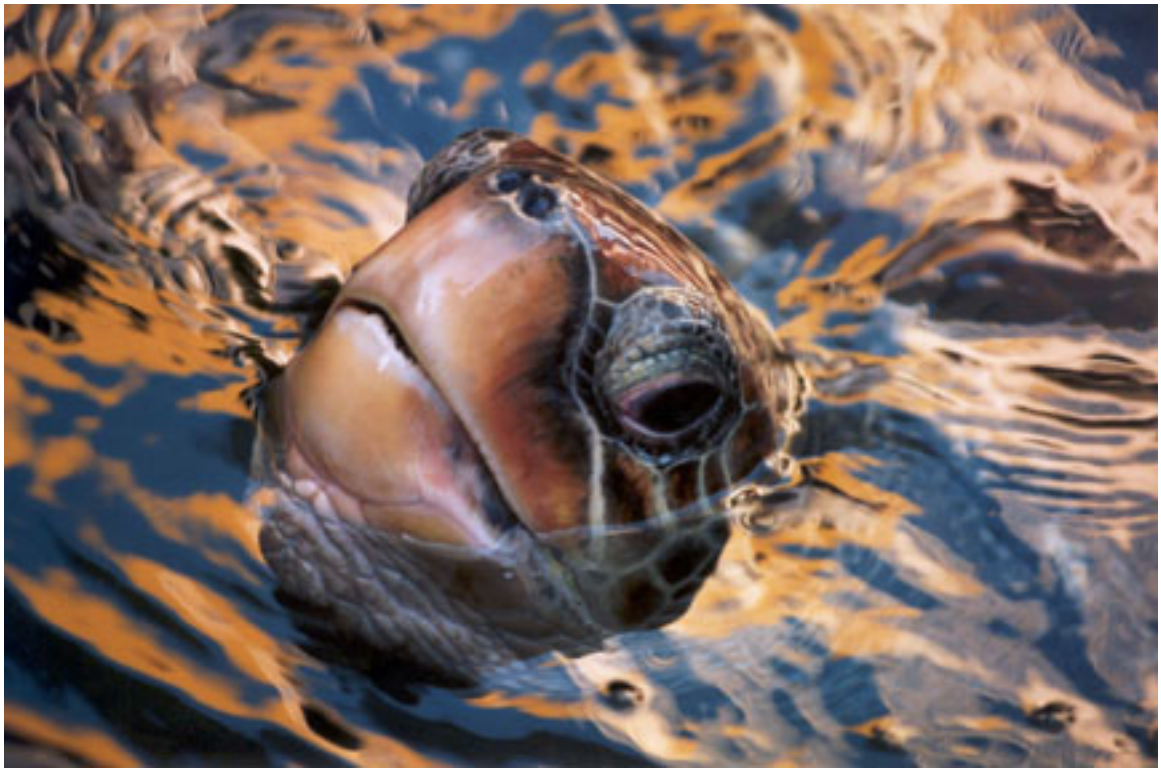

Recovery Plan for Marine Turtles in Australia

Prepared by the Marine Species Section
Approvals and Wildlife Division, Environment Australia
in consultation with the Marine Turtle Recovery Team

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Environment Australia

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Cover Image
Marine Turtle by Trevor J Ierino

Contents

Tables

Maps

Recovery Team Membership

The list below has been compiled from the three meetings held to discuss and develop this plan. Representation at the meetings was determined by each jurisdiction, but was subject to some changes depending on the location and timing of each meeting.

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Environment Australia would like to thank all members of the Recovery Team, who often laboured under difficult conditions.

Members or groups of members and colleagues from within their industries or government sectors have drafted many sections of this plan. Dr Colin Limpus prepared the biological descriptions of marine turtles and collated the information presented in the mortality tables. Peter Pender (Northern Land Council) and Bill Risk (Larrakia Nation) provided valuable insights during the Recovery Team meeting in Darwin.

Although there were no representatives from Tasmania on the Recovery Team, Rosemary Gales, Sally Bryant and Catherine Bone of the Department of Primary Industries, Water and Environment – Nature Conservation Branch and Gwen Fenton, Marine Environment Section, Department of Primary Industries, Water and Environment, provided the information on marine turtles in Tasmania.

Glossary

AFFA	Agriculture, Fisheries and Forestry-Australia
AFMA	Australian Fisheries Management Authority
AMSA	Australian Maritime Safety Authority
APPEA	Australian Petroleum Production and Exploration Association
ASIC	Australian Seafood Industry Council
BRDs	Bycatch reduction devices
CALM	Department of Conservation and Land Management, Western Australia
CMS	Convention for the Conservation of Migratory Species of Wild Animals (also known as the Bonn Convention)
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CSIRO	Commonwealth Scientific and Industrial Research Organisation
EA	Environment Australia
ECOTF	East Coast Otter Trawl Fishery
EIS	Environmental impact statement
ENSO	El Niño Southern Oscillation
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ESSS	Endangered Species Scientific Subcommittee
ESP Act	*Endangered Species Protection Act 1992*
FEMR	Fisheries Environmental Management Review
GBR	Great Barrier Reef
GBRMP	Great Barrier Reef Marine Park
GBRMPA	Great Barrier Reef Marine Park Authority
GoC	Gulf of Carpentaria
ICC	Islander Coordinating Council
IUCN	International Union for the Conservation of Nature and Natural Resources
mtDNA	Mitochondrial DNA
NPF	Northern Prawn Fishery
NPWS	National Parks and Wildlife Service
NSW	New South Wales
NT	Northern Territory
NTDBIRD	Northern Territory Department of Business, Industry and Resource Development
NTDPIF	Northern Territory Department of Primary Industry and Fisheries
NTU	Northern Territory University
NWS	North West Shelf
PWCNT	Parks and Wildlife Commission of the Northern Territory
PZJA	Torres Strait Protected Zone Joint Authority
QEPA	Queensland Environment Protection Agency (includes Queensland National Parks and Wildlife Service)
QFS	Queensland Fisheries Service
QDPI	Queensland Department of Primary Industries
Qld	Queensland
QLGA	Queensland Local Government Association
QSIA	Queensland Seafood Industry Association
RMTP	Regional Marine Turtle Program (SPREP)
SPREP	South Pacific Regional Environment Program
TED	Turtle excluder device
TDPIWE	Tasmanian Department of Primary Industries, Water and Environment
TSSC	Threatened Species Scientific Committee
TSPZ	Torres Strait Protected Zone
WA	Western Australia
WAMTP	Western Australian Marine Turtle Program

Summary

Current Species Status

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) came into force on 16 July 2000 and the list of threatened species under that Act was gazetted in August 2000. All six species of marine turtle identified in this recovery plan are included on that list. The EPBC Act identifies the need to prepare a Recovery Plan and specifies the content of that plan for threatened species listed under the Act. Despite status varying from species to species and country-to-country, global decline of marine turtle populations has been recognised by the World Conservation Union (IUCN) through the assigning of Endangered status to all species except the hawksbill and leatherback turtles, which are listed as Critically Endangered, and the flatback turtle, which is listed as data deficient. Similarly, the Convention for the Conservation of Migratory Species of Wild Animals (CMS) and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) acknowledge the decline in global populations of marine turtles by listings in their appendices. These listings on the CMS provide protection of marine turtles by nations that are parties to the conventions while CITES controls international trade in listed species.

Habitat Requirements, Threats and Limiting Factors

This plan has identified five different habitat types that marine turtles use at different stages of their lives, which are all shared by people to varying extents. These are: the natal beach; mating areas; inter-nesting habitat; feeding areas; and pelagic waters. Ideally marine turtle habitats should be free from human influences that can kill, injure or disable a turtle. Marine turtles are long-lived, slow to mature and are subject to a number of threats. If these threats persist, they will threaten the integrity of wild populations of marine turtles in Australia. The main threats are identified as:

- the bycatch of marine turtles in fisheries;
- unknown levels of harvest by indigenous Australians and unsustainable levels of harvest by people in neighbouring countries of the Asia/Pacific region;
- predation of turtle eggs by native and introduced animals;
- coastal development;
- deteriorating water quality;
- marine debris; and
- loss of habitat.

The actions in this plan aim to reduce the impact of these influences and to increase survival rates, particularly of adults and large immature turtles that will soon become part of the breeding population. Some threats will not be abated quickly but some such as prawn trawling can be resolved largely through the use of appropriate technology such as turtle excluder devices (TEDs). The process to assess otter trawling as a key threatening process added to the impetus to implement TED technology and the successful listing as a key threatening process under the EPBC Act permits the assessment of the introduction of the technology on Australian prawn fisheries over time. Populations of marine turtles that breed in Australia, migrate to feed in other jurisdictions within the Asia/Pacific region, where resident populations have declined. Genetic analysis and an understanding of the level of harvest within Australian and the Asia/Pacific region, together with a consistent approach to marine turtle management in the Asia/Pacific region would benefit what are currently considered globally significant populations.

Recovery Objectives

In the absence of detailed information about populations of marine turtles in Australia, this plan has adopted a threat-based approach. The premise is to reduce the likelihood that current threats will cause mortalities, or to modify activities to reduce the potential for future mortalities at all stages of a marine turtle's life, and to ensure that traditional harvest of marine turtles by indigenous Australians and Torres Strait Islanders is ecologically sustainable. The overall recovery objective is as follows.

To reduce detrimental impacts on Australian populations of marine turtles and hence promote their recovery in the wild.

Recovery activities are directed at improving the conservation status of species to the extent that they no longer need to be listed as endangered or vulnerable. In the absence of historical data, recovery goals cannot be established for populations of marine turtles. An exception is the east coast population of loggerhead turtles for which recovery objectives have been set. Monitoring programs should eventually provide information on which to make these judgements, however, a reduction in the mortality will increase the current survival rate of marine turtles across their range. Monitoring programs established in each jurisdiction will be able to identify any reductions in mortality, the effectiveness of management measures to reduce mortality and subsequent increases in populations over the medium to long term. The specific objectives are to be achieved within the five-year life of the plan. These objectives have the principal aims of reducing or managing factors that cause mortality in marine turtles, and seeking information that will assist in making judgements about the security of marine turtle populations in Australia. The specific objectives are as follow.

A. To reduce the mortality of marine turtles and, where appropriate, increase natural survivorship, including through developing management strategies with Aboriginal and Torres Strait Islander communities for the sustainable use of marine turtles.
B. To develop programs and protocols to monitor marine turtle populations in Australia, assess the size and status of those populations, the causes of their mortality and address information gaps.
C. To manage factors that affect marine turtle nesting.
D. To identify and protect habitats that are critical for the survival of marine turtles.
E. To communicate the results of recovery actions and involve and educate stakeholders.
F. To support and maintain existing agreements and develop new collaborative programs with neighbouring countries for the conservation of shared turtle populations.

Actions and Recovery Criteria
To fulfil these objectives, actions are designed to identify and reduce threats to marine turtles, determine levels of mortality and reduce that mortality. The need to make informed decisions based on the best available information is acknowledged as a principal activity of this plan. A table showing the relevant actions and recovery criteria are shown within the text describing each threat.

The Recovery Team noted the continued decline of the eastern Australian population of the loggerhead turtle and identified the need for its conservation to be implicit in all actions.

The recovery of marine turtles will take time. The assessment of the actions against the criteria for success is essential for the successful recovery of the species of marine turtles identified in this plan.

Estimated Cost of Recovery
The estimated costs are $5.64m over a five-year period. The priority of each action, the feasibility and the estimated cost for each action is identified.

Biodiversity Benefits
The benefits to biodiversity of the actions identified in this plan will include:
- the bycatch of other large marine vertebrates will be reduced with the introduction of turtle excluder devices;
- the effective management of bycatch in fisheries will benefit other marine species;
- the protection of marine turtle habitat will benefit seagrass and shallow continental shelf communities, and those species found on the natal beaches;
- the identification and targeting of sources of marine debris will benefit other marine vertebrates; and
- the control of pests that prey on marine turtle eggs will also reduce predation pressure on other target species within the terrestrial communities on the natal beaches.

Part 1. Introduction

There are currently six species of marine turtle recognised in Australia, all of which are on the lists of threatened species under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). As a consequence of these listings, a recovery plan must be prepared that identifies the objectives, criteria and actions for the recovery of each species.

Data sets identifying long-term trends in marine turtle populations are few. Much of the biological information in this plan has been generated by the Queensland Environment Protection Agency's Queensland Turtle Research Project and to a lesser extent the Western Australian Marine Turtle Project and data from the Parks and Wildlife Commission of the Northern Territory.

There is no doubt that a range of impacts potentially threatens marine turtles across their distribution. However, because of a scarcity of long-term data, the impact at the species and population level of many of these potential threats is difficult to determine. This plan aims to reduce known threats, rather than focusing on the recovery of populations, and should reduce the mortality from human induced sources and thus improve the long-term chances for recovery in the wild.

The management of marine turtles is difficult because of their complex ecology. The size and status of these populations is difficult to quantify because:

- most of their lives are spent in the marine environment;
- hatchlings disperse throughout entire oceans;
- individuals follow their own migratory path;
- they are highly migratory, crossing Commonwealth, State, Northern Territory and international boundaries;
- only the females return to their natal beach, where they lay several clutches of eggs, and not all females nest each year;
- they are long-lived and slow to mature;
- they occupy different habitats at different stages of their life; and
- they are subject to a wide range of impacts at different stages of their life.

Limpus and Reimer (1994) identified a 50–80 per cent decline in nesting loggerhead turtles in Queensland between the mid 1970s and 1990. The Recovery Team identified this decline as an issue of importance prompting the following guiding statement.

> ***In view of the apparent drastic decline of loggerhead turtles in Australia, the lead conservation and fisheries management agencies in each jurisdiction will make every effort, care and precaution to reduce loggerhead mortality to almost zero.***

This plan identifies the steps necessary to reduce threats and thus begin the national recovery of all the listed marine turtles. Many of the impacts on marine turtles are common across the species and jurisdictions. It is intended that as far as possible the Commonwealth, States and the Northern Territory should address them collectively. The information contained in this recovery plan is based on the best information available at the time of drafting. The management and research actions have been developed accordingly. Relevant information that becomes available after publication of this plan will be incorporated in the review process that will follow implementation of the plan.

Background

Marine turtles arose from an ancient lineage of terrestrial reptiles, developing paddle-like limbs as they adapted to life in the oceans. As a consequence of this lineage, marine turtle females must return to land periodically to lay their eggs in beach foreshores. When hatchlings emerge from their nests they orient to the low light of the horizon and head towards it unless distracted by other lights. Once in the water they will swim at 90° to the wave fronts until clear of the inshore waters. Generally hatchling turtles disappear into oceanic currents and gyres where they will stay until large enough to move out into developmental habitats. There they continue to feed and grow within waters that may well be in another nation's jurisdiction. The exceptions are the flatback turtle, which spends most of its life within the continental waters of Australia, and the leatherback turtle, which spends most of its life in the open ocean.

A marine turtle may take up to 30–50 years to mature. Adults do not breed every year. In a breeding year they migrate over long distances between feeding and nesting grounds and nest a number of times. During the nesting season a female will not normally feed until after the final clutch is laid and she begins the return migration to the feeding grounds. These life history characteristics make marine turtles vulnerable to a range of influences that can affect the integrity of their populations and populations in the wild. A detailed description of each species' ecology in Australia can be found in http://www.ea.gov.au/coasts/species/turtles/index.html

Historically, only indigenous Australians took Australian marine turtles and their eggs, but post World War II Australia established itself industrially, and the economy grew. Marine turtles, particularly the hawksbill and green turtles, were subject to unsustainable harvests for soup, meat or shell until 1971. Increased exploitation of other commercial fish species also resulted in increased bycatch of species including marine turtles. The expanding

Australian population and economy has also exposed marine turtles to increasing mortality through marine debris, boat strike in waters popular for recreational boating, habitat loss, predation of eggs by feral animals, noise, oil pollution, and the continuing harvest in Australia.

Marine turtles' life history traits mean that any high annual take of animals will result in a significant population decline, and historically, they are thought to have undergone a steady and significant decline in Australian waters. This plan seeks to promote cooperative activities within sectors of the community that can reduce impacts on marine turtles and enhance the survival of marine turtles in the wild.

Technical Summary of the Biology of Marine Turtles in Australia

There are two extant families of marine turtles, Cheloniidae and Dermochelyidae, and both occur in Australian waters and breed on Australian beaches. Both families share some common morphological features and life history traits. They live almost their entire lives in the marine environment but must surface to breathe. In common with all extant turtles they have no teeth, their beaks being covered by keratinised sheathes. They have an acute sense of smell but not of taste. They have well-developed eyes with colour vision. Hearing is restricted to very low frequencies.

Females come ashore and lay spherical eggs with flexible calcareous shells containing an embryo developed to the gastrula stage. For successful incubation the eggs must be buried in ventilated, low salinity, high humidity nest sites that are not subjected to flooding or erosion and have a temperature range of 25–33°C. Sex of hatchlings is determined by the temperature of the nest during the middle third of development. Incubation period is a function of nest temperature. There is no parental care of eggs or young. Hatchlings do not feed for the first few days of life but live off the remains of internalised yolk sacs.

Family Cheloniidae

Five of six currently recognised species of cheloniid turtles occur in Australia: *Caretta caretta* (loggerhead turtle), *Chelonia mydas* (green turtle), *Eretmochelys imbricata* (hawksbill turtle), *Lepidochelys olivacea* (olive ridley turtle) and *Natator depressus* (flatback turtle). The genus *Natator* is restricted to the tropical areas of the continental shelf of Australia, southern Irian Jaya and southern Papua New Guinea. The remaining genera have a worldwide distribution in tropical and temperate seas.

Family Dermochelyidae

The family Dermochelyidae is represented by a single extant species, *Dermochelys coriacea* (leatherback turtle). The genus has a global distribution in tropical and temperate seas.

Status of Marine Turtles in Australia

In Australia the hard-shelled marine turtles are largely found in the tropical and subtropical waters of Western Australia, the Northern Territory and Queensland. The leatherback is regularly found in the waters of temperate Australia. All species are protected under State/Territory and Commonwealth legislation (Table 1), however some of these jurisdictions allow the taking of turtles for licensed scientific research, educational pursuits and for traditional subsistence use by people of Aboriginal and Torres Strait Islander descent.

Table 1. Commonwealth, State and Northern Territory legislation that protects marine turtles or identifies their status as needing particular conservation action

Jurisdiction	**Statute**
Queensland	*Nature Conservation Act 1992*
Northern Territory	*Territory Parks and Wildlife Conservation Act 2000*
Western Australia	*Wildlife Conservation Act 1950* *Conservation and Land Management Act 1984*
South Australia	*National Parks and Wildlife Act 1972*
Tasmania	*Threatened Species Protection Act 1995* *Living Marine Resources Management Act 1995*
Victoria	*Wildlife Act 1975* *Flora and Fauna Guarantee Act 1988*
New South Wales	*National Parks and Wildlife Act 1974* *Threatened Species Conservation Act 1995*
Commonwealth	*Wildlife Protection (Regulation of Exports and Imports) Act 1982* *Torres Strait Fisheries Act 1984* *Great Barrier Reef Marine Park Act 1975* *Environment Protection and Biodiversity Conservation Act 1999*

The six species of marine turtle found in Australian waters are listed as threatened species under the *Environment Protection and Biodiversity Conservation Act 1999*. Part 13, Division 1 provides for the listing of species that are considered to be extinct, extinct in the wild, critically endangered, endangered, vulnerable or conservation dependent. The status of each marine turtle species is given in Table 2.

Table 2. Status of marine turtles under the *Environment Protection and Biodiversity Conservation Act 1999*

Common name	Genus, Species	Status
Loggerhead turtle	*Caretta caretta*	Endangered
Olive Ridley turtle	*Lepidochelys olivacea*	Endangered
Green turtle	*Chelonia mydas*	Vulnerable
Hawksbill turtle	*Eretmochelys imbricata*	Vulnerable
Leatherback turtle	*Dermochelys coriacea*	Vulnerable
Flatback turtle	*Natator depressus*	Vulnerable

Sub-populations of most species are recognised, and genetic analysis indicates that these populations can be recognised as distinct geographic units and may ultimately need be managed on that basis. Moritz *et.al.* (1998a & b) provide a summary of this knowledge to date and the major breeding populations are identified in Table 3. Given that the breeding behaviour of marine turtles dictates that the females return to their natal beach or another beach in the area to lay their eggs, should a sub-population become extinct over time, it is unlikely that turtles would use those nesting beaches in the future.

Table 3. Major Australian marine turtle breeding populations identified in Moritz *et.al.* 1998b.

Marine turtle species	Population
Loggerhead	Eastern Australia Western Australia
Green	Southern GBR + Coral Sea Northern GBR Gulf of Carpentaria North West Shelf Scott Reef Ashmore Reef
Hawksbill	North East Australia Western Australia
Flatback	Central Queensland North Queensland Northern Territory Western Australia

International Status of Marine Turtles

The status of marine turtles varies from country to country and depends largely on whether they are given the opportunity to recover after any decline. Marine turtles are considered to be declining globally, despite successful conservation efforts in many countries, including Australia. The IUCN in applying its Red List Categories (IUCN, 2002) determined the status of marine turtles globally. Table 4 lists the status categories. Marine turtles' vulnerability is also recognised by their listing under international agreements such as the Convention for the Conservation of Migratory Species of Wild Animals (CMS, also known as the Bonn Convention) and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

Table 4. Status of marine turtles under the CMS, CITES and IUCN

Common name	Scientific name	CMS Appendix	CITES Appendix	IUCN Status*
Loggerhead turtle	*Caretta caretta*	I & II	I only	Endangered
Green turtle	*Chelonia mydas*	I & II	I only	Endangered
Hawksbill turtle	*Eretmochelys imbricata*	I & II	I only	Critically endangered
Olive Ridley turtle	*Lepidochelys olivacea*	I & II	I only	Endangered
Leatherback turtle	*Dermochelys coriacea*	I & II	I only	Critically endangered
Flatback turtle	*Natator depressus*	II only	I only	Data deficient

* See IUCN Internet site: http://www.redlist.org/

Existing Conservation and Management Measures

Commonwealth

The Commonwealth acts in a number of ways to protect turtles, both as a manager of reserves and a manager of fisheries as well through conservation programs. The Commonwealth provides programs to fund actions for listed threatened species that are the subject of recovery or threat abatement plans. Commonwealth legislation prohibits the export of marine turtles or products derived from them.

One means of protecting wildlife and their habitats has been the declaration of protected area regimes and Australia is a global leader in this field. The Great Barrier Reef Marine Park (GBRMP) is one of the world's most extensive protected areas, protecting significant amounts of marine turtle habitat. The Great Barrier Reef (GBR) is included on the World Heritage List with marine turtles identified in the nomination as one of its natural attributes. Internationally significant populations of green, hawksbill, loggerhead and flatback turtles occur on the GBR. A large number of islands and their adjacent waters are closed to visitation seasonally under management plans or permit conditions restricting access for the purposes of seabird and turtle protection. The Commonwealth also monitors nesting marine turtles and hatching success in the Coral Sea National Nature Reserves, on Field Island in Kakadu National Park and at Ashmore Reef National Nature Reserve.

Hunting by Aboriginal and Torres Strait Islander communities living adjacent to the GBRMP may be undertaken only through a permit as prescribed under park zoning plans. Permits have in the past been granted on a community basis or, in the absence of an identified community organisation, to individuals. There is currently a modelling assessment of the southern GBR population of green turtles to determine if an ongoing harvest is sustainable.

Trawlers operating in the GBRMP incidentally catch marine turtles – the main species being loggerhead, green and flatback turtles (Robins 1995). The bycatch of turtles was part of the justification used to list otter trawling as a key threatening process under the EPBC Act. Approximately 49.6 per cent of the GBRMP is closed to trawling and within the GBRMP the use of TEDs is compulsory. This requirement has been extended throughout the East Coast Otter Trawl Fishery. There is also a requirement for fishers to report all interactions with marine turtles.

The Australian Fisheries Management Authority (AFMA) manages a number of fisheries where there are interactions with marine turtles, notably the Northern Prawn Fishery (NPF). In addition to the compulsory use of TEDs from April 2000 there are area closures in the NPF that provide some measure of protection to turtles. Most areas of inshore seagrass habitat in the Gulf of Carpentaria are permanently closed to trawling. These inshore areas are frequently the feeding grounds of turtle species including the green turtle. Seasonal closures in the NPF may also offer protection to turtles as they coincide with nesting periods for some species. The NPF is seasonally closed from 1 December to 30 March and again from 16 June to 31 July.

Western Australia

Under the Western Australian *Wildlife Conservation Act 1950* the loggerhead and leatherback turtle are listed as threatened species. All other turtles are protected as native fauna. Provision is made in this Act for the take by indigenous people. The Western Australian Department of Conservation and Land Management (CALM) is involved in marine turtle conservation and the Western Australian Marine Turtle Program has been operational since 1985. Most significant rookeries are on island nature reserves but there is a need to develop protocols for the management and use of these sites. A wildlife management program is currently being prepared for marine turtles in Western Australian waters. Research and monitoring activities include:

- long-term monitoring of most major rookeries;
- migration studies;
- estimates of inshore numbers at feeding grounds;
- management of oil field lighting and seismic activities to minimise impact on marine turtles;
- diseases in marine turtles (the petroleum industry has provided support);
- development of interaction with indigenous groups in monitoring programs; and
- salvage of leatherback and other turtles entangled in crayfish pot floatlines in summer.

No reliable figures are available on the bycatch of marine turtles from Western Australian trawl fisheries. Fisheries WA have developed a program and timeframe for the implementation of the Western Australian Policy on Fisheries Bycatch. Development of action plans for the Shark Bay Trawl Fisheries and the Pilbara Trawl Fishery has commenced. Marine turtle bycatch will be addressed with these action plans.

The development of bycatch action plans takes account of potential bycatch issues by separating fisheries into three groups on the basis of the nature and degree of significance of bycatch issues.

- **Priority A** includes all trawl fisheries. This group has been given priority due to the comparatively nonselective nature of this gear type. Fisheries specific bycatch action plans for these will be completed by end of 2001. It is anticipated that the use of TEDs will become compulsory in all prawn trawl fisheries within one year of the completion of the bycatch action plans.

- **Priority B** consists of net and trap fisheries with potentially significant bycatch issues, which may or may not occur in sensitive or socially important environments. These fisheries are to be addressed over two years commencing in early 2002.
- **Priority C** fisheries have been identified as having only minor bycatch issues. Bycatch issues in these fisheries will be addressed through the Fisheries Environmental Management Review (FEMR) process currently being undertaken by Fisheries WA.

Northern Territory

The *Territory Parks and Wildlife Conservation Act 2000* lists marine turtles as protected wildlife. The Northern Territory Government also has a 'Conservation through the sustainable use of wildlife' policy, and on behalf of Aboriginal landholders and others has encouraged research into the production of marine turtles through ranching and captive breeding. The commercial export of products derived from turtles is currently prohibited by the EPBC Act. This Act gives effect to the listing of turtles on the Convention on International Trade in Endangered Species of Fauna and Flora (CITES). The Parks and Wildlife Commission of the Northern Territory (PWCNT):

- has carried out aerial and ground surveys to determine where the high use breeding areas are for marine turtles;
- is identifying and mapping marine habitats;
- has examined habitat use by marine turtles around Coburg Peninsula and monitored and tagged flatback turtles on Greenhill Island between 1995and 1997;
- is monitoring nesting by turtles at Coburg Peninsula and Casuarina Beach in Darwin;
- is working with Dhimurru Land Management Aboriginal Corporation particularly on the ghost netting of juvenile turtles on Cape Arnhem;
- is working with the Northern Land Council to increase cooperation between coastal communities and PWCNT;
- has recently reviewed the status of all turtle species in NT waters with loggerhead classified as endangered and leather back turtles classified as vulnerable; and
- in conjunction with relevant stakeholders, is investigating options for ranching and captive breeding of hawksbill turtles.

The Northern Territory Department of Business, Industry and Resource Development (NTDBIRD) has collaboratively been involved in quantifying marine turtle/fisheries interactions and trialling TEDs and BRDs.

Queensland

Queensland legislation prohibits the taking of marine turtles for commercial purposes. The *Queensland Nature Conservation Act 1992* provides protection for marine turtles, listing them as endangered and vulnerable species. Most significant rookeries for all species in eastern Queensland have been declared protected habitat under this Act. State marine parks such as Woongarra Marine Park and the Moreton Bay Marine Park contribute significantly to turtle conservation. Table 5 identifies the proportion of nesting habitat protected in Queensland (Limpus in litt.).

Table 5. Proportion of marine turtle nesting habitat protected in Queensland

Common name	Scientific name	Proportion protected (%)
Loggerhead turtle	*Caretta caretta*	> 90
Green turtle	*Chelonia mydas*	> 90
Hawksbill turtle	*Eretmochelys imbricata*	?> 30
Olive Ridley turtle	*Lepidochelys olivacea*	nil
Leatherback turtle	*Dermochelys coriacea*	nil (Access controlled)
Flatback turtle	*Natator depressus*	~ 75

Queensland Environment Protection Agency (QEPA) has a well-developed monitoring program for marine turtles with some data sets dating from the late 1960s.

The major elements of the QEPA marine turtle research, monitoring and management program are:

- monitoring
  - tagging census, and
  - stranding database;
- research
  - demographic studies at nesting beaches and feeding areas,
  - population genetics studies,
  - migration studies,
  - incubation/embryological research,
  - El Niño Southern Oscillation (ENSO) regulation of green turtle breeding rate,
  - nutritional studies,
  - health studies, and
  - population modelling;
- management
  - fox baiting to improve loggerhead breeding success, and

– environmental education programs.

Otter trawling in the Queensland East Coast Trawl Fishery (ECTF) has a level of marine turtle bycatch and is also captured by the compulsion of the successful key threatening process nomination under the EPBC Act to deal with that bycatch. A management plan for the ECTF now requires TEDs throughout the fishery. In the deepwater net area TEDs will be required by 31 December 2001. Legislative closures (both permanent and seasonal) provide limited protection for nesting and/or feeding ground turtle populations including shallow inshore seagrass areas.

In the trawl fisheries of northern Australia, there are selected area closures that coincidentally provide a measure of turtle conservation. Many of the area closures are associated with inshore, shallow-water seagrass beds that are frequently the feeding grounds of some turtle species. In the Torres Strait, trawling is permanently prohibited in the area west of Warrior Reef. Seasonal closures are applied to northern Australian trawl fisheries for a variety of reasons, however, many of the closures coincide with nesting times of some turtle species. This provides some level of conservation to nesting turtles. On the Queensland east coast, trawling is prohibited north of 22ºS between 15 December and 1 March and south of 22ºS between 20 September and 1 November. There are also a number of closures specifically implemented to reduce trawl activity in known turtle nesting areas such as a closure at the northern tip of Fraser Island to protected nesting loggerhead turtles.

Code of Fishing Ethics: The Capture of Marine Turtles
The ECTF developed a code of fishing ethics in regard to the capture of marine turtles and to minimise the impact of trawling on marine turtle populations. The major elements of the code are to:

- refrain from trawling within two to three nautical miles of 'major' turtle nesting beaches during the nesting season;
- limit tows to less than 90 minutes in areas of high turtle numbers;
- apply resuscitation procedures where appropriate, and return live turtles to the water as soon as possible;
- forward information on tagged or marked turtles to the Southern Fisheries Centre;
- participate in research programs monitoring the incidental capture of turtles in trawl nets; and
- participate in research programs trialling bycatch reduction devices.

New South Wales
Within New South Wales all marine turtles are protected under the *National Parks and Wildlife Act 1974*. In addition, the loggerhead turtle is listed as endangered and green and leatherback turtles are listed as vulnerable under the *Threatened Species Conservation Act 1995*. Nominations have also been made to list the hawksbill and flatback turtles as threatened under this Act. There are resident groups of hawksbill, loggerhead and green turtles in the waters of northern New South Wales. Regular reports of green turtles in Jervis Bay and in some other more southerly estuaries suggest that some individuals may make regular visits to these southern locations. Resident populations appear to have established in some other estuaries particularly near warm water outfalls. A study is underway in Lake Macquarie on the New South Wales Central Coast to assess the apparently resident populations of several turtle species in the vicinity of warm water outfalls from a power generation facility. A number of loggerhead and flatback turtle strandings have also been reported in the states.

The New South Wales National Parks and Wildlife Service (NPWS) has developed the Marine Fauna Management Database that will enable collection of information on dead, sick or injured turtles found along the New South Wales coast. The New South Wales data will complement the database maintained by Queensland and facilitate information exchange. The New South Wales NPWS has also established a tagging program in New South Wales which enables the collection of information on marine turtles rehabilitated and released following stranding. In addition, guidelines for the rescue, rehabilitation and release of marine turtles have been prepared.

Tasmania
The Tasmanian *Threatened Species Protection Act 1995* lists the loggerhead turtle as endangered and the green, leatherback and hawksbill turtles as vulnerable. Under that Act any of the four listed species found in Tasmanian waters cannot be killed, injured, caught, damaged, destroyed or collected except under permit. Current research and monitoring activities include gathering and collating information, when available on:

- assessment of marine turtle mortality related to the rock lobster fishery;
- assessment of marine turtle distribution at sea (particularly leatherbacks) from information provided by fishers; and
- assessment of the feasibility of tracking entangled turtles after release to determine survivorship and migratory paths.

Victoria
Four species of marine turtle are known to occur in Victorian waters. Three of these occur only as rare vagrants, outside their usual range: loggerhead, green and olive ridley turtles. The leatherback turtle is a regular though rare visitor to Bass Strait. It is mostly a pelagic species and, away from its breeding grounds, is rarely found inshore. Thus, there are no breeding areas or important feeding grounds for marine turtles under Victorian jurisdiction.

In May 2002, the leatherback turtle was listed as a threatened species under the Victorian *Flora and Fauna Guarantee Act 1988*.

Benefits to Nontarget Species

Implementation of this plan will benefit a range of species. For example:

- increased marine turtle numbers will benefit sharks that prey upon them;
- the use of TEDs may benefit sharks and rays taken in otter trawling that would otherwise be killed or injured;
- fishers using TEDs will benefit from the absence of large animals in their nets that crush prawns and endanger deckhands;
- protection of benthic habitats will benefit other animals living in those ecological communities such as dugong that share the same habitat as turtles;
- protection of nesting habitat where terrestrial species will benefit from a land management protection regime; and
- actions in Australian jurisdiction will benefit marine turtles that feed in Australia and migrate to other nations to breed.

Affected Parties

Section 270(2)(g) of the EPBC Act indicates the need to identify organisations likely to be affected by the actions proposed in this plan. A list of affected parties can be found at Appendix 1. The list is not exhaustive and includes organisations represented on the Recovery Team.

Evaluation and Review

Section 270(2)(g) of the EPBC Act states that those who will evaluate the performance of the plan need to be identified. The Recovery Team will carry out an annual evaluation and a report of that review will be forwarded to the Threatened Species Scientific Committee (TSSC).

A review of the plan will be undertaken within five years. The Recovery Team with the possible involvement of independent consultants will carry out the evaluation. The output will be an assessment of the performance of the plan that will be sent to the Minister for the Environment for his/her review (Section 279(2)).

Social and Economic Impacts of the Plan

The decline in marine turtles, if not addressed, will result in economic and social costs. For example:

- The loss of turtles reduces the available bush food for some Aboriginal and Torres Strait Islander communities creating an economic cost related to the provision of alternative food supplies and the loss of the culture and values associated with turtles;
- The decline of nesting will reduce economic opportunities in the nature-based tourism industry (for example Mon Repos, Queensland);
- The decline of turtles represents a loss to those in the community who believe that biodiversity has an intrinsic value;

One of the purposes of the plan is to avoid or minimise these costs. Implementation of the plan will have the following economic or social costs:

- The use of TEDs imposes a small economic cost on fishers. In many cases TEDs have already been fitted but will be offset by more efficient fishing and the promotion of more sustainable fisheries through habitat protection.
- Protection of habitat means that there are costs incurred for its management. Healthier ecosystems, tourism and more sustainable fisheries offset these costs.

Part 2. Objectives, Recovery Actions and Criteria

Introduction
The content of recovery plans is specified in Section 270 of the EPBC Act, which requires that a plan state:

- objectives;
- actions to achieve the objectives; and
- criteria against which the success of the actions are measured.

The Recovery Plan Guidelines (Environment Australia 2000) specify the need for an overall objective and specific objectives. The overall objective is expected to be achieved in the longer term and not within the five-year life of the plan whereas the specific objectives must be achievable within this time. The means for achieving these objectives must also be consistent with the Objects of the Act (Section 3), which include the principles of ecologically sustainable development (Appendix 6), and the efficient and effective use of resources.

Lead agencies are referred to throughout this part as the managers of many actions in the tables that follow. Lead Agencies are those agencies that have primary responsibility for the management and conservation of marine turtles in their jurisdiction. Those agencies are Environment Australia (EA), Great Barrier Reef Marine Park Authority (GBRMPA), Queensland Environment Protection Agency (QEPA), Parks and Wildlife Commission of the Northern Territory (PWCNT), and the Department of Conservation and Land Management, Western Australia (CALM).

Recovery Plan Objective

The overall objective is as follows.

To reduce detrimental impacts on Australian populations of marine turtles and hence promote their recovery in the wild.

Measuring recovery against population data has been identified as problematic, as quantitative historical data are not available to set recovery targets for all populations or populations. The Recovery Plan therefore adopts a threat-based approach to manage sources of marine turtle mortality. There is sufficient information to identify a decline of 50 – 80 per cent over 10-15 years in the eastern Australian loggerhead population (Limpus and Reimer 1994). Limpus (1995) has found that in the 1976 and 1977 nesting seasons approximately 3500 loggerhead females nested on the Queensland coast, whereas 300 nested in 1997. From this information a recovery objective for this population has been developed.

Within 30 years, secure or detect an increasing population of the eastern Australian loggerhead turtle population.
Criteria:

- The population is regarded as vulnerable when 1500 loggerhead turtles nest on the Queensland coast each year; and
- The population is regarded as secure when 3500 loggerhead turtles nest on the Queensland coast each year.

The recovery of Australian marine turtle populations may take decades and can best be achieved through the reduction of current levels of mortality throughout the range of the populations. Long-term monitoring programs will provide the information to identify the specific recovery goals for each species and population.

Specific Objectives

The specific objectives are as follow.

A. To reduce the mortality of marine turtles and, where appropriate, increase natural survivorship, including through developing management strategies with Aboriginal and Torres Strait Islander communities for the sustainable use of marine turtles;
B. To develop programs and protocols to monitor marine turtle populations in Australia, assess the size and status of those populations, the causes of their mortality and address information gaps;
C. To manage factors that affect marine turtle nesting;
D. To identify and protect habitats that are critical for the survival of marine turtles;
E. To communicate the results of recovery actions and involve and educate stakeholders; and
F. To support and maintain existing agreements and develop new collaborative programs with neighbouring countries for the conservation of shared turtle populations.

The prescribed management (M) and research (R) actions to achieve the specific objectives are listed below. The action tables include the criteria for measuring the success of the actions and the achievement of the specific objectives.

Recovery Actions

Specific Objective A.

Reduce the mortality of marine turtles and, where appropriate, increase natural survivorship, including through developing management strategies with Aboriginal and Torres Strait Islander communities for the sustainable use of marine turtles.

1. Bycatch of Marine Turtles in Fisheries

As a case study in marine turtle bycatch mitigation, prawn trawling offers some insights into the documentation of bycatch and the trialling and implementation of measures to resolve the issue. Five species of turtle have been recorded as bycatch in prawn trawls in the Northern Prawn Fishery (Poiner and Harris 1994, Poiner and Harris 1996), and East Coast Otter Trawl Fishery (ECOTF) (Robins 1995; Robins and Mayer, 1998). Estimates of the number caught and drowned in the NPF for 1989 and 1990 and estimated average annual catch in the ECOTF is given in Table 6. Flatback turtles made up the majority of the turtle catch (59 per cent) in the NPF (Poiner and Harris 1996) and loggerheads made up the majority of the turtle catch (50 per cent) in the ECOTF (Robins 1995). It is also notable that in the ECOTF, 80 per cent of turtle captures are derived from three components of the fishery: Moreton Bay (52.9 per cent), tiger prawn (15.6 per cent) and the banana prawn (11.4 per cent).

There are no data available on the mortality from otter trawls in Western Australia but data from the Western Australian Marine Turtle Program (WAMTP) shows that most species are caught (Prince 1998).

Table 6. Numbers of turtles estimated to have been caught and drowned in the Northern Prawn Fishery in 1989 and 1990 (Poiner and Harris 1996) and East Coast Otter Trawl Fishery (Robins 1995)

	1989 - NPF	**1990 - NPF**	**1991-92 ECOTF**
Estimated no. caught	5,503 ± 424 (SE)	5,238 ± 404 (SE)	5,295 ± 1231 (SE)
Estimated no. drowned	567 ± 140	943 ± 187	340
No. trawlers	223	200	900
Turtles per standard net hour	0.0124	0.0101	0.0057

In 1999 the Endangered Species Scientific Subcommittee (ESSS) recommended that the incidental catch (bycatch) of marine turtles during coastal otter trawl fishing operations in Australian waters north of 28ºS be added as a key threatening process on schedule 3 of the ESP Act (ESSS 1999). The ESSS advised that otter trawl fishing operations were adversely affecting two listed marine turtle species and could cause another species to become endangered. However, a drafting error in the ESP Act did not allow the listing of a threat that occurs in both State and Commonwealth waters. The EPBC Act has overcome that deficiency and following consideration by the Threatened Species Scientific Committee (TSSC), 'Incidental catch (bycatch) of Sea Turtle during coastal otter-trawling operations within Australian waters north of 28 degrees South' was listed as a key threatening process, effective 4 April 2001. The committee determined that a threat abatement plan was not necessary given actions already underway.

Fisheries known or thought to have a potential impact on marine turtles are identified in Table 7.

The actions (Table 8) necessary to address turtle bycatch comprise two elements:

- to reduce mortality or risk of mortality in fisheries where bycatch has been identified as a problem (for example NPF and ECOTF); and
- to determine the levels of mortality, if any, in other fisheries (such as long-line, scallop, lobster and gillnet fisheries throughout Australia).

A consistent approach to threat management for marine turtles is needed across the various fisheries. turtle excluder devices (TEDs) were made compulsory in the NPF from 16 April 2000, to reduce mortalities to 5 per cent of levels identified in 1989-90 (Poiner and Harris 1996). A program of monitoring has also been developed to ensure compliance. Similarly, TEDs became compulsory in the East Coast Trawl Fishery on 1 January 2001 with the exception of the deepwater trawl where they will be compulsory from 31 December 2001. The management plan proposes that the catch and mortality of marine turtles will be reduced to 5 per cent of levels identified in 1991-92.

The significant challenge remains to reduce the bycatch of marine turtles across the range of the distribution of species and jurisdictions. For example, much remains unknown about the bycatch of marine turtles in Western Australia and Torres Strait. A two-year program for the trial of TEDs in Shark Bay, Western Australia, is being undertaken and the results will assist in the setting of bycatch reduction targets for Shark Bay Fisheries. Similarly, levels of marine turtle bycatch are not known for gill net fisheries that operate within the range of marine turtles.

The National Policy on Fisheries Bycatch (AFFA 1999) has the objective to ensure that bycatch species and populations are maintained in fisheries managed by the States and the Northern Territory. The Commonwealth Policy on Fisheries Bycatch, (AFFA 2000) has a similar objective and seeks to apply requirements to Commonwealth fisheries managers.

Table 7. Fisheries known to or suspected to have an impact on marine turtles

Jurisdiction and Fishery	Impact Confirmed	Impact Suspected	Fishing method and Area of Operation	Manager
Commonwealth				AFMA
Northern Prawn	Yes (Poiner 1996)		- Otter board trawl fishery between Cape York and Cape Londonderry.	
Torres Strait Prawn	Yes (Robins 1998)		- Demersal otter trawl fishery in the Torres Strait	
Eastern & western tuna and billfish	Yes (unpublished)		- Longline	
Tasmania				TDPIWE
Scalefish	No	Yes	- The major methods of catch are gillnet, hook and beach seine and only occurs inside 3 nm.	
Rock Lobster	Yes (Bone 1998)		-Lobster pot using bait as a lure. A float with a line marks the pot and is used to retrieve the pot.	
Queensland				QFS & QDPI
East Coast Otter Trawl	Yes (Robins 1995)		- Operates in Queensland waters between the Queensland/New South Wales border and Cape York. Multi-species fishery prawns, scallops and finfish through the use of several types of trawl apparatus.	
Crab	Yes (QEPA)			
Line	No	Yes	- Commercial and recreational fishery in Queensland waters. Crab pots and inverted cone dillies.	
			- Commercial line fishing along the Qld coast take a variety of reef species and limited amounts of	
Offshore Mesh Netting	No	Yes	estuary fish. The recreational fishery occurs throughout Qld taking estuarine and reef species. - Offshore mesh nets are used in waters that at all times are deeper than 2 metres.	
Northern Territory				NT DPIF
Coastal Net	No	Yes	- This coastal net fishery extends seaward from the coastline from the high water mark to 3 nautical miles from the low water mark	
Barramundi	No	Yes	- Gear is generally set in shallow waters outside rivers in channels or on the flats	
Fin Fish Trawl	No	Yes	- Demersal trawl in certain waters adjacent to the NT	
Shark	No	Yes	- Pelagic net or longline in three managed regions in all waters of the NT	
Western Australia				Fisheries WA
Shark Bay Prawn	No	Yes	- A demersal otter trawl fishery targeting prawns and limited to central Shark Bay trawl grounds.	
Shark Bay Scallop	No	Yes	- A demersal otter trawl fishery for southern saucer scallops in the Shark Bay trawl grounds.	
Exmouth Gulf Prawn	No	Yes	- A demersal otter trawl fishery targeting prawns and limited to the central part of Exmouth Gulf.	
Onslow Prawn	No	Yes	- Demersal otter trawl from Locker Island west of Onslow to Dampier to the east.	
Nickol Bay Prawn	No	Yes	- Demersal otter trawl operating mostly in inshore areas.	
Broome Trawl	No	Yes	- Small trawl fishery.	
Kimberley Prawn	No	Yes	- Demersal otter trawl off the north of the State adjacent to the Northern Prawn Fishery.	
WA gillnet fisheries	No	Yes	- Small scale gillnet fisheries carried out in northern Western Australian waters.	
West Coast Rock Lobster	Yes (Limpus & McLachlan 1979)		- Commercial fishers come from all ports between Denham (Shark Bay) and Bunbury. Lobsters are taken by a lobster pot that uses bait as a lure. A float with a line marks the pot and is used to retrieve the pot.	

Table 8. Research (R) and management (M) actions to reduce mortality of marine turtles as bycatch in fisheries

Prescribed Action	Fishery	Manager	Criteria for Success
A.1.1. Monitor the effectiveness of turtle excluder devices (TEDs) for all vessels in the Northern Prawn Fishery. (M)	Northern Prawn	AFMA	Marine turtle capture and mortality to decline to levels approaching 5% of 1989-90 levels; less for loggerhead turtles.
A.1.2. Regulate for mandatory use of TEDs for all vessels in the Torres Strait Prawn Fishery in the fishing season 2002. (M)	Torres Strait Prawn	AFMA	Marine turtle capture and mortality to decline to levels approaching 5% of 1996-97 levels; less for loggerhead turtles.
A.1.3. East Coast Otter Trawl managers to implement and monitor a marine turtle bycatch reduction strategy that includes compulsory TED use; provides for the expansion of closed areas; ensures the continued monitoring of marine turtle bycatch; and incorporates these initiatives into the East Coast Otter Trawl management plan. (M)	East Coast Otter Trawl	QFS	Trawl induced capture and mortality of marine turtles is reduced to levels approaching 5% of those reported for years 1991-92 (Robins, 1995) and even less for loggerhead turtles.
A.1.4. Fisheries managers to quantify marine turtle bycatch and mortality in Barramundi, Fin Fish Trawl, Shark, Crab, Mesh/Gillnet, Offshore Mesh, Rock Lobster fisheries. (R)		State and Territory agencies	The level of marine turtle bycatch is quantified within the life of this plan.
A.1.5. Fisheries managers to develop and implement Bycatch Action Plans for: Priority A (trawl) fisheries: Shark Bay Prawn; Shark Bay Scallop; Exmouth Gulf Prawn; Onslow Prawn; Nickol Bay Prawn ; Broome Trawl; Kimberley Prawn; and Priority B fisheries: North Coast Shark; Kimberley Gillnet; Barramundi; West Coast Rock Lobster. (M)	*Priority A fisheries* *Priority B fisheries*	Fisheries WA	Bycatch Action Plans, for Priority A fisheries, are complete by the end of 2001 and implemented in 2002-03 including the compulsory use of TEDs in all prawn fisheries. Bycatch Action Plans, for Priority B fisheries, are complete by the end of 2004.
A.1.6. Fisheries managers to develop a bycatch reduction strategy that: incorporates marine turtle conservation; takes into account actions in other trawl fisheries; uses bycatch data to assess the effectiveness of turtle bycatch mitigation measures adopted. (M)	Barramundi Fin Fish Trawl Shark Crab Mesh/Gillnet Offshore Mesh	NT DPIF NT DPIF NT DPIF QFS/QDPI/QCFO QFS/QDPI/QCFO QFS/QDPI/QCFO	Bycatch reduction strategies are developed
A.1.7. Prepare and implement bycatch action plan that addresses marine turtle bycatch.	Western, Eastern and Southern Tuna and Billfish Fisheries	AFMA	Bycatch action plans contain actions that address marine turtle bycatch and actions are implemented according to the timeframe in the plans.

2. Customary harvest by Aboriginal and Torres Strait Islander people

This plan seeks to engage Aboriginal and Torres Strait Islander people in the national recovery and management of marine turtles and to restore and maintain marine turtle populations at levels that can support a sustainable indigenous subsistence harvest of turtles and eggs.

Marine turtles play a diverse role in the lives of coastal indigenous peoples and are significant in the continuing culture of Australia's indigenous communities. The relationship is interwoven into the fabric of everyday cultural, spiritual, social and economic practices and future conservation and management strategies require the involvement and cooperation of Aboriginal and Torres Strait Islander people.

This plan identifies the need for negotiated agreements to be made between indigenous communities and land management agencies that acknowledge customary and statutory law and promote the recovery of species. Agreements should reflect local conditions and allow these to influence management regimes, with parties to the negotiation, fulfilling their respective roles of resource managers and community leaders. A combination of customary and State/Territory/Commonwealth law may be the best combination to achieve the objective of a customary harvest that ensures the long-term survival and recovery of marine turtles in the wild and which does not contribute to any further decline of marine turtles.

All Australian marine turtle populations, except loggerhead turtles, are affected by indigenous harvest of eggs. The following populations are also affected by harvest for meat:

- all green turtle populations;
- to a lesser extent hawksbill turtles from the north eastern Australian and Great Barrier Reef population;
- olive ridley turtles from the Northern Territory population;
- flatback turtles from the Gulf of Carpentaria and North West Shelf; and
- loggerhead turtles from the North West Shelf.

Turtles are of enormous cultural, spiritual and economic (subsistence) importance to indigenous people. Through a long association with turtles, indigenous people have developed a detailed body of traditional ecological knowledge that includes information on the natural history and ecology of turtles. Turtles have spiritual significance, which is found in the stories and accounts of the past in many coastal indigenous communities. They have economic value because they provide sustenance, particularly for isolated communities where a nourishing diet is essential but often difficult to attain due to isolation and the high cost of store bought food. Furthermore, resources such as turtles and other traditional foods reinforce the culture and demonstrate affiliation with tradition and traditional estates.

In ceremonies, turtles play different roles for many coastal indigenous people. In some areas the turtle forms part of creation stories and can be found in all aspects of spirituality, art and life. The activity of pursuing the turtle itself may have great significance and be an expression of continuance of a long cultural tradition. The importance of the hunting and butchering of the turtle is also expressed through the social sharing of the animal as food according to traditional kinship protocols. The hunt may also form an important part of a young male's progression from boyhood to manhood when given the opportunity for his first hunt.

Indigenous hunting of turtles has traditionally been managed through customary law. However, recent improvements in technology and the disruption of culture have affected this management. In some areas customary law can be used to manage the harvest, utilising protocols such as:

- who can catch and cut up turtles;
- not allowing the take of nesting turtles from the beach;
- restrictions on the take of eggs;
- seasonal closures of beaches and hunting areas; and
- traditional owners regulating hunting in their traditional areas.

To ensure the recovery of turtle populations, customary harvest needs to be managed in a culturally sensitive manner so that it is ecologically sustainable. Cooperative management agreements – that is management agreements jointly developed by the relevant indigenous community and the lead agency for that jurisdiction - can both ensure sustainability and provide for community aspirations. These agreements should be based on sound science and local indigenous knowledge. Importantly, such agreements can be initiated, monitored and implemented by the communities themselves. Management agreements should also support humane methods of killing.

Community based management with support from governments is a legitimate and potentially effective management mechanism. To establish itself as an effective management influence, community management regimes need

committed and skilled community members, while recognition, support and commitment from governments is critical (Hunter and Williams, 1998, Birkhead *et.al.* 1996).

Indigenous groups have expressed interest in having greater control over resource use and this may prove to be more effective for the conservation of marine turtles than using a strict law enforcement approach. Local indigenous communities and/or indigenous land management authorities should be engaged in cooperative relationships for enforcement and monitoring rather than increasing government regulatory structures.

Management in the Torres Strait

Green turtles are a traditional part of Torres Strait Islander culture and are hunted from dinghies by hand capture or using the traditional spear. In some of the islands of the Torres Strait Protected Zone (TSPZ) they are still an important source of meat protein. Torres Strait Islanders also eat eggs from green and hawksbill turtles, generally collected where turtles nest close to communities. Turtles are taken at any time during the year. The estimated annual catch by Australian traditional inhabitants in the TSPZ since 1994 is about 2500 turtles per year (Harris 1997). Under the Torres Strait Protected Zone Joint Authority (PZJA), management restricts hunting to traditional inhabitants using traditional spears and prohibits sale of meat, shell or any other product.

Turtles are also caught by Torres Strait Islanders living south of the TSPZ and by Papua New Guineans in the coastal villages of the Papua New Guinea Western Province but there are no estimates of the annual catch from these areas. The Torres Strait Fisheries Assessment Group prepares a stock assessment report annually. This report details the take of marine turtles for the year, data collection methods and other information relevant to the region. It does not include any take by Papua New Guinea but a Papua New Guinea fisheries officer has been trained by AFMA and the Torres Strait Island Coordinating Council to collect data from the Western Province villages.

AFMA monitors turtle catches in two ways. A field data collection officer visits all TSPZ communities to collect catch and effort data. All schools in the Torres Strait islands and on Cape York collect catch data using a special calendar and sticker program. Both methods record size and sex information. AFMA conducts an education program at all schools, with islander officers teaching children about the life cycle of turtles and the need for a conservative approach to their harvesting. Similar education of adult hunters occurs through community meetings and AFMA's weekly fisheries radio program. AFMA has prepared posters, fact sheets and other material on turtle conservation in Torres Strait. AFMA has assisted the high schools with a flatback and green turtle tagging program and run a promotional drive in all communities to encourage the return of turtle tags.

The Island Coordinating Council (ICC) and some other communities believe that levels of indigenous harvest need to be based on sound scientific assessment of target stocks.

Native Title

The Commonwealth *Native Title Act 1993*acknowledges that native title rights and interests may include rights to hunt, gather and/or fish. Where this Recovery Plan envisages the doing of an act as 'affecting' native title, such acts will need to be done in accordance with the requirements in the *Native Title Act*.

Table 9. Prescribed research (R) and management (M) actions to facilitate co-management of marine turtles with indigenous communities

Prescribed Action	Managers	Criteria for Success
A.2.1. Management agreements to be established between lead agencies and indigenous communities which: • recognise customary law and the cultural significance of marine turtles; (M) • quantify existing harvest using the best available science and local indigenous knowledge; (R) • identify and implement negotiated mechanisms that will ensure that customary harvest does not threaten recovery of marine turtles; (M) • control marine turtle use within the communities' area; (M) • recognise that communities only carry out harvesting for traditional	Aboriginal and Torres Strait Islander communities Lead agencies AFMA	Community management agreements are agreed and in place in each jurisdiction.

use; (M) • recognise endangered or critically endangered species and implement a zero take where possible; (M) • identify the research requirements of indigenous communities regarding marine turtle conservation; (M) and • increase awareness of marine turtle conservation issues through information exchange. (M)		

3. Marine Debris

Marine debris causes the death and debilitation of marine turtles and other marine wildlife (Balazs 1985, Cawthorn 1985). Unattended, lost or discarded nets, bait box bands, monofilament fishing line, six-pack yokes, polystyrene and other buoyant plastics and tar balls (weathered petroleum) have been the main concern (Balazs 1985, Cawthorn 1985). Anecdotal reports have received wide press coverage on the marine turtle mortality caused by discarded fishing nets and other debris in northern Australia, particularly in Arnhem Land (Leitch 1997, 1998). Mounsey (1997) reported that on Groote Eylandt the largest proportion of beach-washed discarded netting was from foreign trawl and drift nets. The foreign trawl netting was also identified with the highest level of marine turtle mortality although the mortality was not quantified (Mounsey 1997).

Identifying the sources of marine debris, responding to stranding events and quantifying mortality caused by marine debris are identified as the primary actions to monitor and manage marine debris as a threat to turtles (Table 10). Some assessment of impact of ingested debris should be determined through post-mortem examinations of stranded animals. The identification of the source of the debris that affects marine turtles will allow a more strategic approach to any follow-up activities with polluters, who could then be the target of compliance and/or education programs.

Shipping has been identified as one source of marine debris. To combat this problem Australia has adopted the International Convention for the Prevention of Pollution from Ships, 1973. In particular, Annex V relates to garbage from ships and came into force in Australia in November 1990.

The marine turtle populations affected by marine debris have been identified as: loggerhead turtles from the eastern Australian population; green turtles from the southern Great Barrier Reef population; hawksbill turtles from the north eastern (Queensland) Australian population; leatherback turtles; olive Ridley turtles from the Northern Territory; flatback turtles from Arnhem Land; and Western Australian populations (potential problem but not known at present).

Table 10. Prescribed research (R) and management (M) actions to mitigate incidental mortality resulting from marine debris

Prescribed Action	**Managers**	**Criteria for Success**
A.3.1. Lead agencies to: • monitor mortality of marine turtles due to entanglement in marine debris; and • identify the source of marine debris. (See also action C.1.3.) (R)	Lead agencies	The level of mortality is quantified and the source is identified.
A.3.2. NT agencies to determine the source of the nets entangling marine turtles and the magnitude of their mortality in the Cape Arnhem region. (R)	NTDPIF PWCNT	The source of netting entangling turtles at Cape Arnhem is identified
A.3.3. Lead agencies to undertake remedial action to prevent/reduce marine turtle mortality in stranding events caused by marine debris. (M)	Lead agencies	Lead agencies will respond to debris events.
A.3.4. Commonwealth, States and NT to implement legislation for the prevention of garbage discharge from vessels of all sizes. (M)	AMSA States/NT	Legislation is brought into force in State/NT jurisdictions to prevent the discharge of garbage from vessels of all sizes.

4. Shark Control Activities

Marine turtle mortality in shark control activities has been identified as an issue both in New South Wales and Queensland waters. The death of marine turtles in shark control programs has been documented in Queensland by Paterson (1990) and Gribble *et.al.* (1998) and in New South Wales by Reid and Krogh (1992). The need to reduce the take and monitor future take is identified (Table11).

Shark control activities such as meshing and drumline placement have been identified as having a low or uncertain impact on marine turtle populations. Baited drumlines are reported to catch loggerhead turtles. During the period 1992

to 1996 the Queensland shark control program capture rate has averaged 84 per year of all species, but 87 per cent were released alive, including 90 per cent of all loggerhead turtles (Gribble *et.al.* 1998). A review of the Queensland shark control program (Department of Primary Industries 1998) identified the need to develop a hook that would catch fewer loggerhead turtles or bait that was less attractive to them. The report also identified the need to continue research into areas where performance could be improved such as baited line technology, acoustic alarms and monitoring of species catch (Department of Primary Industries 1998).

In New South Wales, Reid and Krogh (1992) identified a low rate of marine turtles caught in shark control nets. Between 1950 and 1993 a total of 56 turtles were caught with 84 per cent being caught in the Newcastle region.

Table 11. Actions to mitigate incidental mortality and monitor marine turtles in shark control activities

Prescribed Action	Managers	Criteria for Success
A.4.1. Develop and trial shark control methods that reduce marine turtle take. (R)	QDPI	Reduce catch of marine turtles by 10% per year: especially to reduce the take of loggerhead turtles below 10% and ultimately to 0%; and to reduce the take of green turtles significantly.
A.4.2. Determine the mortality and species composition of marine turtle bycatch in shark control activities. (R)	QDPI NSW Fisheries	QDPI will liaise with QEPA and provide data on marine turtle bycatch in shark control activities. EA will liaise with New South Wales Fisheries and provide data on marine turtle bycatch in shark control activities.

5. Boat Strike

Marine turtle mortality due to boat strike has been identified as an issue in Queensland waters, principally in Moreton Bay and Hervey Bay. The need to restrict boat speed in areas of important marine turtle habitat is identified (Table 12) and opportunities for awareness raising and educative activities with boat users should be utilised.

The *Marine Parks (Moreton Bay) Zoning Plan 1997* allows for the designation of turtle and dugong areas where *a person must not (a) operate a speedboat in a planing or non-displacement mode; or (b) operate a boat, hovercraft or personal watercraft in a way or at a speed that could reasonably be expected to result in the striking of a sea turtle or dugong*.

Marine turtles are vulnerable to boat strikes when at the surface to breathe and rest between dives. This is particularly an issue in waters adjacent to large urban populations (Limpus and Reimer 1994) where there are large numbers of boats and other pleasure craft. Data from beach-washed marine turtles can be used to identify areas and seasons where boat strike is significant.

Marine turtles suffering from disease or parasites may be debilitated, spending more time on the surface and taking shallower dives with longer post-dive resting periods. In such cases they are more exposed to boat strikes. Post-mortem examinations of boat-struck marine turtles may not identify the underlying cause of the death particularly if parasites or disease have debilitated the turtle. Veterinary pathologists should be used to establish the cause of death where their services are available.

The marine turtle populations affected by boat strike have been identified as: loggerhead turtles from the eastern Australian population; green turtles from the southern Great Barrier Reef population; hawksbill turtles from the north-eastern Australian populations; and flatback turtles from Queensland.

Table 12. Actions to mitigate incidental mortality and monitor the boat strike of marine turtles

Prescribed Action	Managers	Criteria for Success
A.5.1. QEPA to identify areas of high boat strike. (R)	QEPA	Areas of high boat strike are identified.
A.5.2. QEPA to liaise with Queensland Transport to determine the feasibility of zoning boat speed restrictions where appropriate. (M)	QEPA	Restrictions are applied.

6. Pearl Farming and Other Aquaculture Activities

Concern has been expressed about the potential impact on marine turtles through light disturbance and entanglement in equipment used in pearl farming and aquaculture. There is no available evidence to suggest any mortality due to pearl farming and aquaculture but a precautionary approach is appropriate. Actions are identified in Table 13.

Table 13. Actions to mitigate incidental mortality resulting from pearl farming and aquaculture

Prescribed Action	Managers	Criteria for Success
A.6.1. Fisheries managers to encourage pearl farming and aquaculture licensees to use appropriate, non-disturbing, lighting technology. (M)	WACALM Fisheries WA PWCNT NTDPIF	Appropriate lighting is used.
A.6.2. Operators to monitor any incidental mortality of marine turtles in aquaculture operations. (M)	WACALM Fisheries WA PWCNT NTDPIF	Marine turtle mortality and bycatch is reported to lead agencies.
A.6.3. Develop less appealing craypot buoys to minimise leatherback entanglement in Tasmanian waters.	EA TDPIWE	Appropriate craypot buoys developed.

7. Defence Activities

Periodically the Department of Defence may undertake activities that could impact on marine turtles, such as the use of explosives or landing craft on beaches. The impact of Defence activities on marine turtles and their habitat is not known but can be inferred. Explosive ordnance, if not appropriately managed, is known to cause marine turtle deaths (Klima *et.al.* 1988, Gitschlag and Herczeg 1994) or to modify their behaviour (Lenhardt *et.al.* 1983).

Defence activities can be conducted in a manner that minimises the risk of ill effects on the surrounding environment. Examples of measures, which can be used to reduce the threats to marine turtles and their habitat, are:

- minimising activities that have a potential impact on turtle rookeries during the nesting season;
- pre-exercise surveys of beaches, sand flats and sea grass beds for marine turtles; and,
- developing environmental management systems for relevant Defence training areas that include site-specific management plans for known and potential marine turtle rookery areas.

Actions to manage any potential impacts are identified in Table 14.

Table 14. Actions to mitigate mortality and monitor marine turtles in relation to Defence activities

Prescribed Action	Managers	Criteria for Success
A.7.1. In consultation with lead agencies, the Department of Defence is to • ensure that environmental impact assessments and environmental management plans for Defence activities minimise any possible effects on turtle populations and habitats; (M)	Department of Defence	Assessments and plans recognise marine turtle conservation.
• cooperate with lead agencies to develop management strategies for affected marine turtle populations including monitoring sites on selected Defence estate. (M/R)	Lead agencies	Management strategies are developed.

Specific Objective B.

Develop programs and protocols to monitor marine turtle populations in Australian waters, assess the size and status of those populations and the causes of their mortality, and address information gaps.

Introduction

Long-term data sets for marine turtle populations are rare. The Queensland Turtle Research Project has provided much of the information identifying the continued decline of marine turtles in Australia, particularly the eastern Australian population of loggerhead turtles. The establishment of monitoring programs for key marine turtle populations is necessary to determine the status of marine turtles nationally, to detect change and to measure the effectiveness of management. Combined with a genetic analysis of the composition of populations on feeding grounds and the determination of the geographic range of breeding populations, key demographic parameters can be monitored over time to detect population trends. Adequate information will allow the development of future recovery plans based on population trends rather than the amelioration of threats.

Recent work has been able to identify genetically discrete populations of marine turtles in Australian waters and those of near neighbours in the Asia/Pacific region (Moritz *et.al.* 1998a). This allows the partitioning of some species into management units (Moritz *et.al.* 1998b). The Recovery Team recognises that to complete this picture it may be necessary to visit neighbouring countries to establish the level of harvest of Australian populations through the analysis of the mitochondrial DNA (mtDNA). This will enable management regimes between nations to be harmonised through agreed arrangements.

The educational benefits of monitoring can be significant. If access to beaches is managed intensively and extension services provided there is a visible educational benefit in exposing people to nesting marine turtles. Mon Repos Conservation Park on Queensland's Bundaberg coast demonstrates this (Kay 1995).

1. Monitor Key Populations and Stranded Marine Turtles

The establishment of nationally consistent monitoring programs in each jurisdiction is critical (Table 31). Any long-term monitoring program must prioritise populations and ensure that data collection is consistent across species and jurisdictions. The establishment of a database in each jurisdiction will allow the collation of data on turtles that have been tagged, stranded marine turtles, the causes of mortality and nesting turtles. Data from monitoring programs should be published regularly and programs should be reviewed regularly. Data protocols allow the collation, critical review and management of data on stranded turtles, which is important in identifying the causes and level of mortality within populations.

A national monitoring program managed by the Commonwealth, States and the Northern Territory will need:

- an agreed set of national guidelines for collecting information from stranded marine turtles;
- a nationally agreed minimum set of key monitoring protocols for nesting and other marine turtles;
- the identification of key marine turtle populations;
- a database to record and analyse monitoring information; and
- benchmarks for critical population parameters such as annual recruitment and hatching success.

Most monitoring is confined to nesting beaches because of the accessibility of the nesting females. Information is needed about migrations and behavioural ecology at sea to successfully manage them throughout their range.

There are two widely accepted ways to gather these data: flipper tagging and satellite telemetry. Tagging has provided much of the current knowledge of marine turtle behaviour and ecology and will continue to be the mainstay of any monitoring program. Recaptures of tagged individuals returning to the natal beach have provided valuable data on internesting interval, remigration interval, growth rates and reproductive output. Recaptures of juveniles and adults on feeding grounds have provided valuable data on growth, population size and structure. Recaptures of tagged turtles in places other than their site of original capture has also provided data on the distance travelled and the locations of nesting and/or feeding habitat. However, it can take many years before a turtle is recaptured and decades to build a database of migration destinations based on tag returns. Usually hundreds or thousands of tagged turtles only yields a few returns and successful return relies in the initiative, interest and understanding of the turtle capturer. Often there has been little investment in informing people about the use of tags and their meaning and many indigenous hunters, for example, will not return the tags for fear of reprisal. Whilst the tags are relatively cheap, capture and tagging large numbers of turtles often in remote localities can be expensive.

Satellite telemetry provides real time data on the movement behaviour, migration route and locations of habitats of turtles. Recent work by the Northern Territory University (NTU), Dhimurru Land Management Aboriginal Corporation and the World Wild Fund for Nature involving 25 tracked green turtles provided a strong indication that

adult migrations of the Arnhem Land nesting green turtle population are confined to the waters of the Gulf. The project had enormous benefit in terms of public education and involvement of indigenous communities. Satellite tracking has much to offer but its utility beyond studying movement behaviour at an individual level will depend on achieving a sufficiently large sample size on which to make robust hypotheses.

The establishment of a national tagging database is advocated to assist jurisdictions to manage their programs.

A variety of diseases occur in marine turtles from different pathogens (Herbst and Jacobson 1995). Two diseases of particular concern are cutaneous fibropapillomatosis (George 1997, Limpus and Miller 1994) and digenean trematodes (Fischthal and Acholonu 1976, Glazebrook *et.al.* 1989, Greiner 1995; Greiner *et.al.* 1980). Diseases in turtles appear to occur more frequently in turtles that reside in poorly circulating, near-shore waters close to large human populations, although the link between disease and water quality is inferred. The monitoring of stranded turtles for these diseases may lead to a better understanding of the links between water quality and marine turtles strandings and death.

Table 15. Prescribed research (R) and management (M) actions to facilitate national monitoring of marine turtles

Prescribed Action	Managers	Criteria for Success
B.1.1. Lead agencies to develop an agreed minimum set of key protocols cooperatively for: • monitoring key nesting beaches; and • collecting mortality data from stranded marine turtles or other sources. (M)	Lead agencies	Protocols are developed, agreed and implemented nationally.
B.1.2. Lead agencies to monitor key nesting beaches for marine turtle populations to develop population models in the longer term. (R)	Lead agencies	Complementary monitoring programs are established in each jurisdiction.
B.1.3. Lead agencies to: • monitor marine turtle mortality to determine the levels, distribution and causes of that mortality; and • conduct or support research on the prevalence and frequency of disease. (R)	Lead agencies Lead fishing agencies Lead agencies	Lead agencies have established a marine turtle mortality database. Mortality data is collected through bycatch quantification programs and compulsory reporting. Prevalence and frequency of disease in wild marine turtles is identified.
B.1.4. Lead Agencies to negotiate protocols for the management of national tagging, including satellite/radio tracking, and stranding data including the identification of an appropriate institution to house and manage the database. (M)	Lead Agencies NSW NPWS	A national marine turtle tagging and stranding database is established. Southern migration patterns determined.
B.1.5. Recovery Team to conduct a review of monitoring (actions C.1.2. and C.1.3.) to coincide with the review of the recovery plan. (M)	Recovery Team	A report of the review is prepared.

2. Measuring Recovery

There is sufficient information to identify the decline of 50 – 80 per cent over 10-15 years in the eastern Australian loggerhead population (Limpus and Reimer 1994). However, measuring recovery against population data is usually problematic, as historical data are not available to set recovery targets for all populations or populations. Monitoring and mortality information will be used to assess the status of marine turtles.

Information on populations of marine turtles should be drawn together from all Commonwealth, State and Northern Territory monitoring programs and other available sources. It should be collated within the first year of operation of this plan to provide a national snapshot of the current knowledge of marine turtles' status and to identify gaps in demographic data. Such a snapshot should provide the basis for future monitoring effort that can deliver information to set recovery objectives for threatened populations (Table 16).

In the absence of large sets of ecological, behavioural and morphometric data for each marine turtle population, modelling can offer a method to make decisions about the status of populations. A model for the southern Great Barrier Reef population of green turtles is being developed and should explore the potential application for other species, the risk in such application, and the limits of interpretation on the outputs from the model.

The long-term goal of modelling is to produce decision-making tools for managers. Any model that fulfils the needs of managers should be built into a decision-making support system. The development of such models is not intended to supplant monitoring programs. The identification of characteristic population behaviours (those population parameters that give the model its greatest power of interpretation) of each population will make the data gathering more cost-effective.

Table 16. Prescribed management action to facilitate a national assessment of the status of marine turtles

Prescribed Action	Managers	Criteria for Success
B.2.1. Assess the status of marine turtles in Australia. (M)	EA	A report of the assessment is made within the first year of operation of this plan.
B.2.2. Develop a population viability model for the southern GBR green turtle population that: • identifies the population behaviours that give the model its predictive power; • determines the risk in applying the model to other populations and species of marine turtle; and • determines the limits to the interpretation on the outputs from such a model. (R)	EA QEPA GBRMPA	Such a model is developed within the second year of the plan.

3. Genetic Identification of Australian Marine Turtle Populations

Genetic sequencing is a tool for identifying different breeding populations. The word 'population' is used here to mean genetically distinct groups of marine turtles within a single species complex. Work to date has indicated that most species have distinct populations that can be managed as conservation units. The defining of these populations is still in progress and should be completed as a high priority.

The tracing of female lineages has allowed the identification of populations that nest in definable geographic areas and the identification of those populations where they mix in the feeding areas. As a tool it recognises shared populations and the need to manage populations regionally and in consultation with other jurisdictions. Moritz *et.al.* (1998b) have identified Australian populations that move in and out of the waters of Indonesia, Papua New Guinea and Pacific Island nations.

The analysis of currently undocumented marine turtle populations in Australia and those shared with other Asia/Pacific nations is required (Table 17). The completion of this analysis will allow the identification of further priorities for management and the capacity to identify the composition of populations in feeding grounds. This is particularly important in identifying Australian breeding populations that are subject to harvests elsewhere. Moritz *et.al.* (1998b) identified and prioritised the information gaps in order as:

- green turtle rookeries from east Arnhem Land, Sir Edward Pellew Islands and Indonesia;
- loggerhead turtle rookeries from southern New Caledonia;
- hawksbill turtle rookeries from the west Pacific; and
- flatback turtle rookeries from the Kimberley region, east Arnhem Land and Gulf of Carpentaria.

An important component of this work will be to sample and analyse resident feeding ground populations to determine the relative composition of the representative populations. This information will be added to monitoring and mortality data to determine the impact of mortality on each population. Ultimately it will assist in judging the security of Australian populations in relation to the levels of mortality at any time.

Table 17. Prescribed action to complete genetic analysis of Australian marine turtles

Prescribed Action	Managers	Criteria for Success
B.3.1 Complete the broad genetic analysis of Australian marine turtle populations to determine the: • geographic range of identifiable populations. • population composition of feeding populations; • population size for each population; and • proportion of Australian populations harvested in the waters of PNG and Indonesia. (R)	EA	Genetic analysis of Australian marine turtle populations is completed.

Specific Objective C.

Manage factors that affect successful marine turtle nesting.

Factors that have a negative impact on successful marine turtle nesting need to be managed to increase the survival rate of the eggs and hatchlings of some populations. In developing the Recovery Plan four factors were identified as having an impact on marine turtle nesting success: light pollution; tourism and recreational activities; vehicle damage; and faunal predation on marine turtle eggs.

1. Light Pollution

Lights that attract hatchlings or nesting marine turtles, on land and at sea, are likely to contribute to increased mortality (McFarlane 1963; Philibosian 1976; Witherington 1992). The identification of affected priority areas and the employment of appropriate strategies in consultation with relevant managers of the lighting systems are the priority actions to deal with the impact of artificial light (Table 18).

Some examples of problem light sources are oil production and processing plants, coastal and island development, and boats. Street lighting affects loggerhead turtles from the eastern Australian population; green turtles from the southern Great Barrier Reef population; and flatback turtles from Queensland. Lighting from industrial complexes affects flatback turtles from the North West Shelf; green turtles from the North West Shelf; and hawksbill turtles from the North West Shelf.

Streetlights of coastal towns are known to attract hatchling loggerhead turtles from the eastern Australian populations. Non-attracting lights (for example low-pressure sodium bulbs) have proven effective for loggerhead hatchlings but still attract other species (Witherington and Bjorndal 1991). As well, it may be possible to negotiate darkness zones in coastal areas with planning authorities.

Hick and Caccetta (1997) in studying the lights of the petroleum production facility on Varanus Island (Western Australia) concluded that those lights that were visible and a potential problem to turtles could be dealt with by relatively inexpensive means such as shielding, repositioning and installing timed light switching devices. An investigation of the impact of flares and facility lighting elsewhere in Western Australia has been carried out (Pendoley and Wilshaw 1996, Pendoley 1998). Preliminary results suggest that impacts are determined by the phase of the moon (mis-orientation is greatest on new moon nights) as well as brightness and wavelength of the light sources. Additional research is encouraged to further quantify and qualify the impacts of man-made light sources and to provide management guidelines for operations in marine turtle nesting areas.

Table 18. Prescribed research (R) and management (M) actions to manage the effects of light on marine turtles

Prescribed Action	Managers	Criteria for Success
C.1.1. Identify nesting beaches affected by urban or industrial lighting. (R)	Lead agencies	Nesting beaches affected by lighting are identified.
C.1.2. Lead agencies to: • encourage Local Government to employ light management practices that do not adversely affect marine turtles near nesting beaches; (M) • address lighting problems on affected beaches with Local Government; (M) • implement existing management practices such as zoning anchorage areas for boats; (M) • support research into suitable lighting technology for boats; (R) • support research into improved lighting technology and the impact of lights on turtles. (R)	Lead agencies Local Governments Transport/boating authorities	Suitable lighting technology is developed and employed.
C.1.3. Develop and implement a code of practice to minimise the impact of lighting from petroleum facilities. (M)	CALM APPEA	A code of practice is developed with and adopted by APPEA.
C.1.4. CALM to liaise with petroleum companies operating on the North West Shelf regarding ongoing monitoring research programs (M).	CALM	Liaison between CALM and petroleum companies continues.

2. Tourism and Recreational Activities

Recreational activities on nesting beaches have the potential to impact on marine turtle hatching success. Where tour operators access beaches, a professional code of conduct needs to be developed. Where there is uncontrolled access to nesting beaches, some management of access needs to be implemented (Table 19).

Tourism operators working with native fauna must be licensed in Western Australia, Queensland and the GBRMP, but this is not the case in the Northern Territory. Tourists have been encouraged to visit a turtle rookery at Mon Repos near Bundaberg, and protocols have been established to ensure the visitor experience is enhanced and turtles are able to nest without undue disturbance. Turtle watching procedures are also in place at North West Cape in Western Australia. The management of tourists on nesting beaches may be critical for successful nesting outcomes. Mon Repos is a useful illustration on which a code of practice can be modelled.

The management of uncontrolled visitor activities is more difficult than formal tourism activities. Uncontrolled visitor access to nesting beaches includes activities such as beach fishing, camping and barbecues, and may include nature-based activities. With the increased use of boats and four-wheel drive vehicles, more of the coast is coming within range of such visitors.

The marine turtle populations affected by tourism have been identified as: all loggerhead turtle populations; green turtles from the North West Shelf and northern and southern Great Barrier Reef; hawksbill turtles in the northern Great Barrier Reef and Torres Strait; flatback turtles from the eastern Australian and North West Shelf populations; and an undetermined proportion of all populations present in the Northern Territory.

Table 19. Prescribed research (R) and management (M) actions to manage the effects of tourism and recreational activities on marine turtles

Prescribed Action	Managers	Criteria for Success
C.2.1. Lead agencies to: • identify tour operators that currently access marine turtle nesting beaches; (M) • identify nesting beaches that have uncontrolled access; (R) • develop management arrangements for access and beach activities with relevant Local Government authorities and landowners to ensure conservation of marine turtles; (M) • develop a nationally agreed code of conduct for tour operators with the Australian Eco-Tourism Association; and (M) • implement these actions with particular reference to loggerhead turtles as a priority. (M)	Lead agencies	Nesting beaches and tour operators are identified. Management arrangements for access and beach activities are developed A code of conduct is developed and implemented with tourism industry representatives.

3. Vehicle Damage
Vehicles can damage marine turtle nests and nesting habitat by compacting sand, crushing nests and creating wheel ruts that impede or trap hatchlings. Management of vehicle access to nesting beaches outside protected areas needs to be negotiated by lead agencies with the land managers (Table 20). Intensively managed areas generally prohibit vehicles on beaches but in more remote areas access is uncontrolled. Much of the remote northern Australian coastline is used by Aboriginal communities to fish, hunt and collect food or visit outstations. Some of these activities may involve the use of four wheel drives to access beaches where they will gather food including marine turtle eggs.

The Dhimurru Land Management Aboriginal Corporation, in Nhulunbuy, has taken steps to manage access through the positioning of fences with locked gates. This prevents both Aboriginal and non-Aboriginal access to important nesting beaches. While this is not a solution in all areas, some placement of fences to prevent access will relieve pressure. Other measures such as the development of a code of conduct negotiated with potential user groups will assist.

The marine turtle populations affected by vehicle damage have been identified by the Recovery Team as: green turtles from Gulf of Carpentaria and Northern Territory populations; hawksbill turtles from the north eastern Australian population; olive ridley turtles from the Northern Territory; mainland nesting sites of the North West Shelf; and Torres Strait to Cape Dommet populations.

Table 20. Prescribed actions to manage the effects of vehicles on marine turtles

Prescribed Action	Managers	Criteria for Success
C.3.1. For significant nesting beaches, lead agencies to: • manage vehicle access to areas within their jurisdictions; and • negotiate the management of access with Local Government and other land managers. (M)	Lead agencies	Arrangements are developed to manage access to significant nesting beaches.

4. Faunal Predation of Marine Turtle Eggs
Introduced and native fauna is known to prey upon marine turtle eggs. Feral pigs, foxes, feral dogs, dingoes, bandicoots and goannas have been identified as predators on marine turtle eggs in parts of mainland Australia, and goannas are thought to be a problem on some islands (Bustard 1972, Lemm 1996, Limpus and Reimer 1994, Morris 1987). The magnitude of the problem is not known across the whole range of marine turtle nesting habitat. Where populations are identified as a priority, control programs will be needed to increase nesting success.

Predation by the European red fox has been identified as a key threatening process. A threat abatement plan has been prepared by the Commonwealth to ameliorate the impact of foxes on native species (Environment Australia 1998b). Foxes are a significant predator on the central Queensland coast (loggerhead turtles especially) (Limpus and Reimer 1994) and mainland nesting sites in Western Australia (loggerhead and green turtles) (K. Morris *pers. comm.*). Lemm (1996) observed that, for nearly 75 per cent of all nests with some level of predation, the predators were foxes. Fox predation of loggerhead turtle (and some green turtle) nests occurs in Cape Range National Park adjacent to Ningaloo Marine Park, Western Australia. A program to control foxes and protect turtle nests takes 60-80 foxes annually (K. Morris *pers. comm.*). The establishment of a poison-baited buffer zone adjacent to the Cape Range National Park during the nesting season would increase the level of protection at a critical time.

Choquenot *et.al.* (1996) recognised that the major environmental impacts of feral pigs are predation on native species and habitat degradation. Feral pigs are responsible for high levels of nest predation on nesting beaches used by flatback turtles particularly on Cape York Peninsula.

Control activities in remote areas offer considerable scope for Aboriginal and Torres Strait Islander people to become involved. Technology for poisoning feral predators and excluding native predators is available and can be used where predation is particularly severe or where a priority has been identified, for example fox predation on east coast loggerhead nests. Some estimate of nest predation will be valuable in determining management actions for controlling feral pests and native predators of eggs.

The marine turtle populations affected by predation have been identified as: loggerhead turtles from the eastern and western Australian populations; green turtles from the southern Great Barrier Reef, Gulf of Carpentaria and North West Shelf populations; hawksbill turtles from the north-eastern Australian populations; olive ridley turtles from the Northern Territory; and flatback turtles from Arnhem Land, Gulf of Carpentaria, Queensland and North West Shelf populations.

Table 21. Prescribed actions to manage the effects of predation on marine turtle eggs

Prescribed Action	Managers	Criteria for Success
C.4.1. Lead agencies, in consultation with landowners, to identify sites where predation is a problem and initiate or continue appropriate management actions. (R & M)	Lead agencies	More than 70% of nests, for affected population, produce hatchlings.
C.4.2. Minimise fox predation on loggerhead nests. (M)	QEPA WACALM	Fox predation of eggs and hatchlings approaches zero.
C.4.3. Minimise pig predation of flatback turtle nests on Cape York. (M)	QEPA	More than 70% of nests produce hatchlings.

Specific Objective D.

Identify and protect habitats that are critical to the survival of marine turtles.

Introduction

As marine turtles move through different stages of their life history they require different habitats. For the purposes of this plan, habitats are categorised as: natal beach; mating; internesting; feeding; and pelagic.

The EPBC Act specifies that recovery plans should *identify the habitats that are critical to the survival of the species or community concerned and the actions needed to protect those habitats* (Section 270(2)(d)). Table 32 identifies an initial list of places within Australia considered to be habitat critical to the survival of marine turtles. The habitat identified in Table 32 is not intended to be an exhaustive definition of habitat critical to the survival of marine turtles. A set of general actions has been prescribed (Table 23).

The habitat types and the threats to each type are outlined as follows.

Natal Beach

The natal beach should provide the environment for female turtles to lay eggs, for eggs to incubate, and for hatchlings to emerge and enter the water unencumbered by unnatural influences. Each beach will have characteristics that influence the nesting outcome, including the sex ratio of hatchlings. Alteration or development of the beach foreshores may prevent females from nesting, alter the sex ratio that the beach produces or result in light pollution that attracts hatchlings inland. Alteration of sand temperature could result in the temperature of the majority of nests moving beyond the pivotal temperature for that population. This will have consequences for the future adult population.

Development, vehicular activity and recreational activities have been identified as threats to the natal habitat. Threats to nesting habitat affect all Queensland populations but particularly those in the southern Great Barrier Reef (predation by feral animals, development, disturbance), some Arnhem Land nesting sites (customary harvest, predation by feral dogs, damage from vehicle); and all North West Shelf population (predation by foxes, vehicle damage to nests, disturbance).

Mating Habitats

Mating takes place in the marine environment and mating habitat needs to possess the elements that are important to mating turtles. The ability to aggregate and exercise mate choice is fundamental. During these gatherings marine turtles may be vulnerable. Threats to this habitat type are not well known. Populations affected by threats to mating habitat have not yet been identified.

Internesting Habitats

Internesting habitat is the area within a certain radius of the nesting beach that a breeding female turtle occupies during the nesting season between nesting events. During this time a female will grow the next clutch of eggs and will not feed. Hochscheid *et.al.* (1999) working in Cyprus suggest that the depth of dives of female green turtles is about 25 metres during the internesting interval and that the animals stay close to the coast. Hays *et.al.* (2000) working on Ascension Island suggest the depth is 18 –20 metres but do not reflect on the location of the animals. Repeated commercial trawling is known to threaten the integrity of the habitat (Poiner *et.al.* 1998) and to expose the females to the risk of capture. Otter trawling off the Queensland coast is known to cause mortality in nesting loggerhead turtles. Populations affected by threats to the internesting habitat are: all populations that nest on the Queensland coast but eastern Australian loggerhead turtles in particular. The loss of mature nesting females may have serious consequences for the breeding population.

Feeding Habitat
The species of marine turtle and its life stage will determine the feeding habitat it occupies. With the exception of flatback turtles, hatchlings grow in the open ocean and settle out to occupy developmental habitats as they continue to grow. Juvenile and sub-adults also have small home ranges. The range of threats is considerable, from tar balls and marine debris that threaten hatchlings to trawling and harvest by indigenous people both in Australia and in other national waters. All populations are at some risk except where specific provisions protect the habitat and prevent any take (including catch or capture).

Pelagic Habitat
The pelagic habitat is often in international waters or those of another nation. With the exception of the flatback turtle, marine turtles spend some of their life in the open ocean before settling into a range of habitats as juveniles and later as adults. Leatherback turtles spend most of their life in open oceans or passing through the seas of the Australian continental shelf. Threats are marine debris; trawling; entanglement in crab and crayfish pot floatlines. Populations identified as being threatened in the pelagic habitat are; all populations, particularly leatherback turtles and eastern Australian loggerhead turtles.

1. Land Use and Water Quality
The potential for land use practices to impact on marine turtles was identified as an issue particularly in eastern Australia, which is heavily populated and where the natural environment has undergone major changes. However, land clearing, urban and industrial development and their associated management Australia-wide are identified as an overall issue for concern.

The States and Territories have primary responsibility for the day-to-day regulation of land use. Land clearing in coastal areas for residential or industrial development has the potential to affect turtle populations at various times of the life cycle. It may directly deny nesting habitat or create light pollution that can disorient nesting adults and hatchlings (McFarlane 1963, Philibosian 1976, Witherington 1992). It may also alter the characteristics of the beach in terms of available nesting habitat and alter the pivotal temperature that will in turn alter the sex ratio of any hatchlings (Morreale *et.al.* 1982, Mrosovsky and Yntema 1995). Better management of catchments, urban runoff, effluent and discharges can improve water quality and hence the quality of seagrass meadows and reduce algae growth.

An increased human presence on nesting beaches is only desirable if it can be managed or harnessed in favour of the turtles (Johnson *et.al.* 1996). Coastal development brings impacts such as increased run-off from paved areas, increased turbidity in water and increased levels of chemicals. Sewage discharge may increase nutrient loadings, particularly levels of phosphates, and encourage algal growth. The effect of contaminants such as heavy metals and organochlorins on marine turtle habitat is not known and no link has been established between acid sulphate soils and the loss of marine turtle habitat.

Coastal land management should preferably be developed and implemented under legislation. One way of dealing with coastal land management issues is through the preparation of regional coastal plans. Such plans can identify where activities will impact on marine turtles, particularly on the coast and in the near-shore waters. The proposed management actions (Table 22) aim to maintain water quality, but further action is required to reduce the direct impact on beaches. In minimising the impact of development, cooperation should be sought from Local Government in affected areas. Lead agencies, in cooperation with local councils, can identify impacts and methods of ameliorating those impacts. This could lead to development of a best practice guide for other Local Government bodies whose activities may impact on marine turtle nesting success.

Table 22. Prescribed actions for land and water quality management

Prescribed Action	**Managers**	**Criteria for Success**
D.1.1. The Commonwealth to continue to assist communities with land management and use through appropriate funding programs. (M)	EA/AFFA	Community land management projects are funded annually, as approved under program guidelines.
D.1.2. Each jurisdiction to ensure that all activities that are likely to have an impact on marine turtles are subject to environmental impact assessment (such as EIS) and appropriate conditions. (M)	Lead agencies	The impact of development on turtles is adequately addressed and ameliorated through conditions.
D.1.3. States/NT to encourage local communities to become involved in land and catchment management in catchments adjacent to marine turtle habitat through Commonwealth programs. (M)	States/NT	Identified communities are involved with land and catchment management.
D.1.4. QEPA to manage the impact of coastal urbanisation and development on marine turtles through the development of best practice planning	QEPA	Best practice guidelines are produced.

guidelines with QLGA and councils across the State. (M)		

2. Loss of Sea Grass or Benthic Habitat

Sea grass communities and other benthic feeding habitats of marine turtles are subject to a range of natural and man-made influences. Tropical cyclones and pollution can significantly affect seabed communities over wide areas (Preen *et.al.* 1993) and trawling can also alter significant areas.

Benthic Feeding Habitat

Trawling is the major human activity in the tropical areas with a sedimentary substrate. The patterns of prawn trawling in the Northern Prawn Fishery (NPF) show that trawlers avoid large reef outcrops but trawl over hard seabed capable of supporting attached animals. For example, in the NPF some areas such as north of Mornington Island support very large amounts of sponges and large catches of these in prawn nets are not uncommon. Studies by CSIRO, GBRMPA and QDPI in the Great Barrier Reef region show that the impact of trawling on these organisms is a function of the frequency of trawling, the distribution of seabed flora and fauna, and recovery times of the impacted animals and plants. There is presently no similar information available for the NPF and other trawl fisheries but it is expected that the principles would be the same.

The findings of the report on the environmental effects of prawn trawling in the GBR (Poiner *et.al.* 1998) have implications for the management of trawling impacts on the benthic environment. The implications of the results are outlined below.

1. Large areas of the GBR are subject to trawling. In 1996, effort was recorded in 1300 six minute grids, an area equivalent to approximately 160 000 km².
2. Trawling is aggregated within grids, consequently less area is actually trawled than is indicated by summing up six minute grids.
3. Aggregated trawling in high effort grids removes less benthos than if effort was distributed randomly or uniformly.
4. Each year, trawling removes between 4–15 per cent of seabed fauna from all trawled grids in the GBRMP.
5. Though 50-70 per cent of trawled grids have been trawled only lightly (less than 700–1000 hours) each year, over the last 20 years the cumulative effect of this has been that:
    - vulnerable types of fauna that is, those easily removed and/or slow to recover) have been severely depleted, thus causing substantial changes in the composition of the faunal community; and
    - the overall faunal biomass may have been reduced by approximately 20 per cent, but it would be dominated by 'weedy' species.

The overall effects of trawling are dependent on the distribution and intensity of effort, which is known to be patchy. The key experimental results were extended to estimate the depletion rate of attached fauna subject to a range of trawl intensities observed in the fishery; the total annual removal of fauna from the GBRMP; and the possible status of populations of attached fauna after 20 years of trawling. In attempting to estimate population status, it was necessary to add a simple model for possible recovery dynamics of fauna. Therefore caution is needed in accepting the conclusions because of the assumptions made to conduct the analysis. The actual situation could be better or worse than the conclusions presented above. However, it is clear that trawling does have a significant impact on seabed habitat in trawled areas.

Seagrass Feeding Habitat

Seagrass communities are essential habitats for several marine turtles but particularly green turtles. Tropical and sub-tropical Australia is one of the richest areas in the world with respect to seagrasses. Despite the extensive area and species diversity of seagrasses, there have been reports of declines in seagrasses in tropical and sub-tropical Australia. Changes in seagrass occur at a range of spatial and temporal scales due to man-made and natural causes and the complex interaction of the two. In 1985 cyclone Sandy caused a 183 km^2 loss of seagrass in the Gulf of Carpentaria, which was 20 per cent of the seagrasses of the Gulf. After 12 years, much of the area had recovered to pre-cyclone levels but there is still a large area (20 km^2) devoid of seagrass that previously supported seagrass communities (Poiner *et.al.* 1993). In 1992-93 an estimated 900 km^2 of seagrass in Hervey Bay in Queensland disappeared. The cause of this loss is not known although it is thought that high turbidities, resulting from flooding of the Mary and Burrum Rivers, and run off from cyclone Fran three weeks later, were responsible (Preen *et.al.* 1993). Similarly 1199 km^2 of seagrass in the Torres Strait was lost probably due to high turbidities, resulting from flooding of the Mai River (Long *et.al.* 1997).

Seagrass declines in Moreton Bay have been attributed to the deterioration of water quality from urbanisation, industrialisation and increased land use resulting in increases in nutrient loading, sedimentation, influx of contaminants and toxins or other detrimental effects on seagrass communities (Kirkman 1978, Hyland *et.al.* 1989, Abal and Dennison 1996).

Outbreaks of *Lyngbya majuscula*, a cynobacterium commonly known as mermaid's hair or fireweed, can have major impacts on ecosystem health. In bloom conditions Lyngbya forms dense mats that cover the sea floor, smothering underlying seagrass meadows.

Seagrass systems do not readily recover. The plants require appropriate water quality and special conditions in the substrate that are not present in disturbed or most sandy substrates. Consequently, once an area has been denuded of seagrass, it may not recover or may take a long time.

Table 23. Prescribed action for identification and management of marine turtle habitat

Prescribed Action	Managers	Criteria for Success
D.2.1. Identify critical marine turtle benthic and sea grass habitats and nominate those places to the register of critical habitats under the EPBC Act. (M)	Lead Agencies Community	Critical habitat for marine turtles is listed on the register throughout the life of the plan.
D.2.2. Lead Agencies will protect critical marine turtle habitat using appropriate planning or zoning policies, regulations and laws as required. (M)	Lead Agencies Lead Fishing Agencies Planning Authorities	Habitat critical to the survival of marine turtles is protected.
D.2.3. Implementation of the Queensland East Coast Otter Trawl Management Plan to establish mechanisms to ensure that trawling is ecologically sustainable in the Great Barrier Reef World Heritage Area. (M)	QFS GBRMPA	Trawling in the Great Barrier Reef Marine Park is conducted in an ecologically sustainable manner.

3. Oil Spills and Operational Discharges

Weathered petroleum, emanating from heavy crude oil, has been observed by Balazs (1985) to seal the mouth and nostrils of turtles. Tar balls being mistaken for food items by marine turtles at all life stages are one of the causes of turtle stranding and mortality (Balazs 1985). Oil produced from petroleum facilities on the North West Shelf near areas frequented by marine turtles is generally light crude. The Commonwealth Department of Industry, Tourism and Resources in only aware of one incident in Australia involving an unusual waxy crude, a single observed turtle and incomplete flaring. Management practices have been adapted to minimise the chance of this occurring through reduced flaring and other measures. Further, petroleum operations are currently assessed to ensure no adverse effects on marine turtles under the EPBC Act and the *Petroleum (Submerged Lands) (Management of Environment) Regulations 1999*.

It is estimated that 3.2 million tonnes of oil enter the world's oceans each year, primarily from land based sources and shipping. Shipping discharge is regulated by the International Convention for the Prevention of Pollution from Ships (1973) and its Protocol (1978) - MARPOL 73/78. The Australian Maritime Safety Authority (AMSA) administers MARPOL in Australian waters under the Commonwealth *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*.

Response to marine oil spills is managed by AMSA, with the States and the Northern Territory, through the National Plan to Combat Pollution of the Sea by Oil and Other Noxious and Hazardous Substances (AMSA 1996). The plan was developed cooperatively by the Commonwealth, the States and the Northern Territory, shipping, exploration and petroleum industries and sets out the role and responsibilities of the major participants. The Plan identifies the potential effects on wildlife and the operations and procedures that should be put into place in the event of an oil spill.

Table 24 identifies actions where there is a need to assess impacts on turtles and their habitats.

Table 24. Prescribed actions for the management of oil spills and operational discharges

Prescribed Action	Managers	Criteria for Success
D.3.1. Lead agencies to respond to oil spills in accordance with the National Plan to Combat Pollution of the Sea by Oil and Other Noxious and Hazardous Substances. (M)	Lead agencies AMSA	Contingency plans are implemented in accordance with the national plan.
D.3.2. Proposals for oil and mineral exploration and exploitation are adequately assessed and, as appropriate, conditions imposed to ensure no adverse effects on marine turtles. (M)	Lead agencies	Proposals are adequately assessed and appropriate conditions imposed.
D.3.3. Lead agencies to provide AMSA with information relating to significant nesting sites for marine turtles. (M)	Lead agencies	Information is provided to AMSA for distribution.

4. Noise
Marine turtles do not have an external hearing organ. They can detect sound through bone conducted vibration with the skull and the shell being the receiving surfaces (Lenhardt *et.al.* 1983). Their response to sound varies with different frequencies and intensities of the sound. The available literature is inconclusive about the potential harm to marine turtles from persistent noise in the marine environment. Investigations into this issue may reveal more and will be assessed as the results become available (Table 25).

Under experimental conditions marine turtles can detect low frequency noise and modify their behaviour or, at least demonstrate a startle response (Lenhardt *et.al.* 1983). Seismic testing and explosive removals of platforms are identified as noise sources shown to impact on marine turtles (Minerals Management Service 1997). Effects on turtles have been observed in the Gulf of Mexico where explosive removal of platforms has resulted in the deaths of marine turtles from the explosions and drowning after being stunned (Minerals Management Service 1997). In Australia the method of platform removal is subject to the approval of the designated authority in each jurisdiction. The authority must make a judgement of the efficacy of the method and its potential impact on the environment.

Seismic surveys are an infrequent source of sound in Bass Strait, Western Australia and the Timor Sea. McCauley *et.al.* (2000) tested the effects of air gun seismic arrays on a green and loggerhead turtle. They were exposed to air gun shots and behavioural responses showed at a received level of 166 dB and avoidance behaviour at 175 dB. This was extrapolated to mean that behavioural changes would occur at 2 kilometres and avoidance at 1 kilometre for a seismic vessel with an air gun array in 100-120 metres depth of water that collected three dimensional data. Marine turtles are largely found in shallow water and McCauley *et.al.* (2000) speculated that sound would not carry as far in shallower water but noted that this also depends on the sound transmitting characteristics of the substrate. Turtles resting on the substrate are likely to be able to detect the vibration but the implications of this are not clear. Seismic operators are required by their environment plans under the *Petroleum (Submerged Lands) (Management of Environment) Regulations 1999* to use soft start procedures in areas within the distribution of marine turtles.

Table 25. Prescribed action to determine the effect of noise on marine turtles

Prescribed Action	Managers	Criteria for Success
D.4.1. On going action to ensure that soft start procedures to be implemented in seismic surveys that occur within the distribution of marine turtles.	APPEA EA	Soft start procedures implemented in seismic surveys.
D.4.2. Recovery Team and EA to monitor Australian and international literature on the effect of noise on marine turtles. (M)	EA/Recovery Team	Literature is collated and the results assessed.

Specific Objective E.

Communicate the results of recovery actions and involve and educate stakeholders.

1. Communicate Results of Recovery Actions
The Recovery Plan Guidelines (Environment Australia 1998a) clearly identify the need for education, public awareness and community involvement. Information from actions, particularly those collating the impact of threat (for example, bycatch data) will be fed into the recovery plan process through annual reports from participants (Table 26). Information will be collated by EA for circulation to the Recovery Team, the Threatened Species Scientific Committee (TSSC) and the public.

The need to evaluate the plan was discussed in Part 1 and is identified as an action (Table 26). The operation of recovery plans is generally reviewed after five years. The evaluation will assess the relevance of the objectives and stated priorities; assess the effectiveness of the actions to determine what objectives were achieved; and identify whether there are better ways of achieving the objectives.

The resulting report will provide guidance for the next iteration of recovery planning.

Table 26. Prescribed action to communicate the results of recovery actions

Prescribed Action	Managers	Criteria for Success
E.1.1. Recovery Team to: • review the recovery plan annually; and • host two biennial meetings on marine turtle conservation and management. (M)	Recovery Team/EA	Annual reports are produced and made publicly available Two meetings are held within the life of the plan.
E.1.2. Evaluate the effectiveness of the Recovery Plan after five years of operation. (M)	Recovery Team/ Consultant	A report is provided to the Minister for Environment.

2. Education, Public Awareness and Community Involvement

Volunteers have an important role to play in monitoring populations of marine turtles. In Queensland and Western Australia people have volunteered to gather data in monitoring programs and provided interpretation for CALM and QEPA. The long-term benefit of such activities is the consistent training of numerous individuals who may well move on to work on marine turtles in other areas.

Specific actions for educating commercial fishers were identified during the course of the Recovery Team meetings. Commercial fishers should be targeted as a group requiring greater education and awareness development. Of particular interest is their awareness of appropriate disposal of ship-borne rubbish and endangered species issues. Queensland Seafood Industry Association (QSIA) has been promoting an Endangered Species Awareness Course that is part of a Trainee Master Fisherman's Course and this can be developed for national application. The Australian Seafood Industry Council (ASIC) is well placed to develop such a program and negotiate with other fisheries industry councils about its implementation.

AMSA has carriage of compliance with MARPOL Annex V relating to the management of vessel-sourced garbage and has developed a range of educative material.

Table 27. Prescribed action to raise awareness and involve the community

Prescribed Action	Managers	Criteria for Success
E.2.1. Lead agencies to encourage the participation of volunteers in monitoring programs. (M)	Lead agencies	Volunteers trained and involved in monitoring programs
E.2.2. AFMA to coordinate the development of national guidelines on: • minimising capture, and maximising the recovery of marine turtles taken in trawl, net and longline fisheries; • eliminating the discard of fishing line and netting; and • reporting and/or retrieving discarded netting when encountered. (M)	AFMA	Guidelines are prepared and implemented.
E.2.3. ASIC to liaise with other fishing industry councils to develop a national Threatened Species Awareness Course, (similar to the course currently conducted by QSIA). (M)	ASIC	A National Threatened Species Awareness Training Program is adopted by fishers' organisations in the Northern Territory, Western Australia and the Commonwealth.
E.2.4. AMSA and lead agencies to promote compliance with laws restricting pollution from vessels.	AMSA Lead agencies	Material developed and distributed to fishers and other boat operators.
E.2.4. Lead agencies to require licensed fishers to record all interactions with marine turtles.	Lead agencies AFMA State and NT fisheries agencies	Identification charts and interaction logbooks developed by lead agencies and distributed by fisheries agencies. Fishers report to lead agencies.
E.2.5. Lead agencies to manage database on marine turtle mortality.	Lead agencies, community	Database established with reporting proforma on mortality.
E.2.6. Lead agencies to develop education material on 'tell tale' signs of nesting beaches.	Lead agencies	Material developed and distributed.

3. Indigenous Coastal Community Network

To support the participation of indigenous communities in northern Australia in marine turtle conservation and management, an indigenous coastal community network should be established (Table 28). The northern Australian coastline is not heavily developed and in many places is inhabited only by Aboriginal and Torres Strait Islander people who still use the marine and coastal environments for hunting, fishing and gathering food.

Management agreements agreed between indigenous communities and lead agencies will necessarily relate to local people and conditions, and there is a need to support the agreements through extension activities. An indigenous network that covers northern Australia, including Western Australia, Northern Territory and Queensland, would do this best. An indigenous network with a focus on marine resources should concentrate on management issues such as improve communication between indigenous communities, management agencies and technical experts; involve indigenous people and incorporate their cultural values in the monitoring and management of marine and coastal resources, in conjunction with lead agencies; facilitate training and employment opportunities for indigenous resources managers; develop information and education materials in culturally appropriate formats; and provide a forum for the discussion and exchange of information on issues of interest to the network.

Ideally such a network would be run external to any Commonwealth/State/Territory Government agencies by a specific coordinator/facilitator employed for that purpose.

Table 28. Prescribed action to raise awareness in northern Australian indigenous communities.

Prescribed Action	Managers	Criteria for Success
E.3.1. EA and lead agencies to support the establishment of an indigenous coastal community network to support communities' management of marine turtles with lead agencies. (M)	Appropriate host institution	The network is established.

Specific Objective F.

Support and maintain existing agreements and develop new collaborative programs with neighbouring countries for the conservation of shared turtle populations.

1. Marine Turtle Conservation in the Asia/Pacific

Australia shares its marine turtle populations with other neighbouring countries in the Asia/Pacific region where turtles go to feed or breed. The cultures and management regimes within those nations will differ from Australia's.

Australia has provided support for marine turtle management in the region, in particular under the Convention for the Protection of the Natural Resources and Environment of the South Pacific Region (SPREP) for its Regional Marine Turtle Program (RMTP). The RMTP was an Australian initiative to establish a regionally based program that would coordinate marine turtle conservation and management of shared marine turtle populations (Spring 1994). A review of the RMTP to evaluate its success would be valuable in determining if the program has achieved its conservation objectives.

Australia has recently agreed to a *Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats in the Indian Ocean and South East Asia* (MoU) that will operate under the Convention for the Conservation of Migratory Species of Wild Animals (CMS). This MoU provides the framework on which Australia can work cooperatively with regional neighbours on activities to improve the conservation status of shared marine turtle populations. The focus of the MoU is to provide protection for marine turtle habitat, manage direct harvest and trade, reduce threats and provide for research, education, information exchange and capacity building.

Table 29. Prescribed action to improve regional conservation of marine turtles

Prescribed Action	Managers	Criteria for Success
F.1.1. Commonwealth Government to maintain existing and develop new bilateral or multilateral agreements to ensure that international conservation and management of marine turtles is consistent with domestic policies and international treaty obligations. (M)	Commonwealth	Substantial progress is made in international cooperation and development of agreements to conserve marine turtles.

Part 3. Costs of Recovery

1. Estimated cost of recovery actions and implementation
The estimated costs are $5.640 million and are detailed in Table 30. An important corollary to the table of estimated costs of actions is that many of the costs will come from recurrent operational budgets of the organisations responsible for the activities. Any funding sought from EA will be subject to the approval of the Minister for the Environment and Heritage. The feasibility estimates the chance of success of each action. Although this is a subjective measure the success of any of the actions will be determined by many factors, some of which are outside the control of human endeavour. The priority assigned to each action has been identified according to the following criteria:

Priority 1 Action is critical to prevent extinction or to provide information critical for setting recovery goals;
Priority 2 Action prevents impact short of extinction; and
Priority 3 Refers to all other actions.

Table 30. Priority, feasibility and estimated cost of actions. All figures are in thousands of dollars ($000)

Action	Description	Priority	Feasibility	Year 1	Year 2	Year 3	Year 4	Year 5	Total
A.1	Reduce mortality of marine turtles in fisheries	1	High	250	620	460	310	260	**1900**
A.6	Pearl farming and other aquaculture activities	2	High	5	5	5	5	5	**25**
A.7	Defence activities	2	High	Department of Defence responsibility.					
A.3	Marine debris	2	High	15	15	15	10	10	**65**
A.4	Shark control activities	2	High	25	25	25	0	0	**75**
A.5	Boat strike	2	Moderate	State – Territory responsibility.					
A.2	Customary harvest issues	1	High	300	300	300	300	300	**1500**
B.1	Monitoring marine turtle populations	1	High	175	155	155	155	165	**805**
B.2	Measuring recovery	3	High	40	0	0	0	0	**40**
B.3	Identification of turtle populations	1	High	65	65	50	40	25	**245**
C.1	Light pollution	2	High	5	25	40	20	0	**90**
C.2	Tourism and recreational activities	2	High	10	20	20	10	0	**60**
C.3	Vehicle damage	2	Moderate	State – Territory responsibility.					
C.4	Predation of eggs	1	High	70	70	25	25	25	**215**
D.1	Land use and water quality	3	High	State – Territory responsibility or by application from Commonwealth programs.					
D.2	Loss of sea grass or benthic habitat	1	Moderate	Critical habitat may be nominated to the register at any time.					
D.3	Oil spills, operational discharge and effluent	3	High	Commonwealth/State/Territory responsibility as specified in National Plan.					
D.4	Noise	3	High	Included in F.1					
E.1	Communicate the results of recovery actions	3	High	5	5	5	5	15	**35**
E.2	Education, public awareness and community involvement	3	High	40	50	30	30	30	**180**
E.3	Indigenous coastal community network	2	High	50	50	50	50	50	**250**
F.1	Marine turtle conservation in the Asia/Pacific region	1	High	75	15	15	15	15	**135**
Total ($,000)				**1130**	**1420**	**1195**	**975**	**900**	**600**

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List of Affected Parties

Commonwealth
Department of the Environment and Heritage
Australian Fisheries Management Authority
Agriculture, Fisheries and Forestry--Australia
Great Barrier Reef Marine Park Authority
CSIRO
Australian Maritime Safety Authority
Aboriginal and Torres Strait Islander Commission
Torres Strait Regional Authority/Island Coordinating Council
Department of Defence

State/Territory/Local Government
Queensland Fisheries Management Authority
Queensland Department of Primary Industries and Energy
Fisheries WA
Western Australian Department of Aboriginal Affairs
Western Australian Department of Transport
Western Australian Department of Minerals and Energy
Western Australian Department of Resources and Development
Western Australian Department of Environment Protection
Northern Territory Department of Primary Industry and Fisheries
Northern Territory Department of Lands, Planning and Environment
Queensland Environment Protection Agency
Parks and Wildlife Commission of the Northern Territory
Western Australian Department of Conservation and Land Management
New South Wales National Parks and Wildlife
Victorian Department of Natural Resources and Environment
Tasmanian Department of Primary Industries and Fisheries
Local Governments of Western Australia, Northern Territory and Queensland

Non-government Organisations

Queensland Seafood Industry Association and other State/Territory based fishers' organisations
Australian Seafood Industry Council
Australian Eco-Tourism Association
Universities, for example Northern Territory University, University of Queensland, Murdoch University (Western Australia)
Oil exploration and production industry – Australian Petroleum Production and Exploration Association
Conservation groups for example Humane Society International, World Wild Fund for Nature
Indigenous land management groups
Aboriginal and Torres Strait Islander organisations for example:

- Dhimurru Land Management Aboriginal Corporation;
- Kimberley Land Council;
- Northern Land Council;
- Tiwi Land Council; and
- Anandilyakwa Land Council.

Table 31. Key marine turtle monitoring sites for all jurisdictions

Jurisdiction	Species	Population	Site	Existing Program	To be established
Comm - EA	Green	Coral Sea	NE Herald	Yes	
Comm - EA	Green	Ashmore Reef	Ashmore Reef	Opportunistically	
Comm. - EA	Flatback	Nth Aust.	Field Island	Yes	
CALM conservation reserve	Green	All NWS	Lacepede Island	Yes	
CALM conservation reserve	Green	All NWS	Barrow Island	Yes	
CALM conservation reserve	Green Hawksbill Flatback	All NWS	Montebello Islands	No	Yes
CALM conservation reserve	Green	All NWS	North West Cape	Yes	
CALM conservation reserve	Loggerhead	All NWS	Dirk Hartog Island	Yes	
CALM conservation reserve	Loggerhead	All NWS	North West Cape	Yes	
CALM conservation reserve	Loggerhead	All NWS	Muiron Islands	Yes	
CALM conservation reserve	Hawksbill	All NWS	Rosemary Island	Yes	
CALM conservation reserve	Hawksbill	All NWS	Varanus Island	Yes	
Coastal Reserve	Flatback	All NWS	Munda Beach (mainland)	Yes	
CALM conservation reserve	Flatback	All NWS	Barrow Island	Yes	
CALM conservation reserve	Flatback	All NWS	Thevenard Island	Yes	
Traditional Owners	Green	GoC	Bountiful Island	No	Yes
QEPA	Green	Sth GBR	Heron Island	Yes	
QEPA	Green	Sth GBR	Nth West Island	Yes	
QEPA/RIC*	Green	Nth GBR	Raine Island	Yes	
QEPA	Hawksbill	Nth GBR	Milman Island	No	Yes
QEPA	Loggerhead	East Aust.	Mon Repos	Yes	
QEPA	Loggerhead	East Aust.	Wreck Island	Yes	
QEPA	Loggerhead	East Aust.	Wreck Rock	Yes	
QEPA	Leatherback	East Aust.	Wreck Rock	Yes	
QEPA	Flatback	East Aust.	Peak Island	Yes	
QEPA	Flatback	East Aust.	Wild Duck Is	Yes	
QEPA/Injinoo	Flatback	GoC	Crab Island	No	Yes
?Leasehold	Flatback/Green	Nth Aust.	Fogg Bay	Yes	

PWCNT	Flatback/Green Hawksbill/Ridley	Nth Aust.	Coburg Peninsula	No	Yes
Dhimurru Land Management Aboriginal Corporation	Flatback/Green/ Hawksbill/Ridley	GoC	NE Arnhem Land	Yes	
Anandilyakwa Land Council	Flatback/ Green/ Hawksbill/Ridley	GoC	Groote Eylandt	No	Yes

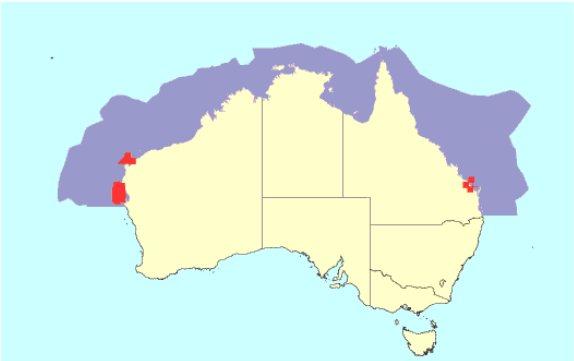
*RIC: Raine Island Corporation

Table 32. Initial list of identified habitat critical to the survival of marine turtles.

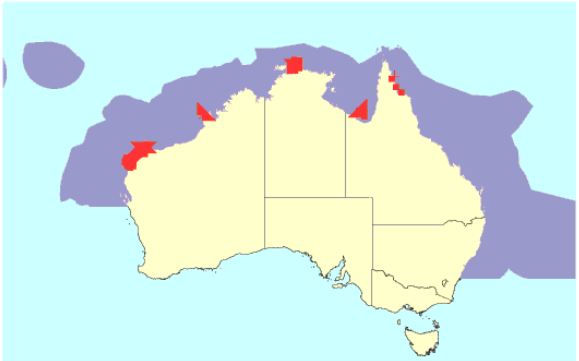
Species	Habitat type	Place name & description	Coordinates	Jurisdiction	Genetic Population	Life Stage
Green turtle, *Chelonia mydas*	Mating / Natal / Internesting	All land above sea level in the Coringa-Herald National Nature Reserve including all waters within a 20 km radius of that land.	16° 23', 150° 12' 16° 23', 150° 30' 16° 52', 150° 30 17° 11', 150° 05' 17° 11', 149° 00' 16° 46', 149° 00' 16° 46', 149° 48' Datum: WGS 84	Commonwealth	sGBR	Adult female Adult male Egg Hatchling
Green turtle, *Chelonia mydas*	Mating / Natal / Internesting	All land above sea level in the Lihou Reef National Nature Reserve including all waters within a 20 km radius of that land.	16° 57', 151° 54' 16° 57', 152° 20' 17° 27', 152° 20' 17° 54', 151° 08' 17° 21', 151° 08' Datum: WGS 84	Commonwealth	sGBR	Adult female Adult male Egg Hatchling
Green turtle, *Chelonia mydas*	Natal / Internesting	Ashmore reef and all waters within a 20 km radius	-12 10.9, 144 30.1	Commonwealth	Ashmore	Adult female Egg Hatchling
Flatback turtle, *Natator depresuss*	Natal / Internesting	Field Island and all waters within a 20 km radius of Field Island	-12 5.9, 132 23.0	Commonwealth	Nth Australia	Adult female Egg Hatchling
Hawksbill turtle, *Eretmochelys imbricata*	Feeding	All waters within the lagoon of the main Cocos (Keeling) Islands atoll, and all waters surrounding the lagoon to a depth of 100m	-12.16721, 96.8219	Cocos (Keeling) Islands Shire Council / Commonwealth	Awaiting DNA results	Subadult / Juvenile
Hawksbill turtle, *Eretmochelys imbricata*	Feeding	All waters within Pulu Keeling National Park and waters within a radius of 20km of North Keeling Island	-11.81465, 96.82467	Cocos (Keeling) Islands Shire Council / Commonwealth	Awaiting DNA results	
Green turtle, *Chelonia mydas*	Natal / Internesting	All sandy beaches above sea level in the main Cocos (Keeling) Islands atoll and all waters within a radius of 20km of those beaches.	-12.16721, 96.8219	Cocos (Keeling) Islands Shire Council / Commonwealth	Awaiting DNA results	Adult female Egg Hatchling
Green turtle, *Chelonia mydas*	Feeding	All waters within the lagoon of the main Cocos (Keeling) Islands atoll, and all waters surrounding the lagoon to a depth of 100m	-12.16721, 96.8219	Cocos (Keeling) Islands Shire Council / Commonwealth	Awaiting DNA results	Sub-adult, juvenile
Green turtle, *Chelonia mydas*	Natal/Internesting	All sandy beaches above sea level in Pulu Keeling National Park and all waters within a radius of 20 km of those beaches.	-11.81465, 96.82467	Cocos (Keeling) Islands Shire Council / Commonwealth	Awaiting DNA results	Adult female, egg, hatchling
Green turtle, *Chelonia mydas*	Feeding	All waters within Pulu Keeling National Park and waters within a radius of	-11.81465, 96.82467	Cocos (Keeling) Islands Shire Council / Commonwealth	Awaiting DNA results	Sub-adult, juvenile

		20km of North Keeling Island				
Green turtle, *Chelonia mydas*	Natal / Internesting	All land above sea level in the Capricorn- Bunkers Group including all waters within a 20 km radius of that land.	-23.23, 151.77 -23.29, 151.68 -23.56, 151.72 -23.57, 152.06 -23.86, 152.35 -23.86, 152.41 -23.24, 151.92	GBRMPA	sGBR	Adult female Adult male Egg Hatchling
Loggerhead turtle, *Caretta caretta*	Natal	Coastal beaches from the Elliot River to Wreck Rock and land within a 1.5km radius inland.	-24.89, 152.51 -24.29, 151.99	Queensland	East Aust.	Adult female Egg Hatchling
Loggerhead turtle, *Caretta caretta*	Internesting	Coastal beaches from the Elliot River to Wreck Rock and all waters within a 20km radius	-24.89, 152.51 -24.29, 151.99	Queensland	East Aust.	Adult female Egg Hatchling
Green turtle, *Chelonia mydas*	Natal & Internesting	Lacepede Island and all waters within an 20km radius	-16.86996, 122.15858	Western Australia	NWS	Adult female Egg Hatchling
Green turtle, *Chelonia mydas*	Natal & Internesting	Barrow Island and all waters within an 20km radius	-20.79909, 115.40497	Western Australia	NWS	Adult female Egg Hatchling
Flatback turtle, *Natator depressus*	Natal & Internesting	Montebello Islands and all waters within an 20km radius	-20.43636, 115.52828	Western Australia	NWS	Adult female Egg Hatchling
Flatback turtle, *Natator depressus*	Natal & Internesting	Mundabullangana Beach and all waters within an 20km radius	-20.46, 118.01	Western Australia	NWS	Adult female Egg Hatchling
Hawksbill turtle, *Eretmochelys imbricata*	Natal & Internesting	Montebello Islands and all waters within an 20km radius	-20.43636, 115.52828	Western Australia	NWS	Adult female Egg Hatchling
Loggerhead turtle, *Caretta caretta*	Natal & Internesting	Dirk Hartog Island and all waters within an 20km radius	-25.84355, 113.05526	Western Australia	NWS	Adult female Egg Hatchling
Loggerhead turtle, *Caretta caretta*	Natal & Internesting	Muiron Island and all waters within an 20km radius	-21.66913, 114.34246	Western Australia	NWS	Adult female Egg Hatchling
Hawksbill turtle, *Eretmochelys imbricata*	Natal & Internesting	Rosemary Island and all waters within an 20km radius	-20.48299, 116.59217	Western Australia	NWS	Adult female Egg Hatchling
Hawksbill turtle, *Eretmochelys imbricata*	Natal & Internesting	Varanus Island and all waters within an 20km radius	-20.65108, 115.5744	Western Australia	NWS	Adult female Egg Hatchling
Green turtle, *Chelonia mydas,* Loggerhead turtle, *Caretta caretta*	Feeding	Shark Bay Marine Reserve and Hamelin Pool Marine Nature Reserve	As defined in the Plan of Management (CALM 1996)	Western Australia	NWS	Adult Juvenile

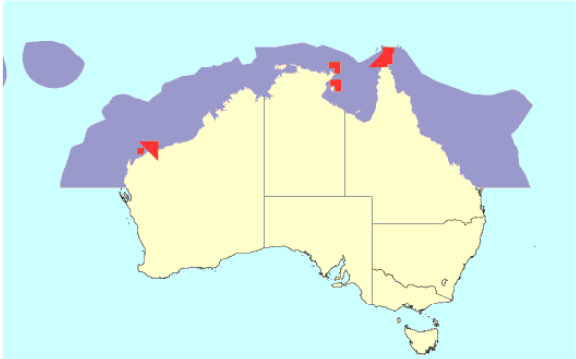
Distribution of Australian Marine Turtles



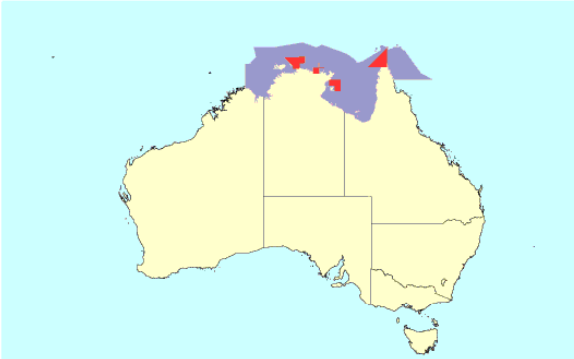
Loggerhead Turtle
Caretta caretta



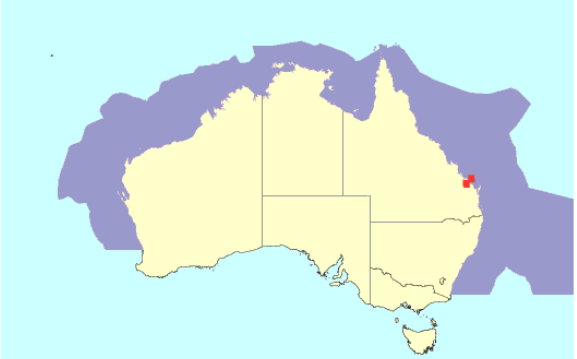
Green Turtle
Chelonia mydas



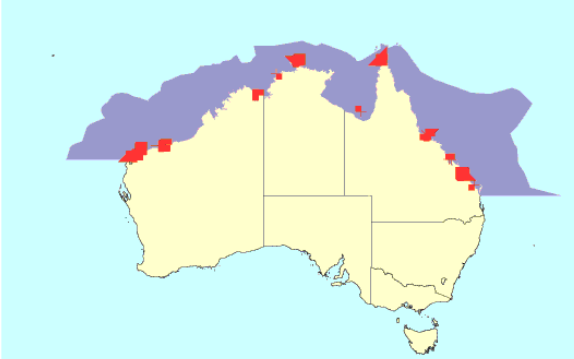
Hawksbill Turtle
Eretmochelys imbricata



Olive Ridley
Lepidochelys olivacea



Leatherback Turtle
Dermochelys coriacea



Flatback Turtle
Natator depressus

Source: General distribution as indicated in Cogger, H. (1996). Reptiles and Amphibians of Australia. Reed. Breeding (rookery) distribution based on areas defined by Limpus, C.J. (1995) Conservation of marine turtles in the Indo-Pacific. Draft: 1 October 1995. Report to Australian Nature Conservation Agency; and Wildlife Management Section, Environment Australia and Marine Turtle Recovery Team (1998) Draft Recovery Plan for Marine Turtles in Australia.

Recorded Breeding Sites
Distribution within Australian Waters

Projection: Geographics

Map produced by ERIN, Environment Australia, Canberra, July 2003.