Fisheries Group 2006 target outcomes for increased Aboriginal involvement are to foster the establishment one major project and two minor projects, these projects can be either in partnerships with other fishing operators, established by the community alone or a combination of both. These outcomes include:

- Establishment of a viable barramundi sea cage farming venture at Port Hurd;
- Establishment of a viable sponge farming venture in Arnhemland communities;
- Establishment of inshore netting ventures off Arnhemland for species such as mullet, milk fish, garfish, etc.; and
- Establishment of recreational fishing tours and access to fishing areas by other fishing tour operators.

If these outcomes are not attained employment opportunities could be lost with the projected financial benefits not realised.

FIGURE 19a. OUTCOMES, PROJECTS, FUNDING AND TIMETABLE FOR FISHERIES DEVELOPMENT IN REMOTE AREAS.

ABORIGINAL FISHERIES	PLANNED OUTCOMES	SPECIFIC R&D OUTPUTS	PROJECTS	FUNDING SOURCES			TIMETABLE (Years)				
				N	E	Y	02	03	04	05	06
DEVELOPMENT OF FISHERIES IN REMOTE COMMUNITIES	DEVELOPMENT OF SUSTAINABLE ABORIGINAL COMMERCIAL AND SUBSISTENCE FISHING ENTERPRISES	Development of a viable Aboriginal seafood industry.	- Establishment of a viable barramundi sea cage farming venture at Port Hurd [H];		X	X	———	———	———	———	———
			- Establishment of a viable sponge farming venture in Arnhemland communities [M];		X	X		———	———	———	———
			- Establishment of inshore netting ventures off Arnhemland for species such as mullet, milk fish, garfish, etc. [M];	X		X		- - -	- - -	- - -	- - -
			- Establishment of recreational fishing tours and access to fishing areas by other fishing tour operators [M].	X		X		- - -	- - -	- - -	- - -

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