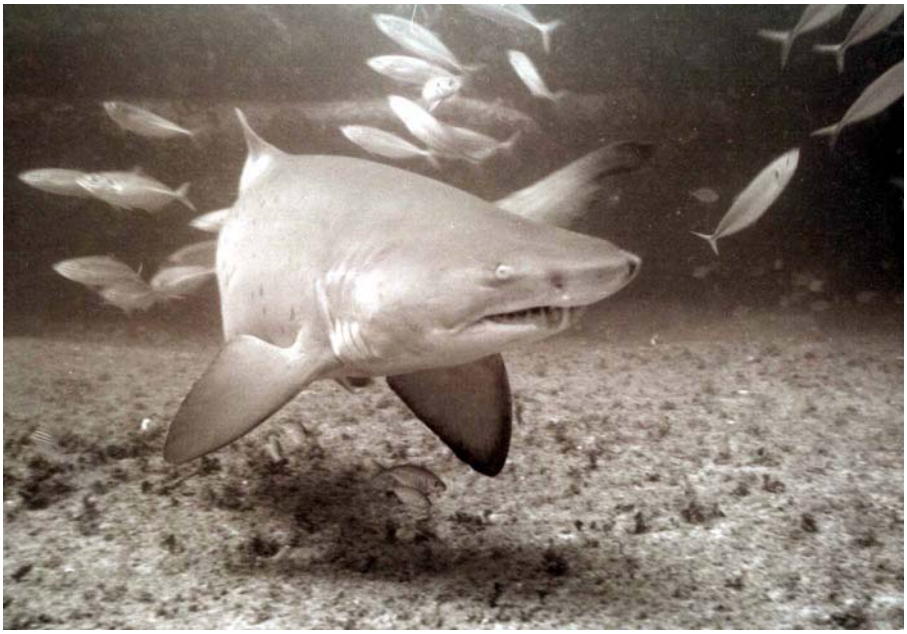
Recovery Plan for the Grey Nurse Shark (*Carcharias taurus*) in Australia



June 2002

Environment Australia

ISBN 0642547882

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

For additional copies of this publication, please contact the Community Information Unit of Environment Australia on toll free 1800 803 772.

Cover Image
Grey Nurse Shark
Photo Courtesy of David Harasti

Table of Contents

Tables

Maps

Figures

Acknowledgments

Environment Australia would like to thank the members of the Recovery Team, particularly Nick Otway and Dave Pollard for their assistance with the drafts. Members or groups of members and colleagues from within their industries or government sectors have also provided data and advice. Thanks are due to the Queensland Shark Control Program and Western Australia Department of Fisheries for providing data. Thanks also go to staff of Environment Australia, in particular David Harasti, Sara Williams and Sarah Johnstone for all their assistance and advice.

Recovery Team Membership

The list below has been compiled from the two meetings held to discuss and develop the plan. Representation was subject to some changes depending on availability of representatives from various sectors and location and timing of the meetings.

Sara Williams	Environment Australia, Marine and Water Division (Chair)
David Harasti	Environment Australia, Marine and Water Division
Nicola Beynon	Humane Society International
Stephanie Lemm	Queensland Parks and Wildlife Service
Geoff McPherson	Queensland Department of Primary Industries
Barry Bruce	CSIRO Marine Laboratories
John Stevens	CSIRO Marine Laboratories
Rory McAuley	WA Department of Fisheries
Nick Otway	NSW Fisheries
Bill Talbot	NSW Fisheries
David Pollard	NSW Fisheries
Noel Hitchins	Scuba Diving Industry
Ross Monash	Recfish Australia
Katrina Maguire	Australian Fisheries Management Authority
Joanna Fisher	Australian Fisheries Management Authority
Andreas Fischer	Aquarium Industry
Craig Bohm	Marine and Coastal Community Network

List of Abbreviations

AFFA	Agriculture, Fisheries & Forestry - Australia
AFMA	Australian Fisheries Management Authority
ANZECC	Australia and New Zealand Environment and Conservation Council
CALM	Department of Conservation and Land Management, Western Australia
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
COFI	Committee on Fisheries
cm	centimetres
CSIRO	Commonwealth Scientific and Industrial Research Organisation
EA	Environment Australia
EPBC Act	*Environment Protection and Biodiversity Conservation Act* 1999
ESAC	Endangered Species Advisory Committee
ESP Act	*Endangered Species Protection Act 1992*
ESSS	Endangered Species Scientific Subcommittee
FAO	Food and Agriculture Organisation of the United Nations
IPOA	International Plan of Action for Conservation and Management of Sharks
IUCN	World conservation Union (formerly International Union for the Conservation of Nature)
km	kilometres
m	metres
MPAs	marine protected areas
NRSMPA	National Representative System of Marine Protected Areas
NSW	New South Wales
NSW NPWS	New South Wales National Parks and Wildlife Service
PIRSA	Primary Industries and Resources South Australia
QDPI	Queensland Department of Primary Industries
QFS	Queensland Fisheries Service
QPWS	Queensland Parks and Wildlife Service
TSSC	Threatened Species Scientific Committee
USA	United States of America
WA	Western Australia

Summary

Current Species Status
The Grey Nurse Shark, *Carcharias taurus,* is listed as two separate populations under the *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act* 1999*)*. The east coast population is listed as critically endangered and the west coast population is listed as vulnerable under the EPBC Act. The *EPBC Act* 1999 and *EPBC Regulations* 2000 (section 7.11) identify the need for preparation of a recovery plan and specifies the content of the plan.

Grey Nurse Sharks are protected under Fisheries Legislation in New South Wales, Western Australia, Victoria, Tasmania and Queensland. The decline of Grey Nurse Shark numbers has been recognised by the International Union for the Conservation of Nature (IUCN), which has listed Grey Nurse Sharks as globally vulnerable. They are also fully protected in South Africa, Namibia and Florida (USA).

Habitat and Distribution
Grey Nurse Sharks are often observed just above the sea bed in or near deep sandy-bottomed gutters or rocky caves in the vicinity of inshore rocky reefs and islands. The diet of the adult Grey Nurse Shark consists of a wide range of bony fishes such as jewfish and kingfish, other sharks and rays, squids, crabs and lobsters.

Grey Nurse Sharks have a broad inshore distribution, primarily in sub-tropical to cool temperate waters around the main continental landmasses. In Australia, Grey Nurse Sharks have been regularly reported from Mooloolaba in southern Queensland around most of the southern half of the continent (excluding the Great Australian Bight), and northward to Shark Bay in Western Australia. The Grey Nurse Shark has been recorded as far north as Cairns in the east, the North West Shelf in the west, and also in the Arafura Sea. The distribution of Grey Nurse Sharks is now confined to coastal waters off southern Queensland, the entire New South Wales coast and the south-west coastal waters of Western Australia.

Threats
Historically, due to their fierce appearance and being mistaken for other sharks that pose a danger to humans, large numbers of Grey Nurse Sharks were killed by recreational spear and line fishers and in shark control programs, particularly in south-eastern Australia. Major threats to the recovery of Grey Nurse Sharks include:

- incidental capture by commercial and recreational fisheries;
- shark control activities;
- shark finning; and
- ecotourism.

The life history characteristics of Grey Nurse Sharks have left the remaining populations vulnerable to any small scale changes, and populations in NSW waters have not recovered since their protection in 1984. The total number of individuals on the east coast of Australia is low and estimated to be less than 500 individuals. The number of Grey Nurse Sharks in NSW could be as low as 292; the highest number of individuals observed during a single survey period at all sites where these sharks are currently known to occur in NSW. There are concerns that this population has fallen to such critically low numbers that individual animals are now failing to find mates and successfully reproduce. In addition, fishing activity, particularly recreational line fishing are thought to be impacting severely on the existing Grey Nurse Shark population.

Biodiversity Benefits
The benefits to biodiversity of the actions identified in this plan will be varied. Some benefits to other marine species can be immediately identified, such as:

- the effective management of bycatch in fisheries;
- the effective management of bycatch in shark control activities;
- the protection of marine habitat; and
- the additional protection for other threatened marine species.

Recovery Team Membership
Representation on the Recovery Team was drawn from a cross-section of affected and interested parties, including government departments, non-government organisations and people involved in or interested in shark conservation and management.

Recovery Objectives
The overall recovery objective is:

To increase Grey Nurse Shark numbers in Australian waters to a level that will see the species removed from the schedules of the EPBC Act.

The specific objectives are to:
A. Reduce the impact of commercial fishing on Grey Nurse Sharks.
B. Reduce the impact of recreational fishing on Grey Nurse Sharks.
C. Reduce the impact of shark finning on Grey Nurse Sharks.
D. Reduce the impact of shark control activities on Grey Nurse Sharks.
E. Manage the impact of ecotourism on Grey Nurse Sharks.
F. Eliminate the impact of aquaria on Grey Nurse Sharks.
G. Identify and establish conservation areas to protect Grey Nurse Sharks from threatening activities such as commercial and recreational fishing.
H. Develop research programs to assist conservation of Grey Nurse Sharks.
I. Develop population models to assess Grey Nurse Shark populations and monitor their recovery.
J. Promote community education about Grey Nurse Sharks.
K. Develop a quantitative framework to assess the recovery of the species.

Actions and Recovery Criteria
To fulfil the specific objectives of this plan, actions are designed to identify and reduce the threats to Grey Nurse Sharks, determine levels of mortality and reduce that mortality. The assessment of the actions against the criteria for success is essential to measure the recovery of Grey Nurse Sharks. These actions and criteria can be found in Table 6 and are summarised as:

- assess commercial and recreational fisheries data to determine current levels of Grey Nurse Shark bycatch;
- modify fisheries logbooks to permit recording of Grey Nurse Shark catch and biological data;
- ensure existing fishery observer programs record interactions with Grey Nurse Sharks;
- prevent unregulated shark finning;
- quantify and reduce levels of Grey Nurse Shark take in shark control activities;
- minimise ecotourism and aquaria impacts on Grey Nurse Sharks;
- develop appropriate mechanisms to protect habitat critical for the survival of Grey Nurse Sharks;
- establish community based programs to identify and monitor key sites for Grey Nurse Sharks;
- collect biological and genetic information to assess the population size and status of Grey Nurse Sharks; and
- develop a community education strategy for Grey Nurse Sharks.

Evaluation and Review

The life of the recovery plan is 5 years. The EPBC Act states the need to evaluate the performance of the plan. A review will be carried out annually by the recovery team. The recovery team will also undertake an evaluation of the plan within 5 years.

Part 1. Introduction

1.1 Conservation Status

The Grey Nurse Shark, *Carcharias taurus* (Rafinesque 1810), is listed as two separate populations under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The east coast population is listed as critically endangered and the west coast population is listed as vulnerable. This species became the first protected shark in the world when the NSW Government declared it a protected species in 1984 (Pollard *et al.* 1996). Grey Nurse Sharks are now protected under fisheries legislation in New South Wales, Western Australia, Victoria, Tasmania and Queensland and is listed as vulnerable globally on the IUCN Red List of Threatened species 2000 (Table 1).

Until recently the Grey Nurse Shark had an undeserved reputation in Australia as a man-eater. Harding (1990) and many others before him, found that the species is not a threat to divers or swimmers unless provoked. Many shark attacks in Australia have been attributed incorrectly to the Grey Nurse Shark (Whitley 1983), often due to its fierce appearance. The Grey Nurse Shark's reputation led to indiscriminate killing of the species by spear and line fishers (Last & Stevens 1994). During the 1950s and 60s there was a concerted effort among spear fishers to wipe out Grey Nurse Sharks along the NSW coastline (Cropp 1964, Ireland 1984). Cropp (1974) speculated that at the time of publication, close to 300 Grey Nurse Sharks had been taken since the use of powerheads became widespread in skin diving circles. He also reported taking 24 grey nurse from a single gutter at Seal Rocks and earlier reflected that the Grey Nurse Shark would soon become rare as a consequence of the introduction of powerheads (Cropp 1974).

Current threats to the species are believed to be incidental catch by recreational fishing and various commercial fisheries (such as NSW Ocean Trap and Line and WA Shark Gillnet Fisheries), and to a much lesser extent protective beach meshing (Pollard *et al.* 1996, Krogh 1994, and Pepperell *et al.* 1993).

Table 1. Current legislation to protect Grey Nurse Sharks or identify their conservation status.

Jurisdiction	Legislation	Status
Queensland	*Fisheries Act 1994 (Fisheries Regulation 1995)*	Protected
Western Australia	*Wildlife Conservation Act 1950*	Protected
Tasmania	*Fisheries Regulations 1996 (General and Fees) Amendment Regulations 1988*	Protected
Victoria	*Flora and Fauna Guarantee Act 1988*	Protected
NSW	*Fisheries Management Act 1994 and 1997 Amendments*	Endangered
Commonwealth west coast Population	*Environment Protection and Biodiversity Conservation Act 1999*	Vulnerable
Commonwealth east coast Population	*Environment Protection and Biodiversity Conservation Act 1999*	Critically Endangered

1.2 Reasons for Listing

The Grey Nurse Shark was listed as vulnerable on the *Environment Protection and Biodiversity Conservation Act 1999* in August 2000. This listing was based on declining population trends, the life history characteristics of the species, limited knowledge of their ecology and abundance, and the fact that Grey Nurse Sharks were still under pressure from some sectors of the Australian commercial and recreational fishing industries.

Recently however, (October 2001) the Grey Nurse Shark was listed as two separate populations under the EPBC Act. Given the serious decline in numbers of the east coast population of Grey Nurse Sharks, this population is now listed as critically endangered. The size of the west coast population is unknown but considering the species life history characteristics and continuing impacts from fishing, this population remains listed as vulnerable under the EPBC Act.

Prior to national listing, Grey Nurse Sharks were protected in NSW in 1984. The species is known to be migratory and the protection provided by NSW becomes ineffective when a shark crosses a state

boundary (Environmental Protection Authority 1996). This was another contributing factor that supported the national listing of Grey Nurse Sharks.

1.3 Benefits to Nontarget Species

Section 270 (2)(h) of the EPBC Act indicates the need to identify the activities in this recovery plan that will benefit species other than Grey Nurse Sharks. Conservation measures to benefit Grey Nurse Sharks and their habitat will also benefit threatened marine species and inshore marine communities. By managing fishery bycatch and researching alternatives to beach protective shark nets, other species, such as whales, dolphins, marine turtles, pelagic rays, some fish species and other sharks that pose no threat to beach users, will be less subject to these sources of mortality. Some of these species are also threatened or uncommon with limited information available about their ecology.

1.4 Social and Economic Impacts of the Plan

Section 270 (3)(c) of the EPBC Act states that there is a need to minimise any significant adverse social and economic impacts in the development of recovery plans. Objectives and actions in this plan have been formulated with this in mind. Responsibility for the actions identified in this plan lie mostly with Commonwealth and State Governments. Various sectors of the fishing industry may be impacted through the need to quantify grey nurse bycatch and any subsequent actions such as the declaration of marine protected areas that may exclude fishing activities. Further management action may be required to reduce the impact on commercial, recreational and spearfishing interests.

There will be some impact on scuba divers due to educative programs, Grey Nurse Shark survey work and possible restrictions on diving with Grey Nurse Sharks at known aggregation sites. Aquaria will also be impacted through a national moratorium on the taking of Grey Nurse Sharks from the wild, the development of management plans for the keeping of Grey Nurse Sharks and the development of Grey Nurse Shark education programs.

1.5 Affected Parties

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

Commonwealth
Department of the Environment and Heritage
Australian Fisheries Management Authority
Agriculture, Fisheries and Forestry - Australia

State/Territory/Local Government
Department of Primary Industries and Resources South Australia
Department of Conservation and Land Management, Western Australia
Fisheries Western Australia
Fisheries Victoria, Department of Natural Resources and Environment
New South Wales Fisheries
New South Wales Marine Parks Authority
New South Wales National Parks and Wildlife Service
Queensland Fisheries Service - Queensland Department of Primary Industries
Queensland Parks and Wildlife Service

Non Government Organisations
Commercial fishers
Recreational fishers
Conservation and wildlife interest groups
Dive clubs
Aquaria
Scuba diving schools

1.6 Evaluation and Review

Section 270 (2)(g)(ii) of the EPBC Act states the need to identify who will evaluate the performance of the plan. An annual review will be carried out by the Grey Nurse Shark Recovery Team and a report of that review will be forwarded to the Threatened Species Scientific Committee (TSSC). Section 279(2) of the EPBC Act also identifies that an evaluation of the plan will be undertaken at intervals of not longer than five years. The Recovery Team will carry out the evaluation with the outcome being a report to the Minister for the Environment and Heritage.

The recovery plan may be varied at any time on the request of the Minister (*EPBC Act* Section 279). Such a request may occur if information that significantly alters the actions identified in the plan is revealed.

Part 2. Biological Description

2.1 Description of Species

The Grey Nurse Shark, *Carcharias taurus* (Rafinesque, 1810), also known in the USA as the sand tiger shark and in South Africa as the spotted ragged-tooth shark, is one of four species belonging to the family Odontaspididae (Pollard *et al.* 1996). The species has a large, rather stout body and is coloured grey to grey-brown dorsally, with a paler off white under belly (Last & Stevens 1994). Reddish or brownish spots may occur on the caudal fin and posterior half of the body, particularly in juveniles (Last & Stevens 1994; Pollard *et al.* 1996). The species has a conical snout, long awl-like teeth in both jaws (with single lateral cusplets), similarly sized first and second dorsal fins and an asymmetrical caudal fin (Last & Stevens 1994; Pollard *et al.* 1996). Grey Nurse Sharks grow to at least 360 cm total length (Last & Stevens 1994). The Grey Nurse Shark is a slow but strong swimmer and is thought to be more active at night (Pollard *et al.* 1996).

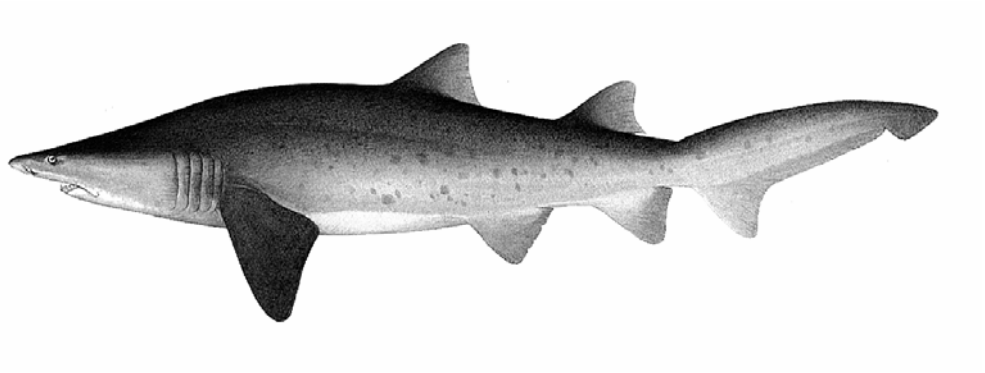


Figure 1: Grey Nurse Shark, *Carcharias taurus* (From: Last and Stevens, 1994)

2.2 Distribution

Grey Nurse Sharks have a broad inshore distribution, primarily in sub-tropical to cool temperate waters around the main continental landmasses, except in the eastern Pacific Ocean off north and south America (Last and Stevens 1994).

In Australia, Grey Nurse Sharks have been regularly reported from Mooloolaba in southern Queensland around most of the southern half of the continent, although the species is uncommon in Victorian, South Australian and Tasmanian waters, and has not been found in the Great Australian Bight. The Grey Nurse Shark has been recorded as far north as Cairns in the east, the North West Shelf in the west and the Arafura Sea in the north (Stevens 1999, Pogonoski *et al.* 2001). However, more recently Grey Nurse Shark distribution in Australia has generally been confined to coastal waters off southern Queensland and along the entire NSW coast, and in Western Australia, predominantly the coastal waters of the southwest.

In NSW, aggregations of Grey Nurse Sharks can be found at reefs off the following locations: Byron Bay, Brooms Head, Solitary Islands, South West Rocks, Laurieton, Forster, Seal Rocks, Port Stephens, Sydney, Bateman's Bay and Narooma (Otway and Parker 2000) (see Map 1). An aggregation is considered to be 5 or more Grey Nurse Sharks present at the same site at the same time (Otway and Parker 2000). Known key aggregation sites for Grey Nurse Sharks in Queensland include sites off Moreton and Stradbroke Islands and Rainbow Beach. The above sites may play an important role in pupping and/or mating activities, as Grey Nurse Sharks form regular aggregations at these sites (Pollard *et al.* 1996).

Relatively little is known about the migratory habits of Grey Nurse Sharks in Australian waters. Evidence suggests migrational movement, probably in response to water temperatures, up and down the east coast. At certain times of the year Grey Nurse Sharks aggregate according to sex. Male animals predominate southern Queensland waters during July to October, while a high proportion (77.4 per

cent) of the catch from beach meshing operations off central NSW at the same time of year is composed of females (Reid and Krogh 1992).

Dive charter operators regularly see Grey Nurse Sharks at the same locations and these observations suggest that the species exhibits some degree of site fidelity (Pollard *et al.* 1996). This characteristic makes the species vulnerable to localised pressures in certain areas (Environment Australia 1997).

2.3 Habitat and Diet

Grey Nurse Sharks are often observed hovering motionless just above the seabed, in or near deep sandy-bottomed gutters or rocky caves, and in the vicinity of inshore rocky reefs and islands (Pollard *et al.* 1996). The species has been recorded at varying depths, but is generally found between 15 m and 40 m (Otway and Parker 2000). Grey Nurse Sharks have also been recorded in the surf zone, around coral reefs, and to depths of around 200 metres on the continental shelf (Pollard *et al.* 1996). They generally occur either alone or in small to medium sized groups, usually of fewer than twenty sharks (Pollard *et al* 1996). Those Grey Nurse Sharks that are observed alone are thought to be moving between aggregation sites. Recent NSW Fisheries survey data indicates that a group of 20 sharks or more would be a notable event.

The diet of the adult Grey Nurse Shark consists of a wide range of fish, other sharks and rays, squids, crabs and lobsters (Compagno 1984). In Australia it is likely that the Grey Nurse Shark diet consists of species such as pilchards, jewfish, tailor, bonito, moray eels, wrasses, sea mullet, flatheads, yellowtail kingfish, small sharks, squid and crustaceans (N. Otway pers. comm.). Observations also suggest that schools of Grey Nurse Sharks can feed cooperatively by concentrating schooling prey before feeding on them (Compagno 1984; Ireland 1984). It is important to note that many of the species that comprise the Grey Nurse Sharks diet are also harvested by commercial, recreational and spearfishing interests.

2.4 Life History

There is limited information available on the biology of the Grey Nurse Shark in Australian waters, mostly limited to catch records from beach protective shark meshing and popular accounts in diving and fishing magazines (Pollard *et al.*1996). The life history characteristics (detailed below) of Grey Nurse Sharks make them particularly vulnerable to over-exploitation (Pollard *et al.* 1996).

2.4.1 *Reproductive Biology*

The Grey Nurse Shark has a relatively low growth rate and take 4 - 6 years to mature (Branstetter & Musick 1994), with both males and females maturing at about 220cm total length (Last & Stevens 1994). The precise timing of mating and pupping in Australian waters is unknown. Many sharks have been observed at Pimpernel Rock, NSW (see Map 1) during the months of March and April with mating scars, ie. bite marks around the pectoral fins and head area (D. White pers. comm. in Otway and Parker 1999). In South Africa mating occurs between late October and the end of November, with pregnant females moving southwards each year during July and August to give birth in early spring, then returning northward. Once impregnated, the female stores the sperm while the ovaries produce eggs that move to the oviduct where they are fertilised (Marsh 1995). Not all migrating females are sexually active and generally only reproduce once every two years (Smith and Pollard 1999).

The reproductive norm for the Grey Nurse Shark includes oophagy and intra-uterine cannibalism which results in a maximum of two young per litter (one in each uterus). Embryos hatch into the uterus at about 55 mm long and at lengths of around 10 cm they develop teeth and consume other embryos in the uterus. The single remaining embryo in each uterus then feeds on any unfertilised eggs as the female continues to ovulate. Gestation takes 9-12 months (Last & Stevens 1994).

2.4.2 *Young*

At birth the Grey Nurse Shark pups measure on average 1 metre in length (Last & Stevens 1994). In Australia it appears that these sharks give birth at select pupping grounds. In July 2001 the first recorded birth of a Grey Nurse Shark was observed, one pup was born in the late morning at Julian Rocks Byron Bay (N. Otway pers. comm.).

2.4.3 *Longevity*

A Grey Nurse Shark held in captivity at a Sydney aquarium lived for 13 years, and others have lived for over 16 years in captivity in South Africa (Govender *et al.* 1991). The average life span of this species in the wild is unknown, although it is likely that larger specimens in the wild may be much older than 13 or 16 years (Pollard *et al.* 1996).

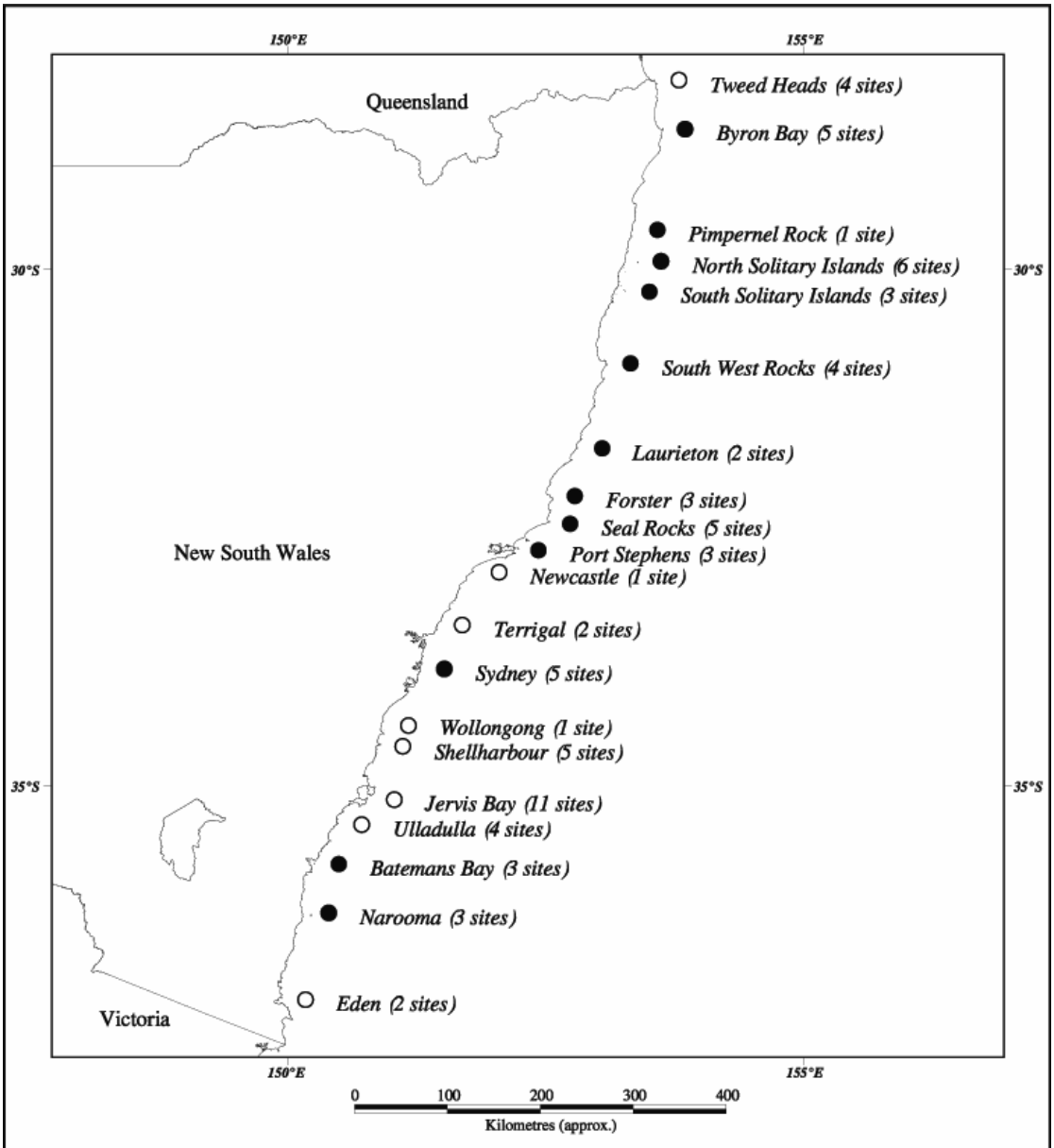
2.5 Degree of Decline

Grey Nurse Shark numbers are believed to be in decline in NSW based on recent NSW Fisheries surveys (Otway and Parker 2000), measures of relative abundance, catch records of protective shark meshing and anecdotal reports. The number of Grey Nurse Sharks in NSW could be as low as 292 (NSW Fisheries survey seven: March - June 2000). This is the highest number of individuals observed during a single survey (four week) period (NSW Fisheries unpublished data). Map One illustrates the survey sites along the NSW coast. There are now concerns that the east coast population has fallen to such critical numbers that individual animals may now be failing to find mates and successfully reproduce.

A decline in Grey Nurse Shark numbers is also evident from beach meshing figures, which need to be considered in the context of the increase in meshing effort since the 1950s. In NSW, the number of Grey Nurse Sharks caught has declined from 58 between October and December 1937 (Coppleson 1962), to a total of only 65 caught between October 1972 and December 1990 (Krogh and Reid 1996, see also Figure 2). In the first two years of shark netting in Queensland (1962/63), a total of 35 Grey Nurse Sharks were caught, while only 27 were caught between 1985 and 1999 (Shark Control Program, QDPI).

In 1984 the Grey Nurse Shark was afforded protected status in NSW and became the first shark species in the world to become protected. Population numbers in NSW have apparently failed to respond to the statewide protection established in 1984 (Otway and Parker 2000). Anecdotal evidence suggests a dramatic decline in the number of Grey Nurse Sharks along Sydney's coastline and at known aggregation sites such as Seal Rocks (Pollard *et al.* 1996). Many areas along the NSW coastline, such as Brush Island just south of Ulladulla, no longer support populations of Grey Nurse Sharks (D. Harasti pers. comm., Otway and Parker 2000).

Very little is known about the conservation status of Grey Nurse Sharks in Western Australia. It appears that the Grey Nurse Shark population of Western Australia may be larger than originally thought; however, at these catch rates it is inevitable that this population will also decline considering their life history characteristics (Pogonoski *et al.* 2001).



Map 1: Areas sampled by the scuba diving community in cooperation with NSW Fisheries 1998-01

LEGEND

- ● Areas where the mean number of sharks was 5 or more in at least one survey
- ○ Areas where the mean number of sharks was less than 5 in all surveys

Environment Australia

Source:
Locations after Otway and Parker (2000).
AUSLIG 1990: Australia, Coastline and State Borders 1:100,000

Caveat:
Data used are assumed to be correct as received from the data suppliers

Projection: Geographic
Datum: GDA94

Produced by: Environment Australia
Commonwealth of Australia, Canberra

Part 3. Threats

There are a number of suggested causes for the observed decline in Grey Nurse Shark numbers. The most identifiable of these is spearfishing (historically), the incidental capture in south-eastern Australia commercial fisheries, recreational fishing and protective beachmeshing (Pollard *et al.* 1996, Krogh 1994, Otway and Parker 2000).

3.1 Commercial Fishing

Although currently protected in most states, Grey Nurse Sharks have been fished commercially in the past. The Grey Nurse Shark was the second most commonly caught shark after the whaler shark around Port Stephens in the 1920s (Roughley 1955). The Grey Nurse Shark was fished by hook and line in and around Botany Bay as early as the 1850s, to provide an excellent quality oil for burning in lamps (Grant 1987). Grey Nurse Sharks were also utilised for their fins and for the high quality leather that could be produced from their skin (Roughley 1955). Grey Nurse Shark meat has been utilised fresh, frozen, smoked, dried and salted for human consumption, especially in Japan (Compagno 1984).

In spite of legislative protection Grey Nurse Sharks are still under threat from incidental catch in some commercial fisheries. In Australia they are primarily caught by demersal nets, droplines, and other line fishing gear (Pollard *et al.* 1996). Recent anecdotal information indicates that Grey Nurse Sharks have been incidentally caught on bottom setlines targeting wobbegong sharks (Otway and Parker 2000). Professional fishers once avoided the rocky habitats where Grey Nurse Sharks congregate but with improved technology (such as Geographical Positioning Systems) they are able to navigate more accurately and fish closer to these areas. There are very few records of Grey Nurse Sharks being caught in Commonwealth managed fisheries (see Appendix A).

The extent of the impact that commercial fisheries currently have on Grey Nurse Sharks needs to be documented. Not all industry participants share the perception that bycatch levels of Grey Nurse Sharks are a threat to their populations. Views may differ because the recording and recognition of Grey Nurse Sharks may be poor, or because interactions are now so infrequent due to population decline. It is necessary to identify which fisheries are impacting on Grey Nurse Sharks and to quantify the level of their bycatch. This could initially be assessed by ensuring that fishery logbooks allow for the recording of Grey Nurse Shark interactions, that fishers are educated on Grey Nurse Sharks and that observer programs are introduced to State commercial fisheries.

Table 2. Commercial fisheries that impact or potentially impact on Grey Nurse Sharks.

Jurisdiction	Fishery
NSW	Ocean Trap and Line
NSW	Ocean Fish Trawl
NSW	Ocean Prawn Trawl
Queensland	East Coast Trawl
Queensland	Queensland Line Fisheries
Western Australia	Northern Shark Fishery
Western Australia	West Coast Demersal Gillnet and Demersal Longline Fishery
Western Australia	Southern Demersal Gillnet and Demersal Longline Fishery

In NSW fishers that incidentally catch Grey Nurse Sharks must release them if still alive. As a consequence sharks are often seen with hook and line trailing from their mouths while others have been observed entangled in fishing gear (Environment Australia 1997). NSW survey reports indicate that approximately 6% of Grey Nurse Sharks sighted show signs of having had interactions with fishing gear (Otway and Parker 2000).

The Grey Nurse Shark is caught as a bycatch in WA commercial shark fisheries. 52.3t (live wet weight) of Grey Nurse Sharks were caught in the Joint Authority Demersal Gillnet & Demersal Longline Fishery (JASDGDLF) and the West Coast Demersal Gillnet & Demersal Longline Fishery (WCDGDLF) between 1985 and 2000 (R. McAuley pers. comm.). In addition it is estimated that 6.6t of Grey Nurse Sharks were taken as bycatch in the WA Northern Shark Fishery in 1996 (Stevens 1999). This northern WA data may not be entirely accurate as there are some problems with identifying

vessels licensed to operate in this fishery and there is likely to be some mis-identification of the species.' (R. McAuley pers. comm.). Even though the species became protected in WA in 1997, it is most likely still caught as bycatch in the commercial shark fisheries.

Hook wounds to Grey Nurse Sharks can puncture the stomach, pericardial cavity, and oesophagus causing infections and death. A hooked shark, upon release, may swim away seemingly unharmed, only to die several days later from internal bleeding or peritonitis. The stress of capture may cause changes in the physiology of a shark including bradycardia, blood acidosis, hyperglycaemia and muscle rigidity.

Management Responses

The primary response required to the impact of commercial fishing on the critically endangered east coast population is habitat protection. This response is further discussed in Section 4.1 of the recovery plan.

The taking of Grey Nurse Sharks in Commonwealth waters is prohibited under the EPBC Act. Those commercial fishers that operate where there is a risk of capture of Grey Nurse Sharks in Commonwealth waters could be in breach of the Act and therefore subject to prosecution. The preferred method of dealing with the bycatch of Grey Nurse Sharks in Commonwealth waters is through the accreditation of fishery management arrangements under Section 208A of the EPBC Act. This allows for the assessment of the fishery to ensure that all reasonable efforts are required as part of the management arrangements to avoid killing or injuring listed species and that the result of any take will not adversely affect the survival or recovery of species in the wild.

Under the EPBC Act, commercial fishers that capture a Grey Nurse Shark in Commonwealth waters must report it to the Secretary for the Commonwealth Department of Environment and Heritage. There have been no reports to date and this could possibly be due to lack of knowledge of this requirement, identification problems and that the catch of Grey Nurse Sharks in Commonwealth waters has been minimal.

Issues

- It is currently not clear which commercial fisheries impact on Grey Nurse Sharks.
- The mortality of Grey Nurse Sharks in all commercial fisheries bycatch has not been quantified.
- There is a need to improve reporting of listed marine species taken in Commonwealth & State fisheries.
- Person(s) that injure or kill a Grey Nurse Shark from the east coast population could be prosecuted under Part 3 Section 18 of the EPBC Act.
- There is a need for fisheries that impact on Grey Nurse Sharks to take all reasonable action to minimise that take.

Prescribed Actions
A.1 - A.8 (see table 6)

3.2 Recreational Fishing

Recreational fishing covers a broad range of amateur fishing activities but can be roughly broken down into groups of gamefishers, sportfishers, spearfishers, estuarine fishers and freshwater fishers. In respect to Grey Nurse Sharks, spearfishers, gamefishers and sportfishers are discussed in this plan.

Spearfishers

As late as the 1980s, Grey Nurse Sharks were perceived by the public as man-eaters, mainly due to their fierce appearance (Taronga Zoo 1996). This misunderstanding led to many Grey Nurse Sharks being killed in the 1950s and 1960s by the intensive fishing efforts of spearfishers using powerheads (Ireland 1984). The Grey Nurse Shark, with its dubious reputation as a threat to humans, was an easy target and many articles recount the desire of the spearfishers to rid the coast of this threat (Cropp 1964a; Ley 1964; Lupton 1962; Taylor and Cropp 1962).

One of the possible explanations for Grey Nurse Sharks being more abundant in Western Australia waters is that they were never subject to the spearfishing pressure during the 1950s and 60s that the New South Wales and Queensland population encountered. Today, due to the Grey Nurse Shark's protected status in NSW since 1984, and an increase in public awareness, there are very few reports of divers killing these sharks (Pollard *et al.* 1996). In fact, many spearfishers and divers have been involved in conservation activities including the protection of Grey Nurse Sharks and survey work on the species (refer to 4.4 - Community Involvement section).

Gamefishers

Grey Nurse Sharks are known to be poor fighters and are no longer favoured by gamefishers in comparison to other sharks (Bureau of Resource Sciences 1996). However, during the two decades from 1961 to 1980, 405 Grey Nurse Sharks were recorded as being taken by game fishing clubs on the NSW coast, from Bermagui northwards along some 460km of coastline (Pepperell 1992). A decline was detected in the proportion of Grey Nurse Sharks caught by gamefishers in the 1960s and 1970s (Environment Australia 1997), and recreational gamefishers voluntarily banned Grey Nurse Shark captures in 1979 (Marsh 1995).

Sportfishers

Sportfishers range from individuals to groups fishing in middle sized boats and charter boats. The extent of the impact that incidental catch by sportfishers has on Grey Nurse Sharks is currently unknown. Most recreational fishers say it as a “minimal problem”, but it is necessary to assess the level of incidental catch, particularly of juvenile sharks, by these fishers. Recreational fishers that line fish with baited hooks in known aggregation areas are likely to hook a Grey Nurse Shark

There have been various reports of recreational fishers catching Grey Nurse Sharks. Aggregation sites such as Fish Rock off South West Rocks and the Pinnacle at Forster are often under pressure from recreational fishing. In July 2001, scuba divers observed that over 50% of the Grey Nurse Sharks at Fish Rock (off South West Rocks, NSW) had hooks and lines trailing from their mouths (D. Harasti pers. comm.). It is believed that the hooks and line were from recreational fishing gear. Whilst the latter observations are based on individuals that survive these interactions, it is not known how many die as a result of these interactions. Recreational fishers have been observed fishing on top of the Grey Nurse Shark gutters at Fish Rock and divers have actually observed Grey Nurse Sharks taking the baited hooks of recreational fishers. Other sites where recreational fishers have been observed catching Grey Nurse Sharks include the Cod Grounds off Laurieton, Pimpernel Rock in the Solitary Islands Marine Reserve and Montague Island off Narooma.

In a recent autopsy carried out on a Grey Nurse Shark that died in captivity, the cause of death was attributed to peritonitis arising from perforation of the stomach wall by numerous small hooks of the type used by recreational fishers (Otway and Parker 2000).

The incidental catch by recreational fishers is expected to have been high on the east coast in the past given the estimates of the low numbers now present. It has been hypothesised by the Recovery Team that recreational fishers may be responsible for higher levels of Grey Nurse Shark mortality than previously realised. The NSW Fisheries Grey Nurse Shark surveys have found that the observed numbers of juveniles is much lower than expected indicating that this problem may be continuing. It is suspected that recreational fishers often kill juvenile Grey Nurse Sharks without realising the species identity.

Management Responses

It is obviously necessary to protect key Grey Nurse Shark areas from the risk of incidental catch. This protection should include establishment of effective marine protected areas and seasonal or permanent closure to commercial and recreational fishers for these important sites (refer to Section 4.1 Habitat Protection).

As a consequence of listing under the EPBC Act 1999, if a recreational fisher carries out activities that result in the taking of a listed species in Commonwealth waters, it must be reported to the Secretary for the Commonwealth Department of Environment and Heritage. Reporting to date has been poor, possibly due to the lack of knowledge of this requirement and possible identification problems.

With the low number of animals of this species on the east coast and their slow reproductive rate, any killing, taking or injuring a Grey Nurse Shark would be likely to have a significant impact on the population. Under Part 3 Section 18 of the EPBC Act:

A person must not take an action that:
(a) has or will have a significant impact on a listed threatened species included in the critically endangered category; or
(b) is likely to have a significant impact on a listed threatened species included in the critically endangered category.

Civil penalty:

(a) for an individual—5,000 penalty units;
(b) for a body corporate—50,000 penalty units.

Therefore, any person(s) who injure, take or kill a Grey Nurse Shark in Commonwealth waters, in the east coast where they are listed as critically endangered, will be considered to be impacting on the population and could be subject to civil or criminal prosecution under the EPBC Act 1999. One penalty unit is currently worth $110 Australian dollars.

Issues
- The extent of the impact that incidental catch by recreational fishers has on Grey Nurse Sharks is currently unknown and needs to be urgently addressed.
- There is a need to exclude hook and line fishing from important aggregation areas.
- An education program is needed for recreational fishers about Grey Nurse Shark.

Prescribed Actions
B.1 – B.2 (see table 6)

3.3 Shark Finning

The high market value for shark fins is leading to a level of catch of sharks worldwide that may be unsustainable. As such, the practice of shark finning, where the fins are removed and the carcass discarded, poses a threat to Grey Nurse Sharks. There are a number of reliable reports from NSW divers of sightings of Grey Nurse Sharks that have survived having their fins cut off.

Shark finning has been banned in NSW. It is prohibited in all NSW waters to take and land any shark species mutilated in any manner other than by heading, gutting or removing gills, or for any boat in all NSW waters to possess any detached shark fins on board. An interim ban on the at sea finning of sharks has been implemented in all Commonwealth tuna long line fisheries. Longer term arrangements will be determined through the Australian National Plan of Action for Sharks. Western Australia Department of Fisheries has implemented a similar ban where fishers in WA waters are required to land whole sharks at port before the fins can be removed.

There are however commercial fisheries in Australia that take shark fins as by product. Shark finning is poorly documented in Australian fisheries and several fisheries in Australia target sharks. Approximately 92 tonnes of dried shark fin was exported from Australian fisheries in 1998-99, valued at about $5.5 million. In 1998-99, approximately 7700 tonne of landed shark catch was reported from target shark fisheries. It is estimated that 55.6 tonnes of the 92 tonnes of export dried shark fin in 1998-99 were derived from target and non-target shark fisheries where the trunk is retained. The majority of this shark fin is from the Southern Shark Fishery, managed by the Commonwealth and from the Western Australia's target shark fisheries (AFFA 2001 draft).

Management Responses

The take of protected species for their fins require monitoring. Such monitoring requires a simple system of identification. The monitoring can be addressed through fin x-rays, as fins show cartilaginous patterns unique to each shark species, DNA analysis, or where the physical morphology of the species can be determined because the shark carcass is largely intact.

In 1999, the United Nations Food and Agricultural Organisation (FAO) Committee on Fisheries (COFI) agreed to an International Plan of Action for Conservation and Management of Sharks (IPOA-Sharks) as a response to the concern about shark fishing around the world. While the plan is voluntary, all concerned countries are encouraged to implement it by undertaking an assessment of the conservation and management of sharks and prepare a national plan of action if required. The Australian government, led by AFFA, is currently developing a National Plan of Action for Sharks for Australia. This is being undertaken with cooperation of the states and territories.

Issues

- The demand for shark fins is high.
- The targeting of sharks for their fins may be impacting on Grey Nurse Sharks.

Prescribed Actions
C.1 (see table 6)

3.4 Shark Control Activities

Meshing of sharks as a protective measure for swimmers and surfers was introduced to New South Wales beaches in 1937 and to Queensland beaches in 1962. These are the only two states in Australia that employ this shark protection measure (Krogh & Reid 1996; Paterson 1990).

New South Wales

In NSW shark nets are usually 150 m long and six metres high with a mesh size of 50 to 60 cm (Krogh 1994). The nets are set parallel to the shore in around 10 to 15 m water depth with the bottom of the net resting on the ocean floor and the top supported by a series of floats (Krogh 1994). The idea of shark nets is not to stop sharks coming in to the beaches, but to intercept and catch them on their regular feeding and territorial runs (Eckersley 1996). There are currently a total of 49 meshed beaches along approximately 200 km of coastline between Newcastle and Wollongong in New South Wales. On average, approximately 4.2km of mesh net protect the beaches on any given day. The only known aggregation site in NSW in close proximity to protective beach meshing nets is Maroubra in Sydney.

In NSW during the early 1950s, up to 34 Grey Nurse Sharks was meshed each year (Krogh & Reid 1996, Pollard *et al.* 1996). By the 1980s, this number had decreased to a maximum of 3 or less per year (Pollard *et al.* 1996), and over the last decade only three Grey Nurse Sharks have been caught in the shark nets (D. Reid. unpublished data). Figure 2 illustrates the decline in numbers of Grey Nurse Shark caught in the NSW shark meshing program over the past fifty years.

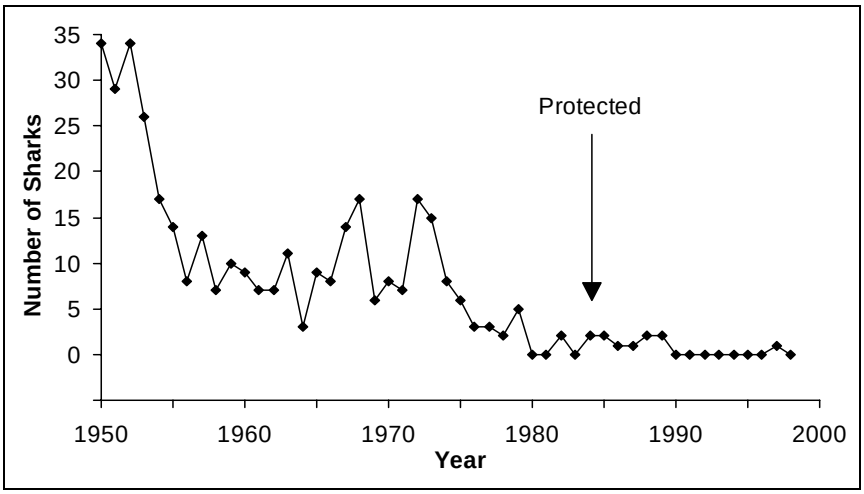


Figure 2: Decline in the numbers of Grey Nurse Sharks caught in shark meshing nets in the Newcastle/ Sydney/Wollongong regions from 1950-1999 (Otway and Parker 2000)

Queensland

In Queensland, a mixture of baited drumlines and mesh nets are used. Drumlines consist of a marker buoy and float anchored to the bottom supporting a steel chain and baited hook. There are indications that drumlines are more selective than protective shark meshing nets as they target those species of greatest threat to humans (Department of Primary Industries 1992), while providing similar levels of protection as nets. The disadvantage with the drumlines is that they can move in heavy seas (Department of Primary Industries 1992) and are known to catch other threatened species such as loggerhead turtles (Department of Primary Industries 1998). Mesh nets however also catch non-target species such as turtles and whales. In some situations, drum lines catch as many sharks (if not more) as nets, but the species composition of sharks can vary between the two methods (Department of Primary Industries 1998). Total catches of Grey Nurse Shark in Queensland from net and drumline in all contract areas is shown in Figure 3.

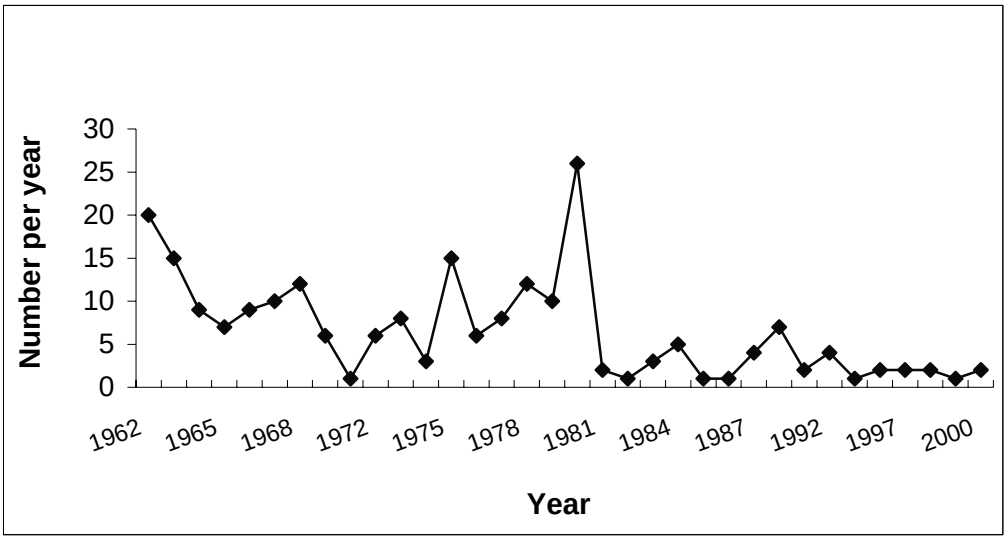


Figure 3: Total catches of Grey Nurse Sharks from mesh nets and drumlines in all contract areas - Queensland Shark Control Program (Courtesy of G. McPherson, Qld Department of Primary Industries)

In Queensland, a similar downward trend as NSW has been detected, with a decrease from 90 Grey Nurse Sharks captured between 1962 and 1972, to 21 Grey Nurse Sharks captured over the last decade. Grey Nurse Sharks are most commonly caught from October to December in the Queensland shark control program (G. McPherson pers. comm.).

While the protective beach meshing program in Qld and NSW has obviously been responsible for captures of numerous Grey Nurse Sharks in the past, the extremely low capture rates in recent years will be likely to continue until the population increases substantially in the coastal waters of Eastern Australia (Otway and Parker 2000).

It is now NSW Fisheries' and the QDPI's Shark Control Program policy that, where possible, all Grey Nurse Sharks caught in these shark nets are transported away from the beaches and released alive. In NSW released sharks will be tagged to assist with scientific studies of population size, growth rates and migratory movements. In NSW Grey Nurse Sharks that die in the nets are to be autopsied and in Queensland they are measured, sexed and their stomach contents examined.

Management Responses

Alternative non lethal methods to beach meshing should be trialed in NSW and Qld. However, the use of any alternative methods would need to be reviewed if they were found to catch more Grey Nurse Sharks. A form of shark control being trialed is the use of electrical fields. Experiments on the use of electrical fields to repel sharks have been carried out in South Africa since 1965 (Cliff and Dudley 1992). However, these trials have encountered many logistical problems (Gribble 1996) and further

investigation is required on reports that electrical fields may have detrimental effects on Grey Nurse Sharks that may not be immediately obvious.

By minimising bycatch and researching alternatives to protective shark meshing nets, the Grey Nurse Shark will benefit, particularly if the population increases. Other non-target species that are captured in the shark nets such as whales, dolphins, dugongs, turtles and rays (Gribble *et al* 1998, Krogh & Reid 1996) would also benefit if protective shark meshing nets were reduced.

Issues
- Shark control activities do impact on Grey Nurse Sharks.
- Beach meshing is non-selective.
- Alternative methods to beach meshing should be trialed.
- Not all Grey Nurse Sharks still alive in shark nets are tagged on release.

Prescribed Actions
D.1 - D.4 (see table 6)

3.5 Ecotourism

Ecotourism activities relevant to the Grey Nurse Shark include scuba diving and shark viewing operations.

Interactions between snorkel and scuba divers and Grey Nurse Sharks were once relatively common. However, these interactions are now rare (Pollard *et al.* 1996). Valerie Taylor noted that during the 1950s, schools of 30 to 50 Grey Nurse Sharks could be seen at almost every reef and island along the NSW coast, but during a week long trip to film the species in 1973, she only managed to find 11 sharks (Environment Australia 1997). In recent times, interactions between divers and packs of 30 to 50 Grey Nurse Sharks are relatively rare (Pollard *et al* 1996, Otway and Parker 2000).

The Grey Nurse Shark has become a big attraction to scuba divers and increasing pressure has been placed on operators to take divers to places where they can encounter these sharks (Otway and Parker 2000). It is possible that poorly managed shark viewing operations at popular sites may deter site-attached populations from residing in the area. There have been reports from Seal Rocks NSW (see Map 1) of scuba divers disturbing Grey Nurse Sharks, either accidentally or deliberately (Pollard *et al* 1996).

If divers continue to keep their distance whilst diving with these sharks, experience would suggest that it is unlikely that scuba diving *per se* will have any detrimental effects on the sharks survival (Otway and Parker 2000). Divers are often in the best situations to observe Grey Nurse Sharks and show genuine interest in surveys, education and conservation of the species. Regular viewing trips, when properly managed, offer a good opportunity for data collection on these and other sharks (Bruce 1995).

While ecotourism is not currently perceived as a major threat to the Grey Nurse Shark, growth in this industry is expected and preventative actions taken now may reduce any impacts in the future. These actions may include a range of options such as seasonal closures of these activities in marine protected areas, or the development and uptake of a code of conduct for commercial operators and dive clubs. A code of conduct is discussed in detail in Part 4.4.

Shark Deterrent Devices
Sharks show the greatest sensitivity to electrical stimuli in the animal kingdom. Further information is thus needed on the effect of shark deterrent devices on Grey Nurse Sharks. Devices such as the 'Shark Pod' (or Protective Oceanic Device) emit an electrical field that repels sharks. The Shark Pod repels sharks at close quarters by creating an electrical field around the scuba diver that totally disrupts the shark's ampullae of Lorenzini. The ampullae of Lorenzini are the natural electrical detectors situated along a shark's face that are used to detect minute electronic signals emitted by potential prey (Taylor 1997). It is not known what sort of effect these types of shark deterrent devices may have on Grey Nurse Sharks.

There is a report of a diver using a Shark Pod device in the shark gutter at the Tollgate Islands off Batemans Bay (N. Otway pers. comm.). The Grey Nurse Sharks were disturbed by the shark deterrent

device and left the gutter that they normally inhabited. These Grey Nurse Sharks did not return until several days later. This type of impact needs to be prevented, and shark deterrent devices should not be used at known Grey Nurse Shark aggregation sites.

Management Responses

Future research is needed to determine whether the presence of scuba divers affects the behaviour of Grey Nurse Sharks. This information could be obtained through a research program using acoustic telemetry and smart tags to asses whether the behaviour of Grey Nurse Sharks is affected by: (1) varying numbers of scuba divers; and (2) the behaviour of the scuba divers whilst observing the sharks.

The Recovery Team recommends that there should be a moratorium on night diving on known Grey Nurse Shark aggregation sites. Grey Nurse Sharks are believed to be most active at night and it is possible that mating and reproduction occurs during this time, or early in the morning. The prevention of night time scuba diving at aggregation sites will reduce any impact on the species when it is most active. It is also recommended that shark deterrent devices are not used in known Grey Nurse Shark aggregation areas.

Issues

- Ecotourism activities relevant to Grey Nurse Sharks need to be managed effectively.
- A code of conduct for diving with Grey Nurse Sharks to be implemented by NSW Fisheries.
- Night diving on known aggregation sites should be prevented.
- Shark pod devices should not be used at known aggregation sites.

Prescribed Actions
E.1 - E.6 (see table 6)

3.6 Aquarium Trade

Grey Nurse Sharks are a good species for captive display due to their size, slow movement, relatively docile nature and slow metabolic rate. They are popular with the public due to their size and fierce appearance. As early as the 1950s and 1960s Grey Nurse Sharks that were retrieved alive would sometimes be sold to aquariums for display purposes (Fisheries Department of Western Australia 1996, Edwards 1997).

Currently there are 30 Grey Nurse Sharks in commercial aquaria in Australia (Table 3). These aquaria are also involved in Grey Nurse Shark captive breeding programs, survey work and educational programs. Six grey nurse pups have been born at Underwater World, Queensland. Aquariums have been actively involved in research activities on Grey Nurse Sharks including behavioural and breeding studies.

Table 3. Commercial aquaria holdings of Grey Nurse Sharks in Australia

Aquarium	Males	Females	Total
Underwater World, Queensland	3	4	7
Underwater World, WA	1	7	8
Melbourne Aquarium, Victoria	1	2	3
Sydney Aquarium, NSW	2	3	5
Manly Oceanworld, NSW	3	4	7
Total	10	20	30

Management Responses

There is concern that with Grey Nurse Shark populations at such low numbers, it is unsustainable for the species to be taken from the wild for aquaria. In NSW there is a statewide moratorium on taking Grey Nurse Sharks from the wild for aquaria. This policy should be extended to all jurisdictions.

Grey Nurse Sharks already in captivity, and those bred for captive breeding programs, should be utilised as an educational resource. It is essential that Grey Nurse Sharks on public display be presented

alongside educative programs informing the public on the biology, status and conservation problems of the species.

Issues

- Wild Grey Nurse Sharks should not be captured for exhibition in aquaria.
- Existing captive Grey Nurse Sharks should be utilised for their educative value.

Prescribed Actions

F.1 – F.3 (see table 6)

Part 4. Management Responses

4.1 Habitat Protection

Australian governments are committed to the establishment of a National Representative System of Marine Protected Areas (NRSMPA). Goals of the NRSMPA relevant to the protection of Grey Nurse Shark aggregation areas include: providing for the special needs of threatened species, migratory species, and species vulnerable to disturbance.

The Commonwealth through the Natural Heritage Trust funded NSW Fisheries to undertake the project *Marine Protected Areas for Protection of Threatened Grey Nurse Sharks*. A report for the project, entitled '*The biology, ecology, distribution, abundance and identification of Marine Protected Areas for the conservation of threatened Grey Nurse Sharks in South East Australian waters*' (Otway & Parker 2000) has been published.

The Grey Nurse Shark is a migratory species that moves between particular sites along the east and west coasts of Australia. When not migrating Grey Nurse Sharks aggregate in or near deep sandy-bottomed gutters or in rocky caves around inshore rocky reefs and island at depths between 15 and 40 metres (Otway and Parker 2000). Known key aggregation sites for Grey Nurse Sharks in NSW are illustrated in Maps 3 and 4 and Table 4. Known key aggregation sites for Grey Nurse Shark in Queensland are illustrated in Map 2 and Table 4. Depending on the time of year, mature and juvenile Grey Nurse Sharks are found in concurrence with one another at these locations.

There is growing concern that legislative protection of Grey Nurse Sharks is not sufficient for their recovery and that strategies such as habitat protection are needed (Marsh 1995, Garbutt 1995). Habitat protection is of particular importance to Grey Nurse Sharks and particular areas where Grey Nurse Sharks aggregate, or particular habitats that are essential at different stages of their life history, should be provided with some effective form of protection (Otway and Parker 2000).

Recognising the importance of Grey Nurse Shark aggregation sites to the recovery of the species, it is essential that any potential threats to the species at aggregation sites must be mitigated against; the marine habitats at aggregation sites must not be directly or indirectly interfered with; and adequate supplies of food species must be made available, and be adequately protected and promoted, within the preferred foraging range of sharks dwelling at aggregation sites. This protection should include the establishment of effective marine protected areas (MPAs), such as ‘no take’ sanctuary zones, and seasonal or permanent closures of sites to both commercial and recreational fishers.

If MPAs were declared at the known aggregation sites for NSW waters (Table 4), a large percentage (approximately 72.4% averaged across the ten NSW Fisheries Grey Nurse Shark surveys) of the known Grey Nurse Shark population would receive a high degree of protection from threatening processes that occur at those locations (NSW Fisheries *unpublished data*).

Two sites, Pimpernel Rock in the Solitary Islands Marine Reserve and the Cod Grounds are in Commonwealth waters. These two sites account for 16.4% of the observed Grey Nurse Shark population (averaged across the ten NSW Fisheries Grey Nurse Shark surveys).

Under a new management plan for the Solitary Islands Marine Reserve, Pimpernel Rock is zoned as a Sanctuary Zone (IUCN category 1a) to provide high level protection for Grey Nurse Sharks and other sensitive marine species (Commonwealth of Australia 2001). The protection at Pimpernel Rock encompasses a 500-metre radius no take zone around the site that excludes all types of fishing. The other known Grey Nurse Shark aggregation sites in NSW and Qld should be considered for similar protection.

The Cod Grounds is a renowned Grey Nurse Shark site located approximately four nautical miles off the coast in Commonwealth waters near Laurieton on the NSW mid north coast. Large numbers of mature female and male Grey Nurse Sharks have been found at this site. During the NSW Fisheries Grey Nurse Shark survey, a minimum of 74 Grey Nurse Sharks were found at the site in September 2000. Sharks are observed at this site throughout the year but the numbers present between the period from May to October are greatest. Grey Nurse Sharks at the site are under pressure from both

commercial and recreational fishers. There were reports in May 2001 by recreational scuba divers of recreational fishers catching and taking Grey Nurse Sharks from this site.

Julian Rocks at Byron Bay and sites within the Solitary Islands Marine Reserve are the only sites in NSW that have some form of habitat protection. However, these sites still allow fishing activities (recreational and commercial) to be carried out within the Grey Nurse Sharks aggregation areas.

An example of habitat protection is at Fish Rock located at South West Rocks NSW. Scuba divers at this site noticed continued declines in the abundance of Grey Nurse Sharks in the area and voiced their concern at a public meeting. In July 1995 NSW Fisheries declared a drop line fisheries closure over an area covering a 500-metre radius around Fish Rock. This closure has now been extended until July 2003 (Otway and Parker 2000). Spearfishing is also restricted at Fish Rock with a restricted species list for spearfishing gazetted by NSW Fisheries on 31st July 1998. This list is predominantly of pelagic species (ie. tunas, marlins, mackerels, and kingfish) and species such as jewfish and morwong are now protected from spearfishing.

Since the selected fishing closures at Fish Rock, Grey Nurse Sharks are now found to aggregate from May to February. Prior to the fishing closures Grey Nurse Sharks were only found from May to November (N. Hitchins pers. comm.). Anecdotal evidence suggests that the numbers of Grey Nurse Shark and aggregation period has increased because their food sources (mainly jewfish) has been protected from fishing impacts (commercial drop lines and spearfishing). However, further protection is still required around Fish Rock as up to 75% of the Grey Nurse Shark population at the site have been found to exhibit line fishing related injuries (N. Hitchins pers. comm.), and there have been several reports of recreational fishers catching Grey Nurse Sharks.

4.1.1 Habitat Critical for the Survival of Grey Nurse Sharks

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* (S270 (2)(d)). It also requires that habitat critical to the survival of the species be entered on a register of critical habitat (S207A). In doing so, the EPBC Act provides a process for the identification and defining of habitats for threatened species. The register is given effect through Section 207A, and Regulation 7.09 provides advice on what areas should be included on the register and how an area should be defined. Section 207B requires that a person must not take an action that significantly damages critical habitat that is in Commonwealth areas.

Table 4 identifies an initial list of places within Australia considered to be habitat critical to the survival of Grey Nurse Sharks. This is an inclusive list and more sites can be added as they are identified over time. These sites were identified in the three year (1999-2001) NSW Fisheries study that determined the distribution and abundance of Grey Nurse Sharks in NSW. Approximately sixty sites were surveyed over the three year study where Grey Nurse Sharks had been known to occur. It was found that Grey Nurse Sharks were no longer found at many of these sites and that major aggregations were only found at the sites listed as habitat critical to the survival of Grey Nurse Sharks in table 4.

To date, there have been no distribution surveys in Western Australian waters for Grey Nurse Sharks. Therefore, no Grey Nurse Shark aggregation sites in Western Australia have been identified, and hence, no sites critical to the survival of Grey Nurse Sharks have been proposed for WA at this stage. The identification of sites in Western Australia will be difficult, as it is not known where the species occurs. It is recommended that a distribution survey, similar to the project run by NSW Fisheries, be initiated in Western Australia (action H.6. Table 6). Unlike New South Wales and Queensland, there are no known sites in Western Australia where divers can regularly observe Grey Nurse Sharks.

Over time, as other important places for Grey Nurse Sharks are identified they can be nominated to the register (action G.4. Table 6). The impacts on Grey Nurse Shark habitats will vary regionally depending on the level of pressure (such as fishing and ecotourism) placed on each site. The need for actions will be determined by these influences regionally or on a stock basis. The sites listed as habitat critical for the survival of Grey Nurse Sharks should also be considered for further protection such as marine protected areas, no take sanctuary zones or aquatic reserves (action G.5. Table 6).

Issues

- Further aggregation sites of Grey Nurse Sharks need to be identified.
- Sites identified as habitat critical for the survival of Grey Nurse Sharks to be listed on the EPBC Act register for critical habitat.
- Mechanisms are needed to protect identified aggregation sites.

Prescribed Actions
G.1 - G.5 (see table 6)

Table 4. Known habitat sites critical for the survival of Grey Nurse Sharks in Eastern Australia (from North to South).

Location	Site Name	Coordinates	Jurisdiction	Protection Status
Rainbow Beach	Wolf Rock	153° 12′ 10” E 25° 54′ 20” S	Queensland	None
Moreton Island	China Wall	153° 29′ 00” E 27° 05′ 10” S	Queensland	Habitat Zone[1] – Moreton Bay Marine Park
Moreton Island	Cherubs Cave	153° 28′ 45” E 27° 07′ 35” S	Queensland	Habitat Zone[1] – Moreton Bay Marine Park
Moreton Island	Henderson’s Rock	153° 28′ 45” E 27° 07′ 50” S	Queensland	Habitat Zone[1] – Moreton Bay Marine Park
Stradbroke Island	Flat Rock (Shark Alley)	153° 33′ 00” E 27° 23′ 30” S	Queensland	Conservation Zone[2] – Moreton Bay Marine Park
Byron Bay	Julian Rocks - Cod Hole	153° 37′ 45” E 28° 36′ 40” S	New South Wales	Aquatic Reserve[3]
Solitary Islands Marine Reserve	Pimpernel Rock	153° 23′ 55” E 29° 41′ 55” S	Commonwealth	Sanctuary Zone (IUCN category 1a) – Solitary Islands Marine Reserve
Solitary Islands	North Solitary Island (Anemone Bay)	153° 23′ 25” E 29° 55′ 20” S	New South Wales	Habitat Protection Zone[4]– Solitary Islands Marine Reserve
Solitary Islands	South Solitary Island (Manta Arch)	153° 16′ 05” E 30° 12′ 10” S	New South Wales	Habitat Protection Zone[4]– Solitary Islands Marine Reserve
South West Rocks	Green Island	153° 05′ 30” E 30° 54′ 40” S	New South Wales	None
South West Rocks	Fish Rock	153° 06′ 05” E 30° 56′ 25” S	New South Wales	Restrictions on spearfishing / drop line fisheries closure
Laurieton	Cod Grounds	152° 54′ 30” E 31° 40′ 55” S	Commonwealth	None
Forster	Pinnacle	152° 36′ 00” E 32° 13′ 40” S	New South Wales	None
Seal Rocks	Big Seal	152° 33′ 15” E 32° 27′ 50” S	New South Wales	None
Seal Rocks	Little Seal	152° 32′ 55” E 32° 28′ 30” S	New South Wales	None
Port Stephens	Little Broughton Island	152° 20′ 00” E 32° 37′ 05” S	New South Wales	None
Sydney	Maroubra - Magic Point	151° 15′ 50” E 33° 57′ 20” S	New South Wales	None
Bateman's Bay	Tollgate Islands	150° 15′ 45” E 35° 44′ 50” S	New South Wales	None
Narooma	Montague Island	150° 13′ 40” E 36° 14′ 30” S	New South Wales	None

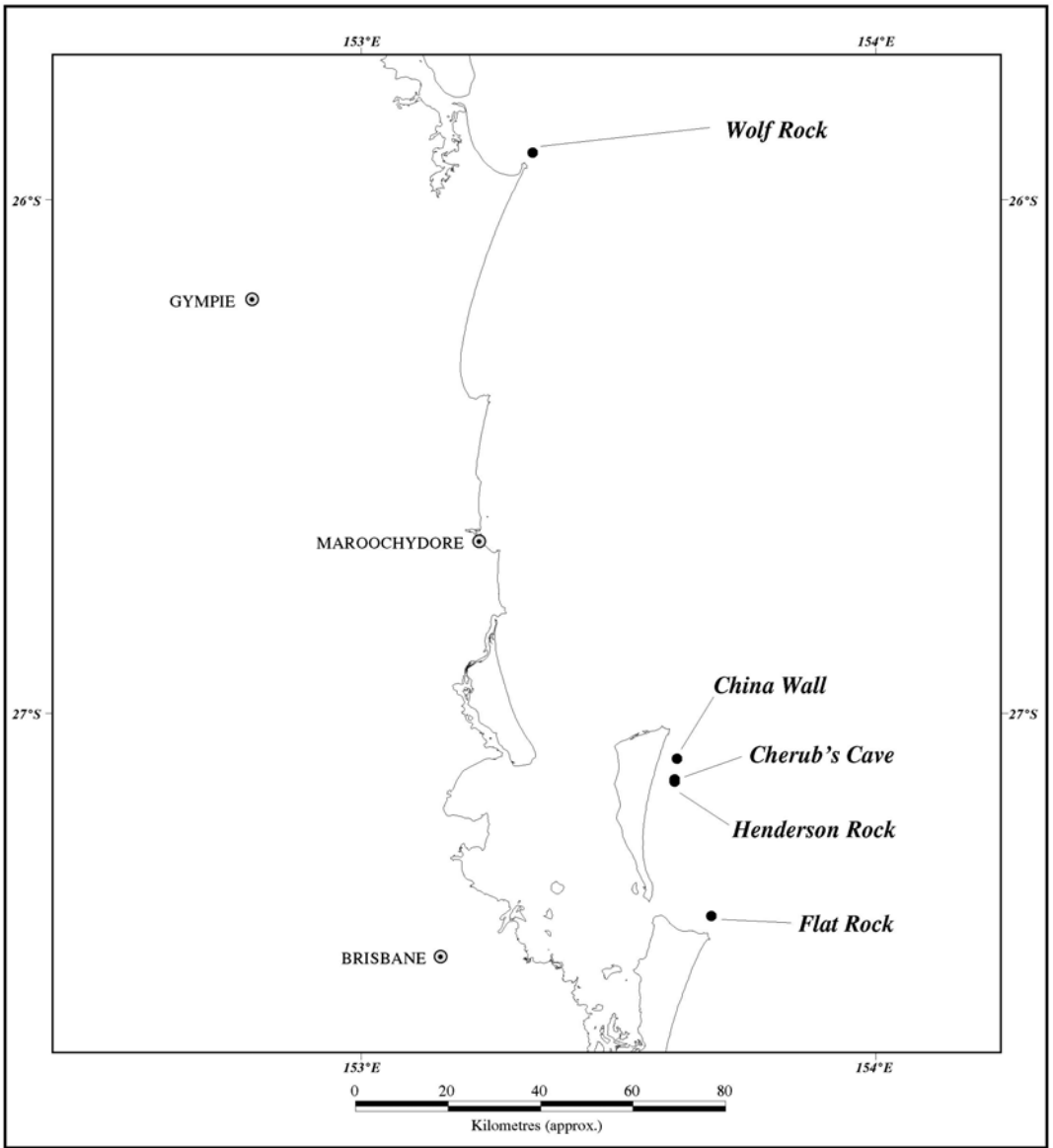
Note: Coordinates were obtained from a variety of sources. These were subsequently checked against a number of data layers (eg Nautical Charts, AMBIS2001), and have been rounded to the nearest 5" (approximately +/- 75m) to indicate their likely level of accuracy. Latitudes and longitudes have been determined by reference to GDA94.

Habitat Zone[1] – Moreton Bay Marine Park: These zones provide areas for reasonable use and enjoyment while maintaining productivity of the natural communities by excluding activities such as shipping operations and mining. Still allow all forms of recreational and commercial fishing.

Conservation Zone[2] – Moreton Bay Marine Park: This zone conserves the natural condition to the greatest possible extent, provide for recreational activities. Conservation zone allows all forms of recreational and commercial fishing but excludes trawling.

Aquatic Reserve[3]: A person must not wilfully disturb, injure or interfere with fish in the Reserve; or wilfully damage, destroy or interfere with marine vegetation in the Reserve. Finfish can be taken by means of a hook and line.

Habitat Protection Zone[4]– Solitary Islands Marine Reserve: Refuges that protect important habitat but allow recreational and commercial fishing activities that have a 'low impact' on the environment. This zoning is under review (Marine Parks Authority 2001).



Map 2: Critical Habitat Sites for Grey Nurse Shark Identified for Queensland

LEGEND

- ● Critical Habitat Sites for Grey Nurse Shark
- ⊙ Major Cities/Towns

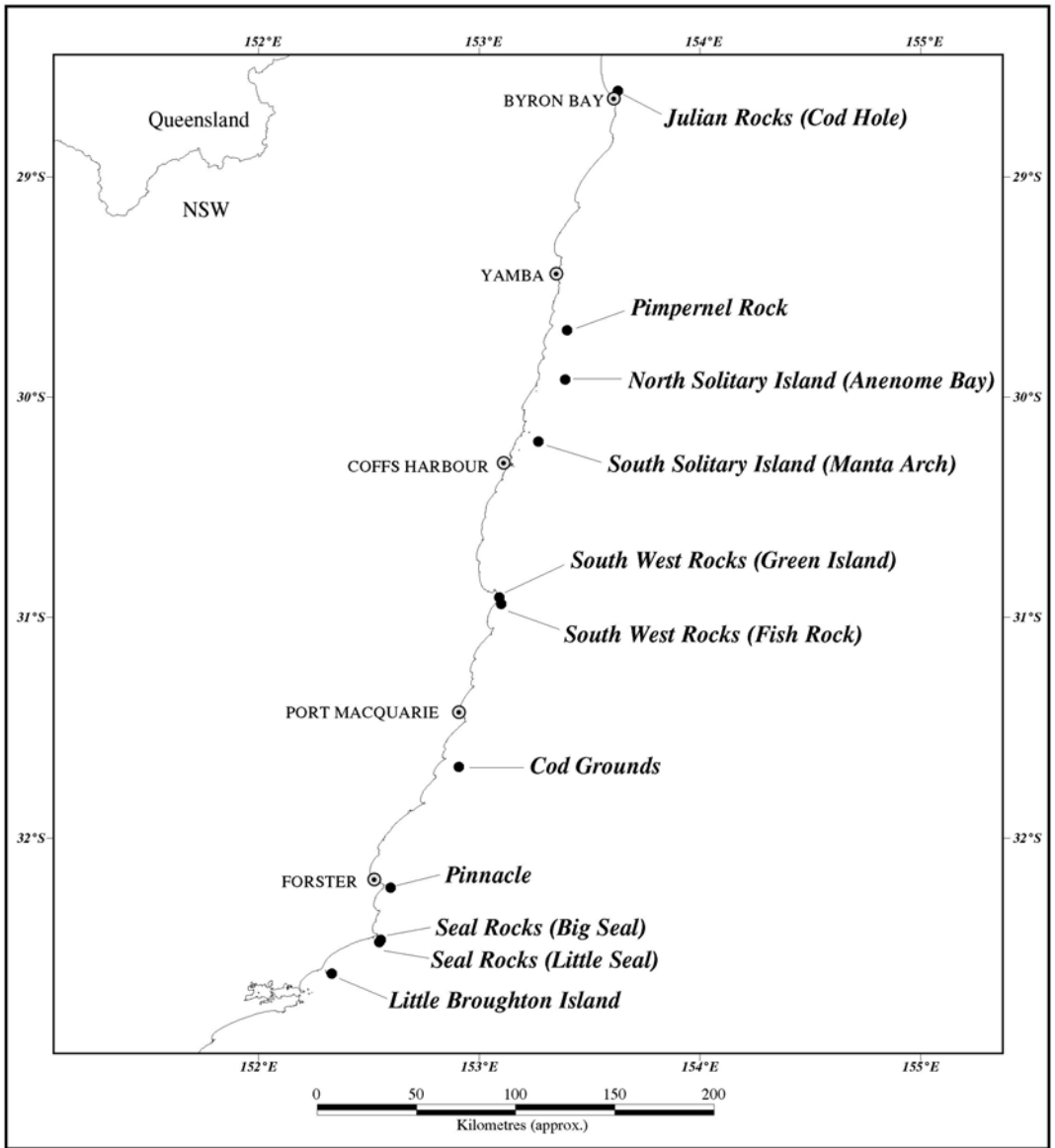
Environment Australia

Source:
Habitat sites from QPWS (unpublished data).
AUSLIG 1990: Australia, Coastline and State Borders 1:100,000
AUSLIG 1994: Australia, Topographic Data 1:250,000

Caveat:
Data used are assumed to be correct as received from the data suppliers

Projection: Geographic
Datum: GDA94

Produced by: Environment Australia
Commonwealth of Australia, Canberra



Map 3: Critical Habitat Sites for Grey Nurse Shark Identified for Northern NSW

LEGEND

- ● Critical Habitat Sites for Grey Nurse Shark
- ⊙ Major Cities/Towns

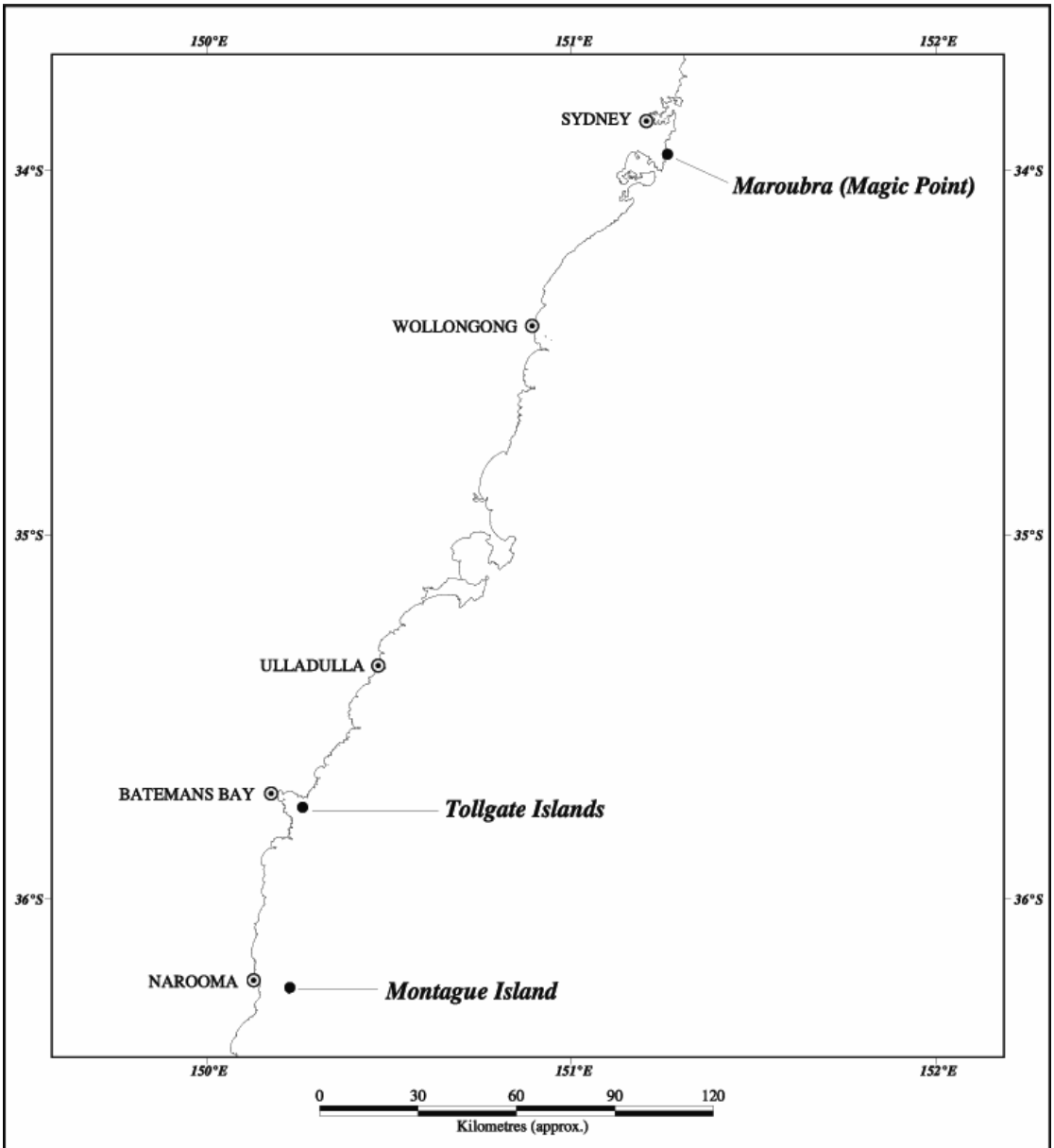
Environment Australia

Source:
Habitat sites after Otway and Parker (2000), and NSW Fisheries (unpublished data).
AUSLIG 1990: Australia, Coastline and State Borders 1:100,000
AUSLIG 1994: Australia, Topographic Data 1:250,000

Caveat:
Data used are assumed to be correct as received from the data suppliers

Projection: Geographic
Datum: GDA94

Produced by: Environment Australia
Commonwealth of Australia, Canberra



Map 4: Critical Habitat Sites for Grey Nurse Shark Identified for Southern NSW

LEGEND

- Critical Habitat Sites for Grey Nurse Shark
- Major Cities/Towns

Environment Australia

Source:
Locations after Otway and Parker (2000).
AUSLIG 1990: Australia, Coastline and State Borders 1:100,000
AUSLIG 1994: Australia, Topographic Data 1:250,000

Caveat:
Data used are assumed to be correct as received from the data suppliers

Projection: Geographic
Datum: GDA94

Produced by: Environment Australia
Commonwealth of Australia, Canberra

4.2 Research Activities

The capacity of managers to make informed decisions about the best way to ensure the recovery of Grey Nurse Shark populations is hampered by a lack of knowledge. There are inadequate data available on Grey Nurse Shark biology, population numbers, abundance and distribution, and the effects human activities may have on their populations. There is a need to make decisions that will reduce the likelihood of further population declines.

Data sets that have been used to show a population decline of the Grey Nurse Shark include: beach meshing records for NSW and Queensland; reports from divers in NSW and a major survey of Grey Nurse Sharks carried out by NSW Fisheries and dive groups (refer to Community Involvement section – 4.4) (Otway and Parker 2000, Otway 2001). To date, ten statewide Grey Nurse Shark distribution and abundance surveys have been completed, covering approximately sixty sites. The numbers of Grey Nurse Sharks observed varied greatly along the entire NSW coast and the total number of animals observed in the ten consecutive surveys is shown in Table 5.

The surveys have documented the distribution and abundance of Grey Nurse Sharks along the east coast of NSW using standardised visual sampling techniques. Tagging studies of individuals at various locations along the coast, and subsequent sightings by divers, captures in beach protective shark nets, and inadvertent captures on setlines, would enable further information to be collected.

Tagging studies will enable:

- estimates of total population size, growth and mortality rates for the species,
- documentation of the inter-annual variability in abundances of Grey Nurse Sharks,
- identification of migratory patterns, localised (short-term) movements and possible home ranges, and hence the size of effective protected areas and alternative forms of protective management,
- an independent estimate of the rates of inadvertent capture as by-catch, and
- identification of localised movements.

There is very little information about the population status of Grey Nurse Sharks in Western Australia. The only information on Grey Nurse Sharks in WA is derived from commercial fisheries logbook data. There are no known aggregation sites in Western Australia and divers are not known to encounter Grey Nurse Sharks (R. McAuley pers. comm.). A research program is needed in Western Australia to determine the distribution and abundance of the species in these waters.

Grey Nurse Sharks are known to be migratory; the ‘nature’ of that migration along the east coast of Australia needs to be quantified, and any risks to the sharks during their migration reduced. Data from protective beachmeshing programs (Krogh 1994; Reid and Krogh 1992) and movements of tagged sharks from the records of gamefish anglers in NSW (Pepperell 1992) provide some evidence in support of migratory habits. However more information is required to test hypotheses concerning the movements of the Grey Nurse Shark in Australian waters (Otway and Parker 2000).

Table 5. Numbers of Grey Nurse Sharks observed during NSW Fisheries surveys, 1998-01

	Size	Total Males	Total Females	Total Unid.	Total	Ratio M:F	Sharks/site
Survey 1		34	75	27	136	1:2.2	2.2
Nov - Dec	< 2 m	22	41	13			
1998	2 - 3 m	11	33	14			
	> 3 m	1	1	0			
Survey 2		20	72	37	129	1:3.6	2.5
Mar	< 2 m	6	28	17			
1999	2 - 3 m	5	39	5			
	> 3 m	9	3	0			
Survey 3		81	79	44	207	1:0.9	4.1
May - Jun	< 2 m	18	37	22			
1999	2 - 3 m	56	37	21			
	> 3 m	7	5	1			
Survey 4		29	118	40	187	1:4.1	4.3
Aug - Sep	< 2 m	14	52	18			
1999	2 - 3 m	13	56	22			
	> 3 m	2	10	0			
Survey 5		35	62	35	132	1:1.8	2.3
Nov - Dec	< 2 m	18	30	27			
1999	2 - 3 m	13	27	7			
	> 3 m	4	5	1			
Survey 6		38	74	37	149	1:1.9	2.3
Mar - Apr	< 2 m	11	23	15			
2000	2 - 3 m	19	49	19			
	> 3 m	8	2	3			
Survey 7		113	126	53	292	1:1.1	4.7
May - Jun	< 2 m	15	34	28			
2000	2 - 3 m	82	71	21			
	> 3 m	16	21	4			
Survey 8		31	77	38	146	1:2.5	2.6
Aug - Sep	< 2 m	6	15	17			
2000	2 - 3 m	23	51	20			
	> 3 m	2	11	1			
Survey 9		25	63	32	120	1:2.5	1.9
Nov - Dec	< 2 m	7	29	25			
2000	2 - 3 m	18	32	7			
	> 3 m	0	2	0			
Survey 10		42	89	35	166	1:2.1	3.5
Mar - Apr	< 2 m	13	44	21			
2001	2 - 3 m	24	41	13			
	> 3 m	5	4	1			

A fundamental property of any long term monitoring program is the collection of data that is consistent across the program, and ideally throughout the range of the species. Valuable information on population trends for Grey Nurse Sharks will, in all probability, take years of consistent monitoring effort. It will be necessary to ensure that spatial and temporal variation in abundance of Grey Nurse Sharks is documented on a regular basis (Otway and Parker 1999). NSW Fisheries currently maintains data from the Grey Nurse Sharks surveys carried out to date.

Autopsies of any dead Grey Nurse Sharks are important for collecting vital biological information about the species and will increase data sets needed for modelling the population. In NSW dead Grey Nurse Sharks are to be autopsied and in Queensland they are measured, sexed and their stomach contents examined. Commercial fishers are encouraged to pass on any inadvertently caught and killed Grey Nurse Shark carcasses to fisheries biologists to assist in the collection of biological data (eg size, sex, age, stomach contents). Collection and subsequent analysis of genetic material from these sharks will help researchers determine the genetic separation between the western and eastern Australian populations.

Environment Australia has provided funding to NSW Fisheries to monitor wobbegong sharks (*Orectolobus maculatus* and *Orectolobus ornatus*) at sites utilised by Grey Nurse Sharks. The scuba diving community will provide information on sightings of wobbegong sharks. The commercial catch of wobbegong sharks will also be analysed to provide an indication of the current level of harvest and potential interactions with Grey Nurse Sharks. This information will provide a preliminary understanding of the interaction between wobbegongs and Grey Nurse Shark.

Issues
- Monitoring for Grey Nurse Sharks is essential to establish spatial and temporal population trends and measure recovery.
- More biological and genetic data for Grey Nurse Sharks is needed.
- Population status of Western Australia needs to be determined.
- More information is needed on the impact of commercial wobbegong fishing on Grey Nurse Shark.
- Commercial fishers should be asked to provide Grey Nurse Shark carcasses to fisheries biologists.

Prescribed Actions
H.1 - H.8 (see table 6)

4.3 Population Modelling and Demography

Management of Grey Nurse Sharks will benefit from decision-making tools such as population models. Population modelling is one tool that can provide useful indications of population status, rates of recovery and population structure and distribution. The current inadequate information base on Grey Nurse Shark populations will improve as more information becomes available on the spatial structure of these populations, (including the extent to which they segregate by size and sex) and their migratory patterns.

Using data obtained in NSW surveys, together with other biological information, a preliminary model that might describe the population dynamics of Grey Nurse Sharks along the NSW coast (Otway and Parker 2000) could be developed and then used for other areas of the shark's range. Recovery of Grey Nurse Shark populations may also be demonstrated from indicators developed using a population dynamics model. By running a series of scenarios simulating recovery it might be possible to identify appropriate indicators of change that may be easier to monitor than spatial and temporal variations in abundance (Otway and Parker 2000). Any such model will require the input of data from regular field surveys to enable the testing of predictions and refinement of the model. It would be beneficial if such a model could calculate an estimated extinction date for Grey Nurse Sharks as this will provide a estimated timeframe for threat abatement.

Issues
- Modelling Grey Nurse Shark populations will help in managing the Grey Nurse Sharks recovery.

Prescribed Actions
I.1 (see table 6)

4.4 Community Involvement and Education

Community involvement, education and support are a key part of this recovery process.

The Grey Nurse Shark once had a reputation as a man-eater in Australia, but this was due to confusion with other species, and its fierce appearance (Compagno 1984). The Australian Shark Attack file states that there have only been four positively identified cases of attacks by Grey Nurse Sharks, none of which were fatal (West 1991). However, all four attacks involved divers feeding the sharks (Marsh 1995). It is important for the public to be aware that Grey Nurse Sharks are not a threat to humans.

The public awareness of the Grey Nurse Shark has increased in the last decade as a result of aquaria education, community involvement in monitoring programs and an increase in media related releases (articles in magazines and newspapers etc.). However, there is still a need to increase public awareness about the Grey Nurse Shark, particularly for recreational fishers. As mentioned in section 3.2, recreational fishers may be responsible for higher levels of Grey Nurse Shark mortality than previously realised. It is suspected that recreational fishers often kill juvenile Grey Nurse Sharks without realising the species identity. Educational initiatives are needed to ensure that recreational fishers are able to identify juvenile Grey Nurse Sharks. It is also necessary to educate the wider public about the plight of the Grey Nurse Shark and in particular, its population status, current threats and the actions required to ensure the recovery and long term conservation of the species.

Natural Heritage Trust funded surveys for Grey Nurse Sharks have been carried out by NSW Fisheries from 1998 to 2001 with a great deal of community involvement. The surveys of 61 sites between Eden and Tweed Heads in NSW could not have been carried out without the help of scuba divers from universities, dive clubs, commercial aquaria, charter operators and scuba diving schools. Community divers also report grey nurse sightings and the occurrence of incidental hooking and illegal fishing. The continued involvement of the dive community is essential for the long-term monitoring of Grey Nurse Shark populations, particularly on the east coast.

The involvement of the dive community will become more important with the initiation of a tagging program for Grey Nurse Sharks. The scuba diving community can provide substantial input to the tagging program by providing information on subsequent sightings. The information provided will contribute to estimates of total population size via ‘mark-recapture’ techniques and document possible migratory movements in the coastal waters of eastern Australia.

NSW Fisheries with assistance from Environment Australia and the dive industry have developed a Diver Code of Conduct for scuba diving with Grey Nurse Sharks (Appendix B). The code of conduct needs to be extensively promoted to the scuba diving community. All scuba diving groups in New South Wales, southern Queensland and Western Australia should be encouraged to adopt the code of conduct as part of their practise for diving with Grey Nurse Sharks. Some of the recommendations in the code of conduct include:

- Do not feed or touch Grey Nurse Sharks;
- Do not block entrances to caves or gutters; and
- Dive groups not to consist of more than 10 divers.

The code of conduct needs to be monitored to determine if it is being effectively utilised by the dive industry. The code has been developed for NSW waters but it is intended that Queensland and Western Australian dive groups will also adopt the code. The code of conduct should be adopted at a minimum as part of any management planning arrangements for marine protected areas where Grey Nurse Sharks are known to occur.

Issues

- Community education and involvement will play an important part in the conservation of Grey Nurse Sharks.
- Community involvement is essential for the long term monitoring of Grey Nurse Sharks.
- Adoption of a code of conduct is essential to minimise any scuba diving impacts.

Prescribed Actions
J.1 (see table 6)

4.5 Conservation Status

Section 517 of the EPBC Act 1999 states " (1) The Minister may, by instrument in writing, determine that a distinct population of biological entities is a species for the purposes of this Act." The Minister used this discretion in October 2001 to list the East and west coast populations of Grey Nurse Shark separately under the EPBC Act 1999.

Although there has been a considerable amount of work on the east coast population of Grey Nurse Sharks, there has been little, if any, research work conducted on the west coast Grey Nurse Shark population. The only information available on the west coast population is from commercial fisheries catch data. The Recovery Team thus does not currently have the necessary information to determine the population status of the west coast population. The population size of the west coast population is unknown, but considering their life history characteristics and the continued impacts of fishing, this population remains listed as 'vulnerable' under the EPBC Act 1999. Information from scientific studies is needed to assess and monitor the conservation status of the west coast Grey Nurse Shark population.

As part of the implementation of the recovery plan, a quantitative framework needs to be developed to assess the recovery of the species. This framework needs to include the development and identification of indicators to measure the recovery of the species. As part of this exercise, a monitoring program needs to be established to measure the recovery of the species and to evaluate the effectiveness of prescribed actions within the recovery plan.

Issues

- Future listing of the west coast population depends on further information derived from scientific studies.
- A quantitative framework is required to assess the recovery of the species.

Prescribed Actions
K.1 – K.2 (see table 6)

Part 5. Recovery Objectives and Criteria

Section 270 of the *EPBC Act 1999* specifies the content of a recovery plan. In particular the Act requires that the plan must state:

- an objective;
- actions to achieve the objective; and
- criteria against which the successes 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 5 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 principles of ecologically sustainable development and the objects of the Act (Section 3A of the *EPBC Act 1999*).

5.1 Recovery Plan Objective:

The recovery objective is:

To increase Grey Nurse Shark numbers in Australian waters to a level that will see the species removed from the schedules of the EPBC Act.

5.2 Specific Objectives:

The specific objectives are to:

A. Reduce the impact of commercial fishing on Grey Nurse Sharks.
B. Reduce the impact of recreational fishing on Grey Nurse Sharks.
C. Reduce the impact of shark finning on Grey Nurse Sharks.
D. Reduce the impact of shark control activities on Grey Nurse Sharks.
E. Manage the impact of ecotourism on Grey Nurse Sharks.
F. Eliminate the impact of aquaria on Grey Nurse Sharks.
G. Identify and establish conservation areas to protect Grey Nurse Sharks from threatening activities such as commercial and recreational fishing.
H. Develop research programs to assist conservation of Grey Nurse Sharks.
I. Develop population models to assess Grey Nurse Shark populations and monitor their recovery.
J. Promote community education about Grey Nurse Sharks.
K. Develop a quantitative framework to assess the recovery of the species.

To fulfil specific objectives, actions are designed to identify and reduce the threats to Grey Nurse Sharks, determine levels of mortality and reduce that mortality. The recovery of Grey Nurse Sharks will take time.

5.3 Recovery Actions and Criteria

Assessment of the success of management actions against the criteria described in this plan is essential to ensure the successful recovery of the Grey Nurse Shark.

The prescribed actions to achieve the specific objectives are listed below. These actions arise from the assessments made by the recovery team. The action tables include the criteria for measuring the success of the actions and the achievement of the specific objectives. Actions contained within this plan are identified against the objects of the *EPBC Act 1999*.

Table 6.
Summary table of objectives, actions and criteria for Grey Nurse Sharks.

A. Reduce the impact of commercial fishing on Grey Nurse Sharks.

Prescribed Action	*Manager*	*Criteria for Success*
A.1. NSW Fisheries to modify logbooks to record incidental capture, length and sex of Grey Nurse Sharks in the following fisheries: • NSW Ocean Trap and Line; • NSW Fish Trawl; • NSW Prawn Trawl; and • Charter Boat Fishery	NSW Fisheries	• Logbooks used within all relevant fisheries are modified.
A.2. Assess data available from NSW fisheries records and logbooks to determine current levels of Grey Nurse Shark bycatch and mortality.	NSW Fisheries	• Report detailing bycatch levels is prepared.
A.3. Assess data available from WA fisheries records and logbooks to determine current level of grey nurse bycatch and mortality in the following fisheries: • West coast demersal gillnet and demersal longline; • Southern demersal gillnet and demersal longline; and • Northern Shark Fishery.	WA Department of Fisheries	• Report detailing bycatch levels is prepared.
A.4. Assess data available from Queensland fisheries records and logbooks to determine current level of grey nurse bycatch and mortality in the following fisheries: • East Coast Trawl; and • Queensland Line Fisheries.	QDPI QFMA	• Report detailing bycatch levels is prepared.
A.5. All fishers to report take of Grey Nurse Sharks in Commonwealth waters to Environment Australia.	Fisheries Agencies Environment Australia	• All Grey Nurse Sharks taken in Commonwealth waters reported to Environment Australia.
A.6. Ensure that existing observer programs operating in relevant fisheries record interactions with Grey Nurse Shark.	NSW Fisheries QDPI WA Department of Fisheries AFMA	• Observer programs collect data on Grey Nurse Shark interactions.
A.7. Improve education of commercial fishers about protected Grey Nurse Sharks.	Commercial Fishers Fisheries Agencies AFMA Environment Australia	• Information sheets/posters provided to commercial fishers. • Education programs promoted by commercial fishers and fishing agencies on Grey Nurse Shark.
A.8. All fishers where there is a risk of capture of Grey Nurse sharks in Commonwealth waters are to prepare bycatch management arrangements that minimise take and for these to be assessed under the EPBC Act.	Commercial Fishers Fisheries Agencies AFMA Environment Australia	• Bycatch management arrangements assessed and approved.

B. Reduce the impact of recreational fishing on Grey Nurse Sharks.

Prescribed Action	*Manager*	*Criteria for Success*
B.1. Encourage recreational fishers to	Recreational Fisher	• Report detailing catch levels is

record and report Grey Nurse Shark catches and sightings including: • location; and • biological data. This data should be assessed to determine historic and current level of catches and sightings.	Associations	prepared.
B.2. Improve education of recreational fishers about protected Grey Nurse Sharks. See action J.1.	Recreational Fishers Fisheries Agencies Environment Australia	• Information sheets/posters published in shops, boat ramps and magazines. • Education programs promoted by recreational fishing groups and fishing agencies on Grey Nurse Shark.

C. Reduce the impact of Shark Finning on Grey Nurse Sharks.

Prescribed Action	*Manager*	*Criteria for Success*
C.1. Prevent unregulated shark finning	WA Department of Fisheries QDPI AFMA AFFA NSW Fisheries	• Regulations requiring that trunks with fins attached for all sharks caught are landed in port, for all Commonwealth and State/NT jurisdictions.

D. Reduce the impact of shark control activities on Grey Nurse Sharks.

Prescribed Action	*Manager*	*Criteria for Success*
D.1. Continue to quantify levels of grey nurse take during shark control activities in NSW and Queensland.	NSW Fisheries QDPI	• Data on annual level of grey nurse bycatch in shark control activities is supplied to EA and Recovery Team.
D.2. Develop and trial non lethal shark control alternatives to beach meshing and drumlines with a view to phasing out shark meshing programs in areas where Grey Nurse Sharks are at risk.	NSW Fisheries QDPI	• Alternatives are developed and implemented. • As alternatives are developed, length of beach meshing nets declines annually.
D.3. Ensure that Grey Nurse Sharks caught in shark control activities are tagged before release.	NSW Fisheries and QDPI.	• Released sharks tagged.
D.4. Review appropriateness of current shark control activities (beach meshing and drumlines) with a view to reducing impacts on Grey Nurse Sharks.	Fisheries Agencies Environment Australia	• Shark control activities are revised to reduce their potential impact on Grey Nurse Sharks.

E. Manage the impact of ecotourism on Grey Nurse Sharks

Prescribed Action	*Manager*	*Criteria for Success*
E.1. Implement a code of conduct to minimise disturbance to Grey Nurse Sharks by ecotourism activities and monitor and review code of conduct in two years.	NSW Fisheries QPWS WA Department of Fisheries Tour Operators	• A Code of Conduct developed and adopted by relevant tour operators in NSW, Queensland and Western Australia. • Signatories by commercial operations and dive clubs.
E.2. Sites that are declared as habitat protected areas adopt the scuba diving code of conduct as part of the management plans.	Environment Australia NSW MPA NSW Fisheries	• Management plans include scuba diving code of conduct for declared sites.

	QPWS	
E.3. Tour operators encouraged to report all Grey Nurse Shark sightings to NSW Fisheries and QPWS.	NSW Fisheries QPWS	• Sightings recorded and data provided to Recovery Team.
E.4 Research is conducted to determine the impacts of scuba diving.	NSW Fisheries CSIRO	• Data recorded and report on scuba diving impacts presented.
E.5. Ban on night diving at sites identified as habitat critical to the survival of Grey Nurse Sharks.	Environment Australia NSW MPA NSW Fisheries QPWS Dive Operators	• No reports of diving on sites identified as habitat critical to the survival of Grey Nurse Sharks.
E.6. Ban on the use of shark deterrent devices at sites identified as habitat critical to the survival of Grey Nurse Sharks.	Environment Australia NSW MPA NSW Fisheries QPWS Dive Operators	• No reports of shark deterrent devices being used at sites identified as habitat critical to the survival of Grey Nurse Sharks.

F. Reduce the impact of Aquaria on Grey Nurse Sharks

Prescribed Action	*Manager*	*Criteria for Success*
F.1. Moratorium on the taking of grey nurse from the wild for aquaria in all jurisdictions.	NSW Fisheries QDPI QPWS WA Department of Fisheries AFMA Environment Australia	• The taking of Grey Nurse Sharks from the wild for aquaria banned in all relevant jurisdictions. • Moratorium reviewed after two years.
F.2. Aquariums to develop management plans for the keeping of Grey Nurse Sharks.	Aquaria Environment Australia	• Management plans for Grey Nurse Sharks in aquariums developed and reviewed • Identification of Grey Nurse Sharks currently in aquaria.
F.3. Develop and contribute to a conservation orientated education programs in those commercial aquaria with captive Grey Nurse Sharks on display.	Commercial Aquaria Environment Australia NSW Fisheries QDPI QPWS WA Department of Fisheries	• Appropriate education programs and displays implemented in commercial aquaria currently displaying Grey Nurse Sharks.

G. Identify and establish protected areas to protect Grey Nurse Sharks at key locations

Prescribed Action	*Manager*	*Criteria for Success*
G.1. NSW and Qld to develop appropriate mechanisms to conserve sites identified as habitat critical to the survival of Grey Nurse Sharks and associated foraging areas in their respective jurisdictions. Mechanisms to conserve Grey Nurse Shark aggregation sites and associated foraging areas should include:	NSW Fisheries NSW MPA QPWS QDPI	• Appropriate protection mechanisms implemented.

• Establishment of effective marine protected areas (such as 'no take' sanctuary zones; and/or • Seasonal or permanent closures of sites to commercial and recreational fishing.		
G.2. Commonwealth to develop and/or continue appropriate mechanisms to protect key sites in the following areas: • Solitary Islands Marine Reserve (Pimpernel Rock) • Laurieton (Cod Grounds)	Environment Australia AFMA AFFA	• Appropriate protection mechanisms continued at Pimpernel Rock; part of the Commonwealth Solitary Islands Marine Reserve. • Appropriate protection mechanisms implemented at Cod Grounds, Laurieton.
G.3. Queensland will establish a community based program to identify future sites important for the conservation of Grey Nurse Sharks.	QPWS QDPI Dive Industry	• Community monitoring program established. • Important sites identified.
G.4. Sites identified as habitat critical to the survival of Grey Nurse Sharks are nominated to the register of critical habitats under the EPBC Act. Those sites listed in this recovery plan to be gazetted in the first year of the plan on the EPBC Act Register for Critical Habitat	NSW Fisheries QPWS QDPI WA Department of Fisheries Environment Australia Community Dive Industry	• Critical habitat for Grey Nurse Shark is listed on the register throughout the life of the plan.
G.5. Lead agencies in each state should protect sites identified as habitat critical to the survival of Grey Nurse Sharks using appropriate planning or zoning policies, regulations and laws.	NSW MPA NSW Fisheries QDPI QPWS WA Department of Fisheries WA CALM	• Sites identified as habitat critical to the survival of Grey Nurse Sharks are protected.

H. Develop research programs towards the conservation of Grey Nurse Sharks

Prescribed Action	*Manager*	*Criteria for Success*
H.1. Continue existing NSW monitoring program and extend to document age and growth, migratory movements, recruitment rates and estimates of mortality.	NSW Fisheries Community Groups	• Population monitoring data at important sites in NSW continues to be collected and analysed.
H.2. Survey key sites identified as habitat critical to the survival of Grey Nurse Sharks in NSW & Qld during winter to establish maternity sites and annual levels of pup production..	NSW Fisheries QPWS Community Dive Groups	• Knowledge of annual pup productivity in NSW and Qld improved.
H.3. Establish a tag/resighting program to improve knowledge of: • Demography and migratory movements; • Localised site movements; and • Estimation of bycatch levels.	NSW Fisheries QDPI QPWS CSIRO WA Department of Fisheries	• Tag/resighting program established. • Data analysed and report provided to Recovery Team.
H.4. NSW Fisheries to expand the autopsy program for all dead Grey Nurse Sharks encountered to increase	NSW Fisheries	• The majority of Grey Nurse Sharks encountered dead in NSW autopsied.

biological knowledge of the species.		
H.5. Other jurisdictions to be encouraged to establish autopsy programs for Grey Nurse Sharks that are encountered dead.	QDPI QPWS WA Department of Fisheries	• Autopsy programs established in Queensland and WA.
H.6. Assess population size, distribution and status in Western Australia.	WA Department of Fisheries	• Population status, distribution and size documented.
H.7. Collect and analyse genetic material to determine the genetic distinctiveness of western and eastern Grey Nurse Shark populations.	NSW Fisheries QDPI QPWS WA Department of Fisheries CSIRO	• Material collected. • Population genetics clarified by analysis of data.
H.8. Establish a wobbegong monitoring program at known aggregation sites to determine relationship with Grey Nurse Sharks.	NSW Fisheries	• Wobbegong monitoring data at grey nurse sites in NSW collected and analysed.

I. Develop population models to assess populations and monitor recovery

Prescribed Action	*Manager*	*Criteria for Success*
I.1. Develop appropriate models for the Grey Nurse Shark to assist in understanding its: • population status; • rates of recovery; and population structure and distribution.	NSW Fisheries	• Appropriate model developed.

J. Promote community education

Prescribed Action	*Manager*	*Criteria for Success*
J.1. Develop and implement a community education initiatives strategy for Grey Nurse Sharks aimed at the general public, divers and commercial and recreational fishers including: • identification; • current threats and status; and • biology.	Environment Australia AFMA AFFA NSW Fisheries QPWS Aquaria	• Community education strategy and initiatives developed and implemented throughout the community. • Increased community awareness of Grey Nurse Sharks.

K. Reassess the conservation status of the Grey Nurse Shark

Prescribed Action	*Manager*	*Criteria for Success*
K.1. Develop a quantitative framework that includes development of criteria and identification of indicators to assess the recovery of the species within the first 2 years of the recovery plan to manage the recovery of Grey Nurse Sharks in Australia.	EA NSW Fisheries QDPI QPWS	• Quantitative framework established to measure recovery of the species within first 2 years of recovery plan being adopted.
K.2. Establish a monitoring program to measure recovery of the species and evaluate the effectiveness of prescribed actions in promoting recovery	EA NSW Fisheries QDPI QPWS	• Monitoring program established and actions evaluated.

Part 6. Costs of Recovery

6.1. Estimated cost of recovery actions and implementation

The estimated costs for recovery actions are $2.5 million over five years and these are detailed in Table 7. An important corollary to the table of estimated costs of the 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 priority, feasibility and estimated cost for each action is identified. 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.

The feasibility estimates the chance of success. 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. There are only a few actions with a low feasibility of success.

Table 7. Priority, feasibility and estimated cost of actions (in order of priority). All figures are in thousands of dollars ($,000)

Action	Description	Priority	Feasibility	Year 1	Year 2	Year 3	Year 4	Year 5	Total
G.5	Sites identified as habitat critical to the survival of Grey Nurse Sharks are protected.	1	High	300	300	200	100	100	**1,000**
G.1	Marine protected areas declared at identified NSW and Qld Sites.	1	High	Costs included in G.6					
G.2.	Marine protected areas declared at identified commonwealth waters sites.	1	High	75	75	30			**180**
G.4	Identify additional habitat critical to the survival of Grey Nurse Sharks.	1	High	Critical Habitat may be nominated to the register at any time.					
G.3	QLD establish monitoring program and identify further sites for protection.	1	High	60	40	40	40	40	**220**
H.7	Determine if east and west populations are genetically distinct.	1	High	100					**100**
F.1	Moratorium on the taking of Grey Nurse Shark from the wild.	1	High	No cost involved.					
H.6	Assess population size and status in WA.	1	Low	60	40				**100**
H.3	Establish east coast tagging study.	1	High	100	20	20	20	20	**180**
H.1	Continue NSW Monitoring Program.	1	High	50	50	50	50	50	**250**
A.1	Modify NSW commercial fishing logbooks.	1	High	State-Territory responsibility					
J.1	Develop community education strategy.	1	High	50	50	10	10		**120**
A.7	Education of commercial fishers.	1	High	Costs included in J.1					
B.2	Education of recreational fishers.	1	High	Costs included in J.1					
C.1	Implement scuba diving code of conduct.	1	High	No cost involved.					
C.5	Ban on night diving at sites identified as habitat critical to the survival of Grey Nurse Sharks.	1	High	No cost involved.					
C.6	Ban on the use of shark deterrent devices at sites identified as habitat critical to the survival of Grey Nurse Sharks.	1	High	No cost involved.					

K.1	Develop a quantitative framework to assess the recovery of the species.	1	High	5					**5**
K.2	Establish a monitoring program to measure recovery of the species.	1	High	5					**5**
H.2	Survey NSW and Qld sites during Winter to determine maternity sites and annual levels of pup production.	1	High	30	30	30			**90**
B.1	Recreational fishers to report sightings.	1	Medium	No cost involved.					
E.3	Dive industry to report sightings.	1	High	No cost involved.					
A.5	Fishers report catch to Commonwealth.	1	Medium	No cost involved.					
A.8	Commercial fisheries bycatch management regimes reviewed.	1	High	No cost involved.					
H.4	NSW Fisheries to autopsy dead Grey Nurse Sharks.	1	Medium	State-Territory responsibility					
E.2	Code of conduct adopted in management plans for protected areas.	2	High	No cost involved.					
A.3	Assess WA commercial fisheries data.	2	High	10					**10**
A.4	Assess Qld commercial fisheries data.	2	High	10					**10**
A.2	Assess NSW commercial fisheries data.	2	High	10					**10**
A.6	Observer programs report incidental catch.	2	High	No cost involved.					
H.5	Other jurisdictions to autopsy dead Grey Nurse Sharks.	2	Medium	State-Territory responsibility					
E.4	Research conducted to determine scuba diving impact.	2	Medium	30	20				**50**
I.1	Develop a population model.	2	Medium	10	10				**20**
F.2	Aquaria to develop Grey Nurse Shark management plans.	2	Medium	Aquaria responsibility					
F.3	Aquaria to develop education programs.	2	Medium	Aquaria responsibility					
C.1	Prevent unregulated shark finning.	2	Low	No cost involved.					
D.1	Continue recording of catch in shark control activities.	3	High	State-Territory responsibility					

D.2	Trial alternative shark control methods.	3	Low	50	50				**100**
D.3	Sharks caught in shark control activities are tagged before release.	3	Low	State-Territory responsibility					
D.4	Review shark control activities.	3	Medium	State-Territory responsibility					
H.8	Commence wobbegong monitoring program at Grey Nurse Shark sites.	3	High	50					**50**
	Total ($,000)			**1,005**	**685**	**380**	**220**	**210**	**2,500**

REFERENCES

AFFA 2001 (July 2001 draft). A review of shark finning in Australian Fisheries. Department of Agriculture Fisheries and Forestry - Australia.

ANZECC 1998. *Guidelines for Establishing the National Representative System of Marine Protected Areas*. Australian and New Zealand Environment and Conservation Council, Task Force on Marine Protected Areas. Environment Australia, Canberra.

Branstetter, S. and Musick, J.A. 1994. Age and growth estimates for the sand tiger in the Northwestern Atlantic Ocean. *Transactions of the American Fisheries Society* 123:242 -254.

Bruce, B.D. 1995. The protection of white shark. A research perspective. *Southern Fisheries.* 3, No.2, pp.10 - 15. Department of Primary Industries and Fisheries, South Australia.

Bureau of Resource Sciences. 1996. Public nomination of Grey Nurse Shark*, Carcharias taurus*, to the *Endangered Species Protection Act 1992.* Fisheries Advice Note No. 446 Fisheries Resources Branch, Canberra.

Cliff, G. and Dudley, S.F.J. 1992. Protection against shark attack in South Africa, 1952-90. *Aust. J. Mar. Freshwat. Res*., 43: 263-272.

Commonwealth of Australia. 1992. National Strategy for Ecologically Sustainable Development. December 1992. Australian Government Publishing Service, Canberra.

Commonwealth of Australia (2001) *Solitary Islands Marine Reserve (Commonwealth Waters) Management Plan*. Environment Australia, Canberra.

Compagno, L.J.V. 1984. FAO Species Catalogue, Vol. 4. Sharks of the World. An annotated and illustrated catalogue of shark species known to date. Part 1, Hexanchiformes to Lamniformes. *FAO Fisheries Synopsis No. 125, 4(1): 249.*

Coppleson, V.M. 1962, '*Shark Attack (2nd Ed.)*', Angus and Robertson, Sydney.

Cropp, B. 1964. *Shark Hunters*. Rigby, Adelaide.

Cropp, B. 1964a. Shark slaughter. *Australian Skindivers Magazine*, March, p.10.

Cropp, B. 1974. *Handbook for Skindivers*. Jack Pollard Sportsmaster, Sydney.

Department of Primary Industries. 1992. Review of the operation and maintenance of shark meshing equipment in Queensland waters. DPI, Brisbane, June 30.

Department of Primary Industries. 1998. The Queensland Shark Control Program – Report of the Committee of review. DPI, Brisbane, Australia.

Eckersley, Y. 1996. Shark meshing - is the net result justifiable? *GEO Australia* 18 (5): 17-26.

Edwards, H. 1997. *Shark: the shadow below*. Harper Collins Publishers, Sydney.

Environment Australia. 2000. Recovery plan guidelines for nationally listed threatened species and ecological communities. Environment Australia, Canberra.

Environment Australia. 1997. Report to the Minister - Public nomination to the *Endangered Species Protection Act 1992*: Great white shark and Grey Nurse Shark - recommended by the *Endangered Species Scientific Subcommittee* in the Threatened Species and Communities Section, Environment Australia, Canberra.

Environmental Protection Authority. 1996. Public Nomination of the Grey Nurse Shark, *Carcharias taurus* and the Great White Shark*, Carcharodon carcharias* to the *Commonwealth Endangered Species Act 1992*.

Fisheries Department of Western Australia. 1996. Listing of Grey Nurse and White Sharks as vulnerable under the *Endangered Species Protection Act 1992*.

Garbutt, R. 1995. Sharks under attack: Grey nurse numbers take a dive in fishing conflict. *GEO Australia* 17: 26-38

Govender, N., Kistnasamy, N. and Van der Elst, R. P. 1991. Growth of spotted ragged-tooth sharks *Carcharias taurus* (Rafinesque) in captivity. *South African Journal of Marine Science* 11: 15-19.

Grant, E. 1987. *Fishes of Australia*. E.M. Grant Pty Ltd, Redcliffe, Queensland, Australia. P21.

Gribble, N. 1996. Summary of the CITES discussion paper for the Animals Committee. In: N.A. Gribble, G. McPherson & B. Lane (eds), Shark Management and Conservation: Proceedings from the Sharks and Man Workshop of the Second World Fisheries Congress Brisbane, Australia, 2 August 1996. Department of Primary Industries, Queensland.

Harding, J.H. 1990. Return of the Grey Nurse. *Sea Frontiers* 36(4): 30-33.

Ireland, D. 1984. The Grey Nurse Shark. *Underwater* 11:10 -13.

IUCN. 1996. *IUCN Red List Categories.* IUCN - The World Conservation Union, Gland, Switzerland.

IUCN. 1994. *Guidelines for Protected Area Management Categories*. Commission on National Parks and Protected Areas with the assistance of the World Conservation Monitoring Centre, Gland, Switzerland.

Krogh, M. 1994. Spatial, seasonal and biological analysis of sharks caught in the NSW protective beach meshing program. *Australian Journal of Marine and Freshwater Research* 45:1087 - 1106.

Krogh, M. and Reid, D. 1996. Bycatch in the protective shark meshing program off south-eastern New South Wales, Australia. *Biological Conservation* 77:219 - 226.

Last, P.R. and Stevens, J.D. 1994. *Sharks and Rays of Australia*. CSIRO Division of Fisheries, Hobart, Tasmania, Australia.

Ley, V. 1964. Big nurse loses teeth. *Australian Skindivers Magazine*, March, p.9.

Lupton, J. 1962. Shootin' sharks. *Australian Skindivers Magazine*, June/July p.7 & 9.

Marine Parks Authority, 2001. *Draft Zoning Plan for the Solitary Islands Marine Park.* Marine Parks Authority, Coffs Harbour, Australia.

Marsh, N. 1995. A grey future for the Grey Nurse Shark. *Underwater Geographic* 39: 39-42.

Otway, N.M. & Parker, P.C. 1999. A review of the biology and ecology of the Grey Nurse Shark (*Carcharias taurus)* Rafinesque 1810. *NSW Fisheries Research Report Series 1*. NSW Fisheries, Sydney, Australia.

Otway, N.M. & Parker, P.C. 2000. The biology, ecology, distribution, abundance and identification of marine protected areas for the conservation of threatened Grey Nurse Sharks in south east Australia waters. NSW Fisheries Office of Conservation, Port Stephens, New South Wales, Australia.

Otway, N.M. 2001 Grey Nurse Shark. *Nature Australia - Autumn*: 20-21

Paterson, R.A, 1990, Effects of long-term anti-shark measures on target and non-target species in Queensland, Australia. *Biological Conservation* 52: 147 - 159.

Pepperell, J.G. (1992). Trends in the Distribution, Species Composition and Size of Sharks Caught by Gamefish Anglers off South-eastern Australia, 1961-90. *Australian Journal of Marine and Freshwater Research* 43: 213-225.

Pogonoski, J.J., Pollard, D.A., and Paxton, J.R. 2001. Conservation overview and action plan for Australian threatened and potentially threatened marine and estuarine fishes. Environment Australia, Canberra.

Pollard, D.A., Lincoln Smith, M.P., and Smith, A.K. 1996. The biology and conservation status of the Grey Nurse Shark (*Carcharias taurus* Rafinesque 1810) in New South Wales, Australia. *Aquatic Conservation: Marine and Freshwater Ecosystems* 6:1-20.

Reid, D.D. and Krogh, M. 1992. Assessment of catches from protective shark meshing off New South Wales beaches between 1950 and 1990. *Australian Journal of Marine and Freshwater Research* 43:283 - 96.

Roughley, T.C. 1955, *Fish and Fisheries of Australia*, Angus and Robertson, Sydney.

Smith, M.F.L. 1992. Capture and transportation of elasmobranches, with emphasis on the Grey Nurse Shark (*Carcharias taurus*). *Australian Journal of Marine and Freshwater Research* 43:325 - 343.

Smith, A.K. and Pollard, D.A. 1999. Threatened fishes of the world: *Carcharias taurus* (Rafinesque, 1810) (Odontaspididae). *Environmental Biology of Fishes 56:365.*

Stevens, J.D. 1999. Management of shark fisheries in northern Australia. In: Shotton, R. (ed), Case studies of the management of elasmobranch fisheries. *FAO Fisheries Technical Paper* 378/1: 456-479.

Stossell, T. 1993. Investigation of the international shark fin trade. Unpublished Report, TRAFFIC USA.

Taronga Zoo. 1996. Comments in support of the nomination of the Grey Nurse Shark*, Carcharias taurus* and the great white shark*, Carcharodon carcharias* to be included in *Part 2 of Schedule 1 of the Commonwealth Endangered Species Act, 1992.* Taronga Zoo, Sydney, Australia.

Taylor, L. (1997) Sharks and Rays. Readers Digest, Sydney, Australia.

Taylor, R. and Cropp, B. (1962) *Shark Hunters (Video).* Sydney Australia.

West, J.G. 1991. The Australian Shark Attack File with notes on preliminary analysis of data from Australian waters. Shark Conservation Workshop, Taronga Zoo, Sydney, 1991.

Whitley, G.P. 1983. *Australian Sharks.* O'Neil Victoria.

Appendix A

Catches of Grey Nurse Sharks in Commonwealth managed fisheries.

South East Trawl Fishery

The South East Trawl Fishery extends from Sandy Cape, Fraser Island, Queensland to Kangaroo Island, South Australia. The fishery extends from 3nautical miles offshore to the 200 nautical mile limit south of Barrenjoey Point, New South Wales, and from 80 nautical miles offshore to the 200 nautical mile limit north of Barrenjoey Point.

The Integrated Scientific Monitoring Program (ISMP) is an on-board scientific monitoring program that collects data on all species (retained and discarded) taken on a number of South East Trawl vessels. On-board monitoring in the ISMP is structured so that data collection is spread as evenly as possible across all regions of the fishery. Data collected between 1997 and 2000 indicates that of 700 to 1000 shots observed each year one Grey Nurse Shark has been recorded and no great white sharks have been recorded.

Between 1993 and 1997 Geoff Liggins, NSW Fisheries managed an on-board observer program in the South East Trawl Fishery which recorded all species taken on those vessels which were monitored. During that period, 823 fishing days with 2,142 shots on vessels operating from Ulladulla and Eden in Commonwealth waters were observed and no grey nurse or great white sharks were recorded as caught.

In twenty five years of operation of the NSW Fisheries Research vessel the 'Kapalla', one juvenile Grey Nurse Shark has been recorded as taken approximately one kilometre from shore[1], that is, within State waters.

AFMA will continue to monitor the capture of these species through research programs such as the ISMP.

South East Non-trawl fishery

The South East Non trawl Fishery (SEFNT) extends from Sandy Cape, Fraser Island, Queensland to the South Australian/West Australian border. Off South Australia, Victoria and Tasmania the Commonwealth manages some species to the shore, however off NSW and Queensland the Commonwealth only manages from approximately 80 nautical miles to the edge of the AFZ. The only exceptions are 3 purse seine operators licensed to fish in to 3 nautical miles offshore NSW. It is therefore extremely unlikely that SEFNT operators would incidentally capture Grey Nurse Sharks in waters adjacent to NSW or Queensland. A pilot Integrated Scientific Monitoring Program has commenced in the SEFNT fishery this year and records to date indicate that of 350 observed shots, no great white or Grey Nurse Sharks were caught.

Southern Shark Fishery

The Southern Shark Fishery extends from the NSW/Victorian border to the South Australian/West Australian border, including waters around Tasmania, and targets primarily school shark and gummy shark. The fishery is currently managed under four separate jurisdictions. State fisheries agencies in Victoria, Tasmania and South Australia have jurisdiction over State proclaimed waters, and the Commonwealth has jurisdiction from outside these waters to the edge of the Australian Fishing Zone. The State fisheries agencies and the Commonwealth have agreed to apply complimentary management arrangements in the areas under their jurisdiction, through arrangements under the Offshore Constitutional Settlement, which will pass jurisdiction for school and gummy shark to the Commonwealth.

[1] Ken Graham, NSW Fisheries, *pers comm.*

Research programs conducted by the Marine & Freshwater Resources Institute (MAFRI) on the Southern Shark Fishery have included research vessel cruises and tagging cruises. During research cruises between 1973 and 1976 experimental gillnets of various mesh sizes and hooks of various sizes were set mainly in Bass Strait, and also off eastern Tasmania and South Australia.

No Grey Nurse Sharks were caught or observed in any of the above research cruises. MAFRI has indicated that it may be possible for Grey Nurse Sharks to occur in a small part of the fishery off far eastern Victoria at times of warm water incursions, however they are unaware of any commercial captures.

Tuna longlining

AFMA manages tuna and tuna like species as part of the Southern Bluefin Tuna, Southern and Western, and Eastern Tuna and Billfish Fisheries from the low water mark to the 200 nautical mile limit around all states except NSW, and from 3 nautical miles to the 200 nautical mile limit off NSW.

Given that pelagic fishing gear is used in these fisheries, there is a very low chance of incidental captures of Grey Nurse Sharks. The incidental capture of one Grey Nurse Shark was included in the Southern and Western Tuna fishery logbook.

AFMA will continue to collect data on incidental capture of Grey Nurse Sharks.

Great Australian Bight Trawl Fishery

The Great Australian Bight Trawl Fishery Extends from Kangaroo Island, South Australia to Cape Leeuwin, Western Australia and generally from the 200 metre isobath to the 200 nautical mile limit, however it does extend to the low water mark in one part of the Great Australian Bight. It is highly unlikely that this fishery would interact with Grey Nurse Sharks given their geographical distribution. Logbook records for the 10 licensed vessels in the fishery include no grey nurse or great white shark captures.

Logbooks

The following Australian Fisheries Management Authority (AFMA) logbooks provide for the specific recording of Grey Nurse Shark captures: the AL05 (long line sectors of the Southern & Western Tuna and east coast Tuna & Billfish Fisheries and the Christmas and Cocos Tuna Fisheries), NP13 (Northern Prawn and Torres Strait Prawn Fisheries), GN01A (South East Non Trawl, Southern Shark and Fisheries), SQ05 (Squid Jig Fishery), CS01 (Coral Sea Fishery) and NWS02 (North West Slope Trawl and Northern Prawn Scampi Fisheries). Several other logbooks also provide for the recording of wildlife interactions, which can include Grey Nurse Sharks. These include the TPB02 (Southern & Western Tuna and east coast Tuna & Billfish Fisheries, and the wild sector of the Southern Bluefin Tuna Fishery), TPB03 (the farmed sector of the Southern Bluefin Tuna Fishery) and the OT03 (other sectors of the Southern and Western Tuna and the east coast Tuna Fisheries). Previously, captures were only voluntarily recorded in these logbooks under either 'comments' or 'wildlife interactions'. It is planned to amend the logbooks for other fisheries in the future. State and Territory managed fisheries also need to have the Grey Nurse Shark included in the wildlife interaction component of the compulsory reporting in their logbooks.

APPENDIX B

Code Of Conduct For Diving With Grey Nurse Sharks

To comply with the Code of Conduct for Diving with Grey Nurse Sharks all divers **must not**:

- Night dive in sites identified as habitat critical to the survival of Grey Nurse Sharks
- Touch, feed or interfere with the natural behaviour of Grey Nurse Sharks
- Chase, harass or interrupt the swimming patterns of Grey Nurse Sharks
- Block cave entrances, gutters or entrap Grey Nurse Sharks
- Dive in groups totalling more than ten divers
- Use mechanical apparatus including but not limited to scooters, horns and shark pods.

All divers must comply with this Code of Conduct.

All commercial operators shall be signatories to the Code of Conduct for Diving with Grey Nurse Sharks and must conduct all dives in recognised Grey Nurse Shark areas under this Code.

In addition to the divers obligations listed above all commercial operators **must**:

- Give a dive brief at each dive site identifying Grey Nurse Shark habitat areas.
- Ensure all divers on their charter vessels comply with the Code of Conduct.
- Participate in scientific research to collect information regarding Grey Nurse Shark populations and distribution.
- Display the Code of Conduct in all dive stores and on board dive boats.