ASSESSING THE ECOLOGICAL SUSTAINABILITY OF THE NORTHERN TERRITORY MUD CRAB FISHERY

A report prepared for
Environment Australia as required for assessment under guidelines for Schedule 4 listings under the Wildlife Protection (Regulation of Exports and Imports) Act 1982.

Prepared by
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Disclaimer

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TERMS OF REFERENCE

Description of fishery

The Northern Territory mud crab fishery is based on the taking of *Scylla serrata* by pots for the live food trade, recreation and subsistence purposes.

The major stakeholder groups are the commercial wild harvest sector, recreational fishers and those, such as the indigenous population, who utilise the mud crab as a subsistence food as well as it having cultural significance. The aquaculture sector has a long-term interest in the wild stock aspect of the fishery for broodstock purposes. There is also a sector of the community who do not take, or consume mud crab, but still have a significant interest in the health of the resource and the impact of the fishery on the ecosystem and greater environment.

The fishery has been actively managed since the early 1980's when formal arrangements were put in place to ensure that the fishery had the opportunity to develop within well defined management boundaries.

As such, the fishery has not been subject to the boom and bust cycle often seen in developing fisheries, but has had a management regime that has sought to continually refine the initial controls for the fishery.

Responsible agency

The NT Government has legislative control over the mud crab fishery and the responsibility to manage the resource in a sustainable manner on behalf of the entire community, for the benefit of all.

The Fisheries Division of the Department of Business, Industry and Resource Development (DBIRD) is the primary government agency responsible for management of all fish and aquatic resources that the NT has jurisdictional responsibility for, including mud crab.

Administration is by way of the *NT Fisheries Act* (1988) and subordinate legislation, such as the Fish and Fisheries Regulations (1995), various Gazette notices and conditions of licence, but primarily through the Mud Crab Fishery Management Plan (NTG 1991).

Species

The mud crab is a large portunid crab common throughout the Indo–West Pacific area and is distributed from the mid coast of New South Wales, north, including Queensland and the NT around to the south west coast of Western Australia. However, the greatest catches are taken in the north of Australia (ABARE 2001).

Although there are four identified species of mud crab, (Keenan et al 1998) and all four species are permitted to be taken in the NT, the catch is made up almost entirely of *Scylla serrata*, the green mud crab (Figure 1) (Knuckey 1999).

This is because two of the species, *S. paramamosan* and *S. trababequeta*, are not found in NT waters, and the other species, *S olivacea*, although found in small numbers across the west of the NT, is seldom caught.

FIGURE 1: Green Mud Crab *Scylla serrata*

Identification and distribution of the species is well documented within the NT with a sample of around 20,000 mud crabs revealing over 99.5% to be *S. serrata* and less than 0.5%, *S. olivacea* (Knuckey 1999). Species composition has been reviewed and the identification used by Knuckey confirmed by the work of Keenan et al in 1998.

Extensive biological studies have been undertaken on *Scylla serrata* in the NT and background information on the species is contained in Appendix I.

Small numbers of other crab species and fish are sometimes caught during fishing, but the quantities of non-target species are not significant. This is primarily due to the fishing gear used and it's construction. Because of the depth in which fishing takes place, those animals, which are caught, can be successfully released back into the water unharmed. Bycatch species are discussed further in Principle 2.

Fishing method

The fishery is based on pots which are set in estuarine and coastal waters. The pots may be up to 0.5m^3 in volume with two sides permitted to be up to one metre in length.

However, a standard industry configuration has been used from the early days of the fishery where the volume of pots is closer to 0.15m^3 (Figure 2). There is no plan to legislate a reduced pot size at this stage, as different pot configurations may be more efficient or effective in different areas being fished.

The pots are rectangular in shape and made of 75mm by 45mm weld mesh steel with an entrance funnel at each end. The pots are very light, weighting around 2-3 kg each and are hand hauled aboard small dinghies, which are generally less than 5.5 meters in length. These characteristics are very similar for the commercial, recreational and many of the subsistence fishers.

Figure 2: Typical pot for taking mud crab

Due to the effectiveness of the standard pot design, no other fishing method is used by the commercial sector. Non-commercial fishers, in addition to the standard pot design may also use dilly pots, and less commonly spears and crab hooks.

Dilly pots have a legislative restriction on the minimum size of netting that can be used. This was put in place to minimise the chance of animals becoming entangled in the netting material, or having a significant impact on the environment if fishing gear is lost. Ghost fishing is not considered an issue for pots, because when not baited, they do not attract animals into them, and as crabs, isopods and small fish rapidly consume most bait, there is little chance of any negative interaction.

When using pots, the general technique is to bait the pots with fresh red meat or fish, set the pots, and then check them each rising tide. This would generally equate to two sets and retrievals a day, although this is not prescribed and may be more or less, depending on circumstances, such as crab abundance, tides or weather conditions.

Commercial fishers are limited to 60 pots per licence and non-commercial to 5 pots per person, with no more than 10 per vessel, even if there are more than two persons on the vessel.

Commercial crabbers are also allowed to use what is termed a restricted bait net to catch bait for use in their pots. The major species taken are mullet, blue salmon, catfish and shark. The use of this apparatus will be discussed in the later sections on bycatch and byproduct; i.e. Principle 2, Objective1.

Area fished

The fishery covers all tidal waters adjacent to the NT and includes rivers, bays and the open sea (Figure 3). Most commercial activity is focused in the tidal flats adjacent to the coast, out to five kilometres offshore, and within rivers in some areas. Currently, the majority of commercial activity occurs in the southwestern areas of the Gulf of Carpentaria with a smaller amount in the Darwin region.

Compulsory logbook information provided by commercial crabbers indicates that approximately 40% of the catch is taken from the McArthur River area, 30% from the Roper River area, 15% from Blue Mud Bay and 15% from the Darwin region which includes Adelaide River, Bynoe Harbour and Chambers Bay (Hay *et al.* 2001) (Table1, Figure 3).

For the majority of non-commercial fishers, most activity occurs within the rivers and creeks adjacent to areas of easy access, such as close to boat ramps, communities, or towns such as Borroloola, Darwin, Shoal Bay, Bynoe Harbour, Gove and Fog Bay areas (Figure 3) (DPIF 2001a). It is estimated that around 65% of the recreational catch was taken from the Darwin region and 25% from the McArthur River area (Coleman 1998).

Table 1: Commercial catch and Effort in the NT Mud Crab Fishery by Major Area 1984 – 2000

Year	Total		Borroloola		Roper		Blue Mud		West		Darwin		Arnhem	
	Catch	Effort	Catch	Effort	Catch	Effort	Catch	Effort	Catch	Effort	Catch	Effort	Catch	Effort
00	1037755	983524	533992	453580	277289	225120	73300	64860	487	1800	130202	207564	23410	30600
99	754812	981060	315175	430680	199903	253380	115044	113700	70	540	99016	148080	25605	34680
98	528325	1042157	285983	543570	134301	222000	34380	43035	1933	10320	47842	171872	23886	51360
97	595014	936276	329518	407100	152847	267102	18966	24780	4050	12360	58448	151494	31185	73440
96	572704	846204	333664	397315	169254	280850	10587	19680	738	3945	40280	106839	18181	37575
95	264263	656329	115043	262118	74835	185170	12020	20880	706	3444	38715	129007	22945	55710
94	199060	622092	87547	288145	55364	143980	4142	8520	3331	14400	26979	105127	21698	61920
93	226222	547794	129475	256860	512000	127781	11295	25025	1029	1920	19964	80538	13259	55670
92	192722	510968	95213	193120	56881	125700	6754	19440	1601	12280	23594	135758	8680	24670
91	143064	410088	47109	85860	53864	136380	0	0	1804	6570	31772	158858	8514	22420
90	134152	462920	38701	84720	22275	61740	0	0	1222	3240	64264	281120	7690	32100
89	174498	417578	30568	45600	80385	142380	0	0	123	400	58377	213102	5046	16096
88	115757	369150	25191	65160	46175	88025	0	0	2096	10855	40336	195214	1960	9896
87	129361	356136	35091	72055	37463	62154	0	0	1045	4694	50361	185429	5402	31804
86	95496	235933	43309	73824	7021	12907	19	65	2640	5520	38273	129697	4234	13920
85	90260	193462	44707	65490	1811	4090	0	0	1382	4564	40051	112278	23090	07040
84	18795	63568	4678	8810	3062	21406	146	450	0	0	10909	32902	0	0

Data source: NT FISHDAT

1. Catch in kilograms whole weight
2. Effort measured in potlifts per day
3. Major areas for reporting purposes based on the fishing grids (see Appendix II) below

Arnhem	1129, 1130, 1131,1132,1134,1229,1234,1235,1236
Darwin	1230,1231,1232
West	1529,1429,1329,1330,1530
Blue Mud	1335,1336
Roper	1434, 1435, 1535
Borroloola	1536, 1537,1636,1637

In most areas, the commercial and other sectors operate together. However in recognition of the importance to non-commercial operators and the proximity to the majority of the population in the NT, when the initial management arrangements were developed, the commercial sector agreed to have Darwin Harbour and the creeks in Shoal Bay closed to commercial crabbing (Figure 4).

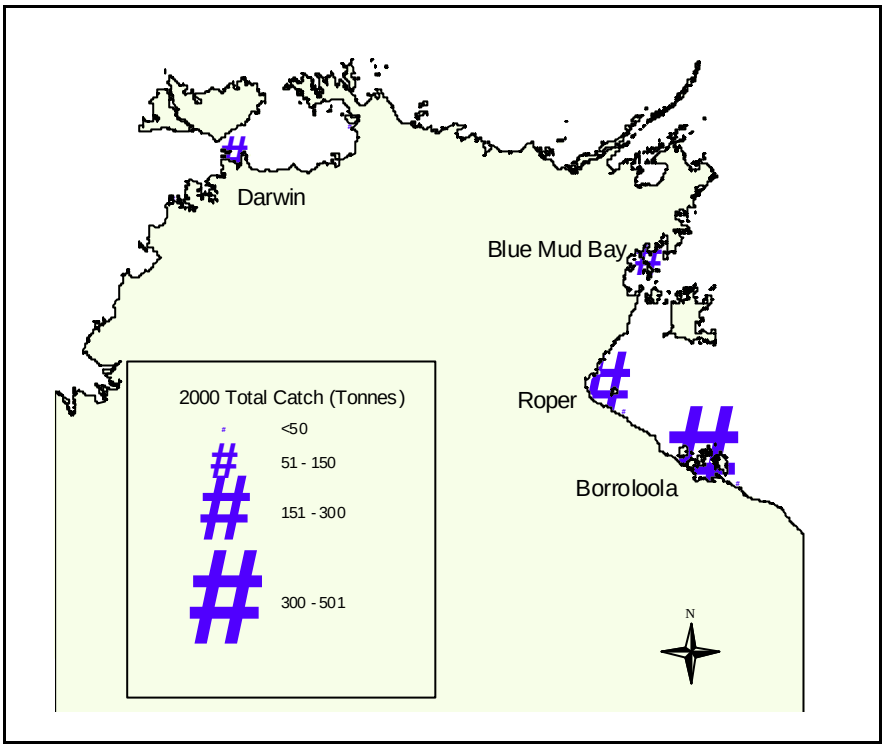

Figure 3: Permitted areas of activity in the NT mud crab fishery highlighting major fishing areas

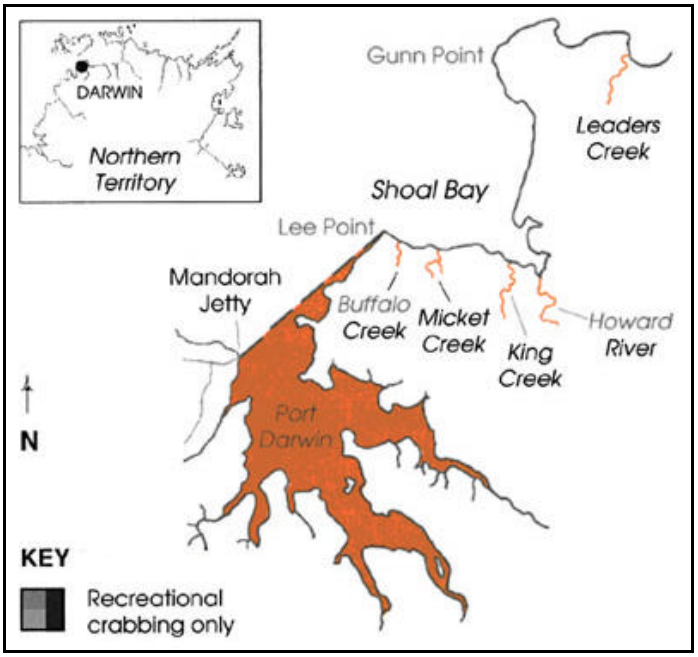

Figure 4: Map showing commercial closures in the vicinity of Darwin.

Large areas of the NT coast are not currently fished for mud crab, but over time operators may move to some of these areas to minimise competition between other commercial and non-commercial crabbers and to maintain catch rates at premium levels by dispersing fishing effort. There is no intention at this stage to close areas to crabbing until some level of equilibrium is reached in the fishery, or specific research identifies that additional protection for the resource or the environment is required and that closures are the most appropriate way to achieve this. It is anticipated that the research work on fishery habitat currently being undertaken as part of the National Research Strategy will provide a greater understanding of the relationship between habitat and crab abundance.

Number of operators

The commercial sector has been subjected to limited entry since 1984, when 45 licences were granted. A number of operators appealed the decision to restrict numbers to that level, and four additional licences were granted in 1985. In 1988 it was legislated that there would be no more than 49 licences issued in the fishery and that these licences would be fully transferable, but pot entitlements were not to be divisible.

In 2002, investment in a mud crab licence, and it's associated vessels and fishing gear is estimated to be valued at approximately $330,000 (NTSC 2002).

As the non-commercial sector is not licensed in the NT, exact numbers in respect to participation rates for these sectors can not be provided. Prior to 1985 recreational fishers were required to register their pots with the Fisheries Division. The maximum number of fishers registered to use pots was around 2,300 (DPIF 2001b).

However, in 1995 a survey conducted by the Fisheries Division estimated that around 10,000 persons fished for mud crab during that year (Coleman 1998). It is anticipated that the National Survey of Recreational and Indigenous Fishers (NSRIF) currently being undertaken will provide estimates as to recreational participation and for the first time indigenous participation.

Fishing Tour Operators (FTO), (fishing guides who take out paying clients to fish recreationally), have been licensed in the NT since 1995 and all are permitted to allow their clients to catch crabs as part of their operations. Around 180 licences were issued in 2000/01, but a very small proportion of these operators reported taking mud crab, with most targeting barramundi or blue water species.

Catch

Recreational catch has only been quantified once, during the 1995 FISHCOUNT survey. That assessment estimated that non-commercial, non-indigenous fishers caught around 75,000 mud crabs of which around 52,000 were retained (Coleman 1998). This equates to the removal of around 40t to 50t of mud crab (DPIF 2001a).

Researchers are unsure as to whether the recreational catch is relatively constant, or if catches are proportional to the total available catch, and are therefore linked to the

rate of commercial catch. It is anticipated that the NSRIF will cast further light on this matter when results are available in 2002.

Based on compulsory logbook data, the commercial sector has reported increased catches in this fishery from around 24t in 1984, to over 1,000t in the fifteen years till 2000 (Table 1). As can be seen in Figure 5, some of the increases in annual catch have been substantial. For example the years 1995 to 1996, 1998 to 1999 and 1999 to 2000 all show significant jumps in catch (Hay *et al* 2001).

Based on logbook data for 2000, licensed FTO's caught around one tonne of mud crab of which 20% was released (DPIF 2001a).

Fishing effort

The 1995 FISHCOUNT survey is the only measure of effort for the recreational sector. The survey indicated that mud crabbing was more important to residents than visitors. It was estimated that effort expended for crab and other non-fish organisms was 256,832 hours, with the vast majority of this effort directed towards crab fishing. This high amount of effort relates to the time that pots are set in the water. That means if pots are set for a 24 hour period, that equates to 24 hours fishing effort, regardless if pots are checked once, twice or ten times in that period. It is anticipated that the NSRIF will provide more precise details in respect to recreational crabbing effort.

Commercial effort was historically measured in pot days (number of pots pulled per day). However, due to changed fishing practices in the late 1990's it was considered prudent to change the measure of effort to pot lifts, (number of pots, by number of times pulled per day) as this provides a more accurate representation of fishing effort (Hay *et al*. 2001).

The fishery in its developmental phase in the early 1980's had a reported 63,500 potlifts annually and this progressed to over 1.7 million potlifts by 2000 as the latent effort in the fishery was taken up, with all licences utilised, all pots and most available days fished (Table 1, Figure 5).

The limited entry management regime has been in place for this fishery since 1985, successfully anticipating a future increase in market driven fishing effort. This prediction was factored into the management regime and followed a decision to initially reduce licence numbers by utilising the 'show cause' provisions in NT legislation and exclude a large number of potential entitlements.

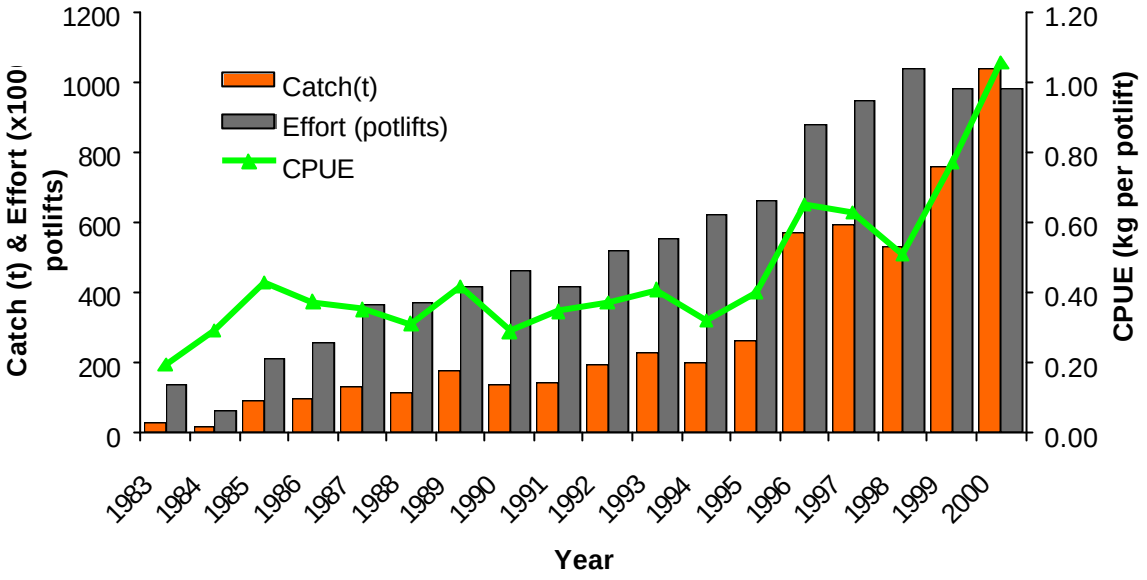

Figure 5: Reported commercial catch and effort in the NT mud crab fishery – 1983 -2000

FTO crabbing effort is negligible, and due to the patchy and opportunistic nature, provides no real useful effort trends. However, due to the preciseness of the reporting system in place, if there is a significant change, it will be readily identified during the annual audits provided for the fishery status reports.

Compliance

The Marine and Fisheries Enforcement Unit (MFEU) of the Police and Emergency Services undertake compliance on behalf of the Fisheries Division. This involves an audit of the returns and other relevant paper work as well as extensive field patrols. It is felt that this combination of approaches provides the best compliance strategy available within available resources.

There has been a heavy focus on the mud crab fishery, especially in respect to exceeding the maximum number of pots allowed. In the mid to late 1990's there where a significant number of charges laid for excess use of pots. Industry, with support from the recreational sector, has identified this as an issue of major concern, and have lobbied Government for a number of years to bring about increased penalties, for licensed fishers caught exceeding maximum pot limits and recreational fishers exceeding possession limits. Since that time, with the assistance of Industry and increased enforcement presence, the number of persons charged has decreased significantly.

Few other enforcement issues that impact directly on the resource, or associated species have been identified, although new conditions relating to a prohibition on what are described as "commercially unsuitable crab" has recently become a major focus. This arose from a request from Industry to prohibit the commercial sector from being in possession of crabs that do not meet certain minimum standards for meat content. Further details on this matter can be found at Appendix III.

Existing Management Arrangements

The existing management plan does not have specific objectives. Instead the *Fisheries Act* states that management plans must consider a number of general provisions as a basis for the management of all NT fisheries. These should be considered in achieving the overall goals of the *Fisheries Act*, which are to conserve, enhance, protect, utilise, and manage the fish and aquatic life resources of the Territory to:

- Promote, develop and maintain commercial and amateur fishing;
- Provide for optimum yields and maintain the quality of them;
- Ensure that fisheries are not endangered or overexploited;
- Encourage tourist and scientific interest; and
- Ensure that the habitats of fish or aquatic life and the general environment are not detrimentally affected.

These goals are read in conjunction with the legislative requirement to ensure continued access to the resource for indigenous people.

The shortcomings of this lack of clear objectives and performance indicators related to the mud crab fishery has been identified, and a public discussion paper has been prepared which suggests a number of clear and measurable goals for the fishery (DPIF 2001b) as identified in Table 2.

Table 2. Proposed objective and performance indicators for the Mud Crab Fishery Management Plan

Objective	Proposed Performance Indicators
To maintain long term sustainability of the mud crab resource	• An annual review of catch and effort will be prepared as an indicator by 1 May each year. If catch shows a downward trend of greater than 10% per annum for two or more consecutive years, MCFAC will review existing controls and advise the Director. • An annual review of the monthly sample of the size of mud crab harvested in the commercial catch will be prepared by 1 May each year. If average sizes in the sample show a downward trend of greater than 5 mm per annum for two or more consecutive years, MCFAC will review existing controls and advise the Director. (NB. this will require a substantial increase in the number of mud crabs being measured). • A compliance report will be prepared by 1 May each year, indicating all offences, but specifically instances of prosecutions for over potting in the fishery. • The landings and proportion of total landings by all sectors (recreational, traditional and commercial sectors) will be estimated by 1 May 2003. • The current five year Strategic Research plan for Mud Crab will be reviewed by 1 September 2003. • The final report on FRDC project 2000/142 “Methods for monitoring abundance and habitat for northern Australia mud crab *Scylla serrata*.” will be prepared by 1 May 2004.
To achieve the optimal and	• The code of practice for catching, handling, storing and

quality yield mix from the resource	transporting mud crab has been developed in 2001 with a view to minimising mortalities and maximising sustainability, quality and value will be reviewed annually. • Effort levels will be monitored in the commercial and recreational sectors and any significant increase in either sector will be reviewed by MCFAC and advice provided to the Director.
To minimise impact on unretained catch, protected wildlife, the environment and the ecological processes on which they rely	• A report will be prepared by 1 May 2003 which outlines the impacts the fishery has on wildlife, especially that which is protected and the environment. • The code of practice for catching, handling, storing and transporting mud crab has been developed in 2001 and will be reviewed annually, with a view to minimising mortality and maximising sustainability, quality and value. The code also encourages crabbers to release unwanted animals with as much care as possible and to not discard environmentally unfriendly products into the environment.
To create equitable, quality fishing opportunities for all stakeholder groups	• The share of the 2000/01 annual catch, based on the National Recreational and Indigenous Fishing Survey, fishing tour operator and commercial catch statistics will be estimated, and used as a benchmark for future management decisions.
To govern through a cost effective, easily understood and administered management regime	• The management plan will be produced in a form that has explanatory notes provided. • Copies of the Plan will be produced in appropriate other languages such as Vietnamese and Khmer. • An education and information program will be developed for the fishery by 1 May 2002 or to coincide with the implementation of the new Management Plan.

A summary of the history of management arrangements and key matters that have arisen for the NT Mud Crab Fishery is included as Appendix IV.

Stakeholder involvement in the development of a management program

The Mud Crab Fishery Advisory Committee (MCFAC) is the peak advisory body to the Director of Fisheries and comprises representatives from key user groups and Government (see Appendix V for committee structure).

MCFAC was established in 1990 and was responsible for the development of the initial management plan in 1991 and subsequent amendments. MCFAC has continued to supply advice to the Director of Fisheries since then, and has been the key group responsible for the progressive changes that have taken place, or have been proposed for the fishery.

Formal and informal discussions take place regularly with key stakeholders and individuals within the various sectors.

As well as MCFAC, a series of regional coastal Aboriginal consultative committees have been formed. These committees provide formal advice from the indigenous constituents of the regions on all aspects of fishing, including mud crabbing.

Any significant change to the management plan must go through a full public consultation process for a minimum of one month as prescribed under the *Fisheries*

Act. This period is generally extended to allow for a greater level of input, especially from the general community and indigenous sector.

The recent Review of the Northern Territory Mud Crab Fishery Management Plan Discussion Paper – Fishery Report #58 (DPIF 2001b) has had a two month public comment period, plus a further one month extension, prior to the development of a draft management plan which will undergo an additional public comment period.

Availability of Management Plans

Prior to participating in the commercial fishery, all new entrants are provided a copy of the Management Plan when they undertake their compulsory interview with the Management Officer responsible for the Fishery.

Copies of the Management Plan are provided to key stakeholder groups and are available at the Fisheries Division, or via the Internet.

What has proved to be very effective as a supplement to an entire copy of the plan, is the development of a series of informative Fishnotes (produced in other key languages) that cover key matters affecting those involved in the fishery. References for these are provided in the Further Readings – Fishnotes section of this report.

Environment likely to be affected by fishery

As previously mentioned the mud crab fishery is focussed in the estuarine and intertidal waters of the NT. The fishery is pot based and is believed to be relatively benign in respect to its effect on habitat and environment in general.

Specific areas in the NT that have been identified as requiring protection are generally dealt with by way of provisions in other fisheries legislation, not necessarily in the Mud Crab Fishery Management Plan. At this stage those areas are restricted to all areas of non tidal activity within rivers, plus commercial closures in the vicinity of Darwin as indicated in Figure 4.

It is anticipated that the research program on fishery habitat currently being undertaken as part of the National Research Strategy on Mud Crab will provide recommendations on appropriate areas for closure. As part of the Administrative and Working Arrangements in place between DBIRD and Parks and Wildlife Commission of the NT (PWCNT), any areas of high conservation value requiring protection are developed through cooperative management arrangements. No specific areas have as yet been identified that require the prohibition on the taking or fishing for mud crab.

The PWCNT is the NT Government organisation responsible for marine parks and biodiversity considerations. Only one marine park, Cobourg, has been declared to date. The fishery component for the Cobourg Marine Park Management Plan is well developed with the controls proposed for the areas of high conservation value, as identified by the Cobourg Fishery Management Area Advisory Committee

(CFMAAC), agreed to in principle by the crab fisher and Government representatives on the committee. The draft plan is still with Committee and will most likely become available for public comment in 2002, subject to any policy change that may come about as a result of the new Northern Territory Government.

The fishery does not take place in areas of coral habitat and as such there is negligible effect on coral reefs.

The fishery may take place in areas where there may be seagrass, but is almost totally focussed in areas where there are mud and sand benthic communities. Due to the benign nature of the fishery, where individual pots are retrieved by dinghy, pulled vertically by hand off the substrate, there is little, if any disturbance to the environment. Pots are designed and set so as to remain in place over the high tidal ranges prevalent in the NT. This at times leads to a change in fishing patterns with pots set in deeper water where tidal influence is less during spring tides when the tidal flow is strongest.

The fishery only seeks to take mud crabs and as such would appear to have little direct impact on other species. Although there are large numbers of crabs removed annually, as catches are being maintained, or increasing, there is no evidence of any detrimental effect on species that may utilise the mud crab as a food source such as crocodiles, cod or grouper. Also, as only actively feeding crabs are vulnerable to capture the bulk of the population will remain available for other species to utilise. As such there is believed to be very few short or long-term concerns with respect to impact on the environment and no need for any rehabilitation in respect to the impacts of this fishery.

Proposed management arrangements for fishery

The Government's aim in respect to the use of natural marine and aquatic resources, is to ensure that resources are used in an ecologically sustainable manner whilst maximising return to the community. This is achieved in respect to the mud crab fishery by having a discrete input controlled commercial fishery that operates within defined effort parameters and a recreational fishery that has possession limits and gear restrictions.

The existing legislative framework for the fishery has been previously described. It was recognised that although the existing management regime was considered adequate to continue the sustainable use of the resource, it was timely to review the Mud Crab Fishery Management Plan whilst the NT environment is in good condition, stocks are healthy and the risk of overfishing is low. Also, it proved timely to assess aspects of the fishery in light of the Commonwealth's environmental audit.

This review was achieved by the preparation of a public discussion paper, Fishery Report #58, that allowed consideration of future management directions in a conducive and proactive environment. The report outlined a range of options including output controls and closures, but due to the still unclear understanding of recruitment, dispersal and stock size, they are not considered as valid alternatives at this time.

Report #58 was developed by MCFAC to stimulate discussion, prior to the development of a formal draft management plan which will come into force for five years before a full review is undertaken again. However, adjustments can be made as required, or arising from assessments undertaken as part of the production of annual status report.

There are no relevant international agreements with respect to this fishery and jurisdictional responsibility is clearly ceded to the NT Government with the Director of Fisheries responsible for licensing, research and good management of the fishery under the *Fisheries Act* and subordinate legislation, especially the Mud Crab Fishery Management Plan.

Research plan

A five year national research strategy for mud crab was developed at a workshop held in Darwin in May 1999 and was endorsed by WA, NSW, Qld and NT with a view to having an agreed phased approach to research. A summary of the strategy is included in Appendix VI.

The key areas of national research identified were:

- to develop a process to calculate relative productivity of mud crab habitat based on satellite imagery and abundance estimation techniques.
- to determine if validated commercial catch and effort data could be used as a stock abundance indicator; and
- to develop a fishery independent index of stock abundance based on juvenile pre-recruit index.

The first phase of the project relating to relative productivity of mud crab habitat has received Fishery Research and Development Corporation (FRDC), NT and Qld Government financial support for a three year project to undertake assessment of critical habitat and the development of fishery independent abundance estimates.

It is anticipated at the project completion that it will be possible to; identify major fishing areas, determine long-term monitoring mechanisms for the health of the fishery and identify critical mud crab habitat.

The NT has also had a strategic research program focussing on mud crab ongoing since 1992 and this will continue with a number of long term monitoring programs and short term projects including;

- annual review of catch and effort by area
- tagging programs
- annual review of the monthly sample of the size of mud crab harvested in the commercial catch
- assessment of the landings and proportion of total landings by all sectors (recreational, traditional and commercial sectors) to be estimated by 1 May 2003 based on the National Recreational and Indigenous Fishing Survey, fishing tour operator and commercial catch statistics
- Final report, 1 May 2004 on the FRDC project “Methods to Estimate Abundance and Habitat for Northern Australian Mud Crab”.

- A report by 1 May 2003 which outlines the impacts the fishery has on wildlife, especially that which is protected and the environment.

The status of the research program is assessed annually by MCFAC and is reported on in the annual status report.

This report now specifically addresses the EA guidelines in respect to the two key principals for determining if a fishery adequately addresses the necessary Environmental Assessment.

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 will recover.

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

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

The NT mud crab fishery has a long time series of catch and effort data from the commercial sector, since the commencement of the fishery, on which to base assessments. There has also been a dedicated research program in place since 1990, which is considered and endorsed by MCFAC annually.

As management interventions, compulsory logbooks (see Appendix VII for an example) and a research program were introduced to the fishery long before there was a heavily exploited resource, the fishery has been monitored and been able to develop within defined boundaries, and as such has not seen the overcapitalisation and boom and bust cycles evident in many developing fisheries.

As the vast majority of product is shipped interstate, or overseas by air, it has been possible to validate the accuracy of the log book system. Such a validation system for an input control managed fishery occurs infrequently. The findings of this ongoing exercise has been that in excess of 97% of the reported catch was airfreighted from Darwin and this has supported the assumption that the crab catch data is relatively accurately reported (Hay et al 2001).

The existing commercial logbook system is being revised to provide weekly estimates of removal. This will more precisely determine the fishing activity within each month. This will be co-ordinated to coincide with when the crabs are being loaded and shipped to Darwin for processing.

FTO data has been collected via compulsory logbooks (see Appendix VIII for example) since 1995 and can be interrogated to determine activity directed towards mud crabbing.

Recreational information has been gathered from FISHCOUNT (1995 survey) and will be enhanced by the data collected in the NSRIF survey currently underway.

A number of fishery independent data collection activities have been undertaken with a view to gaining a greater understanding of the biology of the species taken and the workings of the fishery. The current research program continues the collection of a time series of data collected since the early 1990's, as well as focussing on the research needs identified in the five year national strategy for mud crab research endorsed in 1999.

Initial work on a habitat density and the development of estimate assessment methodology, identified in the research strategy as a priority, has commenced. This project combines a number of techniques including, mark/recapture, depletion experiments and aerial and satellite habit mapping to derive density estimates per unit of critical habitat with a view to estimating total mud crab population densities in NT waters.

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

Three major workshops as well as the preparation of a Ph.D. thesis have been undertaken since 1996 to enhance the understanding of the status of the NT mud crab fishery. Additionally, ongoing annual assessments are undertaken for reporting purposes to MCFAC, the Director of Fisheries and the Minister.

Two workshops (1996 and 2000) have been lead by Professor Carl Walters of the University of British Columbia, who is a recognised world leader in fishery stock assessment and the development of research techniques to improve the precision of assessments. These workshops considered all available data on the Australian mud crab fishery, but especially information gained from the NT which has had a specific mud crab research program in place since 1990.

Public input is an integral part of each workshop, particularly during the introductory session and while preliminary findings are presented at the workshop's conclusion. Extensive public input is seen as an essential component of these workshop as it allows input from stakeholders in to determine the direction the workshop will take and also in critiquing any outcomes presented (Ramm, 1997).

Another major workshop, held in 1999, assessed all existing data and information as part of the development of the agreed national five year research strategy for mud crabs (Calogeras 2000).

There is also an annual assessment of the status of the fishery for consideration by MCFAC, as well as the preparation of an annual status report which addresses key areas such as catch/effort, stakeholder participation, research, compliance and management as well as any other major issues that have occurred during the past year, or are proposed for the future (DPIF 2001a). It is anticipated that all future reports will also include key areas identified as being necessary for review by Environment Australia during future assessments.

The Ph.D. thesis (Knuckey 1999) was the cumulation of a six years research project undertaken by the NT scientist responsible for the mud crab research program. The thesis is an extensive work, with some findings briefly summarised in Appendix I. This work provided a sound basis for understanding the fishery by providing information on the dynamics of the fishery and selectivity of fishing gear, size and biological information regarding, age at maturity, reproductive cycles, growth rates, mortality rates and some population modelling.

The major findings of the research include:

- That only 15% of female mud crabs were mature at the previous legal size limit of 130 mm. This prompted an increase in the limit to 140 mm in 1996 to ensure that over 70% of females had reached maturity before being vulnerable to fishing mortality. This work also found that heavier male crabs were more likely to have mated, although functional maturity occurred from around 120 mm (Knuckey 1996).
- NT mud crabs live for around 3 to 4 years.
- NT mud crabs reach maturity and recruit to the fishery within twelve months of age and a high percentage of these 1^{+} recruits are harvested.
- The current commercial pot design was extremely selective towards greater than legal sized mud crabs with few undersized animals caught.
- That CPUE data may not adequately reflect abundance. This became evident in the assessment model when catches increased after 1995.

These findings set the basis for the formal workshops, as well as the development of the ongoing research program. The major findings of the workshops supported Knuckey's research and confirmed that using existing standard catch/effort modelling tools, it was not possible to develop models that accurately represented the stock size of the fishery.

This was mainly due to the fishing techniques employed in the fishery which sees crabbers move their pots on a regular non-random basis (at least daily) to maintain catch rates. All crabs do not appear equally vulnerable to capture due to a number of factors such as moult stage or possibly the presence of larger or more aggressive crabs around pots. Therefore, there may be no discernible drop in catch per unit of effort (CPUE). This is not to say that the catch and effort data does not provide a good insight to the fishery, but it can not be confidently used at this stage to model the fishery, or estimate stock size. It was, however, with a high level of confidence in both the modelling by Knuckey and Walters, that utilising existing fishing methods, and with the effort caps in place, there appeared to be no threat to the population of mud crabs (Knuckey 1999, Ramm 1997, Buckworth in prep).

What has been recognised though is that the fishery does appear to have a high annual exploitation rate, possibly higher than 70% (Knuckey 1999, Ramm 1997) in areas fished, but was unlikely to suffer from recruitment overfishing. This was because it was noted that high exploitation rates such as this are common for crab fisheries that exhibit similar fishing practices and species characteristics to the mud crab, such as short life spans, early maturity and high fecundity (Walters *pers com*. 2000).

Walters best describes how this exploitation rate was reached in the 1999 assessment report as follows:

The exploitation rate ….."has been estimated by the simple approach of recognising that the fishing mortality rate (F), defined as F=(catch)/(stock size), can be estimated directly by obtaining a stock size estimate from local fishery depletion and/or depletion experiments, then dividing this stock estimate into the measured catch. To obtain a stock size estimate for typical or average years, we use the fact that total stock size consists of the product of two factors that can be independently estimated:

stock size = (crabs per unit habitat area) x (total habitat area).

….. rough estimates of total habitat area for several fishing locations along the coast for which local catch statistics are available, and estimated crabs per unit area within these locations by two methods that agreed quite closely:
and

(2) depletion and mark-recapture estimates….

Both these methods indicated mid-season densities in the vicinity of 150 catchable crabs/km2 of creek/shallow coast water surface area. Taking these densities, multiplied by the estimated total habitat area for several locations, then dividing this total into measured catches, gives annual exploitation rates of around 70-90%.

Professor Walters continued:

"Further evidence of high exploitation rates was obtained by examining the seasonal pattern of recruitment of new crabs to the fishery, and using this to predict changes in average size of crabs through the season under alternative assumptions about the numbers of larger, older crabs still alive at the start of the season.

If there were a substantial carryover of older crabs, average body sizes near the start of each season should be considerably larger (170-200 mm carapace width) than later in the season when new recruits enter the fishery at carapace widths of 140-160 mm. Average body sizes from fishery sampling change from 152-153 mm carapace width in the early February-March period prior to major recruitment, to around 157 mm in the July-November period. The observed pattern is thus indicative of extremely high exploitation rate, and very little carryover of larger crabs from previous years' recruitments."

The commercial catch has been monitored on a monthly basis since 1992 and biological data has been collected from the three commercially most important regions in the NT (McArthur, Roper and Adelaide River regions). Data on species, carapace width, sex, weight, stage of moult and maturity are recorded.

The data has shown no obvious trend with respect to change in carapace width for male or female crab from the regions over time. This is an indication that the population is not being fished down towards the minimum size limits. In fact the data indicates that the median sized crab taken is somewhere in excess of 15-20mm above the minimum size limit. The preciseness of this analysis must however be

treated cautiously and can only be used as one of a number of indicators about the health of the fishery. This is because crab growth is not continuous and size increase is achieved by a series of moults. Size and sex compositions also vary throughout the year due to behaviour and reproductive phases and the sample size is very small (Hay *et al* 2001).

Taking cognisance of the outcomes from the assessment workshops, in line with the agreed national strategy and with the support of FRDC, a project entitled, "Methods to Estimate Abundance and Habitat for Northern Australian Mud Crab (*Scylla serrata*)", has commenced and is being lead by NT Fisheries.

The methodology is simple and based on the assumption that the abundance of mud crab is relative to the area of critical habitat by the density of mud crabs per unit of critical habitat. This project has been developed through an assessment of the data available for the NT fishery during the formal workshops, the ongoing research work being undertaken, experience in other similar fisheries after discussions with stakeholders and after assessment of the validity of the project by FRDC. A fundamental component of this project is the mapping of critical mud crab habitat across the NT. Areas to be investigated include mangroves, mud flats, and salt marsh areas (Hay *et al* 2001).

Only two parameters therefore need to be calculated; the area for each critical habitat type and abundance of crab per unit of critical habitat type. The benefit of this program is that it combines two recognised assessment techniques, mark-recapture and depletion.

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

The distribution of mud crab is well documented with most areas of mangrove lined coast in the Indo-West pacific region having one, or more of the four species present. In Australia the range extends from New South Wales, northerly around to Western Australia. *Scylla sp.* also occurs in the western Pacific, through south-east Asia as far north as Japan, and westerly through the sub continent to South Africa.

S. serrata is associated with mangrove forests that are inundated with fully saline oceanic water for the greater part of the year, although the species tolerates reduced salinity (Keenan et al 1998). This is the situation for most NT waters. This species is the most widespread of the *Scylla* and occurs from South Africa to Tahiti in the east, north to Okinawa, and south to Port Hacking in Australia, and the Bay of Islands, New Zealand (Keenan et al 1998).

The other species in the NT, *S. olivacea,* is also associated with mangrove forests and coastlines, but those which are inundated with reduced salinity seawater during the wet season. In Australia, distribution is limited to embayments where salinity is reduced (Keenan et al 1998). This species is moderately distributed and is common in the South China Sea, but also occurs in specific locations across the Indo-West Pacific, including the NT.

The size and growth of NT mud crabs was examined extensively from 1990 to 1996 using data obtained from tagging experiments and the collection of length-frequency data. Analysis of this data found that there appeared to be no biologically significant variance in the general length-weight relationships for male and female crabs from the major areas sampled, Roper, McArthur and Adelaide River (Knuckey 1999).

The data showed for all areas sampled that L_∞ (based on the largest 1% of the sample) for males was 190.1 mm, for females 190.9 mm and for sexes combined, 190.4 mm (Knuckey 1999).

The average carapace size of the reported catch is around 155 mm for both sexes (Knuckey 1999, Hay et al 2001). This is well in excess of the legislated minimum size limits of 130 mm for males and 140 mm for females.

Experimental work in the tropical waters of the Territory have found that mud crabs will reach around 130 mm after about 12 months. At that size, males are vulnerable to the fishery and females will become vulnerable most likely after the next moult (Knuckey 1999).

Sexual maturity is reached at around 15 months. Due to the selectivity of the fishing gear, all crabs will become fully vulnerable to the fishery at about 18 months of age (Knuckey 1999).

It was estimated that 50% of females had reached maturity at a carapace size of 136.5mm (Knuckey 1999). For this reason, in 1996 the female size limit was raised from 130 mm to 140 mm, as the previous size limit only protected around 15-20% of the female crabs. The new limit would result in protection of over 70%. It was also found that over 90% of mature females had mated and contained sperm which could be retained in the body for a number of months (Knuckey 1999).

Female mud crabs are highly fecund and can produce a large number of eggs (up to 8 million) per spawning, can spawn a number of times from one mating and undertake spawning offshore late in the year, around December. The females are in peak gonad condition at this time and disappear from the catches. It is believed that the offshore movement occurs at this time because the larvae are intolerant of low salinities caused by monsoonal rains that occur during the wet season, and the offshore waters provide a more stable environment.

There is no offshore fishery for mud crabs, so those female crabs that are at sea are not harvested. The period when the females migrate offshore (December to February) coincides with the closure to the Northern Prawn Trawl Fishery so incidental catch of female mud crabs is not an issue during that period. Female mud crabs in berry (with eggs visible) are infrequently seen in the fishery, but are still fully protected, and must be released immediately if caught.

During random measurements and checks of fishing operation during a six year period from 1990 to 1996 only 5 berried female mud crabs were encountered by research staff during at seas monitoring (Knuckey pers com). Chances of breaches are unlikely as it appears that berried females do not generally enter pots. No

crabbers have ever been detected by MFEU officers being in possession of berried female mud crab.

As the larvae and zoea form part of the plankton, where settlement of the megalopae occurs is most likely subject to environmental factors, such as tidal flow and wind directions. Although the exact areas of settlement are not know at this stage, it is considered prudent to continue to manage the fishery as a whole, not on a regional basis as there is little evident to the contrary. Gopurenko, Hughes and Keenan (1999) having determined the relationship between *Scylla serrata* populations over the species wide geographic distribution, using mitochondrial DNA, are continuing their work on regional patterns of genetic structure among Australian populations. Their results should provide an insight into genetic make up of *Scylla serrata* in northern Australia.

Preliminary testing by David Gopurenko of crabs from the Adelaide River, close to Darwin, and Roper River in the Southern Gulf of Carpentaria found no discernible difference between the two groups (Jane Hughes *pers com*.). Indicating that *S. serrata* is a single genetic stock in the area covered by the commercial fishery.

Male mud crabs reach physiological maturity, based on the presence of sperm at around 110 mm. Functional maturity, based on the evidence of mating scars was reported from male mud crabs as small as 125 mm. Full adult morphometry, based on the presence of large claws occurred on average at around 146 mm (Knuckey 1999).

Although all mature mud crabs, and even those at a much smaller size, had the capacity to mate, less than one third exhibited any mating scars. It has been reported that those males which are successful, will mate often with a number of females.

The split size limits (males 130 mm and female 140 mm) would appear to be effective in protecting the viability of the resource, as high fertilisation rates are evident in the female catches, and large quantities of male crabs are still captured exhibiting mating scars. The idea of full protection of females has been rejected in the NT for a number of biological reasons, including; the risk of producing a sex ratio imbalance, could lower male functional size, lead to insufficient males to fertilise (Knuckey 1999) and result in greater competition by female crabs with males for habitat.

Large areas of the NT, approximately 60%, which based on the species world wide distribution and limited fishing activity contain mud crabs, are not fished due to a range of factors, but most often related to access and the inability to transport crabs to market.

On the basis of all the above information there would appear to be little risk of overfishing occurring.

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

There is an excellent time series of data relating to catch and effort for the commercial sector of the fishery, as log books have been compulsory completed from well before there was any significant activity in the fishery. This data has been validated by a comparison between processor/trader returns, commercial take and with airfreight data.

All commercial fish traders or processors must be licensed with the Fisheries Division and complete compulsory log sheets identifying quantities and from whom the product was purchased. This information can be compared with the reported landings from commercial fishers and other sources. This information is audited on a regular basis by the Marine and Fisheries Enforcement Unit.

As previously mentioned, the vast majority of catch is airfreighted live from Darwin to interstate or overseas market. This data has been compared with reported commercial catches over a number of years and there has been a good correlation (over 97%) between the two datas (Hay et al 2001).

There are no reports of quantities of mud crab being moved by means other than air, and MFEU records, based on charges or convictions for non-commercial overfishing, and information from other jurisdictions would indicate that there is not a high level of illegal unreported catch.

Recreational catch data has come from one source to date, the 1995 Fishcount survey, which gave an indication that catches were around 50t for the year. The current NSRIF survey will provide a further data reference point, but this will not be available until 2002.

No data is available for indigenous take, but it is not anticipated to be a high total catch, although the eating of crab, especially for coastal communities may be a significant part of their diet. The current NSRIF survey will provide some initial information on the indigenous take, but this will not be available until 2002.

The unreported or illegal commercial catch is not considered great in this fishery as there is good correlation between airfreight and commercial logbook data and there has been negligible evidence to support that there is a black market of any quantity. As such it is the assessment of the Fisheries Division that, all available information has been factored into assessments to date and are considered as part of the total removals from the fishery.

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

The outcomes from all the workshops and the research work undertaken in the NT for the last 12 years indicates that the current harvest strategy of capping potential

effort in the fishery has proved to be an effective management technique and has allowed for natural perturbations in abundance that have been seen in the fishery.

Based on modelling undertaken at the most recent workshop it became apparent that the continuing increasing high catch rates have been due to unusual high recruitments, not increased fishing power in the fishery (Buckworth in prep). It was further noted that these high catches do not imply overfishing, but that no new effort, through increased licence numbers, should be considered in expectation that high catches will continue, as that could result in overfishing (Buckworth in prep).

As previously mentioned, there is no estimate of total biomass, or an appropriate total allowable catch as this has proved impossible to accurately determine due to the fishing practices used in this fishery (i.e. the shifting of pots to maintain catch rates, means it is not possible to determine any significant perturbations in CPUE).

Instead, the focus has shifted to the development of fishery independent assessments based on habitat mapping and density estimates. This information will be available in 2003 and may provide a means of assessing stock size.

The ongoing monitoring of the size and sex distribution of the fishery will continue through the research monitoring program. This will be continually investigated to see if there has been any change in these aspects of the fishery. The proposed management program has in place a trigger that if there is a decrease in size of 5mm or more for two years, an agreed response will be put in place.

Due to the fast growth rates exhibited by mud crab (Knuckey 1999), it is believed that if the fishery was being overfished the results would be obvious within the year as catch and average sizes of animals would be expected to noticeably decrease due to the high exploitation rates (Ramm 1997, Knuckey 1999).

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

The draft mud crab fishery management plan identifies a number of reference points that will trigger management actions should these trigger points be reached. The following table (table 3) summarises the proposed reference and triggers points.

Table 3: Reference and trigger points for the NT Mud Crab Fishery.

TOTAL CATCH	
Reference point 2001	Commercial catch - 1033t
Trigger point	If commercial catch shows a downward trend of greater than 10% per annum for two, or more consecutive years, MCFAC will review controls and advise the Director.
TOTAL EFFORT	
Reference point 2001	2000 Commercial effort 983,500 pot lifts
Trigger point	If commercial effort shows an upward trend of greater than 10% per annum for two or more consecutive years, MCFAC will review controls and advise the Director.
MEDIAN SIZE	
Reference point 2001	Male mud crabs – 155 mm Female mud crabs – 155 mm
Trigger point	If median sizes in the monthly sample show a downward trend of greater than 5 mm per annum for two or more consecutive years, MCFAC will review controls and advise the Director
CATCH SHARE	
Reference point in 2001	Yet to be determined The landings and proportion of total landings by all sectors (recreational, traditional and commercial sectors) will be estimated by 1 May 2003. Based on NSRIF and commercial and FTO logbook data.
Trigger point	If benchmarks set in 2003 alter by more than a yet to be agreed variance MCFAC will review controls and advise the Director.
BYCATCH	Bycatch is negligible and new controls to legislate for a minimum mesh size, or escape gaps, will further enable escape of non-target species
Reference point in 2001	Data collected from fishery independent catch sampling projects up to 2001 will be collated.
Trigger point	Bycatch abundance changes by more than 50% in any one year period or more than 100% in any three year period will lead to a review by MCFAC which will advise the Director.
BYPRODUCT	Byproduct is virtually non existent
Reference point in 2001	Existing byproduct levels
Trigger point	If reported byproduct increases by more than 100% in any one year period or more than 200% in any three year period will lead to a review by MCFAC and advice to the Director.

The respective trigger points for each performance indicator have been set at the above levels as smaller changes may merely be responses to environmental changes, not fishery related impacts. It is anticipated that over the next five years, these triggers will be further refined.

With respect to byproduct and bycatch triggers, these have been deliberately set high as only small changes in catches could lead to the levels of increase proposed in Table 3.

Particular response to triggers are yet to be finalised, but there are a number of options available in the management plan such as, revised size limits, closed seasons or areas, additional gear restrictions or fishing practices. Response options will be developed by MCFAC and made available for public comment, prior to gazettal as part of the Management Plan.

The Director of Fisheries also has powers to make reasonable adjustments to fishing activities by licence condition at any time, and the Minister may impose emergency provisions under the *Fisheries Act*.

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

The mud crab fishery is managed by input controls for the commercial sector and a combination of input and output controls for other sectors. This management technique has proven to be successful since the declaration of the fishery in 1991. (for further discussion refer to Fishery Report #58).

Due to the inability to use standard stock assessment techniques based on catch and effort data, the agreed response at all stock assessment workshops and by scientists who have interrogated the data, has been to continue with the existing effort based commercial controls and gear and possession limits for other sectors.

The management plan has the ability to make adjustments to the effort by adjusting the number of pots allowed, fishing strategies and individual and personal possession limits. In addition, the size limits can be revised upwards to increase the level of protection to breeding size animals if there is any threat to the reproductive capacity of the fishery. This is, however, unlikely to occur based on characteristics in similar fisheries in other areas and the practices used in this fishery (Walters *pers com*. 2000).

There are also powers to consider a range of seasonal or area closures if it was determined through a consultative process, or in the case of any emergency situation, by the Director or the Minister, to make immediate adjustments to the fisheries management regime.

As the commercial sector has only a small number of operators (legislated at 49) for the entire NT coastline, and each is only entitled to use 60 pots, with little latent effort, there would appear to be no risk to the resource under the exiting scenario (Buckworth in prep). No other commercial licensee is permitted to take mud crab.

The issue of significant and long term localised depletion has been raised with this fishery. However, the chance of this occurring is considered to be negligible, or at the very worst a very short term threat in very localised areas. This is because although there may be a high level of removals, recruitment is an annual event, the animals are fast growing, not all animals are vulnerable to capture at the same time due to moult stage and animal size, crabs may move into fished areas and fishers move their pots on a daily basis. Additionally, recruitment is from offshore via the

release of larvae in the plankton (Fielder and Heasman 1978) and it is believed that this allows the regeneration of any highly fished area. Commercial pressures also mean that crabbers can not afford to fish if catch rates fall too low in an area. Although quantities of crab may still exist in the area, they may not be of commercial quality, legal, or in sufficient quantities to justify the expense of crabbing. The large quantities of crabs available in quite small areas of habitat has been demonstrated in the preliminary work undertaken in developing the FRDC habitat and population estimate experiment.

Industry have identified overpotting as one of the key threats to the resource and have been requesting Government since 1996 to substantially increase monetary penalties and also exclude offenders from the fishery. Compliance measures, listed below, will be covered in the draft management plan and should prove a substantial deterrent to those that may consider overpotting in the fishery.

First offence	up to 10 pots in excess	$5,000
First offence	10 to 30 pots in excess	$10,000 + $500/pot
First offence	over 30 pots in excess	$10,000 + $1,000/pot
Second offence	up to 10 pots in excess	$5,000
Second offence	over 10 pots in excess	$20,000 + $500/pot
Second offence (within 2 years)	$ penalty, plus suspension from operating in the fishery for a 2 year period.	

No licence is in place for recreational fishing in the NT. The recreational limit is an in possession limit of 10 mud crabs per person, with no more than 30 allowed on any vessel, even if there are more than 3 people on board.

Although this limit may be considered high, and is more than a person could reasonably consume themselves, it does allow a recreational fisher to take sufficient to feed his/her family or friends. There have been no reports of decreased catches in the recreational sector, but if this became evident, possession limits, gear restrictions or other controls can be adjusted accordingly in the management plan if required.

The recreational sector has requested that Government substantially increase penalties for those exceeding the possession limits. The following penalty structure is proposed in the draft management plan.

1-10 mud crabs in excess	$ 5,000 plus $ 500 per crab
Over 10 mud crabs in excess	$ 10,000 plus $ 1,000 per crab

The MFEU is aware of the potential for black market sales of recreationally caught mud crabs and continually monitors the situation.

1.1.8 *Fishing is conducted in a manner that does not threaten stocks of byproduct species*

Based on extensive observations by NT Government research officers, the impact on byproduct in this fishery is believed to be negligible, or very low. There are also no reports of sale of byproduct from this fishery.

The catch of non-target species taken in pots is minimal due to the fishing gear used and practices of commercial crabbers. What little byproduct could be taken consists mainly of catfish, cod and occasionally, other species of crab. These are generally returned to the water, but cod or catfish may be used as bait in pots. Reported catches are less than 500kg per year.

The major non-retained catch relates to what have been termed empty, or soft crabs, but is now referred to by industry as commercially unsuitable crab. For crabs to grow in size they must shed their shell. During this process their water content increases, the shell cracks open and the crab then extracts itself from the old shell and the new shell begins to harden at a greater size. Crabs in this form contain little meat. This matter has been addressed in the recent addition of a condition of licence to prohibit the taking of crabs in this state (Appendix III).

As a result of tagging experiments undertaken by DPIF it would appear that released mud crabs, even those in the intermoult stage, that have been tagged, are not unduly harmed by the process of capture and release from pots (Knuckey 1999).

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

The management regime has proved extremely successful in achieving all the objectives of controlling take, effort and access to the fishery whilst minimising the take of byproduct.

There are sufficient deterrents to those caught offending and the assessment process is regular, thorough and inclusive.

Those involved in the commercial fishery have highlighted key areas that require addressing by focussing enforcement towards the key offences, of overpotting, or taking excess crabs. The recently introduced Code of Conduct for the fishery provides another avenue to ensure that aspects of the fishery relating to environmental considerations and appropriate behaviour towards the environment and ecosystem are addressed (NTCFA 2001). The support for the non-retention of commercially unsuitable crabs will also enhance the sustainability of the fishery over time and minimise unwanted, or unnecessary mortalities from the fishery.

Additionally, the pots used in the fishery are highly selective towards greater than legal size mud crabs with little other catch taken (Knuckey 1999).

As a result of the ongoing assessments of the fishery, no other viable management regime has been advanced that would as adequately allow the fishery to continue to develop, whilst putting in place a cost effective and relatively simple management regime.

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

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

The premise of fisheries management in the NT, is to manage the stocks on a sustainable basis and for this reason a precautionary management regime has been implemented in this fishery.

Based on all the available advice, the stocks are not in need of recovery, therefore a response is not relevant or applicable to this fishery.

However, as previously outlined there are a number of powers available to Government to act if this unlikely situation arose.

The draft Plan of Management will outline a number of automatic responses should any of the triggers identified occur.

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 a 'whole of fishery' effort or quota reduction are implemented.***

Based on all the available advice, the stocks are not below any biological bottom line, therefore a response is not relevant or applicable to this fishery.

However, as previously described there are a number of powers available to government to act if this unlikely situation arose.

Principle 2.

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

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

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

All fishers are obliged to provide information on all species taken under their commercial licences. The mud crab logsheets have a specific section to provide such information. To date only small amounts of cod, blue swimmer crabs and catfish, less than 500 kilograms in total in any one year have been reported. All this catch can generally be released unharmed, but small amounts are sometimes retained for use as bait.

Additionally, when the mud crab research program is being undertaken by the NT Government, all catches are reported. Using gear that is identical to that used by the commercial sector has shown that the catch of incidental species is negligible (Knuckey pers comm. 2001).

Based on the logbook information and reports from Fisheries Staff, who spend extensive time in the field assessing the workings of this fishery, there is believed to be little threat to any other species.

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

Based on extensive observations by NT Government research officers, the impact on bycatch in this fishery is believed to be negligible, or very low.

As such, no specific risk analysis has been undertaken. Due to the fishing methods in place, most unwanted catch can be returned to the water alive and it is believed that survivability is high.

To further ensure that unwanted species can be released, proposals in the draft management plan seek to have mandatory escape panels included in the pot design, but this is mainly to ensure that immature mud crabs can readily escape.

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

a) pots

With respect to the pot aspect of this fishery, there does not appear to be any need for additional bycatch reduction measures. Based on the observations to date, few non target animals enter crab pots and those taken can generally be released alive and as such, any specific additional response is not required.

Logbooks and the outcomes of the fishery independent research work undertaken as part of the "Methods to Estimate Abundance and Habitat for Northern Australian Mud Crab'' project, can continue to monitor for any changes in bycatch in this fishery.

Ghost fishing is not considered an issue, as pots when not baited do not attract animals, and as most bait is readily consumed by crabs, isopods or small fish, within a very short period, there is little chance of entrapment occurring.

To further ensure that there is no detrimental effect from lost pots, the use of finger type projections that trap animals within pots will be banned and the inclusion of escape gaps, or minimum mesh size for pots, will further reduce any possibility of taking animals if they are lost or abandoned.

b) restricted bait nets

An additional aspect of this fishery relates to the entitlement of all commercial mud crab fishers to use what is termed a restricted bait net to obtain, or supplement the bait used in their pots. The net can be up to 100 m in length, not exceed 65 mm (2½") in mesh size with a drop of no greater than 5 m. The net can not be set and left, or used inside rivers. When in use, the licensee must be in attendance of the net at all times, and can only anchor one end of the net. The nets must be cleared in water of at least 30 cm depth so as to be able to release protected, or unwanted species.

Based on logbook returns, using this method, around 50t of catch is reported each year (this equates to an average of around one tonne per licence) consisting mainly of blue salmon, catfish, small sharks and mullet. No barramundi is permitted to be retained. The use of these nets appears to be decreasing as more operators purchase bait, but they can still be an important adjunct to fishing operations if bought bait is not available.

When used in line with the provisions of the legislation, this gear should not have any negative interaction with protected, or non target species, as the operator is present and can release any catch immediately, whilst it is still alive.

2.1.4. *An indicator group of bycatch species is monitored*

As no species, or group of species, is taken in sufficient quantities or caught frequently enough to result in a negative impact, it is not considered necessary, or useful to attempt to utilise any bycatch species as an indicator. This will however be monitored via log books and fishery independent research and as one of the

proposed performance indicators, a report will be prepared by 1 May 2003 which outlines the impacts the fishery has, if any, on bycatch species.

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

As there are no relevant species that are indicator species, there are no decision rules for perturbations in bycatch species. However, the Fisheries legislation provides powers to adjust fishing practices if a detrimental impact has been identified on a bycatch species.

Aspects of the restricted bait net fishery will need to be monitored and catches validated against logbook data.

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

As no specific new controls are proposed, this section is not applicable. However, the existing scheme has not identified any negative perturbations in non target species from any source.

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.

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

Currently there is no formal reporting of interactions with endangered, threatened or protected species, arising out of the pot fishery for mud crab, but the risk associated with the fishing gear, methods and techniques allowed is very small. As there has been no reports ever of interaction from any source, it would provide little benefit to reporting provisions on compulsory logsheets, this could be undertaken to formalise the process.

As has been the case in the past, such interactions would generally be reported to the MFEU, PWCNT or the Fisheries Division through one of a number of sources such as concerned fishers or citizens, government or NGO officers or via the series of regional Aboriginal coastal consultative committees that are in place in the NT around the coast.

As previously stated, the practices in the fishery do not make it likely that such issues will arise. However, if it is found that during the period of the plan that there are practices that are affecting threatened or protected species, practices will be adjusted in the relevant fisheries legislation or through the code of conduct. This has been the case in other fisheries where it was felt that there may have been a negative effect on these species.

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

There are no formal assessments of the impact of this fishery on endangered, threatened or protected species as there have been no reports of negative interactions with such species arising out of the pot fishery for mud crab. This includes any instances of entanglement with pot lines by seabirds, turtles, dugongs or crocodiles.

By way of fishery independent assessment of interaction, in the 12 years of the NT Government's research program, which has a high field component, there has never been a reported, or sighted negative interaction with threatened, protected or endangered species by the above fishing gear (Knuckey and Hay pers comm. 2001). This observation is supported by MFEU officers who in over 20 years service also with a high field component, provide similar reports (Russell pers comm. 2001).

To ensure that this matter is seriously investigated, it is a proposed outcome of the new draft management plan, that a report will be prepared by May 2003 which outlines any significant impacts or risks the fishery may have on protected, threatened or endangered species.

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

As the fishery only seeks to take mud crabs, it is believed that it has had little impact on other species or communities. Even though a large number of crabs are removed annually there appears to be no detrimental effect on species that may utilise the mud crab as a food source such as crocodiles, large cod or grouper.

There are no identified threatened ecological communities in the Northern Territory. However, should any be identified, to ensure that this matter is seriously investigated it is a proposed outcome of the new draft management plan that a report be prepared which outlines any significant impacts the fishery may have on the threatened ecological community.

Through the FRDC project, which has an extensive habitat mapping component as part of its program, it may be possible over time to identify threatening processes and any impact on communities in the area. This project will also provide data that can be used to protect critical habitats and threatened ecological communities if identified in the future.

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

As previously mentioned, it is not believed that there is any threat to protected, endangered or threatened species by this fishery.

There are a number of legislative restriction which ensure that gear is checked regularly in respect to pots and provisions to ensure that fishers are in attendance continually when using restricted bait nets.

Any relevant aspects of turtle or dugong recovery plans will be included in the management of this fishery, either through legislation, or via the commercial sector's Code of Conduct.

Findings from the report, which will be prepared by May 2003, will outline any significant impacts the fishery may have on protected, endangered or threatened species, will be factored into management arrangement if required in the context of the NT situation.

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

As previously stated, there are no threatened marine communities identified in NT waters.

The mud crab fishery is focussed in the estuarine and intertidal waters of the NT, is pot based where individual pots are retrieved by dinghy, pulled vertically by hand off the substrate and as such is extremely benign in respect to its effect on the habitat and the general environment.

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

To date no issues have been identified for this fishery.

If any threats are identified, there are adequate provisions under the fishery legislation or other legislation to utilise a range of available controls to protect the resource or environment.

Issues can be dealt with through the formal consultative processes, or through informal meetings with stakeholders. If critical issues are identified, the Minster has powers under the Fisheries Act to apply emergency provisions.

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

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

No specific work has been carried out on the impact of the fishery on the ecosystem and the environment generally.

Some comparative assessments of fished and unfished areas may provide some insights to the impacts on the ecosystems. This may be best achieved by comparing two adjacent similar areas, one fished, one unfished. It is proposed, subject to resource availability, that this will be undertaken as part of the FRDC project.

The recently adopted Code of Conduct, developed by the commercial sector, encourages all those involved in the commercial fishery to have cognisance of the environment and to minimise detrimental actions.

The extensive habitat mapping component of the FRDC project may over time identify if there has been any impact to the environment due to crabbing activity.

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:***

- ***Impacts on ecological communities***
- ***Impacts on food chains***
- ***Impacts on the physical environment***

No specific work has been identified on these aspects of the fishery and based on the perceived low risk with ongoing good recruitment to the fishery and what must be a high biomass to support increased catches, none is planned until the FRDC project is finalised and the results are assessed.

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

If evidence arises which suggests that there is a threat to ecological communities, food chains or the physical aspects of the environment arising from this fishery, appropriate action will be put in place under the fisheries or other appropriate legislation, or via the Code of Conduct.

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.*

No specific work has been carried out on the impact of the fishery on the ecosystem and the environment generally. However, findings from the FRDC project "Methods to Estimate Abundance and Habitat for Northern Australian Mud Crab" will be available by May 2003, and will outline any significant impacts the fishery may have on protected, endangered or threatened species. These results will then be factored into management arrangements providing a basis for sound trigger points in the future.

Table 4. Existing decision rules, which trigger management responses to impacts, should they be detected during monitoring. .

BYCATCH	Bycatch is negligible and new controls to legislate for a minimum mesh size, or escape gaps, will further enable escape of non-target species
Reference point in 2001	Data collected from fishery independent catch sampling projects up to 2001 will be collated.
Trigger point	Bycatch abundance changes by more than 50% in any one year period or more than 100% in any three year period will lead to a review by MCFAC which will advise the Director.
BYPRODUCT	Byproduct is virtually non existent
Reference point in 2001	Existing byproduct levels
Trigger point	If reported byproduct increases by more than 100% in any one year period or more than 200% in any three year period will lead to a review by MCFAC and advice to the Director.

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

There are no specific management responses in place at this time. Research to date has been focussed on improving assessment techniques and therefore little information is presently available to direct management responses. However, should there be a negative effect identified through monitoring or logbook information, the Minister or Director of NT Fisheries is able under the *Fisheries Act* (sections 28 & 29) to undertake appropriate remedial actions to protect the overall ecosystem.

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APPENDIX I: MUD CRAB (*SCYLLA SP.*) THE SPECIES

The mud crab, *Scylla* sp., are a large aggressive portunid crab which feeds on shellfish, worms, small crustaceans, vegetation as well as fish and meat scraps. Four species of *Scylla* have been identified, *S. serrata, S paramamosain*, *S. olivacea* and *S. tranquebarica,* but the NT the fishery is based on *S. serrata* with very small numbers of *S. olivacea* taken (less than 0.5% of the catch).

S. serrata has a broad smooth shell (carapace) with nine equally sized spines on either side of the eyes. It's two large claws are used for feeding and defence, and the most posterior legs are flattened for swimming. The colour can range from dark brown to blue to a mottled green. Mud crabs are widely distributed throughout the Indo-West Pacific region usually in mangrove and estuarine habitats. In Australia, the mud crab extends from the mid coast of New South Wales north through Queensland and the Northern Territory to the south west of Western Australia.

The mud crab, like all hard shelled crustaceans, must undergo the complicated process of moulting if it is to grow. When a crab is ready to moult, it splits out of its old shell and forces itself out backwards using body fluids to expand to a larger size. It may take two days before the crab can defend itself until the new soft shell slowly hardens at the larger size. Mud crabs in this phase are often termed "soft" or "empty" because the meat has not yet had time to develop within the weak shell and this may take a few weeks.

Juvenile mud crabs have proved difficult to find in the NT, but it is believed that they generally live in the high mangrove zone of tidal areas where they scavenge for plant and animal matter. The mud crabs moult often as they grow and based on research undertaken in the Northern Territory, it appears that they reach about 100 to 120 mm carapace width in the first year. Within the second year, mud crabs are between 130 - 170 mm width and have reached maturity. The larger mature mud crabs tend to feed more in sub-tidal areas in creeks and rivers and on the mud flats.

As juveniles, male and female mud crabs are difficult to differentiate. However, noticeable differences between the sexes become obvious as they reach maturity. Females develop a large, rounded, pigmented abdominal flap which is modified to carry and protect the eggs, whereas males have a thin, unpigmented triangular abdominal flap and develop very large claws compared to the females. Juvenile females do not have the same rounded pigmented flap as mature females, but exhibit a broadbased, triangular shaped, unpigmented flap.

Based on the presence of a mature abdominal flap, around 50% of females have reached maturity at 136.5 mm carapace width and most mature females have mated.

For males, it appears that based on the presence of sperm, mud crabs around 110 – 120 mm are physically mature. Functional maturity (males that have mated) can be determined based on the presence of what are termed mating scars on the sternum and first walking leg. The minimum size that these scars were found was around 125 mm, but most males with these marks were on average between 150 to 165 mm in carapace width. Although it appears that all female mud crabs mate, only around 30% of males have mating scars.

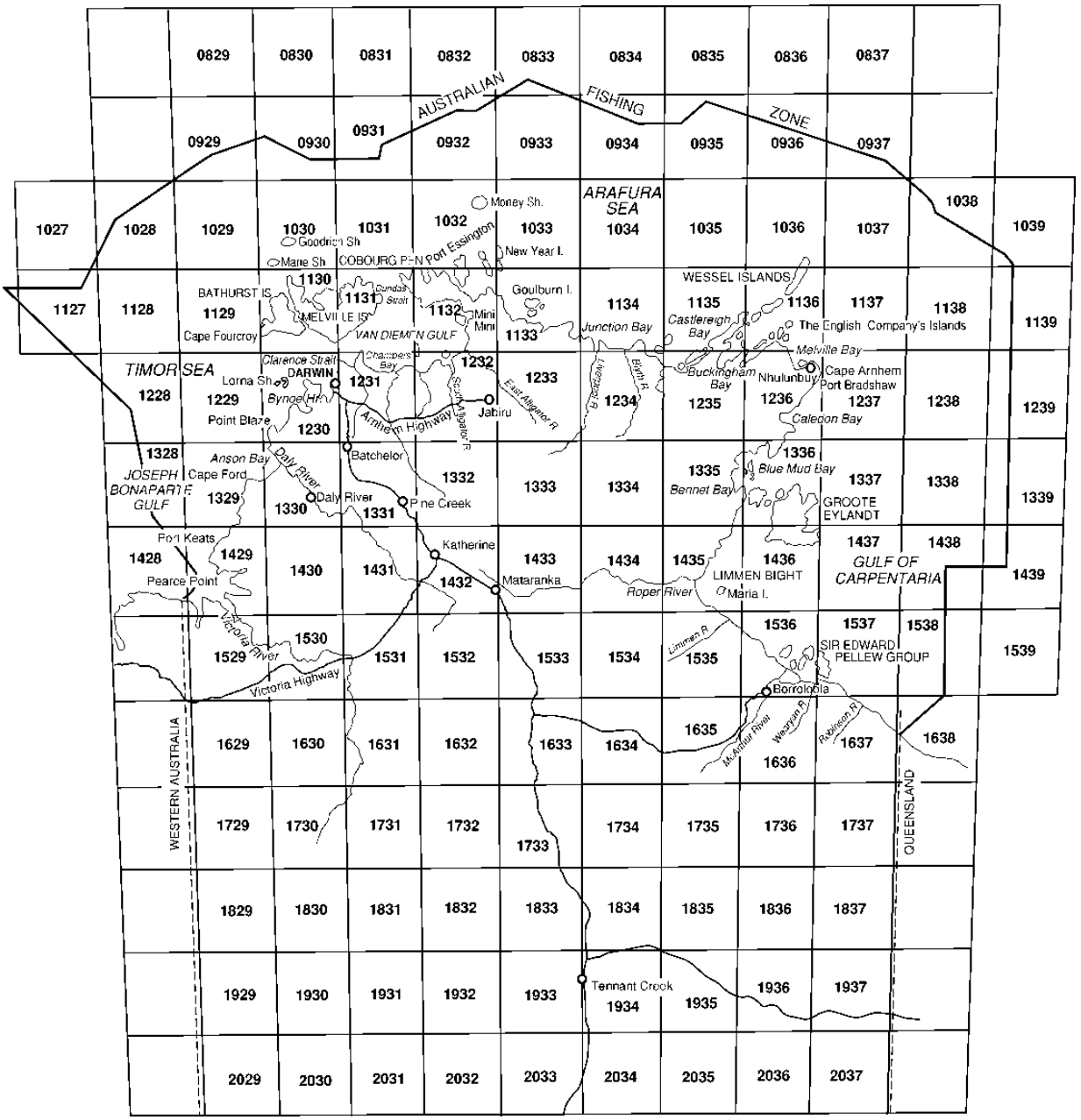
Mating can only occur after a mature female, or an immature female about to reach maturity, has moulted and the new shell is still soft. When a female is about to moult, a male will hold her underneath him with the first pair of his walking legs. In this "doubled" position, which may be maintained for up to one week, the male can protect the female during moulting and mating, until she can defend herself. The female is turned upside down during mating, her abdominal flap is lifted over the back of the male shell. In this position the male transfers gelatinous bags of sperm to the female which are stored until her eggs have matured enough to be fertilised. Females can mate more than once and can spawn up to three times from a single mating.

Around November, December, which may be up to several months after mating, the females migrate offshore to spawn. Specimens have been reported up to 50 km from land. The eggs (up to 8 million) developing in the ovaries are fertilised as they are transferred to the feather like structures that carry the eggs under the female's abdominal flap. The eggs hatch into free-swimming larvae called zoea 20-40 days after fertilisation. As the zoea drift with other plankton inshore with the currents, they moult

and change from zoea through the megalopa phase until they attain the form of a juvenile mud crab with a shell width of 3 - 5 mm. They then remain in the estuarine environment as they grow to maturity. Mud crabs live for 3 to 4 years.

APPENDIX II: GRID MAP FOR CATCH REPORTING PURPOSES

NORTHERN TERRITORY OF AUSTRALIA – FISHING GRIDS REFERENCE



APPENDIX III: COMMERCIALLY UNSUITABLE MUD CRAB

CIRCULAR TO ALL COMMERCIAL MUD CRAB FISHERS

RE: CONDITION ON MUD CRAB LICENCE TO PROHIBIT THE POSSESSION OF COMMERCIALLY UNSUITABLE MUD CRABS BY COMMERCIAL FISHERS

On 6 April 2001 1 wrote to licensees advising that the NT Crab Fishermen's Association (NTCFA) had a ballot of all mud crab licensees and there had been support for a proposal to prohibit the possession of commercially unsuitable crab (often termed as empty crab).

The NTCFA provided supporting information that they believed that the continuing harvesting of commercially unsuitable crab has a negative effect on the resource and the industry for the following reasons:

- unacceptably high levels of mortality of commercially unsuitable crabs during transport and storage;
- in other jurisdictions a reduction in the number of full crabs in the wild population arising from increased harvesting of commercially unsuitable crabs;
- lower prices for NT mud crab due to quality concerns and the resultant increase in fishing activity so as to maintain the level of return to fishers;
- possible negative impact on the Ecological Sustainable Development (ESD) assessment of the fishery under the Environment Australia (EA) guidelines.

With these matters in mind and with the support of the NTCFA, mud crab licensees and the Mud Crab Fishery Advisory Committee, I have made it a condition of licence that commercial mud crabbers must tie their mud crabs before returning to approved campsite's or other places used to store mud crabs. Further, a mud crab licensee can not possess a commercially unsuitable mud crab after it has been tied.

A copy of the new licence conditions are attached for your information and will be enforced as of 14 May 2001.

Please ensure that if you have temporarily transferred the licence, have some one else working the licence or have assistants, that they aware of these new conditions.

A longterm solution to the issue of commercially unsuitable crabs will be considered as part of the review of the Mud Crab Fishery Management Plan and the Division, in conjunction with Industry, will assess the effectiveness of these conditions over the next 12 - 18 months.

Please contact Mr Mark Kelly on 89992144 if you have any queries or wish to discuss this matter.

Yours sincerely

RICHARD SELLERS
DIRECTOR OF FISHERIES
4 May 2001

ADDITIONAL LICENCE CONDITION FOR ALL MUD CRAB LICENCES

These conditions must be read in conjunction with the existing conditions already on mud crab licences.

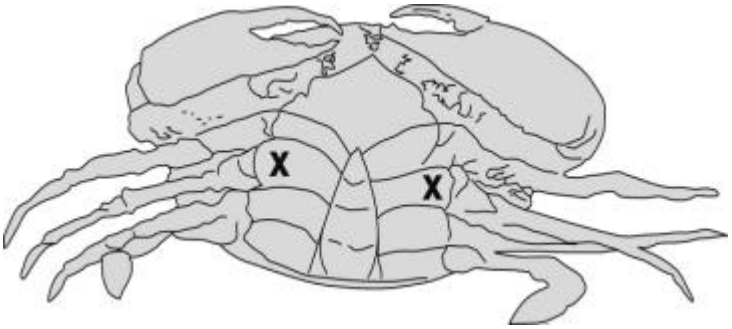
A. A mud crab licensee shall at the completion of clearing the pots used in the conduct of fishing operations under the licence and before returning to an approved camp site or other such place:
   (a) measure mud crabs for legal size; and
   (b) test for commercially unsuitable mud crabs; and
   (c) tie all mud crabs.

B. Subject to these conditions, a mud crab shall be deemed to be tied if the nippers are restrained.

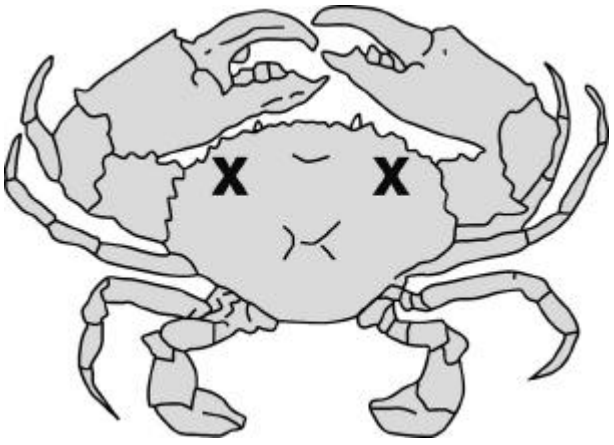
C. A mud crab licensee shall not possess a commercially unsuitable mud crab after being tied.

D. Subject to these conditions a mud crab shall be deemed to be commercially unsuitable in line with the following:

(a) a male mud crab by pressing the abdominal shell on the underside of the crab at a point either side of the abdominal flap and adjacent to the middle leg, as identified by an ***X*** on the attached diagram, and if this causes an inwards movement of the shell.



(b) a female mud crab by pressing the carapace at a point near the widest point of the carapace, as identified by an ***X*** on the attached diagram, and if this causes inwards movement of the shell and an audible clicking sound.



APPENDIX IV: SUMMARY HISTORY OF MANAGEMENT ARRANGEMENTS

Year	Catch	Milestone
1972	na	▪ Recreational crabbers required to register up to 3 pots for a $5.00 fee.
Prior 1980	na	▪ Mud crabs could be taken commercially on a General Fishing Licence. No restriction on number of pots allowed.
1980	na	▪ Specific fishery for Mud Crabs developed in 1980 with 61 licences. No restriction on number of pots allowed.
1982	na	▪ Licence numbers peak at 112.
1984	24 t	▪ Increasing fishing effort so $5/pot fee introduced with no restriction on number of pots allowed. 45 licences issued.
1985	91 t	▪ Effort continues to increase so moratorium placed on issuing of any new mud crab licences and cap set at a maximum of 55. ▪ Agreed management regime put in place which allowed transferability of licences, 60 pot maximum and some closures to commercial crabbing in Darwin Harbour, Leaders Creek and most of the creeks in Shoal Bay. ▪ Minimum size limit for males and female mud crabs of 130 mm. ▪ Recreational crabbers no longer required to register pots.
1988	116 t	▪ Maximum number of licences permitted in the fishery reduced to 49. This was the number that were active immediately prior to the 1985 limitation.
1990	134 t	▪ Fishery declared a managed fishery and the Mud Crab Fishery Advisory Committee formed to develop a Plan of Management.
1991	143 t	▪ Management Plan in force 1 February 1991. ▪ Commercial licence numbers set at 49 using 60 pots. Closures around Darwin remain in place. ▪ Recreational crabbers entitled to use 5 pots each, with a maximum of 10 per vessel. ▪ A recreational possession limit in place of 10 per person with a maximum of 30 per vessel.
1993	226 t	▪ Amendment to the Management Plan saw the protection of berried female mud crabs and prohibiting the use of tangle nets.
1996	569 t	▪ Amendment to the Management Plan saw the increase of the minimum size limit for female mud crabs increased to 140 mm and the prohibition of possession of restricted bait nets for commercial crabbers in the area from Bing Bong Creek to the Queensland border.
1999	757 t	▪ National Five Year Research Strategy Developed for Mud Crab.
2000	1030 t	▪ Review of Plan Commenced.
2001	Est. 800 to 1000 t	▪ Discussion paper on management options for the fishery released in May. ▪ Code of Conduct released in July. ▪ EA Assessment undertaken.

APPENDIX V: MCFAC STRUCTURE

Independent chair	Mr Dick-Slack-Smith
Recreational representative	Ms Jan Young
Commercial fishing representatives	John Munroe
	Mr Ngia Long Tran
Fish trader representative	Mr Darryl Everett
Enforcement representative	OIC MFEU
Scientific representative	Ms Tracy Hay
Fishery management representative	Mr Mark Kelly
Observers	Mr Iain Smith
	Mr John Harrison
	Mr Patrick O'Leary

APPENDIX VI NATIONAL STRATEGY FOR RESEARCH ON MUD CRAB (SCYLLA SP.) IN AUSTRALIA ENDORSED *AT THE MUD CRAB WORKSHOP - DARWIN NT 29 - 31 MAY 1999

Area of Research	*Term/period*	*States endorsed*	*Justification*
Relative productivity of mud crab habitat Habitat alias • Satellite imagery • Abundance estimation • Trials of sampling and protocols	 Year 1 Year 2, 3, 4 Year 1	WA/NT/QLD	♦ Push from Industry ♦ Protection of critical habitat ♦ Estimate of stock size for WA - development opportunities ♦ Possible long-term monitoring of fishery health ♦ Identification of major fishing area
Stock abundance indicators Commercial catch and effort data • Effort validation • Effectiveness of "pot lift" as an index of abundance • Comparison of pot design Fishery independent index of stock abundance ♦ Juvenile pre-recruit index - Trials of juvenile sampling/behaviour - Habitat identification - Field trials	 Year 1 Year 2* Year 2* Year 1, 2 Year 1, 2 Year 3, 4, 5	NT/QLD/WA	♦ Determination of sustainability indicators ♦ Increasing economic efficiency of operation ♦ National consistency in effort measurements ♦ Capacity to predict future catches ♦ Possible link to offshore migration of females
Spatial difference in population reproductive characteristics • Comparison of sex ratio • Comparison of % frequency of sperm plugs • Comparison of % females with >1 sperm plug • Offshore migration	 Year 2* Year 2* Year 2* Long term	NT/QLD/WA	♦ Impacts of different harvest strategies on reproductive (mating) success ♦ Appropriateness of single-sex and size limit regulations

APPENDIX VII COMMERCIAL LOG SHEET

THE NORTHERN TERRITORY OF AUSTRALIA - FISHERIES ACT
MUD CRAB FISHERY

LICENCE No: _____ NAME (print): _____

MONTH: _____ YEAR: _____ **NIL RETURN** (tick,if appropriate): ☐

N.T. PORT OF LANDING: _____ No. OF CREW: _____

BOAT REGO No's: _____ TOTAL DAYS FISHED: _____

CATCH DETAILS

GRID NUMBER								
AREA or RIVER								
FISHING METHOD	POTS		POTS		POTS		POTS	
START DATE / FINISH DATE								
No. OF POTS SET IN RIVER								
No. OF POTS SET ON MUDFLATS								
No. DAYS POTS PULLED TWICE								
CATCH (list species)	WEIGHT (kg)	CUT*	WEIGHT (kg)	CUT*	WEIGHT (kg)	CUT*	WEIGHT (kg)	CUT*
Mud Crab								
BY CATCH (specify)								

RESEARCH

PERCENTAGE MALES								
PERCENTAGE WITH FLAP PARASITE								

* (trunk,fillet,gilled & gutted,whole,fins,etc)

MARKET DETAILS

PRODUCT SOLD (list species)	CUT*	STORAGE (fresh, frozen,etc)	WEIGHT SOLD (KG)	DESTINATION N.T. (public or traders no.)	DESTINATION INTERSTATE (state and traders name)

COMMENTS: _____

official use only

Signature of Licensee: _____ Date: / /

APPENDIX VIII FISHING TOUR OPERATOR LOG SHEET

IN CONFIDENCE

FISHING TOUR OPERATOR - DAILY LOG©

DATE ▶ | LIC. No# ▶ D 2 | GRID No. ▶ | FISHED FROM (✓ any) ▶ Boat ☐ Shore ☐

SPECIFIC AREA FISHED (name of reef, bay river etc). ▶

PERSON DETAILS (all anglers, including yourself)

PERSON NO.	1	2	3	4	5	6
ORIGIN ▶ Home State (Aust.) Country (O'seas)						
FISHING SKILL ▶ Expert / Average / Beginner	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐

TARGETING AND HOURS FISHED

B = Barramundi	G = Game Fishing	R = Reef/Bottom Fishing	C = Crabbing	O = Other
Methods (✓ any) Trolling ☐ Casting ☐ Bait ☐	Methods (✓ any) Trolling ☐ Casting ☐ Bait ☐	Methods (✓ any) Casting ☐ Bait ☐	Methods (✓ any) Pots / Dillies ☐ Other ☐	Methods (please write in) eg: beach seine, cast net etc.
(calculation space) Total Line Hours ▶	(calculation space) Total Line Hours ▶	(calculation space) Total Line Hours ▶	(calculation space) Total Pot Hours ▶	(calculation space) Total Hours ▶

CATCH DETAILS (or tick here if NIL CATCH) ☐

Species	Target Fished	No. Caught Kept	No. Caught Rel.	Species	Target Fished	No. Caught Kept	No. Caught Rel.	Species	Target Fished	No. Caught Kept	No. Caught Rel.	Other Species (please write in)	Target Fished	No. Caught Kept	No. Caught Rel.
Barramundi				Mangrove jack				Sooty grunter							
Bream				Moonfish				Snapper (Golden)							
Catfish (forktailed)				Mullet				Snapper (Saddle-T)							
Cobia				Mud crab				Snapper (Tricky)							
Cod (all types)				Queenfish				Stripey							
Coral trout				Emperor (Red)				Sweetlip							
Javelin fish				Salmon (Blue)				Tarpon							
Jewfish				Threadfin salmon				Trevally							
Spanish mackerel				Saratoga				Tuna							
Mackerel (Other)				Shark / All				Tusk / Parrotfish							

Comments/Notes

Guides Name:

I _____ (print name) certify that the information provided here is true and complete. Signed: