



Assessment of the  
**Northern Territory Mud Crab Fishery**

**Environment Australia**

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Assistant Secretary  
Marine Conservation Branch  
Environment Australia  
GPO Box 787  
Canberra ACT 2601

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**Assessment of the ecological sustainability of management arrangements for the  
Northern Territory Mud Crab Fishery**

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## EXECUTIVE SUMMARY

### Background

The Fisheries Division of the Northern Territory Department of Business, Industry and Resource Development (NT Fisheries) has submitted a document for assessment under Parts 13 and 13A of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The draft document *Assessing the Ecological Sustainability of the Northern Territory Mud Crab Fishery* was received by Environment Australia (EA) in August 2001 after a period of discussion between NT Fisheries and EA, during which preliminary drafts were refined. The submission was released for a thirty-day public comment period that expired on 3 March 2002. Two public comments were received and NT Fisheries provided a response to the issues raised. A final version of *Assessing the Ecological Sustainability of the Northern Territory Mud Crab Fishery* (the submission) was submitted for assessment in July 2002.

The document reports on the assessment of the Northern Territory Mud Crab (NTMC) Fishery against the Commonwealth *Guidelines for the ecologically sustainable management of fisheries*. The assessment considered the submission and associated documents, public comments and the NT Fisheries' response to the comments.

The area of the fishery encompasses both Northern Territory and adjacent Commonwealth waters. The fishery is subject to an arrangement under the Offshore Constitutional Settlement (OCS) between the Commonwealth Government and the Government of the Northern Territory, dated 1 February 1995, in relation to fish and other aquatic life. Under this arrangement, the Northern Territory Government manages the mud crab fishery in State and Commonwealth waters. A prohibition on fishing for mud crabs in inland waters that are not subject to tidal influence exists under the current management plan. The seaward side of current fishing activity is up to 5 km offshore.

The fishery mainly targets green mud crab (*Scylla serrata*). Another mud crab species (*S. olivacea*) also inhabits the western waters of the Northern Territory and may be taken in the fishery, although over 99.5% of the harvest is *S. serrata* (Knuckey, 1999).

*Scylla* species are widespread in the western Indo-Pacific region from the east coast of Africa to the western Pacific as far as Tahiti. Kailoa *et al* (1993) indicate that mud crabs found in Australian waters (since then reclassified into four *Scylla* species, *S. serrata*, *S. olivacea*, *S. paramamosan* and *S. trababequeta*) inhabit warm tropical to warm temperate waters from Exmouth Gulf in Western Australia to the Bega River in New South Wales, although only in isolated populations south of Broome and Sydney. Mud crabs are harvested in fisheries under the management controls of Western Australia, Queensland and New South Wales as well as the Northern Territory, with the Western Australian fishery the least developed fishery. Kailoa *et al* (1993) indicate that *Scylla* species reach a maximum age of 3 years and a size of 240mm carapace width (CW). In tropical waters these species may mature at 18 months, but as growth rates and maturity vary with temperature, maturation may occur at a later stage in more temperate waters.

Mud crabs are typically found in sheltered estuaries, tidal reaches, mud flats and mangrove forests; their favoured habitat is a soft, muddy bottom. The species is highly fecund, with a wide larval dispersal and potential for a high degree of genetic mixing through offshore spawning. Egg-bearing ("in berry") females are believed to migrate to deeper water up to 50

km offshore. *Scylla* species are carnivorous feeders whose diet changes according to maturity. Primary predators are finfish, sharks and rays, crocodiles, turtles and herons (Kailoa *et al* 1993).

Just over 1,000 tonnes of *S. serrata* are currently harvested in the NTMC Fishery annually, at an estimated value of A\$13 million (Phelan and Hay, 2002). Catch in the fishery has been increasing over time, from 18.8 tons in 1985 to 1037.76 tons in 2000. Most mud crabs harvested in the NTMC Fishery are marketed live, either in Australia or overseas, and as a result the bulk of the commercial catch is air freighted from Darwin. Limited access caused by the wet season means that the fishery is seasonal, with peak catches occurring between May and November (Kailoa *et al*, 1993).

The fishery targets mud crabs using a rectangular crab pot of steel mesh, placed on the bottom of estuarine and coastal waters and connected to a float on the sea surface. Pots are typically baited with fresh red meat or fish and checked with each rising tide, although the frequency of retrieval is not prescribed and may be more or less than this. Commercial fishers have a restricted bait net licence and typically catch blue salmon, catfish, small sharks and mullet for use as bait in the crab pots. Relatively small amounts of catch are recorded annually in bait nets in this fishery. The bait net fishery is considered by NT Fisheries to be a separate fishery, and the submission does not specifically include discussion of bait nets. As obtaining bait for crab pots is a significant activity in the NTMC, EA has provided some comment on the use of bait nets throughout the document.

Bycatch taken in crab pots includes mud crabs at an unmarketable stage and blue swimmer crabs. Bottom-dwelling fish such as cod and catfish may be used as bait, and therefore deemed byproduct, but otherwise, NT Fisheries believes it is discarded as bycatch. It is unclear from the submission the proportion of catch taken in the bait net fishery deemed as bycatch.

Protected species interactions with crab pots are highly unlikely. However, Kailoa *et al* (1993) indicates that mud crabs may form part of the diet of marine turtles and as a consequence it is possible that some competition may occur between marine turtles and the fishery. The extent of this competition is not considered sufficient to threaten turtle populations. There is potential for protected species interactions in the bait net component of the fishery with marine turtles, dolphins, dugong and crocodiles. NT Fisheries advised that there have been no recorded interactions with protected species in the crab pot or bait net fishery.

There is some harvesting of mud crabs by the indigenous and recreational sectors, which NT Fisheries consider small scale. Information on exact levels of harvest from these sectors is uncertain. This issue is discussed in detail under Principle 1, Objective1.

The fishery is managed under the *Mud Crab Fishery Management Plan 1991* (NT), enacted under the *Fisheries Act 1988* (NT), and it is this plan that the assessment report has considered. NT Fisheries proposes to draft a new management plan by the first half of 2003.

The fishery is not zoned and commercial operators may fish in any part of the fishery area. Commercial fishing effort is concentrated in four main areas in the Northern Territory due to access difficulties. Most of the catch is taken at shallow depths in estuarine and coastal waters. Although the management regime allows fishing throughout the year, the bulk of the harvest occurs during the tropical dry season (May to November).

The commercial fishery management regime implements a limitation on the number of commercial licences, minimum size limits, gear restrictions, total pot number limit, bait net restrictions and a commercial catch recording and compliance regime. Recreational fishery management has pot, minimum size and possession limits. There is little latent effort in the commercial fishery.

### **Overall assessment**

The material submitted by NT Fisheries suggests that the fishery operates in accordance with the Commonwealth's *Guidelines for the ecologically sustainable management of fisheries*. The NTMC Fishery is assessed as being a well managed fishery where the risks of being ecologically unsustainable in the short to mid term are considered to be low. Overall, the nature of the target species, access, the limited numbers of fishers, and the management regime suggests that the fishery is being managed in an ecologically sustainable way.

EA is satisfied that the information collection system, management arrangements and objectives are sufficient to maintain ecologically viable stocks within acceptable levels of probability. NT Fisheries management of the fishery relies heavily on a low number of operators, pot limits, minimum size limits, low use of areas of potential mud crab habitat and the fecund nature and wide dispersal of *Scylla serrata*. This reliance appears to be sound.

Research and management provisions in relation to the target species are satisfactory. The fishery poses a limited risk to bycatch, byproduct, protected species and the broader marine ecosystem. There is little monitoring of such interactions, and the overall understanding of systemic impacts of the fishery and the system role of the target species is rudimentary. More monitoring and research on the ecosystem impacts of removal of mud crabs is needed to allow management to identify and react to ecosystem changes in a timely manner. There is also some uncertainty of the impact of the fishery on ecologically related and dependent species.

The review provisions in the management regime should include more detail in relation to trigger and reference points, and these points need to be matched to the objectives and performance indicators.

Research, estimates of catch and the management provisions for the commercial component of the fishery are good. Research and estimates of recreational and indigenous catch are poor, but as the recreational and indigenous take is probably low enough to be sustainable, it is not likely to be a cause for immediate concern for the sustainability of the fishery. This is an area that should be enhanced in the future management of the fishery.

On balance, EA finds that the NTMC Fishery employs sound management strategies aimed at minimising the environmental impacts of the fishery. The assessment report identifies a number of key areas requiring ongoing attention, focussing on ensuring continuation and improvement of existing management practices.

As the official fishery area encompasses Commonwealth as well as State waters, consideration under Part 13 of the EPBC Act is required *vis-à-vis* the impact of the fishery on listed threatened species, listed migratory species, cetaceans and listed marine species.

A number of protected species occur in the fishery area. The submission indicates no interactions with species protected under the EPBC Act have been recorded in this fishery. The likelihood of such interactions between protected species and crab pots is considered low. There are some concerns however about the potential risk to protected species posed by the bait net component of the fishery. There is some risk that gill nets used in the bait fishery may capture dolphins, dugongs and/or marine turtles. This issue was raised with NT Fisheries during this assessment and they have committed to undertake a review of the appropriateness of bait nets across NT commercial fisheries. EA strongly recommends that this review give specific consideration to the capture of, and interaction with, species listed for protection under State and Commonwealth legislation.

The low impact of crab pots on protected species, combined with NT Fisheries' commitment to review the use of bait nets and their impact on protected species, provides confidence that there is adequate protection afforded Part 13 species in the NTMC Fishery. As all reasonable steps are taken to avoid the killing or injuring of protected species, and the fishery is unlikely to have significant impact on the species, a declaration under sections 208A, 222A, 245 and 265 of the EPBC Act would be appropriate. Such a declaration would serve to accredit the NTMC Fishery management plan and provide individual fishers, operating in accordance with the plan, with an exemption from permit requirements if they are at risk of taking or injuring listed species in Commonwealth waters.

The assessment concludes that the fishery is managed in an ecologically sustainable way. EA recommends that the export of *Scylla serrata* taken in the fishery should be exempt from the export permit requirements of Part 13A of the EPBC Act, with that exemption to be reviewed in five years. This assessment mainly covers the harvest of *S. serrata*, which comprises 99.5% of the catch. Although the report was concerned primarily with *S. serrata*, EA is satisfied that *S. olivacea*, which comprises the remaining 0.5%, is taken in sufficiently low percentages to also be granted an exemption from the export permit requirements of Part 13A of the EPBC Act.

To further strengthen the effectiveness of the management arrangements for the NTMC Fishery, and to contain the environmental risks in the medium to long term, a series of recommendations have been developed. The implementation of these recommendations and other commitments made by NT Fisheries in the submission will be reviewed as part of the next Commonwealth review of the fishery in five years time.

## **Recommendations**

Before the next review in 2007, the Northern Territory will:

1. Incorporate recreational and indigenous catch in stock and ecosystem assessments.
2. Continue existing complementary arrangements, provided under Memorandums of Understanding, to consider the proportion of the mud crab stock being caught in Western Australian and Queensland waters in any research, assessment or management response.
3. Develop guidelines for undertaking review of fishery management plans once reference points and triggers are reached. In the absence of such guidelines being developed, a timetable for the review process will be incorporated into the mud crab fishery management plan.
4. Link the objectives, performance indicators, trigger points and management responses already established by NT Fisheries together and incorporate them into the management plan.
5. Incorporate the outcomes from current habitat mapping in future management arrangements for the fishery.
6. Review the appropriateness and effectiveness of existing bait net provisions and log books, particularly in relation to capture of, and interaction with, species listed for protection under relevant State or Commonwealth legislation.
7. Undertake a risk assessment of the removal of the mud crab from the ecosystem. The risk assessment will consider the impact of the removal of mud crabs on ecologically related and dependant species. The National Research Priorities for Mud Crabs is to have regard to the outcomes of this risk assessment.
8. Incorporate outcomes from the risk assessment described in recommendation 7 into the management of the fishery. This may include development of objectives and performance indicators that relate to that risk assessment. It may also include identification of areas that are sensitive to fishing.

## **PART I - MANAGEMENT ARRANGEMENTS**

The Northern Territory Mud Crab Fishery (the fishery) is managed by the Fisheries Division of the Northern Territory Department of Business, Industry and Resource Development (NT Fisheries). It is the second largest fishery in the Northern Territory.

The management regime consists of the following documents, all of which are documented and publicly available:

- The *Mud Crab Fishery Management Plan 1991*, made under the *Northern Territory Fisheries Act 1988* (the current management plan).
- The *Northern Territory Fisheries Act 1988*.
- The *Northern Territory Fish and Fisheries Regulations 1995*.
- Relevant Gazetted notices and licence conditions.

There are a number of other documents, including research reports, scientific literature and discussion papers, which are germane to the management of the fishery.

The current administration of the fishery is primarily through the 1991 Management Plan. A new management plan is in development and scheduled to be introduced to the fishery in 2003. This new management plan is being developed through a consultative process, providing the opportunity for interested parties, affected parties and the general public to be involved in its formulation. A discussion paper on review of the current management plan has had a three month public comment period, before the development of a draft management plan, which will also undergo a public comment period.

All new entrants to the fishery and key stakeholder groups are provided with a copy of the management plan. The Plan is also available from NT Fisheries and on the internet. Fishnotes are available to further advise stakeholders.

A range of expertise and community interests are involved in the Mud Crab Fishery Advisory Committee (MCFAC), a fishery management committee consisting of an independent chair, two commercial fisher representatives and single representatives from the recreational, fish trade, scientific, management and enforcement sectors. Three industry observers are also present. MCFAC was established in 1990 and as part of its work developed the 1991 Management Plan for the fishery. It is the primary group responsible for proposing changes to the management of the fishery.

The Northern Territory has established a specific process for consulting with indigenous fishers and communities. While indigenous fishers are not directly represented on the MCFAC, they are consulted through a series of coastal Aboriginal Consultative Committees. The committees provide formal advice from time to time to MCFAC on indigenous issues and views in relation to fisheries, including the mud crab fishery.

Comments received during the public consultation phase raised concerns about the extent and effectiveness of consultation with indigenous stakeholders. In response, NT Fisheries have advised that they consider indigenous communities as important stakeholders in the NTMC fishery and that their consultation process is effective and continually reviewed to ensure continued effectiveness. NT Fisheries have also advised that a review is underway of the Aboriginal Consultative Committees.

EA concurs that indigenous communities are important stakeholders and consultation with them should be an important part of broader stakeholder consultation by NT Fisheries. EA suggests that NT Fisheries maintain regular review of their indigenous consultation mechanisms to ensure ongoing effective consultation with this important stakeholder group. In particular, such reviews should take into account the comments raised during the public consultation period relating to the level and effectiveness of indigenous consultation.

Under the *Northern Territory Fisheries Act*, any significant change to the management plan must undergo public consultation for at least one month. NT Fisheries generally extends this period to allow greater input from the community and indigenous sector. Formal and informal discussions between MCFAC and key stakeholders and individuals take place regularly.

Broad management objectives are contained in the *Fisheries Act 1998* (NT). The current plan does not contain fishery-specific objectives and performance criteria with which to measure the effectiveness of management arrangements, nor does it contain performance indicators and triggers for the fishery. The proposed new management plan is to contain objectives, performance criteria, and trigger and reference points, mainly for target species. Objectives are also proposed for byproduct, bycatch and impacts on the environment, but associated proposed performance indicators could be strengthened. The proposed objectives and performance indicators make little reference to the impact of the fishery on the systemic role of mud crab. Specified management responses triggered by indicators are limited to review only, with no deadline by when review must be completed or contingency action. This is discussed in further detail under Principle 1, Objective 1.

Management of the fishery is primarily based on input controls. Since the creation of a commercial fishery in 1985, it has been a limited entry fishery (with the number of licences reduced since then from 55 to 49) and the number of pots used by commercial fishers has been controlled.

The commercial fishery management regime comprises a combination of input and output controls. These are:

- licences limited to 49;
- each licence can use only 60 pots;
- a minimum size limit of 140mm carapace width (CW) for females and 130mm CW for males;
- gear restrictions (pot dimensions are regulated, restricted bait net dimensions are specified and a prohibition of use of bait nets in Northern Territory waters from Bing Bong Creek to the Queensland border);
- recreational bag limit;
- prohibition on retention of berried females;
- some closures around Darwin and a number of rivers;
- prohibition on harvesting in inland non-tidal waters;
- prohibition on retaining barramundi with a restricted bait net; and
- a requirement that restricted bait nets be attended when fishing and cleared in water at least 30cm deep.

Recreational fishing also is controlled. The management regime includes:

- pot limits;

- limits on other gears that may be used, such as hand-spear, hand-held hook, hook and line, cast net or beach seine;
- possession limits;
- size limits (same as commercial operations);
- prohibition on harvesting of berried females;
- prohibition on fishing in non-tidal waters.

Recreational fishers are not licensed. Current levels of recreational fishing are estimated to be about 40-50 t, or about 3-5% of commercial catch levels (based on extrapolation of a single 1995 FISHCOUNT survey). Results of the National Recreational and Indigenous Fishing Survey (NRIFS) 2001 are expected to refine estimates.

Fishing tour operators (FTOs) also may take mud crabs. Although there is a freeze on the number of commercial licences, that does not extend to FTOs. The submission does not detail FTO harvest levels, but notes that a "very small" proportion of the 180 FTO licences in 2000/01 reported taking mud crab.

Fishery dependent and independent information relating to the target species is collected on a regular basis in the fishery. Fishery dependent data is obtained through monthly commercial logbooks, which NT Fisheries intend to become weekly in the future, and a single survey of recreational fishing in 1995. Commercial data is validated against airfreight records.

A number of research projects are underway or identified in a strategic research program and a five year national co-operative research strategy. Mud crab stocks are assessed using Catch Per Unit Effort (CPUE) data generated from logbook information as well as modelling work done in fishery workshops.

Annual fishery status reports are prepared and include information on fishery status, catch and effort data, research, compliance and management. The reports include some information on recreational and indigenous harvest, but only include a single 1995 estimate of recreational harvest and no estimation of indigenous harvest. The NRIFS should provide further information on recreational and indigenous fishing, however, EA advises that more frequent information on harvest from these sectors is needed.

EA considers the compliance and enforcement measures in the NTMC Fishery to be adequate. Compliance is undertaken by the Marine and Fisheries Enforcement Unit (MFEU) through a combination of field patrols conducted by the Northern Territory Police and paper trail audits (notably validation of log data with airfreight data).

Patrols are mainly conducted in major fishing areas, but they may also operate in other areas as part of other police activities. Most commercial fishers are interviewed in the field annually by Fisheries Division staff. Focus is on commercial and recreational operators, especially with regard to the use of excess pots, illegal use of gear and storage of apparatus in non-approved sites. MFEU also investigates under-reporting on compulsory logbooks and alleged back marketing (Calogeras and Hay, 1999).

Enforcement presence has been increased since the mid to late 1990s. New increased penalties are proposed for the main identified compliance issue of commercial over-potting. NT Fisheries have advised that they are currently in the process of working with the Fisheries Enforcement Unit to undertake a risk assessment. EA believes that this would be a useful

process that should encompass compliance risks for both the commercial and recreational sectors.

Although the fishery poses minimal risk to the environment, fishery management regimes nonetheless need to be able to assess, avoid, remedy or mitigate any adverse impacts on the wider marine ecosystem in which the target species lives and the fishery operates. The submission does not demonstrate this capability and monitoring programs do not give confidence that management will be in a position to identify and react to change in a timely manner. Given the nature of the fishing gear used and the biological characteristics of the species, significant impact on the broader marine environment is unlikely. The possible exception is the impact of the removal of mud crabs from the ecosystem on ecologically related and dependent species. This issue is discussed in further detail under Principle 2, Objective 3.

The Minister has the capacity to make emergency amendments to the Management Plan if the Minister is of the opinion that the emergency “endangers or may endanger stocks or aquatic life, or any species or class of fish or aquatic life, in any management area of managed fishery in respect of which there is an operative management plan”. While NT Fisheries believes that monitoring is adequate to detect early changes in stocks, EA’s view is that there is some risk that early change may not be detected and acted upon without more systematic monitoring and clear timeframes for the implementation of required action.

The submission does not indicate whether NT Fisheries take into account the harvest regimes in adjoining jurisdictions, although *S. serrata* is subject of commercial fisheries in Western Australia, New South Wales and Queensland. An inter-state research project is in place, and the species is among those considered at annual meetings of the Northern Fisheries Managers. It is not clear how the outcomes from these discussions are included in management strategies for the fishery, other than for setting research priorities, or whether there is a co-operative analysis done of the taking of straddling stocks over Northern Australia. This issue is discussed in greater detail under Principle 1, Objective 1.

It is not clear if the current or proposed management plan requires compliance with relevant threat abatement plans, recovery plans, the National Policy on Fisheries Bycatch, or bycatch action strategies developed under that policy. There is an undertaking that any relevant aspects of turtle or dugong recovery plans would be included in management.

There are no international or regional management regimes to which Australia is a party which relate specifically to mud crabs. The prime international regime affecting the fishery is the UN Convention on the Law of the Sea (UNCLOS). The management regime essentially complies with this.

Australia is developing a National Plan of Action – Sharks (NPOA-Sharks) as required under the International Plan of Action – Sharks, developed by the Committee on Fisheries of the United Nations Food and Agriculture Organisation (FAO). The NPOA places some obligations upon managers of all fisheries in which sharks are taken. Given that the bycatch in the NTMC fishery includes some shark species, albeit at low levels, the NPOA-Sharks may be germane to the fishery. NT Fisheries advise that they are actively contributing to the development of the NPOA – Sharks.

## **Conclusion**

Management arrangements in the Northern Territory Mud Crab Fishery are reasonably precautionary. NT Fisheries relies on a low number of operators, pot limits, size limits, low use of potential mud crab habitat and the fecund nature and wide dispersal of the species. The management strategies appear to have adequate capacity to control harvest in the commercial fishery and to a lesser extent, the recreational harvest. Measures are also in place to minimise illegal activity.

A consultative process is used to develop the management regime, which is reviewable. Sound objectives are proposed through the development of the new management plan. Also proposed are performance indicators, trigger and reference points. The development of the management plan involves some input from a range of sectors, including the public, NGO's and indigenous communities. Ongoing monitoring of the effectiveness of stakeholder consultation is considered an important feature of the management of the NTMC.

A more detailed analysis of the management regime is contained in Part II of this report.

## **PART II – GUIDELINES FOR THE ECOLOGICALLY SUSTAINABLE MANAGEMENT OF FISHERIES**

### **Stock Status and Recovery**

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

### **Maintain ecologically viable stocks**

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

### **Information requirements**

Fishery dependent data is obtained through monthly logbooks, which NT Fisheries have indicated are to become weekly, and a recreational fishing survey in 1995. Commercial logbooks are validated against airfreight records, as more than 97% of reported catch is air freighted out to interstate and overseas. The monthly monitoring is used to evaluate changes in sex or size composition of catch. Hay (1999) indicates that logbooks do not closely reflect actual spatial effort, such as the areas and rivers fished and fisher movement patterns. A switch to weekly reporting is an attempt by NT Fisheries to address this and make the information from the logbooks more relevant for fishery managers. EA considers this an appropriate response.

Fishing Tour Operator (FTO) data is obtained through daily logbooks, and incorporated into stock abundance estimates. No analysis of this undertaken, as NT Fisheries’ risk assessment suggests that the catch from this sector is minor.

Recreational data is available only for one year from FISHCOUNT 95. NT Fisheries has stated that this data has been incorporated into stock assessments in a fishery workshop. When available, the outcome of the National Recreational and Indigenous Fishing Survey (NRIFS) will also be included in the stock assessment. NT Fisheries have indicated that they consider the recreational catch to be minor based on the 1995 data, and consequently their risk analysis is that recreational fishing is too low to initiate annual reporting, research or monitoring. This will be reconsidered on receiving the outcomes of the NRIFS results.

Fishery independent information is obtained through a strategic mud crab research program that has been collecting time series data since 1992. The program combines both fishery-independent and fishery-dependent work, and is annually assessed by the MCFAC. The fishery independent component comprises the habitat mapping and density estimates funded by the Fisheries Research and Development Corporation (FRDC) and tagging studies to determine growth and movement. A report is to be prepared by May 2003 on the impacts of the fishery on wildlife and the environment. It is unclear what information this is to be based on and whether it will address the risks of localised depletions on related species such as predators. A second report is to be produced by May 2004 on the FRDC project “Methods to Estimate Abundance and Habitat for Northern Australian Mud Crab”.

Further fishery independent research is conducted through a co-operative research strategy, established in 1999, involving the Northern Territory, Queensland, Western Australia and New South Wales. The strategy addresses three broad areas over a five-year period, funding permitting. NT Fisheries are confident that funds have been obtained from the FRDC, NT and Queensland governments for the five year strategy, which will look at:

- *Relative productivity of mud crab habitat:* determination of relative productivity of habitat using satellite imagery and abundance estimation
- *Stock abundance indicators:* using validated commercial catch and effort data; effectiveness of “pot lift” as an index of abundance; comparison of pot design. Fishery independent index of stock abundance to be developed based on juvenile pre-recruit index (trials of juvenile sampling/behaviour, habitat identification and field trials)
- *Spatial difference in population reproductive characteristics:* Assessing the effects of regional harvest policy through analysis of spatial difference in population reproductive characteristics, sex ratios and fertilisation rates; in the longer term attempting to elucidate the offshore migration patterns of spawning female crabs.

### **Assessment**

The NTMC fishery crab stocks are subject to annual assessments based on CPUE data obtained from the commercial logbooks. In addition, modelling work presented in the most recent workshop was used to examine the relationship between catch rates, fishing effort and recruitment to determine if increasing catch rates are due to increased recruitment or increased fishing power.

An annual assessment of the fishery is undertaken by NT Fisheries for consideration by MCFAC. An annual report is produced which addresses catch/effort, stakeholder participation, research, compliance, management and other major issues. NT Fisheries have indicated that future annual reports are anticipated to include issues identified by EA as being necessary for review.

The stock assessment process employed does not attempt to establish a total allowable catch for this species. NT Fisheries asserts that the biological and life history characteristics of the target species do not lend themselves to such a stock assessment and management tool. EA considers this response to be appropriate.

Three workshops have been held on the fishery. These mainly involved an exchange of information between various jurisdictions on their current research and management regimes. International and national stock assessment experts, including Dr Carl Waters, undertook review of the stock assessment of the NT mud crab in the 1999 workshop. Results of stock assessments are unclear, but suggest that traditional catch/effort data is not useful for modelling stock size accurately because fishers move pots daily to maintain catch rates.

EA believes it is important to develop a fishery independent method of assessment of relative abundance due to the inaccurate reflection of fishing patterns in logbooks (Hay 1999). There is a FRDC-funded program to develop an indicator based on juvenile pre-recruit index, but delivery is not likely for 3-5 years with field trials proposed in years 3,4 and 5 of project.

The removal of stocks by licensed commercial fishers is factored into the stock assessment process. Good commercial data is available from fisheries dependant and independent

sources. However, the reliability of recreational and indigenous data is poor. There are no estimates for indigenous harvest, and only a single point estimate from 1995 for recreational data. Therefore it is difficult to factor recreational and indigenous catch into stock assessments, and may lead to doubts about overall harvest data. Indigenous harvest is not considered by NT Fisheries to be high, despite crab being a significant part of the diet of coastal communities. NT Fisheries has advised it is relying on information from the Consultative Committees in relation to indigenous take.

As removal of target species by all sectors of the fishery should be considered in the overall assessment and management of stocks, EA strongly recommends that NT Fisheries incorporates estimates or known harvest levels of mud crabs taken by indigenous and recreational sectors into stock and ecosystem assessments.

Sound information is available on the large-scale regional distribution of *Scylla serrata*. The species is found from Shark Bay in Western Australia to Sydney in NSW. Mud crab stocks may show a high genetic mix as a result of offshore spawning and a planktonic larval stage (Kailoa et al, 1993).

There is a single genetic stock harvested in the Northern Territory, but whether this is the same single genetic stock across Western Australia, Queensland and New South Wales as well is unclear. It is also unclear how management takes this into account in stock assessment and management responses, but some cooperation between jurisdictions is evident through annual meetings of the Northern Fisheries Managers and the cooperative research program.

As information on the spatial settlement patterns of the megalopae stage is not available at this stage, NT Fisheries is continuing to manage the fishery as a whole rather than on a regional basis. EA strongly recommends that NT Fisheries maintain and enhance existing complementary arrangements provided under current Memorandums of Understanding and take cross jurisdiction stock issues into account in research, stock assessment and management responses.

The other mud crab species present in the Northern Territory, *S. olivacea*, has a distribution limited to embayments where there is reduced salinity. No specific information on the spatial distribution of this species within Australian or Northern Territory waters was provided in the submission. As it constitutes less than 1% of the catch in the Northern Territory, EA does not consider the lack of information on *S. olivacea* to be a major impediment to sustainably managing the fishery.

There is no formal estimate of total biomass or upper limit to harvest, such as a Total Allowable Catch (TAC) for this fishery. Management is reliant on the fact that this is a highly fecund and fast growing species with an offshore larval phase and one that has supported a high level of exploitation for some years without signs that stock is adversely affected. NT Fisheries submit that their current input controls, including effort controls, have proven to be sufficient in maintaining the fishery at sustainable levels. As catch rates continue to increase, they argue that overharvesting has not occurred. Nevertheless, there is no estimate of the potential productivity of the fishery or the proportion of the fishery that can be ecologically sustainably harvested.

An increase in the total fishing pressure through recreational and indigenous harvest, which is not capped, has not been considered. Fishery-independent research is currently underway to

identify potential mud crab habitat and its productivity. This will assist in determining the potential productivity of Northern Territory waters and should be incorporated into the management regime, if necessary using mechanisms such as closed areas or seasons.

The fishery is not likely to suffer from recruitment overfishing as extensive areas of coastline are not exploited (Calogeras and Hay, 1999). NT Fisheries maintains that even when new areas are exploited, overfishing will not occur due to the current effort restrictions in place.

They further assert that catches are not likely increase in the event that fishing effort is increased for a number of reasons. All crabs are not equally vulnerable to capture due to their moult stage as individuals in moult remain stationary and are unlikely to enter crab pots. The possibly the presence of larger crabs may deter other crabs from entering the pot and pots are believed to fish competitively if set within 50m of each other. For this reason pots rarely take more than one crab.

Fisheries data shows that the median crab CW is 15-20mm above the minimum size limit. This appears to be a function of fast growth rate rather than selection of larger crabs by fishers. Larger crabs are not overtly selected by fishers as smaller mud crabs are more valuable in the fishery due to restaurant trade preferences.

Most recorded catch for males and females relates to animals well above minimum limit, this is thought by NT Fisheries to be a symptom of the fast growth rates of *S. serrata*. It is not clear what proportion of catch is composed of immature males and immature females, however given the high fecundity and wide dispersal characteristics of *S. serrata*, as well as the gear selectivity for larger crabs, it is likely that the levels of immature crabs being harvested are sustainable.

Although there is information on growth rates and size at maturity, there is a lack of information about the link between habitat productivity and mud crab growth rates. Research on habitat mapping in combination with validation by annual surveys could provide further information on the distribution and abundance of mud crabs.

EA is concerned by the greater proportion of larger males being caught as opposed to smaller ones. The presence of mating scars indicates that larger males are the ones that breed (Knuckey, 1999). No information is available on whether smaller sized males will begin breeding if a long term pattern is established of catch biased towards removing greater proportions of larger males.

There is a high annual exploitation rate of between 70 to 90 percent in areas fished, according to submission quotes from Walters in a 1999 workshop report. This equates to 70 to 90 percent of 40 percent of the potential mud crab habitat being exploited, as approximately 60 percent of potential habitat is unfished through access and transport difficulties, both of which could change significantly over time. The NT Fisheries submission recognises that this may result in local fishery depletion but argues that this is unlikely to lead to recruitment overfishing due to the larval dispersal of the mud crab. Trend data apart from catch and effort is not provided, and the lack of clarity on recruitment, dispersal, and stock size is of concern.

## **Management response**

The current NTMC Fishery management regime aims to maintain ecologically viable stock levels through a range of input and output controls capable of controlling the level of take and measured by performance indicators and criteria.

Reference points are broad, and primarily relate to target species (such as commercial catch, effort, and median size by sex). While current reference points appear to be sound, there is no clear commitment to refinement of reference points over time, nor evidence of contingency planning to deal with the eventuality that a reference point is exceeded. There are no interim management procedures to apply during periods of review once trigger or reference points are reached. Breach of a reference point triggers a review, however there is no deadline by when the review should be completed. The MCFAC is responsible for advising the Director of proposed management action in the event that a review is triggered. There are no guidelines or parameters for consideration by the MCFAC when advising the Director, and there are no decision rules in place for the Director to act on once they have received the advice of the MCFAC. The director is not legally required to consider the advice of the advisory committee.

EA believes that there needs to be a stronger link between the trigger and reference points and timely management action. NT Fisheries have advised that guidelines will be developed for undertaking review of fishery management plans following the trigger and reference points. EA commends this decision. Should these guidelines not be developed, EA recommends that a timetable for the review process following reference point triggers be incorporated into the NTMC fishery management plan.

In the submission, NT Fisheries anticipates that a review of the trigger points will occur sometime over the next five years, but gives no specific undertaking as to whether this will definitely occur, nor is there an indication of what will be considered in revising the trigger points.

While NT Fisheries has already established proposed objectives, performance indicators, trigger points and management responses for the NTMC Fishery these are not tightly linked. EA recommends that NT Fisheries link these important components of the management regime and incorporate them into the new management plan.

The NTMC is managed through a system of input and output controls designed to regulate the level of harvest from the fishery. These are:

- licences limited to 49;
- each licence can use only 60 pots;
- a minimum size limit of 140mm carapace width (CW) for females and 130mm CW for males;
- gear restrictions (pot dimensions are regulated, restricted bait net dimensions are specified and a prohibition of use of bait nets in Commonwealth waters from Bing Bong Creek to the Queensland border);
- prohibition on retention of berried females;
- some closures around Darwin and a number of rivers;
- prohibition on harvesting in inland non-tidal waters;
- prohibition on retaining barramundi with a restricted bait net; and

- a requirement that restricted bait nets be attended when fishing and cleared in water at least 30cm deep.

Commercial sector management strategies such as licence limitation, gear prescriptions, controls over attendance and size limits, appear adequate. Recreational management is less adequate, given the lack of time series data to suggest trends and numbers of recreational fishers. There are possession limits, but no controls or current estimates on the total numbers of recreational fishers or the level of recreation take. It is unclear how NT Fisheries can determine when a trigger point is exceeded, particularly with respect to recreational fishing.

Penalties for overpotting by commercial fishers are in place, with pressure on NT Fisheries from the industry to increase these as a deterrent to fishers who may overpot. Penalties are also in place for the recreational sector for exceeding possession limits.

Given the inshore nature of the species and the risk of substantial effort increases, a structured approach to estimating recreational and indigenous harvest should be implemented and factored into management.

Effort creep would appear to be a real risk in the fishery, despite the cap on commercial licences. Increase in effort from 1980 to 2000 was of two orders of magnitude; although the species has a short life cycle, it is still susceptible to increased fishing effort.

Some effort creep is evident in the movement by some crabbers to bigger motors, which may be more economical and efficient in transporting “significant loads over long distances” (Calogeras and Hay, 1999). Some fishers may travel more than one hundred kilometres to set pots and generally stay in the vicinity for a number of days before returning to camp to unload. Camps tend to be remote, land-based and rudimentary, and the use of mother boats, pontoons or barges as a base has the potential to become more common as crabbers travel further afield. The fishery currently has some added security in that much of the available mud crab habitat is not fished, and these areas may provide recruits to fished areas. Effort creep has the potential to restrict this recruitment security. NT Fisheries should consider appropriate mechanisms for controlling spatial effort creep in the fishery; for example closed areas and vessel size restrictions.

While pot dimensions are regulated at  $0.5\text{m}^3$ , the standard commercial pot has a smaller total volume of  $0.15\text{m}^3$ . Changes to a larger pot size may have some impact on the number of crabs caught, although NT Fisheries maintain that this will not occur as there is generally no more than one crab caught per pot.

Given that the fishery is managed primarily through effort controls, the fact that effort creep is possible has consequent implications for levels of management control; the submission makes no reference to further measures to reduce effort or contingency planning for this eventuality. EA suggests that NT Fisheries consider undertaking research into changes in fishing efficiency, including the development of contingency plans and management strategies to compensate for the potential increase in harvest.

NT Fisheries submit that the MFEU continually monitors for the sale of recreationally caught fish on the black market, and that there is negligible evidence of a black market.

EA has concerns about localised depletions of mud crab. Fishers have legal access to a very large fishery area. To date the nature of operations using small boats with limited terrestrial

access to launch them, has restricted the actual fishing area utilised to about 40% of potential mud crab habitat. While this currently limits the risk of overall depletions, there are no specific management provisions in place to prevent expansion into these areas.

The single point data for recreational fishing is of concern, given that there is a risk of localised depletions. There is no limit to the number of participants and no information about whether recreational catch is constant or rising. NRIFS data may be able to provide trends in recreational fishing, in which case NT Fisheries should have contingency plan established, should NRIFS reveal that recreational fishing for mud crabs in the Northern Territory is significantly greater than the level of harvest shown by the 1995 FISHCOUNT survey.

*S. serrata* has high fecundity and females appear to move offshore to spawn during September to February (Hill, 1994). December to February is a closed season for the Northern Prawn Fishery so they are infrequently caught in that fishery and if caught must be released as they are fully protected. Few commercial fishers have been found retaining berried females. NT Fisheries has considered giving full protection to females from the fishery. The idea was rejected due to the potential skew in sex ratio and risk of greater male-female competition for habitat.

Sexual maturity occurs at about 15 months but male mud crabs reach the minimum size limit (130mm) in around 12 months, so some immature animals are entering the fishery. NT Fisheries has submitted that due to the selectivity of the fishing gear, all crabs only become fully vulnerable to the fishery at about 18 months of age, reducing the likelihood of immature males being caught. Presumably, this also relates to the average catch size of 155mm, which means the crabs are more likely to be mature when caught.

The minimum size limit for females is 140 mm, at which size over 70% are mature. Originally the size limit was the same as for males, but NT Fisheries changed this in 1996 after it was found during the course of Knuckey's research (1999) that 50% of females had reached maturity at 136.5 mm. The results of the research finding were reviewed and implemented. This was an important management action that identified a potential reduction in biological diversity and /or reproductive capacity and acted to rectify it.

The manner in which the NTMC Fishery is conducted poses limited risk to byproduct species. Byproduct levels are less than 500kg per year, and consist mainly of catfish, cod and blue swimmer crab, although the latter is better considered bycatch. No reports of sale of byproduct are known, but it is unclear what monitoring program is in place to detect such sales. Fish byproduct species may be used as bait for crab pots. Undersized crabs are returned to the water, and the submission states that research suggests survival is high.

Existing monitoring programs provide some data on byproduct species as commercial logbooks make some provision for recording bycatch and byproduct, although the format of the logbooks is such that it is very unclear where byproduct is to be recorded. It is not clear what fishery-independent programs exist (if any) as levels of byproduct and considered low.

EA considers the byproduct in this fishery to be low, and apart from concerns over the impacts of bait nets (raised under Principle 2), consider the management of byproduct stocks to be adequate.

## **Conclusion**

EA is satisfied that the information collection system and stock management arrangements are sufficient to maintain ecologically viable stock levels within acceptable levels of probability. The regime is capable of controlling the level of take from the fishery.

The lack of assessment of spawning biomass is an issue requiring some attention, however this is not seen as a critical failing of the management. NT Fisheries are encouraged to examine the issue in the mid to long term. There is also a need for indigenous and recreational catch to be incorporated into the stock and ecosystem assessments. This issue should be addressed in the short to mid term by NT Fisheries.

The management arrangements appear to be achieving the mud crab fishery objective relating to continued development of the fishery. With negligible latent commercial effort and unknown recreational or indigenous effort, for precautionary reasons the fishery should be no longer considered developmental.

While the management objectives, performance indicators, reference points and management response have been developed, there are no formal links between them. The regime also lacks contingency planning and commitment to specific strategies (apart from review) should trigger points be breached. Data collection and analysis for byproduct species could be improved.

## **Recommendations**

1. Incorporate recreational and indigenous catch in stock and ecosystem assessments.
2. Continue existing complementary arrangements, provided under Memorandums of Understanding, to consider the proportion of the mud crab stock being caught in Western Australian and Queensland waters in any research, assessment or management response.
3. Develop guidelines for undertaking review of fishery management plans once reference points and triggers are reached. In the absence of such guidelines being developed, a timetable for the review process will be incorporated into the mud crab fishery management plan.
4. Link the objectives, performance indicators, trigger points and management responses already established by NT Fisheries together and incorporate them into the management plan.

## **Promote recovery to ecologically viable stock levels**

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

This objective is not applicable to the fishery at present. Some trigger points are in place, based on reference points from 2001. There is no indication if these reference points will remain constant or are subject to review. Emergency powers exist under s29 of the *Fisheries Act 1988* should the fishery decline, including halting fishing in all or part of the fishery, restricting the number of vessels in the fishery, restricting the amount taken from the fishery, and restricting the quantity or nature of fishing gear.

## **Ecosystem impacts**

Principle 2: *'Fishing operations should be managed to minimise their impact on the structure, productivity, function and biological diversity of the ecosystem'*

## **Bycatch protection**

Objective 1: *'The fishery is conducted in a manner that does not threaten bycatch species'*

## **Information requirements**

Data collection of bycatch in the commercial fishery is through logbooks, which have a specific section to record the weight and type of bycatch caught. The degree of compliance with bycatch reporting requirements is not clear, although the MFEU undertakes compliance work on behalf of NT Fisheries.

Bycatch in crab pots is minimal as the gear is selective. Bait nets present a much greater chance of catching bycatch. NT Fisheries have advised EA that that fishers using bait nets are also required to record bycatch on specific bait net fishery log sheets.

Estimates of bycatch, collected through research and field observations by NT Fisheries staff, indicate that bycatch levels are low. EA is satisfied that reliable information is collected on the composition and abundance of bycatch in crab pots, given the scale of the fishery. It is anticipated that the habitat mapping research project currently underway will provide useful information related to bycatch. A report is scheduled to be produced by May 2003 on the impacts of the fishery on other wildlife and the environment, including bycatch species. At this stage information on how this will be conducted and the information to be collected is not available. EA strongly encourages the timely completion of this project and looks forward to its finalisation.

The degree of bycatch information collected to date suggests that data on temporal or spatial variations in bycatch, such as species, quantities, and stages of life cycle is not available. While the degree of bycatch is likely to be very low, EA suggests it maybe useful to obtain both fishery dependent and fishery independent data on bycatch levels over a range of sites and at various times during the fishing season.

## **Assessment**

There has been no formal risk assessment in relation to bycatch undertaken by NT Fisheries, although they consider the level of harvest of bycatch to be sustainable. NT Fisheries assert that while the exact level of compliance with bycatch reporting is not certain, field observations, independent research and the nature of the fishing gear results in minimal bycatch and a very low risk to the status of any bycatch species.

Although the fishery regime does not demonstrate robust knowledge of the capture of non-target species in the fishery and its implications, analysis of existing data suggests bycatch is not high. This would be in keeping with the general view that bycatch in crab pots is low relative to other fishing methods. EA concurs with NT Fisheries view that the fishery poses minimal risk to bycatch species.

Bycatch in crab pots is minimal as the gear is very selective, however bait nets present a much bigger chance of bycatch, in particular turtles and dugong. The submission recognises that ‘aspects’ of the bait net fishery need to be monitored. NT Fisheries have recently advised EA that a review will be conducted into the appropriateness and effectiveness of bait nets used in all NT commercial fisheries. EA considers this review to be important and recommends that particular attention be given to the appropriateness of existing bait net provisions and logbook reporting, and to the impact of interactions with, and capture of, species listed for protection under relevant State and Commonwealth legislation. As the use and impact of bait nets is not exclusive to the mud crab fishery, a broader approach is required. The issue of protected species interaction with bait nets is discussed in greater detail under Principle 2, Objective 2.

Using logbook information, it is estimated that 500 kilograms of cod, blue swimmer crabs and catfish are caught in crab pots per annum. NT Fisheries considers these levels to be low. The catch in bait nets is estimated to be five tonnes per annum, consisting mainly of blue salmon, catfish, small shark and mullet. The submission states that no barramundi are to be retained, but does not estimate the amount of barramundi being caught or released.

There is no obvious differentiation between byproduct and bycatch in the NT Fisheries submission, as the same figures for weight and species caught are provided for both byproduct and bycatch.

## **Management response**

There is a range of measures in place to minimise bycatch in the fishery. The management response to bycatch mainly relies on current pot design. There are limits on pot numbers, volume and size of escape gaps to reduce the risk of interactions taking place. Escape gaps have been specifically designed to minimise the capture of undersized crabs and fish species. Fishing operators are also limited to two sets per day to reduce the potential bycatch of the fishery. These measures appear to be effective as there are low levels of non-target species entering the pots, and the survivability of released bycatch is thought to be high.

Ghost fishing is not considered an issue as pots only attract animals when baited, and bait is quickly consumed by crabs, isopods or small fish when present. Potential for ghost fishing is therefore diminished once the original bait is removed. Some consideration needs to be given to the risk of a lost pot becoming re-baited by animals that enter it and are unable to escape; some consideration also should be given to pot decay rates.

To minimise the potential for ghost fishing, under the proposed new management plan, pots are modified to have a smaller mesh, or escape panels, and a prohibition on finger-like projections that prevent escape of fauna caught in the pot.

At present, no indicator species of bycatch is monitored and consequently no decision rules have been developed for bycatch indicator species.

NT fisheries advise that extensive observations of fishers, fisheries independent research and compliance activities demonstrate low bycatch levels in the fishery. Their view is that very low bycatch numbers and the low levels of risk mean bycatch monitoring is not required. EA suggests it would be advisable to reassess the risks to bycatch on a regular basis, for instance every three years, until more robust data is obtained and the validity of the low-risk assessment is established.

The proposed bycatch performance indicator is the development of a report on the impacts of the fishery on bycatch. Should the report indicate that bycatch is greater than currently estimated, there needs to be a commitment to implement appropriate response action. The bycatch trigger points proposed by NT Fisheries have been set high, but will still be triggered by small changes in catches due to the low numbers of bycatch presently being caught.

Fishing effort can be adjusted if detrimental effects are identified, although detecting and identifying those effects relies on commercial logbook data and a study to be completed in May 2003.

While EA recognises the constraints on obtaining useful data on bycatch from any fishery, it would be constructive for NT Fisheries to obtain further data over time to allow for a review of trigger points and possible management responses.

EA is satisfied that the measures in place to minimise bycatch are sufficient to avoid unsustainable capture and mortality of bycatch species in crab pots, and that a review of bait net fishing activities will address concerns in relation to bycatch in that gear.

## **Conclusion**

Following analysis of the submission and supporting documents, EA considers that the NTMC fishery meets Objective 1, and is conducted in a manner that does not threaten bycatch species. Current information suggests levels of bycatch in crab pots are low relative to that taken in other fishing methods.

While a bycatch information collection system is in place, the reliability of the information could be strengthened. Furthermore, some modification to the management arrangements to address bycatch more specifically could be considered, particularly with respect to obtaining and analysing data. The regime lacks contingency planning and commitment to specific strategies to deal with changes in assessed risks for bycatch. These issues should be considered in the development of the new management plan.

On balance, EA is satisfied that the management response in relation to bycatch is appropriate for the fishery operating at current levels of effort. This situation may need to be renewed if there is an increase in activity in the fishery.

EA has some concerns regarding the use and impacts of bait nets in the fishery, and supports the Northern Territory in undertaking a review of bait nets across its commercial fisheries as an initial step in addressing these concerns. This review should specifically address the use and effectiveness of log books for recording catches in the bait net fishery.

### **Recommendation**

5. Review the appropriateness and effectiveness of existing bait net provisions and log books, particularly in relation to capture of, and interaction with, species listed for protection under relevant State or Commonwealth legislation.

## **Protected species and threatened ecological community protection**

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

### **Information requirements**

There are no formal mechanisms for reporting interactions with endangered, threatened or protected species. NT Fisheries submit that if there were any such interactions, these would be reported to the MFEU or the Fisheries Division, and that no such reports have ever been received. NT Fisheries also assert that the fisheries independent data collection and fishing operations, which are conducted in the same manner as the commercial operators, have not shown or identified any risk to protected species.

While the bait net fishery records catches using log books, there is no provision for the recording of interactions with protected species. Given the nature of the bait nets used in this fishery (gill nets), there is a risk of interaction with protected species, in particular dugong, turtles and dolphins. NT Fisheries consider the risk posed by bait nets to protected species to be low, as all fishers are required to attend nets at all times and that the compliance operation, independent observations and information from commercial fishers supports this view.

Overall, the reliability of data collected on interactions with endangered, threatened or protected species is unclear. With low levels of interactions there is limited prospect for data validation.

Research in progress includes a report on the impacts on bycatch and the wider environment due in May 2003. There is a strong reliance on this research to provide information on bycatch, byproduct, protected species interactions and ecosystem interactions. The five year habitat mapping research program was also flagged as a potential source to identify threatening processes and ecological community impacts.

### **Assessment**

Protected species occurring in the fishery area include dugong (*Dugong dugon*), loggerhead turtle (*Caretta caretta*), green turtle (*Chelonia mydas*), leathery turtle (*Dermochelys coriacea*), hawksbill turtle (*Eretmochelys imbricata*), olive ridley turtle (*Lepidochelys olivacea*), flatback turtle (*Natator depressus*), salt-water crocodile (*Chelonia mydas*),

seasnakes, pipefish and seahorses. There are no threatened ecological communities in the fishery area.

There is no formal risk assessment of the impact of the fishery on endangered, threatened or protected species. The submission focuses on crab pot impacts and does not address restricted bait net impacts. The potential impact on protected species is likely to be different between the two methods.

While the risk of protected species interaction with crab pots may be low, there is a clear potential risk of interaction with bait nets. Given the type of net used, the placement of these nets across watercourses and the distribution and movements of some protected species; EA considers the risk of interaction with protected species is high. Resolution of this issue is important and a review of the use of bait nets in the NTMC fishery is required. As previously discussed, the impact of bait nets will be considered by NT Fisheries as part of a broad review of the appropriateness of bait nets in their commercial fisheries. EA recommends that the review include an analysis of the impact of bait nets on interaction with, and capture of, protected species.

Recent research suggests Indian Ocean populations of marine turtles cannot withstand current levels of indigenous harvest and incidental mortality in commercial fisheries. There are no recorded instances of interactions with turtle species in the NTMC fishery, and there is no indication that turtle species are significantly affected by operations in the fishery. However, it would be prudent to consider documents such as the *National Recovery Plan for Marine Turtles in Australia* as part of the risk assessment of the fishery on threatened and protected species, particularly during the review of bait net fishing activities.

Bannister *et al* (1996) indicates that the extent of cetacean entanglement with crab fisheries generally is likely to be very low. When it occurs it appears to involve entanglement on crab buoy lines, and is largely restricted to large cetacean species which are generally not found in Northern Territory waters. Two species of inshore dolphin, Irrawaddy dolphins (*Orcaella brevirostris*) and Indo-Pacific hump-backed dolphins (*Sousa chinensis*), both of which are considered to be of insufficiently known conservation status, inhabit coastal, estuarine and occasionally riverine habitats off the Northern Territory. There are no known direct interactions with these species. The greater risk to both species would appear to be competition for prey. Both species are known to feed on some crustaceans, but it is unknown whether this includes mud crabs. For this reason EA does not consider it a significant factor in this assessment, although further research into the potential interaction would be advisable.

The submission does not suggest provisioning occurs with dolphins through the taking of crab or baits from the pots. In the view of EA, such interactions, if they occur, are unlikely to affect the conservation status of the species.

As there are no threatened ecological communities identified in the Northern Territory, consideration of the impact of the fishery on any threatened ecological communities is not required. In the event that such communities are in future identified in the area of the fishery, the new draft management plan proposes to require a report on any significant impacts of the fishery on the threatened ecological community. EA supports this proposal, and suggests it should go further and commit to addressing any findings of a report in management responses.

### **Management response**

No measures are specifically in place to deal with interactions with protected species in the crab pot fishery. Gear design limits the opportunity for interaction. Operational restrictions reduce the risk of gear being unattended for any length of time, reducing the risk of adverse impacts, especially in relation to bait net fishing. Current management practice relies on pot designs to minimise capture. EA considers the risks posed by the crab pot fishery to protected species to be minimal and that current fishing practices should be maintained.

NT Fisheries requires fishers operating in the bait net fishery to remain in attendance to release any catch of protected species. NT Fisheries assert that this ensures low risk of interaction with protected species.

While the risk to potential species is considered low, the submission contains no commitment to implement mitigation measures if the need is identified. There are no reference or trigger points related specifically to protected species interactions. The management response to an increase in levels of interactions with bycatch and byproduct is to review potential methods to reduce interactions. Without protected species being specifically reported it is unclear how such a review would be triggered.

As review of performance measures is good fisheries practice, EA assumes that NT Fisheries will review those relating to non-target and protected species as regularly as they will review those relating to target species. EA encourages NT to incorporate review triggers and associated decision rules into any future management plan.

Although there are currently no recovery or threat abatement plans under the EPBC Act relevant to the NTMC Fishery, the proposed management regime should include provisions to oblige compliance with any such plans that may be developed in the future.

### **Conclusion**

EA is satisfied that the crab pot component of the NTMC Fishery poses no significant threat to protected species or ecological communities because levels of interactions with crab pots appear to be low. EA recognises the monitoring and compliance activities in the fishery that have the capacity to detect interactions with protected species. However, no reporting mechanisms specific to protected species are in place, and no mechanisms are in place to trigger management actions in the event that protected species interactions become an issue in this fishery.

EA considers that it is unlikely with current fishing methods and levels of effort that interactions will increase. This situation may change if there is an increase in activity in the fishery, for example through effort creep or a substantial increase in recreational fishing. Management regulations, ongoing monitoring and operational practices should ensure low levels of interactions with protected species.

Some contingency planning for modifications to the management arrangements to address the impact of the fishery on endangered, threatened or protected species would appear to be precautionary, particularly if the risks of interactions increase.

The impact of the bait net fishery on protected species is unknown although there is potential for interaction with such species. EA considers resolution of this issue important and a review of the use of bait nets in the NTMC fishery is required. This review should specifically include an analysis of the impact of bait nets on interaction with, and capture of, protected species.

#### **Recommendation**

Recommendation 5 also applies here.

### **Minimising ecological impacts of fishing operations**

Objective 3: *‘The fishery is conducted, in a manner that minimises the impact of fishing operations on the ecosystem generally’*

#### **Information requirements**

No specific work has been undertaken on the impacts of the fishery on the ecosystem and the environment generally. Future research may be undertaken to do comparative assessments of fished and unfished areas. The habitat mapping project is expected to provide useful information relating to the environment in which the fishery operates. While the impact of the fishery on the environment is likely to be low in comparison with other fisheries, steps should be taken to confirm this initial assessment.

#### **Assessment**

There has been no formal assessment of the fishery’s actual or potential impacts on the ecosystem. Low risk is assumed because of limited interaction of crab pots with other species, the lack of physical disturbance caused by pots and the limited time the pot is on the bottom. The future installation of escape gaps in crab pots should lower this risk further.

The impact of the fishery on ecological communities, related species and the structure and productivity of food webs is unknown. The submission shows that little work has been done on the role of mud crab in its trophic role sense. Understanding the role of the target species in the boarder marine ecosystem is an important feature of ecologically sustainable fisheries management. EA recommends that NT Fisheries undertake a risk assessment of the removal of mud crabs from the ecosystem with a view to identifying risks to ecologically related or dependent species.

EA recognises that NT Fisheries regularly convenes stock assessment workshops but notes that these workshops focus on the target species and do not consider in detail the impact of mud crab biomass removal on ecologically related and dependent species. It is also recognised that the habitat mapping project may yield some results relevant to this issue.

Mud crabs are prey to crocodiles, large cod and grouper. No detrimental effects on those species have been identified, despite the removal of large amounts of mud crabs through the fishery. There is an assumption that impacts on ecologically related species are minor. The basis for this non-detriment view is not clear.

Juvenile crabs also provide a prey species for fauna such as zooplankton, benthic molluscs, adult crustaceans e.g. bivalves and gastropods, small crabs, and polychaetes (Kailoa et al, 1993). Predators of adult crab include large fish such as rock cod of Family Serranidae and barramundi, sharks, crocodiles, turtles, rays, and herons.

No estimate has been made of the ratio of undersize to legal size mud crabs, nor of the percentage of virgin total biomass left in the marine environment after fishing removals.

Fishery mortality affects about 70% of the mature biomass in the fished area (40% of the fishery). For this to be ecologically sustainable, there would need to be a high level of redundancy in the system. The submission suggests there have been no noticeable substantial changes resulting from the fishery, and that the stock assessment workshops would identify any such change. As mud crabs are generalist feeders and highly fecund, a significant degree of redundancy may be expected. Other predators may be expected to fill any gap created by mud crab removal.

EA is concerned that the high exploitation rate of areas fished (70-90%) means that there may be very little carryover of larger crabs from previous year's recruits. This may impact on the capacity of the species to fulfil its systemic role in fished areas.

EA strongly recommends that NT fisheries undertake a risk assessment of the removal of the mud crab from the ecosystem. Such a risk assessment should specifically address the impact of the removal of mud crabs on ecologically related or dependent species.

In areas of high tidal range there may be a risk of pots dragging on the bottom, however this is not addressed in the submission. EA considers the impact of the fishery on the physical environment to be very low. The fishing method and gear employed is not expected to significantly alter or disturb substrates and impact on areas such as seagrass beds or reefs.

Water quality and air quality are not considered at significant risk from the mud crab fishery operators due to the gear used and small vessels operating in the fishery.

### **Management response**

No management actions have been implemented to specifically minimise the impact of the fishery on the broader marine ecosystem. Despite this, the general fishing method and operation have little physical impact and the development of different management arrangements may not be necessary. As previously stated, the impact of the removal of mud crabs from the ecosystem is unknown, and assessment of their trophic role is recommended. EA further recommends that the results of such an assessment be factored into management of the fishery.

The management regime contains no clear contingency planning for dealing with the eventuality that the fishery does have a systemic impact.

The success of management would be enhanced in a systemic sense if a specific system-based management objective were to be developed for the fishery. Such an objective would be useful in addressing the issues outlined above. Although the development of system-based objectives in Australian fisheries is a fairly new concept, EA believes NT Fisheries should direct some effort into assessing options for system-based management objectives and associated biological reference, target and limit levels and performance measures for

application in the fishery, including consideration of the merits of increasing the proportion of mud crabs that is protected.

There are no decision rules or trigger points relating to wider ecosystem impacts. NT Fisheries relies heavily upon the outcome of a single, albeit large, research project on habitat mapping – “Methods to Estimate Abundance and Habitat for Northern Australian Mud Crab”, and in the submission undertakes to factor results from this study into management arrangements, including trigger points. EA strongly recommends the timely completion of this project and the incorporation of outcomes from the habitat mapping research in future management decisions.

### **Conclusion**

The level of understanding of the impact of the fishery on the general marine environment is not extensive and little information is collected. Given the nature of the fishery, impacts on the sea floor should not be great as the gear used, although bottom-set, is not dragged across the sea floor and would be expected to have little impact on the benthos. The combination of the following factors suggest that the fishery is unlikely to have a significant impact on the marine environment generally:

- the fishing method has limited interaction with, and therefore is not believed to have a significant impact on, the benthos or other components of the physical environment
- low levels of bycatch are suggested by available data and the nature of the fishing gear; and
- mud crabs are not identified as a keystone species in the system, although there is a lack of understanding of the importance of their trophic role.

While the overall impact of the fishery on the broader marine environment may not be considered high, there remains some concern about the impact of large quantities of removal of mud crabs on ecologically related and dependent species.

Due to the combination of heavy localised fishing pressure and the potential for fishers to increase the geographical scope of the fishery, EA is concerned about the lack of knowledge on ecosystem impacts of mud crab removal, particularly in relation to areas prone to localised depletions and those previously unfished. It is likely the most significant impacts will be on ecologically related and dependent species.

A risk assessment should be conducted as a matter of priority to identify the impacts of the removal of mud crabs from the ecosystem. The assessment should specifically address the trophic role of the species and the results should be considered when setting National Research Priorities in the region. EA also recommends that the outcomes of such an assessment be incorporated into the management of the fishery.

EA does have a concern that high levels of harvest may have long-term impacts. There is no specific management response proposed other than reliance upon legislative capacity to take remedial action. It remains unclear upon what basis NT Fisheries would be aware of the need for remedial action, given the lack of work on the impact of the fishery on the ecosystem.

NT Fisheries relies heavily upon the outcome of a research project on habitat mapping. The project is expected to provide information on the productivity of mud crab and may provide

further information on the environment in which the fishery operates. It is important that the results of this project are factored into management of the fishery.

The ecological sustainability of the fishery would be enhanced in a systemic sense if a specific system-based management objective were to be developed. Such an objective would be useful in addressing the issues outlined above. EA believes effort should be directed at assessing options for system-based management objectives and associated biological reference, target and limit levels and performance measures for application in the fishery.

### **Recommendations**

6. Undertake a risk assessment of the removal of the mud crab from the ecosystem. The risk assessment will consider the impact of the removal of mud crabs on ecologically related and dependant species. The National Research Priorities for Mud Crabs is to have regard to the outcomes of this risk assessment.
7. Incorporate outcomes from the risk assessment described in recommendation 8 into the management of the fishery. This may include development of objectives and performance indicators that relate to that risk assessment. It may also include identification of areas that are sensitive to fishing.
8. Incorporate the outcomes from current habitat mapping in future management arrangements for the fishery.

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### *List of acronyms*

CW	carapace width
EA	Environment Australia
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
ESD	ecologically sustainable development
FRDC	Fisheries Research and Development Corporation
FTO	fishing tour operator
MCFAC	Mud Crab Fishery Advisory Committee
MFEU	Marine and Fisheries Enforcement Unit
NPOA	National Plan of Action
NT Fisheries	Fisheries Division of the Northern Territory Department of Business, Industry and Resource Development
NTMC	Northern Territory Mud Crab
TAC	Total Allowable Catch
OCS	Offshore Constitutional Settlement
UNCLOS	United Nations Convention on the Law of the Sea

*Summary table of the assessment of the Northern Territory Mud Crab Fishery against the Guidelines for the ecologically sustainable management of fisheries*

Guidelines	S/NI <sup>1</sup>	Comments
<b>MANAGEMENT REGIME</b>		
<b>The management regime must meet principles 1 and 2 of the Guidelines</b>	S	
<b>The management regime must take into account arrangements in other jurisdictions.</b>	NI	Not clearly demonstrated. A co-operative research strategy has been established, however it is unclear how these talks have resulted in data on straddling stocks in WA, NT and Qld being incorporated into stock assessment and management responses. See Recommendation 2.
<p><b>The management regime must comply with any relevant international or regional management regime to which Australia is a party.</b></p> <p>The management regime does not have to be a formal statutory fishery management plan as such, and may include non-statutory management arrangements or management policies and programs. The regime should:</p> <ul style="list-style-type: none"> <li>• be documented, publicly available and transparent;</li> <li>• be developed through a consultative process providing opportunity to all interested and affected parties, including the general public;</li> <li>• ensure that a range of expertise and community interests are involved in individual fishery management committees and during the stock assessment process.</li> <li>• be strategic, containing objectives and performance criteria by which the effectiveness of the management arrangements are measured;</li> <li>• be capable of controlling the level of harvest in the fishery using input and/or output controls;</li> <li>• contain the means of enforcing critical aspects of the management arrangements;</li> </ul>	<p>NA</p> <p>S</p> <p>S</p> <p>S</p> <p>NI</p> <p>S</p> <p>S</p>	<p>Current plan does not contain fishery-specific objectives and performance criteria. Proposed new plan to contain objectives and performance criteria, mainly for target species. Objectives proposed for byproduct, bycatch and impacts on the environment, but proposed performance indicators are weak. Timelines for review and management responses in case indicators are triggered are not clear. See Recommendations 3 and 4.</p>

<sup>1</sup> S/NI: satisfactory/needs improvement

Guidelines	S/NI <sup>1</sup>	Comments
<ul style="list-style-type: none"> <li>provide for the periodic review of the performance of the fishery management arrangements and the management strategies, objectives and criteria;</li> <li>be capable of assessing, monitoring and avoiding, remedying or mitigating any adverse impacts on the wider marine ecosystem in which the target species lives and the fishery operates</li> <li>require compliance with relevant threat abatement plans, recovery plans, the National Policy on Fisheries Bycatch, and bycatch action strategies developed under that policy.</li> </ul>	<p>S</p> <p>NI</p> <p>S</p>	<p>Not clearly demonstrated – currently there is no information on ecosystem impacts of the fishery. Whilst the nature of the fishing gear poses no significant risk to the broader marine ecosystem, there is some doubt that the data collection and monitoring programs are capable of identifying and reacting to impacts in a timely manner. The impact of the fishery on ecologically related species is relatively unknown.</p>
<p><b>PRINCIPLE 1.</b></p> <p>A fishery must be conducted in a manner that does not lead to over-fishing, or for those stocks that are over-fished, the fishery must be conducted such that there is a high degree of probability the stock(s) will recover.</p>		
<p><b>Objective 1.</b> The fishery shall be conducted at catch levels that maintain ecologically viable stock levels at an agreed point or range, with acceptable levels of probability.</p>		
<p><i>Information requirements</i></p> <p><b>1.1.1</b> There is a reliable information collection system in place appropriate to the scale of the fishery. The level of data collection should be based upon an appropriate mix of fishery independent and dependent research and monitoring.</p>	<p>S</p>	
<p><i>Assessment</i></p> <p><b>1.1.2</b> There is a robust assessment and periodic review of data collected on the dynamics and status of the species/fishery that should include, where relevant, an assessment of the status and trends in age and sex composition. Assessment should be with a view to identification of reduction in biological diversity and/or reproductive capacity. Review should take place at regular intervals but no greater than three years should elapse between reviews.</p>	<p>NI</p>	<p>Single point data for recreational fishing of concern, as is the lack of any estimates of indigenous. NRIFS data may provide trends.</p>
<p><b>1.1.3</b> The distribution and spatial structure of the stock(s) has been established and factored into management responses.</p>	<p>NI</p>	<p>Unclear how management takes straddling stocks into account. See Recommendation 2.</p>
<p><b>1.1.4</b> There are reliable estimates of all removals, including commercial (landings and discards), recreational and indigenous, from the fished stock. These estimates have been factored into stock assessments and target species catch levels.</p>	<p>NI</p>	<p>Good commercial data available, but recreational and indigenous data poor, therefore difficult to factor into management. See Recommendation 1.</p>

Guidelines	S/NI <sup>1</sup>	Comments
1.1.5 There is a sound estimate of the potential productivity of the fished stock/s and the proportion that could be harvested.	S	
<p style="text-align: center;"><i>Management response</i></p> 1.1.6 There are reference points (target and/or limit), that trigger management actions including a biological and/or effort bottom line beyond which the stock should not be taken.	NI	There is no clear commitment to refinement of reference points over time, nor evidence of timelines and contingency planning to deal with the eventuality that a reference point is exceeded. See Recommendations 3 and 4.
1.1.7 There are management strategies in place capable of controlling the level of take.	S	
1.1.8 Fishing is conducted in a manner that does not threaten stocks of by-product species. (Guidelines 1.1.1 to 1.1.6 should be applied to byproduct species to an appropriate level).	S	
1.1.9 The management response, considering uncertainties in the assessment and precautionary management actions, has a high chance of achieving the objective.	S	
<b>Objective 2.</b> Where the fished stock(s) are below a defined reference point, the fishery will be managed to promote recovery to ecologically viable stock levels within nominated timeframes.		
<p style="text-align: center;"><i>Management response</i></p> 1.2.1 A precautionary recovery strategy is in place specifying management actions, or staged management responses, which are linked to reference points. The recovery strategy should lead to the recovery of the stock within a specified period of time, or until the species recovers.	NA	
1.2.2 If the stock is estimated as being at or below the biological and / or effort bottom line, management responses such as a zero targeted catch, temporary fishery closure or a ‘whole of fishery’ effort or quota reduction are implemented.	NA	
<b>PRINCIPLE 2.</b>  Fishing operations should be managed to minimise their impact on the structure, productivity, function and biological diversity of the ecosystem. <sup>2</sup>		
<b>Objective 1.</b> The fishery is conducted in a manner that does not threaten bycatch species.		

<sup>2</sup> The issues addressed under the principle are those that define components of ecosystem integrity

Guidelines	S/NI <sup>1</sup>	Comments
<p><i>Information requirements</i></p> <p><b>2.1.1</b> Reliable information, appropriate to the scale of the fishery, is collected on the composition and abundance of bycatch.</p>	NI	Data collection through commercial logbooks in bait net fishery requires review. See Recommendation 5.
<p><i>Assessment</i></p> <p><b>2.1.2</b> There is a risk analysis of the bycatch with respect to its vulnerability to fishing.</p>	S	
<p><i>Management response</i></p> <p><b>2.1.3</b> Measures are in place to avoid capture and mortality of bycatch species unless it is determined that the level of catch is sustainable (except in relation to endangered, threatened or protected species). Steps must be taken to develop suitable technology if none is available.</p>	NI	Use and provisions for restricted bait nets requires review to consider the impacts on non-target species interactions. See Recommendation 5.
<p><b>2.1.4</b> An indicator group of bycatch species is monitored.</p>	NA	
<p><b>2.1.5</b> There are decision rules that trigger additional management measures when there are significant perturbations in the indicator species numbers</p>	NA	
<p><b>2.1.6</b> The management response, considering uncertainties in the assessment and precautionary management actions, has a high chance of achieving the objective.</p>	S	
<p><b>Objective 2.</b> The fishery is conducted in a manner that avoids mortality of, or injuries to, endangered, threatened or protected species and avoids or minimises impacts on threatened ecological communities.</p>		
<p><i>Information requirements</i></p> <p><b>2.2.1</b> Reliable information is collected on the interaction with endangered, threatened or protected species and threatened ecological communities</p>	NI	No formal reporting for protected species undertaken in the fishery. This needs to be reviewed in relation to bait nets. See Recommendation 5.
<p><i>Assessments</i></p> <p><b>2.2.2</b> There is an assessment of the impact of the fishery on endangered, threatened or protected species.</p>	NI	The risk posed to protected species from bait nets under current provisions requires a review. See Recommendation 5.
<p><b>2.2.3</b> There is an assessment of the impact of the fishery on threatened ecological communities.</p>	NA	
<p><i>Management responses</i></p> <p><b>2.2.4</b> There are measures in place to avoid capture and/or mortality of endangered, threatened or protected species.</p>	S	
<p><b>2.2.5</b> There are measures in place to avoid impact on threatened ecological communities</p>	NA	

Guidelines	S/NI <sup>1</sup>	Comments
2.2.6 The management response, considering uncertainties in the assessment and precautionary management actions, has a high chance of achieving the objective.	S	
<b>Objective 3.</b> The fishery is conducted, in a manner that minimises the impact of fishing operations on the ecosystem generally.		
<b>Information requirements</b> 2.3.1 Information appropriate for the analysis in 2.3.2 is collated and/or collected covering the fisheries impact on the ecosystem and environment generally.	NI	No work has been undertaken on the impacts of the fishery on the ecosystem and the environment generally. As a preliminary measure, a risk assessment of the removal of the mud crab from the ecosystem needs to be undertaken. See Recommendation 6.
<b>Assessment</b> 2.3.2 Information is collected and a risk analysis, appropriate to the scale of the fishery and its potential impacts, is conducted into the susceptibility of each of the following ecosystem components to the fishery. <ol style="list-style-type: none"> <li>1. Impacts on ecological communities               <ul style="list-style-type: none"> <li>• Benthic communities</li> <li>• Ecologically related, associated or dependent species</li> <li>• Water column communities</li> </ul> </li> <li>2. Impacts on food chains               <ul style="list-style-type: none"> <li>• Structure</li> <li>• Productivity/flows</li> </ul> </li> <li>3. Impacts on the physical environment               <ul style="list-style-type: none"> <li>• Physical habitat</li> <li>• Water quality</li> </ul> </li> </ol>	NI	No risk analysis has been conducted. A risk assessment of the ecosystem impacts of the fishery, particularly in relation to ecologically related and dependant species should be conducted. See Recommendation 6.
<b>Management responses</b> 2.3.3 Management actions are in place to ensure significant damage to ecosystems does not arise from the impacts described in 2.3.1.	NI	Outcomes from the risk assessment should be incorporated into the management of the fishery, including objectives and performance indicators and areas sensitive to fishing. See Recommendation 7.
2.3.4 There are decision rules that trigger further management responses when monitoring detects impacts on selected ecosystem indicators beyond a predetermined level, or where action is indicated by application of the precautionary approach.	NI	There are no decision rules or trigger points for the wider ecosystem impacts. NT Fisheries places heavy reliance upon the outcome of a single, albeit large, research project. The results of this project should be incorporated into management of the fishery. See Recommendation 8.
2.3.5 The management response, considering uncertainties in the assessment and precautionary management actions, has a high chance of achieving the objective	S	

