Australian Government

Department of the Environment and Heritage

Assessment of the
Northern Territory Trepang Fishery

December 2004

ISBN: 0642551073

Disclaimer

This document is an assessment carried out by the Department of the Environment and Heritage of a commercial fishery against the Australian Government *Guidelines for the Ecologically Sustainable Management of Fisheries*. It forms part of the advice provided to the Minister for the Environment and Heritage on the fishery in relation to decisions under Part 13A of the *Environment Protection and Biodiversity Conservation Act 1999*. The views expressed do not necessarily reflect those of the Minister for the Environment and Heritage or the Australian Government.

Assessment of the ecological sustainability of management arrangements for the Northern Territory Trepang Fishery

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Background
The Northern Territory Fisheries Group of the Department of Business, Industry and Resource Development (DBIRD) has submitted a document for assessment under Part 13A of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The draft document *Assessing the Ecologically Sustainable Management of the Northern Territory Trepang Fishery* (the submission) was received by the Department of the Environment and Heritage (DEH) in June 2004. The submission was released for a thirty-day public comment period that expired on 20 August 2004. Three public comments were received. DBIRD provided a response in December 2004 to the issues raised and amended the submission where necessary.

The submission reports on the Northern Territory (NT) Trepang Fishery against the Australian Government *Guidelines for the Ecologically Sustainable Management of Fisheries*. The DEH assessment considers the submission, associated documents, public comments and the DBIRD response to the comments.

Table 1: Summary of the Northern Territory Trepang Fishery

Area	Waters adjacent to the Northern Territory, seaward of the high water mark to three nautical miles (nm) (State waters only). The fishery is divided into two zones at Cape Grey – Zone 1 extends west to the Western Australian border and Zone 2 extends east to the Queensland border. Fishing is prohibited in a number of formal closures in place in the waters adjacent to Kakadu National Park (to the low water mark) and two small aquatic life reserves in Darwin Harbour.
Fishery status	The target species is considered underfished.
Target Species	Trepang (also known as beche-de-mer or sea cucumber). All species are permitted to be taken, however sandfish *(Holothuria scabra)* is the main target species.
Byproduct Species (please note that NT Trepang defines these byproduct species as target stock, although they are not currently harvested in the fishery. For the purposes of this assessment, the target species is considered to be sandfish only).	Other Trepang species are permitted including: *Holothuria atra* (lolly fish) *Holothuria whitmaei* (black teat fish)* *Holothuria nobilis* (white teat fish)* *Actinopyga echinites* (deep water red fish) *Thelenota ananas* (prickly red fish) These species are currently not harvested due to a lack of commercially viable quantities.
Gear	Hand harvest with the use of snorkel, SCUBA/hookah gear or low tide walking.
Season	Generally limited to the dry season [April-October] due to weather conditions (including cyclones, storms, turbid water, poor visibility).
Commercial harvest 2002/03	278 tonnes
Value of commercial harvest	2001/2002: Approximately $2.4 million. The current value of the fishery is not available as fishery information is confidential in fisheries with less than 5 licence holders.
Recreational harvest	No records of recreational take.
Commercial licences issued	6 licences issued (3 permitted in each zone), 4 licences active in 2003.

Management arrangements	Input controlled through: ▪ Limited entry (six transferable licences) ▪ Restricted to waters within 3nm of high water mark ▪ Two separate fishing zones, with three licences permitted in each ▪ Harvesting by hand collection only ▪ Limitations on the number of harvesters/divers under each licence ▪ Limited fishery area Output controlled through: ▪ Minimum size limits for target and byproduct species: - *Holothuria scabra* (Sandfish): 16 cm - *Holothuria atra* (lolly fish): 15 cm - *Holothuria whitmaei* (black teat fish): 26 cm - *Holothuria nobilis* (white teat fish): 32 cm - *Actinopyga echinites* (deep water redfish): 12 cm - *Thelenota ananas* (prickly redfish): 30 cm
Export	Exported after processing to Asia (primarily Singapore and Hong Kong).
Bycatch	No reported bycatch due to the highly selective hand harvest of the target species.
Interaction with Threatened Species	No interactions have been reported to date.

*please note that DBIRD has previously defined the black teat fish as *Holothuria nobilis* and the white teat fish as *Holothuria fuscogilvia.* These species names were revised by Rowe and Gates (1995) and were revised in other beche-de-mer fisheries in the early 2000s. DBIRD have agreed to amend the species names to be consistent with current available scientific literature.

The area of the fishery includes waters off the NT, seaward of the high water mark to three nautical miles (State waters only). The fishery includes all the offshore islands of the NT and is divided into two fishing zones at Cape Gray, south east of Nhulunbuy. One zone extends west to the Western Australian border and the other extends east to the Queensland border. Fishing is prohibited in a number of formal closure zones including waters adjacent to Kakadu National Park (to low water mark) and two small aquatic life reserves in Darwin Harbour.

The fishery targets trepang (also known as beche-de-mer or sea cucumber), primarily sandfish (*Holothuria scabra).* A second species of sandfish, *H. scabra var. versicolor*, (golden sandfish) has recently been recognised in other beche-de-mer fisheries and may be more susceptible to overfishing than *H. scabra*. Public comment raised concerns that golden sandfish may be harvested in the NT Trepang Fishery and not reported separately to *H. scabra.* Public comment suggested that if golden sandfish are present in NT waters, management arrangements must be set in an extremely precautionary manner until further information on the species biology and ecology is obtained. At this stage golden sandfish have not been identified in NT waters and as such no management measures are in place for the species. DEH considers that further research should be undertaken to determine if the species is present in NT waters (further discussed in Principle One).

Byproduct species listed on permits include lollyfish (*H. atra),* black teat fish (*H. whitmaei),* white teat fish (*H. nobilis),* deep-water red fish (*Actinopyga echinites)* and prickly red fish (*Thelenota ananas).* DBIRD advises that these species are not currently being harvested due to a lack of sufficient quantities available for harvest in the fishery area.

The majority of holothurians are slow moving benthic animals and are usually found in close association with the substrate. They are important components of the reef and inshore ecosystems.

Sandfish are found throughout the Indo-Pacific in regions generally ranging from 30°N to 30°S (Hamel et al 2001). Sandfish appear to favour low energy environments such as bays and protected shorelines and are often found in areas with terrigenous inputs such as near estuaries, mangrove areas and swamps (Hamel et al 2001). Research conducted in Queensland indicates that sandfish are generally more abundant in seagrass areas (Skewes et al 2000).

Sexual reproduction by broadcast spawning generally occurs in the warmer months from December to February. A small proportion of the population may also spawn year round. The planktotrophic larvae of the species spend 10-14 days in the water column before settlement (Battaglene 1999) so there is potential for limited larval dispersal between populations (Uthicke and Benzies 1998). The NT Trepang Fishery does not generally operate from November to April due to poor water visibility, strong currents and strong winds from the prevailing wet season. As a result of this natural seasonal closure, trepang stocks are generally protected throughout the spawning period. DBIRD will continue to monitor fishing activity during this spawning period and will implement management measures (including seasonal fishery closures) to protect the spawning stock if deemed necessary.

In its juvenile form, sandfish are generally found in seagrass beds, while mature specimens tend to be found in deeper waters (Hamel et al 2001). The size at which sandfish first become sexually mature appears to vary greatly between regions. Studies conducted by Skewes indicate that maturity occurs at 150 mm in the Torres Strait, which suggests a breeding age of two years (Skewes et al 2002).

Outcomes of a genetic study of sandfish populations along the northeast coast of Australia and the Solomon Islands indicated limited genetic variability between shallow and deep water populations of sandfish (Uthicke & Benzies 2001). This is consistent with the view that juveniles settle in shallow seagrass beds and then migrate to deeper areas during their life span and therefore there is a mixing of genetic material between shallow and deeper areas (Uthicke & Benzies 1998). This theory is not yet well understood. Information on the other species of trepang permitted in licence conditions is limited.

Trepang are generally at risk of overexploitation and localised depletion due to their limited dispersal, patchy distribution, ease of collection, slow recovery of species from overfishing and limited information on biological and spatial distribution available for management. Trepang fisheries have a history of “boom-bust” cycles, with a number of international fisheries collapsing due to overfishing. The species therefore requires strict management controls to ensure the sustainability of harvests. For several years pressure has been mounting to consider if trepang should be listed under the Convention on International Trade in Endangered Species (CITES) to afford the species further protection in trade.

Approximately 103 917 kg of trepang were harvested in the NT Trepang Fishery in 2001/02, at an estimated value of $2.4 million. The fishery has a long history, dating back to at least 1720 when Macassans from Indonesia fished for trepang in northern Australia. Activity in the fishery declined in 1880 due to the taxes and charges being imposed on Macassan fishers (MacKnight 1976). Fishing continued throughout 1880 – 1940, at which time activity ceased, due in part to the impact of World War II on Chinese markets.

Increasing interest in Australia in the late 1980s led to investigations of the potential for developing the NT Trepang Fishery. In 1992, 6 licences were issued in the NT for the hand harvesting of trepang. These licences were made transferable in 1993 and at the time of the assessment are all owned by one company. Four licences were active in 2001 and have remained active to date.

Trepang is exported, after processing into a dry product, to Asia, primarily Singapore and Hong Kong. Product has recently been sold in cooked and frozen form, with canning also being trialled. Market preferences mean that smaller specimens of trepang are not harvested, as they are valued at less than half the price of adult sized specimens.

Trepang is harvested by hand using snorkel, SCUBA, hookah gear or low tide walking. Diving generally takes place in shallow coastal embayments and foreshores in waters up to 15 m in depth and is limited to daytime neap tides and during the dry season when water visibility improves.

All fishing operations are vessel based, with a "mother boat" anchoring in deeper offshore waters, while dinghies follow divers through the harvesting areas. Dive sessions can last up to three hours and are constrained by poor visibility, strong winds, currents and the presence of predators or threats (sharks, crocodiles, jellyfish).

Due to the highly selective nature of the fishery, no bycatch is taken in the fishery. Five other trepang species are permitted as byproduct, however DBIRD advise that they have not yet been harvested due to a lack of market demand. If these byproduct species are harvested in the future, appropriate adjustments to management arrangements will be made to address any issues if necessary. This issue is further assessed under Principle One of this report.

Species protected under the Australian Government EPBC Act occurring in the area of the fishery include marine turtles, crocodiles and sharks, however no interactions have been reported to date. Given the highly selective and benign fishing methods used in the fishery, impacts on protected species are unlikely to occur in the future. Potential interactions are assessed under Principle Two of this report.

The National Recreational and Indigenous Fishing Survey (NRIFS) conducted during 2001 estimated the recreational and indigenous harvest of trepang in the NT to be negligible, with nil reports from either sector. There are no bag limits or other restrictions on trepang take for non-commercial fishers, however DBIRD advises that this may be reviewed if this sector becomes active.

The fishery is managed under the NT *Fisheries Regulations 1995* (Fisheries Regulations) under the legislative framework of the NT *Fisheries Act 1988* (Fisheries Act).

Overall assessment

The material submitted by DBIRD demonstrates that the management arrangements for the NT Trepang Fishery meet most of the requirements of the Australian Government *Guidelines for the Ecologically Sustainable Management of Fisheries*.

While the fishery is relatively well managed, DEH has identified a number of risks that must be managed to ensure that their impacts are minimised. These risks include:

- the absence of a robust stock assessment;
- limited management measures for ensuring that harvest is limited to sustainable levels;
- limited information on critical elements of trepang biology and ecology;
- potential for localised and serial depletion; and
- the susceptibility of the target and byproduct species to overfishing.

Recommendations to address these issues have been developed to ensure that the risk of impact is minimised in the longer term. Through the implementation of the recommendations and the continuation of a responsible attitude to the management of the fishery, management arrangements are likely to be sufficiently precautionary and capable of controlling, monitoring and enforcing the level of take from the fishery while ensuring the stocks are fished sustainably.

The NT Trepang Fishery is in a developmental phase and has made considerable progress in developing sound management arrangements. DBIRD advises that the developmental status of the fishery will be reviewed after more information is obtained on fishing capacity from research and monitoring. The management regime aims to ensure that fishing is conducted in a manner that does not lead to over-fishing and for fishing operations to be managed to minimise their impact on the structure, productivity, function and biological diversity of the ecosystem. On balance, the fishery is being managed in an ecologically sustainable manner and is working to address existing problems and minimise environmental risks.

The operation of the fishery is consistent with the objects of Part 13A of the EPBC Act. Given the management arrangements specified in the submission, including limited entry and a commitment to further research, DEH considers that the fishery will not be detrimental to the survival or conservation status of the taxon to which it relates in the short term. Similarly, it is not likely to threaten any relevant ecosystem in the short term. DEH therefore recommends that the fishery be declared an approved Wildlife Trade Operation (WTO) with the actions specified in the recommendations to be undertaken by DBIRD to contain the environmental risks in the long term. DEH considers that the fishery, as managed in accordance with the management plan is not likely to cause serious or irreversible ecological damage over the period of the export decision. Specifically, the WTO declaration would allow the export of product from the fishery for a period of 3 years. The WTO declaration will require annual reporting on the progress of implementing the recommendations of this report and other managerial commitments. The implementation of the recommendations will be monitored and reviewed as part of the next DEH review of the fishery in 3 years time.

Recommendations

1. DBIRD to advise DEH of any material change to the NT Trepang Fishery's management arrangements that could affect the criteria on which EPBC decisions are based, within 3 months of that change being made.
2. DBIRD to cooperate with other jurisdictions in efforts to undertake research on key gaps in the knowledge of trepang biology and ecology.
3. Within 2 years DBIRD to develop and implement a robust research and ongoing monitoring program to provide more accurate assessments of stock abundance and inform performance measures for the fishery. The research and ongoing monitoring program will also aim to determine whether a second species of sandfish, *H. scabra* var. *versicolor,* is present in the fishery.
4. DBIRD to develop sustainable yield estimates for the NT Trepang Fishery within 2 years.
5. Within 6 months DBIRD to review the current interim limit reference points for sandfish and implement revised limit reference points, to ensure that they provide a precautionary basis to detect changes and impacts to the target stock. The review will take into account available research on sandfish stocks of Australian beche-de-mer fisheries (including research conducted in the NT) and the biological characteristics of the target species.
6. DBIRD to develop and implement finer scale data collection and reporting and management measures to mitigate the risk of localised depletion of trepang in the fishery. These measures

will be developed and implemented in consultation with local indigenous communities, conservation groups and industry.

7. DBIRD to review the current size limits on target and byproduct species to ensure that they are set in a precautionary manner consistent with available research on the size at first maturity of trepang reproductive biology.
8. Within 2 months of a species other than *H. scabra* being harvested, DBIRD to develop and implement a species-specific trigger limit for that species.

PART I - MANAGEMENT ARRANGEMENTS

The NT Trepang Fishery is managed by DBIRD.

The management regime is described in the following documents, all of which are, or will be publicly available:

- NT *Fisheries Act 1988* (Fisheries Act)*;*
- NT *Fisheries Regulations 1995* (Fisheries Regulations)*;*
- Relevant Gazetted notices and licence conditions.

A number of other documents, including research reports, scientific literature, discussion papers and annual reports are integral to the management of the fishery.

DEH considers it important that management arrangements remain flexible to ensure timely and appropriate managerial decisions. Due to the importance of the management arrangements and documents referred to above to DEH's assessment of the fishery, an amendment could change the outcomes of our assessment and decisions stemming from it.

Recommendation 1: *DBIRD to advise DEH of any material change to the NT Trepang Fishery's management arrangements that could affect the criteria on which EPBC decisions are based, within 3 months of that change being made.*

DEH considers that management of the fishery incorporates a sound range of consultative mechanisms and a clear commitment to effective consultation with a variety of stakeholders. An annual status report is published and distributed to all stakeholder groups and is available from the NT Fisheries Group of DBIRD. As of the 2004 reporting year, the annual status report will also report on management objectives, performance indicators and triggers and how the fishery is performing against these.

Discussion papers or proposals for amendments to the fishery management arrangements are distributed widely to stakeholder groups and other interested individuals and advertised in major NT newspapers and NT Government websites through a public consultation process. All management arrangements are also discussed with key stakeholders and through the Aquatic Resource User Group (ARUG) forum and regional Aboriginal Consultative Committees (ACC). Public comment raised concerns that consultation with indigenous communities in the area has not been adequate. DEH strongly encourages DBIRD to ensure that all stakeholders in the fishery, particularly indigenous groups, are effectively consulted in the future management of the fishery.

The overall management objectives for the NT Trepang Fishery are specified in the Fisheries Act. The Fisheries Act contains a number of objectives that apply to all NT fisheries. Objectives include providing for optimum yields and maintaining the quality of the yield of target species, ensuring that the fish stocks of the Territory are not endangered or overexploited, encouraging tourist and scientific interest in fish and aquatic life, ensuring that the habitats of fish or aquatic life and the general environment is not detrimentally effected and providing socio-economic benefits to the community. These Territory wide management objectives are achieved in the NT Trepang Fishery through a range of fishery specific management objectives outlined in an interim management plan. Each objective has a number of performance indicators, reference points and management responses (outlined in Table 2). An assessment of the effectiveness of these measures is included in Part Two of this report.

Management of the fishery is based on a mixture of input and output controls (outlined in Table 1). Such controls include:

- Limited entry with 6 licences current (4 presently active). A maximum of 7 assistants, including divers, may work with the licence, with no more than 4 divers in the water at any one time;
- Area restrictions – 3 licences are permitted to operate in each of the two zones of the fishery;
- Minimum size limits for all species of trepang listed on the permit;
- Gear restrictions – hand harvest only.

DEH considers that the management arrangements require further refinement to ensure the sustainable management of the fishery in the long term. Further discussion of management arrangements is included in Part Two of this report.

Compliance with the management controls for the NT Trepang Fishery is undertaken by the NT Police, Marine Fisheries Enforcement Unit (PMFEU) under the Fisheries Act. The PMFEU monitors and enforces critical aspects of compliance through inspection on arrival and departure of fishing vessels through the port of Darwin. Principal management arrangements can be monitored in port, including verification of catch returns against processor returns. Inspections can also be undertaken during normal surveillance operations or in response to intelligence. Monitoring of trepang vessels is infrequent due to the vast distances away from ports, the low number of vessels active in the fishery and the perceived low level of risk in the fishery. No at-sea inspections were undertaken throughout 2002/03, however vessels were periodically inspected during routine wharf side inspections of all commercial vessels in Darwin. Powers exist to confiscate product, vessels and vehicles as well as impose financial penalties and prison sentences for those convicted of breaches under the Fisheries Act. DBIRD has committed to undertake a compliance risk assessment in December 2004. DEH considers that compliance and enforcement activities have the capacity to ensure the ongoing reliability of data in the fishery. Compliance and enforcement issues are further discussed in Part Two of this report.

The strategic management directions of the NT Trepang Fishery are reviewed and assessed at the annual Northern Australian Fisheries Management Workshop (NAFMW). Membership of the NAFMW includes State, Territory and Commonwealth fisheries managers, researchers and compliance staff. The fishery is also reviewed in relevant local, national or international workshops, stakeholder meetings and in the annual status reports for NT. The annual status reports are discussed more fully in Part Two of this report.

As a result of discussions at the NAFMW in 1997, a specific workshop was held in Brisbane in late 1997, to consider management of trepang fisheries on a national basis. The workshop identified general management principles that should be considered so that trepang fisheries are conducted in a sustainable way. Research priorities were also discussed and highlighted that there are significant gaps on key life history parameters, abundance, densities and stock structures of Australia's trepang fisheries.

Fishery dependent data relating to the target species is collected on a regular basis in the fishery. Some fishery independent information is also collected. Discussion of the information collection system can be found in Part Two of this report.

An analysis of the fishery's capacity for assessing, monitoring and avoiding, remedying or mitigating any adverse impacts on the wider marine ecosystem in which the target species lives and the fishery operates is contained under Principle Two of this report.

Trepang is harvested (as beche-de-mer) under separate fishery management arrangements in NT, Western Australia, Torres Strait and Queensland including the Coral Sea, Moreton Bay, East Coast and the Gulf of Carpentaria fisheries. As beche-de-mer stocks are vulnerable to overexploitation, and resources for beche-de-mer research are limited throughout Australia, it is vital that DBIRD cooperate with other jurisdictions to undertake research on beche-de-mer ecology and biology and to implement precautionary management strategies to ensure the sustainable management of stocks. This is further discussed in Principle One of this report.

No threat abatement plans or recovery plans are currently in place for species of relevance to the NT Trepang Fishery. If a threat abatement plan does become relevant, NT Fisheries has committed to ensuring that relevant recommendations are incorporated into management arrangements.

No regional or international management regimes, to which Australia is a party, are of direct relevance to the fishery. The prime international regime affecting the fishery is the United Nations Convention on the Law of the Sea (UNCLOS). The management regime essentially complies with this. Other international regimes are applicable to fisheries management but do not explicitly involve this fishery, for example the 1992 Convention on Biological Diversity and in particular the 1995 Jakarta Mandate requiring that, in relation to the sustainable use of marine and coastal biological diversity, the precautionary principle should apply in efforts to address threats to biodiversity. While these agreements are not specifically addressed in the submission, the fishery's compliance with their requirements can be assessed by examination of Part Two of this report.

DEH considers it is incumbent on all authorities to develop a thorough understanding of the framework of national, regional and international agreements and their applicability to export-based fisheries for which they are responsible.

Conclusion

DEH considers that the NT Trepang Fishery management regime is documented, publicly available and transparent, and is developed through a consultative process. The management arrangements are adaptable and underpinned by objectives and performance criteria by which the effectiveness of the management arrangements can be measured, enforced and reviewed.

The management arrangements provide basic capacity for controlling the harvest through a combination of input and output controls appropriate to the size of the fishery. Periodic review of the fishery is provided for, as are the means of enforcing critical aspects of the management arrangements.

The management regime adheres to arrangements established under Australian laws and international agreements.

DEH considers that there is scope to further refine the management arrangements and has provided a recommendation for improvements in the longer term.

PART II – GUIDELINES FOR THE ECOLOGICALLY SUSTAINABLE MANAGEMENT OF FISHERIES

Stock Status and Recovery

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

Maintain ecologically viable stocks

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

Information requirements

Fishery dependent data are obtained through compulsory daily logbooks, which include information on the species caught, fishing method, catch (number and weight), effort (number of divers and fishing time), depth fished and fishing location. Logbook data within the fishery is based on 35 statistical grids around the coast, with finer scale description of areas within those grids.
Licensees are also required under the Fisheries Act to provide marketing details including point of sale, the level of processing undertaken and the weight of individual species sold. Compulsory logbook data must be returned together with monthly market summary sheets by the 28th day of the following month. Fisher logbooks are cross-referenced against market returns on entry into the database. Any discrepancies detected through data entry are investigated.
An onboard observer program is proposed by DBIRD to document vessel and gear details, location, depth fished, fishing practices, catch composition, and ground type and to undertake biological assessment of species taken. As part of this program, any data suitable for assessing the fishery activities with regard to adverse impacts on the wider marine ecosystem can be collected. The program was proposed for commencement in 2004 but has not yet been implemented.
DEH considers that data reliability for target species is reasonable and that compliance and enforcement activities have the capacity to ensure the ongoing reliability of data in the fishery.

Fishery independent research on the dynamics or life history of trepang populations is not currently available for the NT Trepang Fishery. Research from other jurisdictions will be utilised when available and if relevant. DBIRD has also committed to undertaking any independent and/or collaborative research opportunities that arise to expand the level of knowledge on Holothurians.

DBIRD collects comprehensive fishery dependent data in an effort to counteract the lack of fishery independent data. DEH has concerns that the data validation utilised in the fishery largely relates to landed target species (sandfish) only but expects that the proposed onboard observer program would improve data validation for all species harvested in the fishery.

Understanding of the basic biology and ecology of trepang is fundamental to the ecologically sustainable management of the fishery. Significant knowledge gaps exist across all Australian trepang/beche-de-mer fisheries, which would benefit from a cooperative approach. Areas requiring attention include but are not limited to:

- Juvenile ecology and habitat preference;
- Reproduction (fecundity, reproductive strategy, required density for successful fertilisation);
- Recruitment patterns (source/sink populations or localised recruitment);
- Basic biology (size at first maturity, growth rates, maximum size and age);
- Species distribution; and

- Ecological role of trepang.

Public comments also raised concerns about knowledge gaps.

This lack of understanding is common across all Australian beche-de-mer fisheries and DEH understands that resources in individual trepang fisheries throughout Australia are limited due to the small size and low priority of trepang fisheries generally. DEH considers that further research on trepang biology and ecology is required, particularly given the species' vulnerability to overexploitation. DEH therefore recommends that DBIRD cooperate with other jurisdictions to address key knowledge gaps on trepang biology and ecology.

Recommendation 2: *DBIRD to cooperate with other jurisdictions in efforts to undertake research on key gaps in the knowledge of trepang biology and ecology.*

DBIRD has committed to the implementation of an industry funded research program, which will provide useful fishery independent information on a range of biological and environmental issues.

The research program will obtain information on a range of parameters to provide a total picture of trepang stocks. The research program will also collect information on ecosystem information if resources are available. The project was scheduled to commence in 2004 with industry funding, but has not yet been implemented. The program will collect data on a range of variables including: species and numbers harvested, length of specimens and a range of weight measurements, gonad condition, water temperature/salinity, weather conditions, depth fished, moon and tide phase, sediment/bottom samples.

Public comment suggested that the findings of studies by Vail (1989) and Carter (2001) on the stock size of trepang populations could be used as baselines for follow up studies to assess if the current fishery is maintaining stocks at an ecologically sustainable level. DBIRD has acknowledged this data and considers both studies to be valuable sources of stock size data for specific areas within the NT fishery. DBIRD may incorporate a comparison of baseline stock size with current stock sizes in future research programs. DEH strongly supports future research in this area.

DEH considers that research and data validation are vital to the sustainability of the fishery and that the research program and onboard observer program should be established as a priority. DEH therefore recommends that DBIRD develop and implement the research and ongoing monitoring program to provide more robust assessments of stock abundance for target and byproduct species and inform performance measures for the fishery. While DEH commends DBIRD for its commitment to research on all trepang permitted to be taken in the fishery, further information should be collected on the possible existence of a second species (or distinct sub-species) of sandfish, *H. scabra* var. *versicolor,* in the fishery. As discussed above, this species has recently been recognised in Qld waters and is considered to be more vulnerable to overfishing than the sandfish. DEH therefore recommends that the research and monitoring program should also determine whether the golden sandfish is present in the fishery. DEH considers that if *H. scabra* var. *versicolor* is found in the fishery, precautionary management measures should be implemented to ensure the sustainability of golden sandfish. Further, all recommendations made in this report will apply to the management of golden sandfish.

Recommendation 3: *Within 2 years DBIRD to develop and implement a robust research and ongoing monitoring program to inform more accurate assessments of stock abundance of target and byproduct species and inform performance measures for the fishery. The research and ongoing*

monitoring program will also aim to determine whether a second species of sandfish, H. scabra *var.* versicolor*, is present in the fishery.*

DEH encourages DBIRD to investigate the feasibility of conducting research on genetic connectivity between populations, recruitment rates, growth rates, longevity, mortality rates and possible ecosystem impacts arising from the fishery.

Overall, given the range of fishery dependent data gathered by DBIRD and the commitment to undertake research and an onboard observer program, DEH considers that there is a reliable information collection system in place appropriate to the scale of the fishery. Continuation of existing data collections and research programs, combined with further extension and refinement of such activities will be vital to the future management of the fishery.

Assessment

The performance of the fishery is reviewed annually and reported through the publication of an annual fishery status report and at meetings of the NAFMW. The fishery status report provides current information on catch, effort, stakeholder participation, research, compliance and management together with major issues that have occurred throughout the year. As of the 2004 reporting year, status reports will report on objectives, performance indicators and triggers and how the fishery is performing against those criteria. DEH strongly supports this transparent reporting process. The status reports are provided to major stakeholders and representative groups and are available on the DBIRD Group website.

No formal stock assessment has been conducted for the fishery. Public comment suggested that yearly stock assessments be conducted for the fishery. While DEH agrees with the need for stock assessments, resources are currently limited for such a program. DEH considers that research and ongoing monitoring programs (as outlined in Recommendation 3) will provide more accurate assessments of stock abundance and subsequently inform performance measures for the fishery.

Apart from data collected through logbooks, little is known about the distribution and spatial structure of stocks. Logbook data provided in the submission indicates a small decrease in catch per unit effort (CPUE) from 1995 to 2001.

Trepang are generally at risk of overexploitation and localised depletion due to their limited dispersal, patchy distribution, ease of collection, slow recovery of species from overfishing and limited information on biological and spatial distribution available for management. In the absence of a robust stock assessment, CPUE can be used as a tool for determining the health of a fishing resource. A decrease in CPUE can indicate a decrease in stock abundance and possibly overfishing of the resource. DBIRD states that the decrease in CPUE is expected in a developmental fishery, where fishers are refining harvesting processes and locations and that catch rates are sustainable. DEH is concerned with the decrease in CPUE, particularly given the vulnerability of beche-de-mer to overfishing, and has made a recommendation to ensure that research is conducted to provide a robust stock assessment of trepang to ensure the sustainable management of the fishery (Recommendation 3).

The fishery is currently zoned into two inshore fishery management areas and an offshore zone that is completely closed to harvesting. The interrelationship between the inshore and offshore stocks is not fully understood, however research has indicated that there is genetic mixing of trepang between the inshore and offshore areas. A study by Uthicke and Benzies (1998) indicated that juvenile sandfish may settle in inshore seagrass beds and later migrate offshore to deeper waters to spawn. DBIRD considers that, as these deeper waters are below fishable depths, the offshore area is

considered a safeguard for the fishery, providing permanent protection to sexually mature animals. DEH considers that, while the offshore area may provide a safeguard for mature animals, the inshore area must be managed in a precautionary way to ensure that there is sufficient migration to allow sexually mature animals to spawn.

Although the offshore area provides some safeguard for the target species on a large scale, localised depletion on a small scale is a concern in trepang populations. Large numbers of specimens can be harvested easily from a small location and, due to the limited ability of trepang to spawn across a large distance, recruitment to the area may not occur again. Localised depletion can have a major effect on the wider ecosystem as well as on the target species itself (as discussed in Principle 2). Management response to the risk of localised depletion is discussed in further detail below.

Removals by the recreational and indigenous sectors are insignificant. Estimates of removals are provided by NT recreational fishing surveys (which had an indigenous component in 2002) and daily logbook returns by Fishing Tour Operators. No harvest has been reported in either of these reports. DEH expects that DBIRD will factor harvest of trepang from the recreational and indigenous sectors into management arrangements, should they occur in the future.

Byproduct is not currently taken in the fishery. DBIRD advises that there have been no reports of at sea discarding of trepang, or reports of illegal activity in NT waters. DBIRD considers that any potential illegal take of trepang by international fishers would be outside of the fishery and therefore does not pose a threat to the fishery. DEH expects that DBIRD will continue to monitor illegal activity in regard to the trepang fishery and implement management action if significant take is detected.

Management response

The NT Trepang Fishery management regime aims to maintain ecologically viable stock levels through a range of input and output controls. These measures were outlined in Table 1 and Part I of this report.

DEH considers that the combination of input and output controls should ensure adequate protection of the target stocks in the short term, but is concerned that no management strategies have been implemented to control the level of take to ensure the longer term sustainability of the fishery. DEH is further concerned that the lack of knowledge on the general biology and ecology of the target species may have the potential to seriously undermine the effectiveness of DBIRD management strategies. A number of recommendations have been made throughout this report to address these concerns, with a number already being undertaken by DBIRD.

The NT Trepang management regime contains a series of management objectives, performance indicators, reference points and management responses as outlined in Table 2.

Table 2 – Management Objectives, Performance Indicators, Interim Trigger Points and Management Actions used in the NT Trepang Fishery

Species/Group	Management objectives	Performance indicators (valid for life of plan)	Interim Limit reference point	Management response to be taken
Target species	Ensure intergenerational equity by maintaining ecologically sustainable annual catches in all sectors	1. Sustainable yield estimates developed 2. Change in total catch 3. Change in CPUE 4. Change in average weight 5. Change in catch composition 6. Change in licence ownership	1. Triggers to be refined when yield estimates developed 2. Total catch increases to over 640 t/year 3. The rolling three year CPUE average varies by a factor of 30% 4. Weighted average decreases by more than 20% 5. Catch of trepang species other than *H. scabra* increases to over 30% of total catch 6. Any licences traded	• Director to be notified within 60 days if trigger reached • An internal examination of cause and implication of reference point being triggered with report prepared within six months to Director • Consultation with industry and other stakeholders on need for alternative management strategy or action if necessary and agreement on line of action • If appropriate, any amended arrangements to be implemented within 12 months of trigger being reached.
Byproduct species	Ensure sustainability of byproduct species taken in the NT Trepang Fishery	1. Monitoring logbook 2. Ongoing monitoring	N/A – no byproduct in fishery	N/A
Bycatch species	Ensure sustainability of bycatch species taken in the NT Trepang Fishery	1. Onboard monitoring 2. Monitoring logbook	N/A – no bycatch in fishery	N/A
Endangered, threatened or protected species and/or communities	Ensure the continued protection of species and communities listed under the *EPBC Act 1999* and *Territory Parks and Wildlife Act*	1. Endangered, threatened or protected species and or communities are identified in NT waters 2. Onboard monitoring 3. Monitoring logbook	1. Identifiable impacts observed by commercial fishers, observers or other agencies regarding EPBC listed species or communities 2. Any relevant new species or communities listed	• Director to be notified within 60 days if trigger reached • Consultation with stakeholders and agreement on line of action regarding the implementation of threat abatement plan if required. • Amended arrangements to be implemented within 12 months of trigger being reached.
Ecosystem components	Minimise effects on ecosystem components	1. Identification of any threatening professes 2. Onboard monitoring	Identification of significant negative interaction with components of the natural ecosystem present on fishing grounds	• Director to be notified within 60 days if trigger reached • Consultation with stakeholders and agreement on line of action regarding

				appropriate remedial action • Amended arrangements to be implemented with 12 months of trigger being reached.

Taken from the NT submission: ***Assessing the Ecologically Sustainable Management of the Northern Territory Trepang Fishery,*** **October 2004**

DEH notes that Performance Indicator 1 for Target Species (Sustainable yield estimates developed) has not yet occurred in the fishery. DEH considers that these estimates are important to the management of the fishery, particularly as there is currently very limited understanding on the stock status and sustainability of trepang within the NT. DEH therefore recommends that DBIRD develop sustainable yield estimates based on information obtained from the research program, in accordance with the interim management arrangements for the fishery.

Recommendation 4: *DBIRD to develop sustainable yield estimates for the NT Trepang Fishery within 2 years.*

A Total Allowable Catch (TAC) has not been set on the level of take in the fishery. A PhD was undertaken in 1995, which estimated a Maximum Sustainable Yield (MSY) of 169 t with a suggested TAC of 122 t for the fishery (Carter 2001). These estimates were not adopted into the management of the fishery, as the findings of the study were not within 95% confidence limits.

Under the management arrangements for the fishery, management action is triggered if the harvest of trepang exceeds 640 t/year. DBIRD state that this level equates to twice the highest reported catches taken since 1992 and allows for continued growth in the fishery, within what is considered to be a sustainable harvest level. DEH is concerned that this reference point does not take into account available research on the sustainability of the target stock and is not sufficiently precautionary to ensure the ecological sustainability of the fishery.

Further, DEH considers that the reference points relating to the levels set for total catch, rolling three year CPUE, weighted average decreases and the catch of byproduct beche-de-mer species outlined in Table 2 have been set too high to allow the precautionary management of the fishery. This is a particular concern for the rolling CPUE limit, as the CPUE for the fishery has decreased in recent years, indicating that harvest from the fishery may not be sustainable at current levels. The reference points and the lack of an enforceable TAC that reflects the most recent research on NT trepang stocks were also raised as a concern during the public comment period.

DEH recommends that DBIRD review the interim reference points for the fishery and implement revised reference points to ensure that they provide a precautionary basis to detect impacts and changes to the target stock. The review should consider further implementation of effort limits for the fishery and must be commensurate with available research on trepang stock sustainability in Australian beche-de-mer fisheries (including research conducted in the Northern Territory) and the biological characteristics of the target species.

Recommendation 5: *Within 6 months DBIRD to review the current interim limit reference points for sandfish and implement revised limit reference points, to ensure that they provide a precautionary basis to detect changes and impacts to the target stock. The review will take into account available research on trepang stocks of Australian beche-de-mer fisheries (including research conducted in the NT) and the biological characteristics of the target species.*

As outlined above and in Part II, localised depletion is a potential concern in all trepang fisheries. At this stage DBIRD considers that management arrangements in place for the fishery are sufficient to prevent localised depletion and that, because all licences are owned by the one operator, harvesters in the fishery voluntarily move on to a new site when stock at a site is no longer returning high harvest rates, therefore allowing individuals left on the site to spawn. Nevertheless, the industry funded research program is in part aimed at identifying the risk to localised depletion for the NT Trepang fishery as a further precaution.

DEH considers that the risk of localised depletion of trepang on the target stock and on the wider ecosystem has not been adequately addressed in management arrangements or by the voluntary "move on" procedures. DEH further considers that the scale of reporting is currently too large to provide an accurate view of fishing effort, and therefore potential for localised depletion in the fishery. A number of public comments also raised concerns regarding localised depletion and the lack of fine spatial scale reporting to provide a more accurate picture of stock status, abundance and effort in the fishery. The use of Global Positioning Systems (GPS) or Vessel Monitoring Systems (VMS) to assist with data collection was suggested, as was a network of localised "no take zones" as a means of providing a buffer and a source of larvae for fished areas.

DBIRD has committed to investigating and possibly implementing the use of GPS or VMS data in the fishery. DEH supports logbook reporting on a finer spatial scale than that currently in place and recommends that DBIRD implement an improved reporting system, which could include VMS technology.

DEH also recommends that DBIRD develop and implement management measures to mitigate the risk of localised depletion of trepang in the fishery, to protect the target stock and the wider ecosystem. DEH concurs with public comment received for the fishery, which suggested that these management measures should be developed in consultation with local indigenous communities, conservation groups and industry.

Recommendation 6: *DBIRD to develop and implement finer scale data collection and reporting and management measures to mitigate the risk of localised depletion of trepang in the fishery. These measures will be developed and implemented in consultation with local indigenous communities, conservation groups and industry.*

Public comments submitted for the fishery suggested that a new approach to modelling the effects of fishing and spawner density by Professor Craig Johnson would be useful to apply to the beche-de-mer fishery, to assist with the prevention of localised depletion and to improve understanding of the importance of spawning density to trepang populations. DBIRD has committed to obtaining further information on this new model to investigate whether adequate information can be collected to use such a model.

While DEH considers current limit reference points inadequate for the sustainable management of the fishery (Recommendation 5), the management regime contains appropriate management responses for breaches of trigger points in the fishery (see Table 2).

The fishery currently targets a single target species, sandfish, although other Holothurians may be targeted in the future. Size limits are specified for the take of these beche-de-mer species (as outlined in Table 1). While the size limits specified for NT Trepang are similar to those set for the Torres Strait Beche-de-mer Fishery, they vary significantly from limits imposed in Queensland beche-de-mer fisheries and are set at levels below, or extremely close to, the estimated size of sexual maturity, as outlined in Table 3.

Table 3: Comparison of size limits across NT, Qld and Torres Strait beche-de-mer/trepang Fisheries

Species	Estimated size at first maturity	NT MLS Limits	Qld MLS Limits	Torres Strait MLS Limits
Holothuria scabra (Sandfish)	15 cm	16 cm	20 cm	18 cm (take is not currently permitted)
Holothuria atra (lolly fish)	12 cm	12 cm	20 cm	15 cm
Holothuria whitmaei (black teat fish)	26 cm	26 cm	30 cm (take is not currently permitted)	25 cm (take is not currently permitted)
Holothuria nobilis (white teat fish)	32 cm	32.4 cm	40 cm	32 cm
Actinopyga echinites (deep water red fish)	12 cm	12 cm	20 cm	12 cm
Thelenota ananas (prickly red fish)	34.5 cm	30 cm	50 cm	30 cm

DEH considers that size limits currently set for the NT Trepang Fishery do not adequately take into account available evidence on size at first maturity and therefore do not achieve the management objective of protecting a proportion of the spawning stock. DEH therefore recommends that DBIRD review the current size limits of target and byproduct species to ensure that they are set in a precautionary manner consistent with available research on the size of first maturity of trepang species and management in other beche-de-mer fisheries.

Recommendation 7: *DBIRD to review the current size limits on target and byproduct species to ensure that they are set in a precautionary manner consistent with available research on the size at first maturity of trepang species and with management in other Australian beche-de-mer fisheries.*

DEH considers that the interim limit reference points set for the take of "other species" (triggered at 30% take of "other species") is not sufficient to adequately protect the species of beche-de-mer in the fishery, particularly in the case of black teat fish, which has experienced serious decline in other Australian fisheries. Public comment also raised concerns about this issue. DEH understands that no other species is currently being taken in the fishery but recommends that within 2 months of a species other than *H. scabra* being harvested, DBIRD will develop a species-specific trigger point for that species. This approach will be taken for any species other than *H. scabra* harvested in the future.

Recommendation 8: *Within 2 months of a species other than H. scabra being harvested, DBIRD to develop a species-specific trigger point for that species.*

Conclusion

DEH considers that the management regime in the NT Trepang Fishery provides for the fishery to be conducted in a manner that does not lead to over-fishing in the short-term but is concerned that the information collection system and management arrangements require further refinement to ensure the sustainable management of the fishery in the long term.

DEH considers that there is scope to further refine some of the existing information collection, assessment and management responses and has provided a number of recommendations for improvements in the longer term.

Promote recovery to ecologically viable stock levels

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

This objective is not applicable to the fishery at present. Trigger points and management responses are in place to avoid the risk of overfishing the trepang stocks of NT. DEH has serious concerns in relation to these trigger points and has made recommendations to ensure that the management arrangements are capable of detecting and remedying any significant decline in stock abundance.

Public comment raised concerns that restocking may be considered if the target stock becomes overfished. DBIRD states that restocking is not currently being considered for the fishery and will not occur without appropriate research on best practice methods. DEH does not support restocking as a management response to overfishing and expects that DBIRD will inform DEH during the early consideration of restocking in the fishery.

Conclusion

DEH considers that the NT trepang stock is not currently below a defined reference point but is concerned that management arrangements are not currently sufficient to detect declines in stock abundance. DEH considers that the implementation of recommendations made in Principle One will be essential to ensure the ecologically sustainable management of the fishery in the long term.

Ecosystem impacts

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

Bycatch protection

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

Information requirements

Due to the highly selective nature of the fishery (hand collection of live individual specimens) bycatch is limited to commensal organisms such as pearl fish living on or within the trepang. Compulsory logbook catch data and market logbooks have not reported any take of non-target species. The proposed observer program should confirm the extent of any bycatch implications for the fishery.

Assessment

Bycatch species (apart from commensal organisms) are not taken in the NT Trepang Fishery. As a result no risk assessment has been conducted. The proposed observer program should confirm the assumptions about bycatch.

Management response

No bycatch species are taken in this fishery, other than commensal organisms. Accordingly, no management measures are imposed in the fishery. Public comment suggested that the research

program should be broadened to gather information on any bycatch species, including commensal organisms, taken in the fishery. DBIRD advises that resources are limited for research and that research on impacts to bycatch species may be undertaken if resources become available in the future. DEH considers that possible impacts to bycatch species have been minimised.

Conclusion

DEH considers that there is a high likelihood the fishery is conducted in a manner that does not threaten bycatch species. Should this situation change, or the proposed observer program indicate otherwise, DEH expects that DBIRD would undertake appropriate actions to ensure that bycatch species are not threatened by this fishery.

Protected species and threatened ecological community protection

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

Information requirements

Protected species occurring in the fishery area include crocodiles, turtles, sharks and cetaceans however there have been no interactions reported to date. Information has been provided to all NT fishers outlining the requirements to report interactions with threatened species under the EPBC Act. A leaflet on interactions with protected species and a threatened species list was also distributed with updated logbook sheets that allow reporting of interactions.

Assessment

Given the minimal impact, highly selective and benign fishing method used in the fishery, the most likely negative impact on protected species would be boat strikes. There have been no reported interactions to date.

There are no threatened ecological communities occurring in the area.

Management response

No measures to manage the impact of the fishery on protected species and ecological communities have been developed due to the highly selective and benign fishing method employed in the fishery.

The proposed observer program will enable onboard monitoring of the NT Trepang Fishery and provide monitoring data, suitable for providing information to validate the assumption that there is nil impact by the fishery on endangered, threatened or protected species.

Conclusion

DEH notes that there have been no reported interactions with protected species in this fishery and considers that 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. Should this situation change, or the observer program indicate otherwise, DEH expects that appropriate actions will be undertaken to ensure the fishery avoids mortality and/or injury to these species and avoids or minimises impacts on threatened ecological communities.

Minimising ecological impacts of fishing operations

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

Information requirements

Research regarding ecosystem impacts is not available for this fishery due to its relatively small size and limited number of participants. Impacts to the ecosystem are believed to be low due to the relatively benign method of collection and wide distribution of harvest.

Assessment

As in most hand collection fisheries, the potential of the NT Trepang Fishery to impact unacceptably and unsustainably on the environment generally is considered to be low. As a consequence, DBIRD has not conducted a risk assessment of these issues in the fishery.

Fishing gear is not regarded as posing a significant risk to the physical environment in the fishery as harvesters are limited to hand collection only, with the assistance of SCUBA or hookah breathing apparatus. During collection divers operate from live boats, which are not anchored but move with the diver, therefore minimising impacts of anchoring on the sediment.

The impact of removing beche-de-mer from the ecosystem is not well understood, however it is generally believed that the species play an important role in water quality, benthic communities and structure and productivity flows of the ecosystem. Experimental studies outlined in the public comment period indicate that heavy overfishing can lead to general environmental degradation, including the decrease in occurrence of seagrass beds, which provide important habitat for many species including the endangered dugong. The effects of overfishing are further compounded by the susceptibility of trepang to localised depletion.

Management response

There are no management measures in place in the NT Trepang Fishery to minimise the effects of harvesting trepang on the wider ecosystem. DEH considers that the risk of localised depletion of trepang and subsequent impact on the ecosystem has not been adequately addressed in management arrangements. DEH has made a recommendation to address the issue of localised depletion, which should also address potential ecosystem impacts resulting from localised depletion (Recommendation 6).

In response to public concerns about possible ecosystem impacts, DBIRD has advised that independent or collaborative research opportunities that arise will be undertaken to expand the level of knowledge about the biology and ecology of Holothurian resources of the NT. DEH has made a recommendation (Recommendation 2) to improve cross-jurisdictional cooperation between beche-de-mer/trepang fisheries in efforts to undertake research on key gaps in the knowledge of trepang biology and ecology.

Conclusion

DEH considers that the fishery is conducted in a manner that minimises the impact of fishing operations on the ecosystem generally. A recommendation has been developed (Recommendation 6) to ensure that the risk of significant impact by the fishery on the marine environment generally is minimised in the longer term.

REFERENCES

Battaglene S.C. (1999) – Culture of Tropical Sea Cucumbers for the purposes of stock restoration and enhancement. **In:** *The Conservation of Sea Cucumbers in Malaysia, Their taxonomy, Ecology and Trade – Proceedings of an International Conference.*

Carter, J.L. (2001) – Collaborative ecological research with indigenous Australians; the trepang project. Ph.D. Thesis, Northern Territory University Darwin. pp 486.

Hamel, J.F, Conand C., Dawson D.C. & Mercer A. (2001) – The Sea Cucumber, Holothurian scabra. Its exploitation as Beche De Mer.

MacKnight C.C. (1976) – The Voyage to Marege: Macassan Trepangers in Northern Australia.

Rowe, F.W.E., and Gates, J. (1995) – Zoological Catalogue of Australia. Vol 33. Echinodermata. CSIRO Publishing Melbourne.

Skewes T., Dennis D. & Burridge C. (2000) – Survey of H. scabra (Sandfish) on Warrior Reef, Torres Strait, January 2000.

Skewes, T.D., Dennis, D.M., Koutsoukos, A., Haywood, M., Wassenberg, T. and Austin, M. (2002) – Research for Sustainble Usage of Beche-de-mer Resources in Torres Strait. Annual Report to TSFSAC #37; October 2002. CSIRO Division of Marine Research.

Uthicke S. and Benzies J (1998) – Improving the Conservation Management of the commercial sea cucumber *(H. scabra)* sandfish.

Uthicke S. and Benzies J (2001) – Management of harvest fisheries: Population genetic analyses suggest different management strategies for two commercially important holothurian species. Changes in the Marine Environment. Abstract from proceedings of the 2001 meeting of the Australian Marine Sciences Association and the New Zealand Marine Science Society 3-6 July Townsville. **In:** *Commission Beche-de-mer Information Bulletin 15:35*

Vail L (1989) – Trepang resources surveys Melville Islands, Gove Harbour, Crocker Island. Funded by the Department of Industries and Development and Northern Territory Fisheries. pp 43

LIST OF ACRONYMS

ACC – Aboriginal Consultative Committees
ARUG – Aquatic Resource User Group
CITES – The Convention on International Trade of Endangered Species
CPUE – Catch per unit effort
DBIRD – The Northern Territory Department of Business, Industry and Resource Development
DEH – The Department of the Environment and Heritage
EPBC Act – *The Environment Protection and Biodiversity Conservation Act 1999*
GPS – Global Positioning System
MARPOL – International Convention for the Prevention of Pollution from Ship
MSY – Maximum Sustainable Yield
NAFMW – Northern Australian Fisheries Management Workshop
NRIFS – The National Recreational and Indigenous Fishing Survey
NT – Northern Territory
PFMEU – NT Police Marine Fisheries Enforcement Unit
SCUBA – Self Contained Underwater Breathing Apparatus
TAC – Total Allowable Catch
UNCLOS – United National Convention on the Law of the Sea
VMS – Vessel Monitoring Systems
WTO – Wildlife Trade Operation