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2009 Shark Assessment Report for the Australian National Plan of Action for the Conservation and Management of Sharks

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Summary

NPOA-Sharks

Australia's *National Plan of Action for the Conservation and Management of Sharks*[1] (NPOA-Sharks) was released in 2004, as part of Australia's commitment to implement the *International Plan of Action for the Conservation and Management of Sharks* (1999). The NPOA-Sharks was designed to provide advice and guidance to fisheries managers, conservation managers and the general public on action needed to ensure that Australia's shark populations are managed sustainably into the future. Australia's NPOA–Sharks is due for review and this report has been prepared to help support the review process.

Objectives

This report identifies significant changes that have occurred in fisheries since the release of the 2001 Shark Assessment Report and identifies new and ongoing issues that should be considered in the context of the NPOA-Sharks. The information presented in the report is based on a compilation of reports provided by Commonwealth, state and territory fishery management agencies, research reports and expert opinion. It focuses on the period from 2001 to 2006, although more recent information is presented in some circumstances. This report is principally fisheries focussed and does not attempt to review the overall effectiveness of the NPOA-Sharks.

Sharks in Australia

Approximately, one quarter of all known chondricthyian species (sharks, skates, rays and chimaeras) world-wide occur in Australian waters (322 species) and of these 51 percent are endemic, occurring only in Australian waters. Sharks are caught by commercial, recreational and Indigenous fishers as targeted catch, non-target but retained catch (byproduct) or as non-target and non-retained catch (bycatch). It is widely recognised that many shark species are more vulnerable to fisheries impacts than finfish, due to their slow growth, late maturity and low fecundity.

Commercial fisheries that target sharks exist in all jurisdictions. The average annual total commercial shark catch from 2000–01 to 2005–06 was 10 733 t. The largest shark catch in a single jurisdiction was recorded for the combined Commonwealth-managed fisheries, with an average total commercial catch of 4972 t (2000–06).

Conservation and management issues

There have been some improvements in the management of commercial shark harvest and bycatch since 2001, most notably in:

- facilitating improved identification of species in the catch (including the development of identification guides for fishers)
- improvements in catch and effort data collection (through improved logbooks and observer programs)
- shark-specific management measures to address species of concern (e.g. Commonwealth school shark rebuilding strategy and Western Australian targeted management in response to concerns over whiskery and sandbar shark populations).

[1] The term 'shark' refers to all species of shark, skates, rays and chimaeras (Class Chondrichthyes), unless otherwise specified.

However, effective management of shark catch is still hampered in some fisheries by, amongst other things, the inadequacies of basic catch reporting in fisheries and limited data validation programs. The identification of high-risk species, stock assessments and monitoring of the effectiveness of management measures are best supported by robust catch data, ideally at the species-level.

Need to improve data collection

Key issues with respect to commercial shark harvest data include difficulties in identifying species at sea, reporting of catches at the group level (e.g. 'shark unspecified', 'whalers unspecified') and differences in reporting systems across jurisdictions. The data for bycatch species is generally much poorer than for byproduct or target; there are few logbook systems that effectively record bycatch. These reporting limitations mean that the full extent of species catches is not well understood, which is of particular concern for high-risk species.

Species-specific data

In the absence of regular fishery-independent surveys of shark populations catch data are often relied on as the main indicator of population size and trends. Accurate species-level reporting should be expected in target shark fisheries and fisheries with substantial shark byproduct or bycatch. However, it is unrealistic to expect accurate species-level logbook reporting in all fisheries due to difficulties in identifying some species. Consideration must be given to alternative approaches to validate shark data with regard to quantities, composition, and bycatch rates (e.g. targeted observer/research programs, electronic monitoring, trained crew member observer programs) to support more reliable assessments and management.

The effective management and conservation of species requires an understanding of all major sources of mortality. There are stock assessments for some key species in targeted shark fisheries. However, the level of species-specific management remains low in relation to the diversity of shark species caught. This is not necessarily a concern in fisheries where shark constitutes only a minor component of the catch. In the absence of robust catch and effort data, risk assessments have been undertaken in some jurisdictions and regions to identify and guide the management of high-risk species.

Non-commercial catch data

The collection of information on the non-commercial (i.e. recreational and traditional) catch of shark in Australia is managed at the state/territory level. There have been little data collected on the scale of shark catch in recreational and traditional fisheries. In some jurisdictions it has been suggested that the recreational catch of shark may be greater than the commercial fishery catch.

Market and trade data

Market and trade data have the potential to provide significant information to assist managers - particularly in terms of the species targeted and levels of catch and market drivers. These data may be particularly informative for species or products where direct catch monitoring is logistically difficult. Due to competing reporting requirements, the information currently reported on trade in shark products is too broad and of limited value for fisheries management and conservation purposes. Also, if the current market and trade data reporting protocols are not well understood this information can be misleading and should not be used as a proxy for shark catch data.

Improved trade and market data collection and reporting would benefit management decisions and reporting obligations. There is scope to improve the fisheries management application of the domestic market and trade data that are collected or that could be collected. However, addressing these issues in relation to existing export and import shark product codes is likely to be more difficult. A review of shark import and export data quality and data protocols may need to be considered.

Conclusions

Although progress in shark conservation and management has been identified, many of the issues identified in the 2001 Shark Assessment Report remain. As a priority in the short-term, there is a general need for:

- an improved application of data verification methods (observer programs, targeted research and analysis, etc.) in target and non-target shark fisheries
- the effective implementation of robust management measures and recovery actions to mitigate threats to high-risk and threatened, endangered and protected species, and to rebuild over-exploited stocks
- precautionary measures to prevent any further declines in shark species.

It is recommended that the development of actions to address these issues should be a priority during the review of the 2004 NPOA–Sharks. Addressing these issues should facilitate more rapid progress towards assessing a wider range of threats to Australian shark resources and the ecosystem services that depend on them.

In the longer-term, there is a need to:

- develop abundance or fishing mortality indices and conduct stock assessments for significant target and byproduct species
- ensure further and more consistent application of risk-based approaches to shark conservation and management
- assess the significance of cumulative fisheries and other impacts on high-risk species
- review the need for and, where necessary, the methods to obtain accurate market and trade data
- examine the need for improved management measures to reduce or restrict the targeting of sharks for the purpose of supplying shark fin to export markets
- support the development of more effective shark bycatch mitigation methods
- conduct assessments of the risk non-commercial fisheries pose to sharks
- continue to encourage the effective monitoring and management of the harvest and bycatch of pelagic shark species on the high seas
- assess the sustainability of imported shark products.

The issues listed are principally fisheries focussed and not exhaustive. Creating a shared understanding of what are the highest priority actions and what is achievable in the short-term will be a key challenge for management agencies within the review of Australia’s NPOA-Sharks.

Disclaimer

This report has been prepared by the Bureau of Rural Sciences, in collaboration with the Shark-plan Implementation and Review Committee (SIRC). It is a national report and does not necessarily represent the views of all SIRC members or the contributing government agencies. It is based on a compilation of broad assessment reports prepared by the jurisdictions represented on the SIRC and other supporting information such as research reports and expert opinion.

The government agency that prepared each jurisdictional report and the publication date are presented on the respective report title page (see Appendices A-H). Some jurisdictional reports were prepared more recently than others. The jurisdictional reports are broad summaries only and they should be referred to for additional information on the data sources used.

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1. Introduction

Background

Concern over the sustainability of the global catch of shark[2] started to build in the late 1980s and early 1990s as shark fisheries expanded and lucrative shark fin markets in Southeast Asia developed (Clarke 2004; Musick and Bonfil 2005; Clarke et al. 2006). In response, the ninth conference of parties to the *Convention on International Trade of Endangered Species of Wild Fauna and Flora* (CITES) adopted a resolution in 1994 on 'the status of international trade in shark species.' The resolution called upon the Food and Agriculture Organization (FAO) of the United Nations (UN) to review information on the global status of shark stocks and the impact of trade on those stocks. The FAO responded through the development of the *International Plan of Action for the Conservation and Management of Sharks* (IPOA-Sharks) which was adopted in 1999 (Musick and Bonfil 2005).

The IPOA-Sharks is a voluntary instrument elaborated within the framework of the 1995 FAO *Code of Conduct for Responsible Fisheries*. This code sets out principles and international standards of behaviour for responsible fishing practices to enable effective conservation and management of living aquatic organisms while considering impacts on the ecosystem and biodiversity. The IPOA-Sharks directs that FAO member states 'should adopt a national plan of action for the conservation and management of shark stocks (NPOA-Sharks), if their vessels conduct directed fisheries for sharks or if their vessels regularly catch sharks in non-directed fisheries'. Additionally, the IPOA-Sharks directs that 'states that implement a NPOA-Sharks should regularly, at least every four years, assess its implementation for the purpose of identifying cost-effective strategies for increasing its effectiveness.' In accord with the IPOA-Sharks, Australia committed to producing an NPOA-Sharks.

As a first step in 2001, Australia released an assessment of the biology and fisheries for sharks in Australian waters to support the development of Australia's NPOA-Sharks. The assessment is titled *Australian Shark Assessment Report for the Australian National Plan of Action for the Conservation and Management of Sharks* (hereafter referred to as SAR2001). This document provided the first consolidated report on Australian shark conservation and management. The SAR2001 identified a number of issues to be addressed including the need for:

- better recording of all shark catches
- protection of species with poor conservation status
- cross-jurisdictional management of shared stocks
- national controls on shark finning, including international trade
- information on the impacts of recreational fishing and beach protection programs on the status of stocks.

Australia's *National Plan of Action for the Conservation and Management of Sharks* was subsequently released in 2004. The NPOA-Sharks was designed to provide advice and guidance to fisheries managers, conservation managers and the general public on action needed to ensure that Australia's shark populations are managed sustainably into the future. The SAR2001 and the

[2] The term 'shark' includes all species of shark, skates, rays and chimaeras (Class Chondrichthyes), unless otherwise specified.

NPOA-Sharks were developed by a Shark Advisory Group comprised of representatives from the Australian Government, state and territory fisheries management agencies, conservation agencies, commercial fishing industry and the recreational, Indigenous and scientific sectors.

Objectives

In accordance with the timeframe specified by the IPOA-Sharks, Australia's NPOA-Sharks is due for review and the 2009 Shark Assessment Report (SAR2009) has been prepared to support this review process. The SAR2009 builds upon the information provided in the SAR2001 and aims to identify substantial changes that have occurred in fisheries since the release of the SAR2001 and any new or ongoing concerns. The assessment includes the presentation, and where possible, analyses of:

- resource information, including fishing methods, catch[3] and effort data, and stock assessments
- conservation and management arrangements, and
- fisheries management arrangements, including regulatory frameworks.

This report was funded under the Natural Heritage Trust. It forms one component of a larger project run by the Bureau of Rural Sciences (BRS). In addition to this report, the BRS project aims to review how current bycatch mitigation policies and legislation are being implemented on-ground, to identify opportunities for improvements, and to facilitate updated national assessments of seabird bycatch in Australia's longline fisheries.

Data sources

This report has been prepared in collaboration with the Shark-plan Implementation and Review Committee (SIRC)[4]. It is based on a compilation of assessment reports prepared by the various jurisdictions represented on the SIRC and other supporting information such as research reports and expert opinion. The jurisdictional assessment reports are appended to this report and follow the format suggested in the FAO Technical Guidelines for Implementation of the IPOA-Sharks.

Much of the information presented in the SAR2001 remains relevant, particularly the biological information. Although, there have been a number of taxonomic changes relevant to Australian shark species since the release of the SAR2001. Standard Australian fish names[5] are used throughout this report. For a list of common and scientific names used in this report refer to Section 11: Shark names.

The SAR2009 focuses on information from 2000–01 to 2005–06. It was generally not possible to include more recent information at the time of writing the report due to the complexities of the data (e.g. multiple jurisdictions/methods), which are discussed throughout the report. More recent information is presented in some circumstances. Therefore, this report serves as an update only and may not cover recent changes in management or advances in research.

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[3] All catch information presented in this report is whole weight in tonnes unless otherwise specified.

[4] The SIRC was established in 2004, as a sub-committee of the Natural Resource Management Ministerial Council Marine and Coastal Committee (MACC), to oversee the implementation and review of the NPOA-Sharks. SIRC membership includes government representatives from fisheries agencies in each state, the Northern Territory, and the Department of Agriculture, Fisheries and Forestry (DAFF); the Department of the Environment, Water, Heritage and the Arts (DEWHA); the Great Barrier Reef Marine Park Authority; and the Australian Fisheries Management Authority.

[5] For more information on standard Australian fish names visit: www.fishnames.com.au

The Australian Fishing Zone

This report considers information on the characteristics and catch composition of fisheries operating within state and territory waters and the Australian Fishing Zone (AFZ; see Figure 1). Information is presented for Commonwealth, state, territory, and joint authority fisheries. The relevant jurisdictions are the Commonwealth, New South Wales (NSW), Victoria (VIC), Queensland (QLD), Western Australia (WA), South Australia (SA), Tasmania (TAS) and the Northern Territory (NT).

In general, state and territory fisheries extend 3 nautical miles (nm) offshore and the Commonwealth manages waters from 3 nm to the edge of Australia's 200 nm Exclusive Economic Zone (EEZ). There are several exceptions to this and a number of jurisdictions have established Offshore Constitutional Settlement (OCS) arrangements to manage fish stocks that occur in more than one marine jurisdiction. Under an OCS agreement, fishing for particular stocks may be managed either through joint authority arrangements made between two or more jurisdictions or by transferring the management of a straddling stock to a single jurisdiction. For example, under OCS arrangements the Commonwealth manages commercial fishing for school shark (*Galeorhinus galeus*) and gummy shark (*Mustelus antarcticus*) stocks in coastal waters off south-eastern Australia on behalf of the states of VIC, SA and TAS.

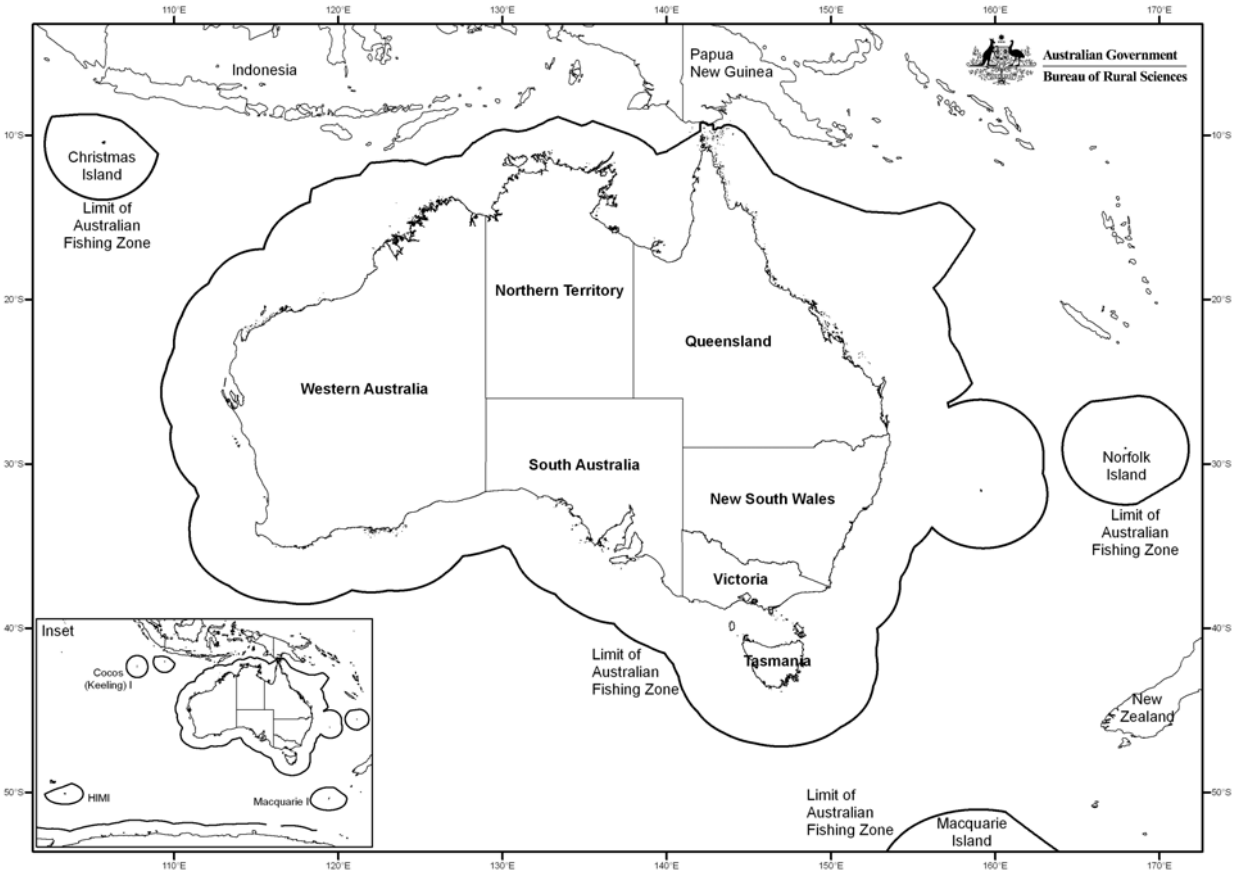

Figure 1. The Australian Fishing Zone

Shark biology

The major class of living fishes, the Osteichthyes (comprising about 95 per cent of fish fauna), has a bony skeleton. The class Chondrichthyes (sharks, rays, skates and chimaeras) is characterised by species that have skeletons made of cartilage.

It is estimated that more than 1200 chondrichthyan species exist world-wide. Of these, an estimated 322 species (182 sharks, 125 rays and 15 chimaeras) inhabit Australian waters (Last and Stevens 2009). An estimated 51 per cent of Australian chondrichthyan fauna is endemic (39 per cent of sharks and 69 per cent of rays). A large number of the sharks and rays that have been studied exhibit characteristics of slow growth, late maturity and low fecundity when compared to bony fishes (Stevens et al. 2000). Such characteristics make sharks particularly vulnerable to overfishing if not carefully managed.

Chondrichthyans are also generally characterised as having small tooth-like denticles (also known as placoid scales) on their skin and reproducing via internal fertilisation. About 65 per cent of chondrichthyans give birth to live young, while the remainder lay eggs externally in protective cases. Chondrichthyans are further divided into two subclasses: elasmobranchs (sharks, skates and rays), and holocephalans (chimaeras) (Last and Stevens 2009).

Elasmobranchs are characterised by having 5–7 gill openings on each side of the head, a body largely covered by dermal denticles and teeth that are embedded in the gums and continuously replaced. In contrast, chimaeras have a single gill opening, skin largely free of dermal denticles and teeth that are fused into plates that grow with the animal. Chimaeras also often exhibit a large head, large pectoral fins, two dorsal fins (the first preceded by a long spine), a weak caudal fin that may have a long terminal filament and they may have an anal fin that is barely separated from the caudal fin. Adult male chimaeras often display additional claspers on their head and in front of the pelvic fins (Last and Stevens 2009).

2. Shark catch in Australian fisheries

Sharks are caught in Australian waters by commercial, recreational and traditional fishers as targeted catch, non-target but retained catch (byproduct) or as non-target and non-retained catch (bycatch). Designated target shark fisheries exist in all jurisdictions, some of which are managed through joint authority or other Offshore Constitutional Settlement (OCS) arrangements. Fishing methods used to target shark species include line (demersal longline, setline, dropline, trotline, handline and rod and reel recreational angling), net (demersal and pelagic gillnet), hand collection and spear. Some demersal trawl fisheries have also targeted deepwater sharks. Sharks may also be incidentally caught by all these methods as well as during trawl (demersal and mid-water), haul seine net, purse seine net and trap operations and in mesh nets or on drumlines (QLD only) set as part of bather protection programs in NSW and QLD. The likelihood of incidentally catching sharks in non-target fisheries is dependent on a wide range of factors including the target species, gear type, management arrangements and species-specific spatial and temporal considerations.

Since 2001, several new OCS arrangements have been introduced resulting in significant changes to the management of a number of Commonwealth and state/territory fisheries. As a result, catch comparisons between pre- and post-OCS fisheries arrangements are difficult and/or inappropriate. Similarly, although all jurisdictions collect some catch data to species-level, data collection and validation protocols vary considerably and many have changed over the period covered by this report. This situation adds another level of complexity to the feasibility of catch comparisons, particularly at the species-level.

All jurisdictions record a component of unspecified shark catch (i.e. the species or species group could not be reliably identified or there was no requirement to identify the shark to a species group or lower taxonomic level). This introduces a common catch data problem as the catch of many species are grouped together into generic categories such as ‘shark other’ or ‘skates or rays’ (see Table 1). In the absence of suitable data validation protocols, analyses of shark ‘group’ data can be limited or biologically meaningless for many species, particularly for species that are rarely caught or difficult to identify (Phillips et al. 2009).

Commercial shark catch by jurisdiction

The annual commercial Australian shark catch from 2000–01 to 2005–06 ranged from about 9400 t to about 11 500 t, with an annual average of about 10 733 t (see Table 2).The catch over 1996–99 ranged from about 8600 t to 9400 t. Note that the weight of catch recorded in logbooks and catch documentation schemes can vary depending on the processed state of catch when weighed (i.e. whole weight, trunked weight, gutted weight). This needs to be taken into account when comparing catches between fisheries and jurisdictions. As mentioned previously, any comparisons of shark catches recorded in the SAR2001 and SAR2009 need to take into account the impact of OCS management arrangements on shark catch data in the Commonwealth and some states/territory fisheries. Specific issues are discussed in more detail in the relevant jurisdictional chapters (see Appendices A – H).

Ideally, catch trends should be considered in conjunction with fishing effort data. However, due to the range of fishing methods used to catch shark and the range of data collection protocols, a standardised unit of fishing effort cannot be practically applied. Fishery-specific catch and effort information is presented in a number of the jurisdictional reports.

Table 1. Examples of species-group catch reporting categories and the range of species encompassed by each catch category. The scope of species covered may vary between fisheries due to the distribution of species, fishery area and methods used.

Catch category	Scope of species	No. of spp[6]
Ray	Batoidea	125
Catsharks	Scyliorhinidae	34
Blacktip shark	*Carcharhinus*, *Loxodon* & *Rhizoprionodon* spp	25
Skate	Rajidae	25
Guitarfish	Rhynchobatidae, Rhinobatidae & Rhinidae	12
Greeneye dogfish	*Squalus spp*	11
Ghostshark	Chimaeridae	10
Wobbegong	Orectolobidae	10
Mackerel sharks	Lamnidae	4
Sawfishes	Pristidae	4
Hammerhead sharks	Sphyrnidae	4
Angel shark	*Squatina spp*	4
Sawshark	*Pristiophorus spp*	3
Sharks - other	Chondrichthyes (sharks, rays, skates, chimaeras)	?

[6] The number of species, within the family or genera listed, known to occur in the waters of continental Australia. Source: Last & Stevens 2009.

Table 2. The total reported commercial catch of shark (tonnes) by jurisdiction for the financial years 2000–01 to 2005–06. The reporting of catch varies with regard to the state of processing (e.g. whole weight, processed weight, landed weight). Date were not converted to a single processing state. The table should only be used to make indicative comparisons between years and jurisdictions. Data were acquired from the respective jurisdiction.

Jurisdiction	2000–01	2001–02	2002–03	2003–04	2004–05	2005–06
Commonwealth[7]	4877	4931	5120	5072	5136	4698
New South Wales	623	643	584	548	517	627
Victoria	62	71	70	50	68	61
Queensland	1571	2110	1742	2048	1576	1558
Western Australia	1656	1956	2133	2305	2800	1581
South Australia	342	201	197	202	184	151
Tasmania	1448	94	72	82	86	31
Northern Territory	435	419	857	978	1119	705
Total	**11 014**	**10 425**	**10 775**	**11 285**	**11 486**	**9412**

Note: The reporting of catch varies with regard to the state of processing (e.g. whole weight, processed weight, landed weight, etc.). The table should only be used to make indicative comparisons between years and jurisdictions. Data were acquired from the respective jurisdiction.

Commonwealth-managed fisheries

The largest shark catch in a single jurisdiction was recorded for the combined Commonwealth-managed fisheries (Table 2). The annual commercial Commonwealth shark catch ranged from about 4700 t to about 5100 t (2000–01 to 2005–06). The annual average over the period was 4972 t. Refer to Appendix A for detailed information on Commonwealth fisheries.

In Commonwealth-managed fisheries sharks are targeted by the Gillnet Hook and Trap (GHAT) and Commonwealth Trawl sectors (CT) of the Southern and Eastern Scalefish and Shark Fishery (SESSF) and the line and aquarium sectors of the Coral Sea Fishery (CSF). In 2006 there were 140 permits in the GHAT, 59 permits in the CT and 9 line and 2 aquarium permits in the CSF.

The largest quantity of shark is consistently harvested by the GHAT and CT sectors of the SESSF, though most shark catch in the CT is harvested as byproduct. The annual shark catch from the remaining fisheries ranges from about 570 t to 945 t, 12–18 per cent of the total annual Commonwealth shark catch (2000–01 to 2005–06). Many of the shark species harvested in the SESSF are managed through annual 'basket' quotas that apply across sectors.

In the SESSF, gummy shark is the principal target shark species and primarily harvested with gillnet, while in the Coral Sea a range of shark species are targeted by line (demersal longline, setline, dropline, trotline and handline) and by hand collection methods in the aquarium sector. Through OCS arrangements established in 2000 and 2001, targeted commercial fishing for gummy shark and school shark in Commonwealth waters and state coastal waters of VIC, TAS and SA is

[7] Commonwealth catch data may include weight of discards, where recorded.

managed as part of the SESSF. During 2000–01 to 2005–06, the reported annual catch of gummy and school shark in Commonwealth-managed fisheries has averaged approximately 2400 t and 325 t, respectively.

Although the vast majority of Commonwealth-managed fisheries do not target sharks, they are caught as byproduct and/or bycatch species in many fisheries. For example, the Great Australian Bight Trawl (GAB) sector of the SESSF and the Eastern and Western Tuna and Billfish Fisheries (the ETBF and WTBF, respectively) regularly record byproduct catches of shark species. The catch of shark in the GAB trawl sector has historically been dominated by a number of angel shark species (Family Squatinidae), gummy shark and sawshark (Family Pristiophoridae). The shark catch in the ETBF and WTBF has historically been dominated by blue shark (*Prionace glauca*), oceanic white tip (*Carcharhinus longimanus*), scalloped hammerhead (*Sphyrna lewini*), and shortfin mako (*Isurus oxyrinchus*), with bronze whaler (*Carcharhinus spp*) also being prominent in the ETBF.

Southern and Eastern Scalefish and Shark Fishery

In 2007, the BRS *Fishery Status Reports* assessed gummy shark catch in the SESSF as not overfished and not subject to overfishing (Larcombe and Begg 2008). Recruitment of gummy shark to the fishery in Bass Strait appears to have been stable over the past 20 years. Although the assessment model predicts a decline in pup production, this is not evident in recruitment to the fishery (McLoughlin 2008).

School shark has been assessed as overfished for a number of years (Larcombe and Begg 2008). The Australian Fisheries Management Authority (AFMA) is implementing a rebuilding strategy for school shark in accordance with the 2009 listing of the species as conservation dependent under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) and with the 2007 *Commonwealth Fisheries Harvest Strategy Policy and Guidelines* (HSP). School shark is now considered to be a byproduct of the fishery for gummy shark and bycatch quotas are set in accordance with a harvest strategy intended to rebuild the adult biomass to 20 per cent of the estimated virgin biomass by 2024. Information currently available makes it difficult to determine whether or not the population is recovering (McLoughlin 2008).

Since 2001, the shark hook component of the GHAT has experienced a decline in the number of licences and active vessels. In 2005, the *Securing our Fishing Future* structural adjustment package commenced and over 550 fishing concessions were voluntarily surrendered in Commonwealth fisheries, including 26 gillnet and 17 shark hook boat statutory fishing rights in the GHAT. However, as much of this fishing effort was not believed to be active in the fishery it is thought to have resulted in only a small reduction in actual fishing effort relative to the number of concessions surrendered (McLoughlin 2008). Economic pressures such as the rising value of the Australian dollar in 2006–07 and the rising cost of fuel are also thought to have contributed to reductions in fishing effort.

There is concern over several species of deepwater sharks or dogfish (Squalidae and Centrophoridae) harvested in the SESSF. Currently, three species have been nominated for listing as threatened under the EPBC Act: Harrisson's dogfish (*Centrophorus harrissoni*), southern dogfish (*C. zeehaani*, formerly *uyato*) and endeavour dogfish (*C. moluccensis*). About 20 species of deepwater sharks can be harvested, predominantly by the CT, but also by the other sectors in the SESSF. In the 1990s, shark fishers targeted upper-slope species for their livers, but catch rates in that period declined markedly and targeting ceased. However, various sectors of the SESSF continue to take these species as byproduct (Morison 2008). Wilson et al. (2009) conclude that

urgent action needs to be taken by fishery managers if the heavily overfished and very depleted stocks of deepwater sharks on the upper slope habitat of the SESSF are to recover.

New South Wales

Refer to Appendix B for detailed information on New South Wales-managed fisheries. Traditionally, sharks have been commercially harvested as byproduct in several NSW fisheries; however, in recent years there has been an increase in targeted fishing for sharks in certain areas. The commercial fisheries that account for the majority of shark catch in NSW are the Ocean Trawl (fish and prawn sectors; sharks are harvested as byproduct during trawl operations) and the Ocean Trap and Line Fisheries (OTLF). In 2006, there were 98 licences in the fish trawl sector, 306 licences in the prawn trawl sector and 504 licence holders in the OTLF.

The ocean fish trawl sector catch comprises mainly demersal species such as shovelnose rays (Family Rhinobatidae), angel sharks and sawsharks. Shark catch in the OTLF comprises mostly whalers (Family Carcharhinidae), wobbegongs (Family Orectolobidae), gummy sharks and pelagic species such as mako sharks (*Isurus* spp.), tiger sharks (*Galeocerdo cuvier*) and hammerheads (Family Sphyrnidae). There are also a small number of OTLF operators that target school and gummy shark in the south of the state.

NSW shark catch remained relatively stable from 2000–01 to 2005–06. Total commercial shark catch averaged 590 t per year and ranged from 517 t to 643 t. This is less than the six year average of 694 t reported in the SAR2001 (1993–94 to 1998–99). From 2000–01 to 2005–06, 'whaler' was the dominant catch category (with the exception of 2003–04 when 'shovelnose rays' was the dominant catch category). The proportion of catch recorded as 'whaler' was 38 per cent of the total shark catches in 2005–06. The steep increase in catch of whalers in the last few years is due to a combination of factors including, but not limited to, some OTLF fishers targeting sharks and the high price of shark fin (up to $250/kg) on international markets. While finning[8] is banned in NSW, fins are legally removed during processing at ports and markets. It is possible the general catch composition may be skewed by catch not recorded to species or group level.

Victoria

Refer to Appendix C for detailed information on Victorian-managed fisheries. Sharks are targeted and caught as byproduct in the VIC Ocean Fishery and the Inshore Trawl Fishery, which operate in coastal waters outside bays and inlets, and in the Western Port/Port Phillip Bay Fishery and the Corner Inlet Fishery, which operate in state internal waters. In 2006, there were 307 licences in the Ocean Fishery and 60 licences in the Inshore Trawl Fishery. Sharks are targeted using mesh nets and longlines, but they are also caught using haul seines, trawl nets, hand lines, and are caught incidentally on drop lines, in rock lobster pots and purse seines.

From 2000–01 to 2005–06, the average annual commercial catch of shark in VIC was approximately 64 t. Since the introduction of OCS arrangements in 2000, catches have been dominated by gummy shark, elephantfish (*Callorhinchus milii*) and several skate species. Commercial catches of gummy and school shark in coastal waters have declined substantially following the introduction of bycatch trip limits in 2000, as part of the OCS arrangements with the Commonwealth.

[8] Shark finning is defined in the NPOA-Sharks as 'the removal of the fins from a shark and the torso discarded to the sea'

Queensland

Refer to Appendix D for detailed information on Queensland-managed fisheries. Sharks are caught as target and byproduct species in QLD net and line fisheries and as bycatch in a range of fisheries. Shark is targeted in two fisheries: the Gulf of Carpentaria Inshore Fin Fish Fishery (GOCIFFF) and the East Coast Inshore Fin Fish Fishery (ECIFFF). The shark fishery within the GOCIFFF is jointly managed with the Commonwealth under an OCS established in 1995. In 2006, there were 87 licences in the N3 sector of the GOCIFFF, and 5 licences in the N9 sector.[9] The ECIFFF operates in part, in the Great Barrier Reef Marine Park and World Heritage Area. In 2006, there were 500 net licences and 1651 line licences in the ECIFFF.

Historically fishers have harvested shark almost exclusively using mesh nets, and only limited effort has been applied using multiple hook apparatus. However, there has been some increase in the use of multiple hook bottom line gear in 2006 and 2007. The dominant catch reporting categories over the reporting period were 'shark - unspecified', 'whaler - unspecified', Australian blacktip (*Carcharhinus tilstoni*), and 'scalloped hammerhead'. Catches in the Gulf of Carpentaria have remained relatively stable over time when compared with the east coast. Catch in the ECIFFF increased with increasing effort in the fishery from 1999 to 2003, peaking in 2003 at about 1400 t. There is a significant interaction between reef sharks and the Coral Reef Fin Fish Fishery that operates primarily in the Great Barrier Reef Marine Park and targets reef fish such as coral trout (Heupel et al. 2009).

The average annual commercial catch of shark from 2000–01 to 2005–06 was 1768 t. An increase in the targeting of shark in QLD in recent years is thought to be attributable to an increase in the demand for Australian shark fin in Asian markets. Operators in the Gulf of Carpentaria offshore grey mackerel/shark fishery have invested significantly in vessels and equipment to maximise their capacity to store and process product. A small number of east coast fishers have invested heavily in vessels that allow them to operate in offshore waters (deeper than 20 m) and use up to 1200 m of net. Approximately 25 vessels take about half of the east coast shark catch.

Management arrangements for the ECIFFF have been recently reviewed by Gunn et al. (2008). The review informed changes in management arrangements for the ECIFFF and some of these changes have also been applied in the GOCIFFF. A broader review of the GOCIFFF, including the shark component, has since commenced (in 2009).

Western Australia

Refer to Appendix E for detailed information on Western Australian-managed fisheries. There are four target shark fisheries in WA: two in the north and two in the south. The northern shark fisheries are the Joint Authority Northern Shark Fishery (JANSF) and Western Australian North Coast Shark Fishery (WANCSF). In 2007, there were nine licences in the WANCSF. Longlining is the preferred method in the WANCSF and gillnetting was historically the preferred method in the JANSF (there has been limited activity in this fishery since 2001). The primary target species of longliners operating in the Gascoyne, Pilbara and south-western Kimberley regions of the WANCSF was sandbar shark (*Carcharinus plumbeus*). The primary component of gillnet catches in the northern Kimberley was historically a suite of whaler sharks, collectively referred to as 'blacktip sharks' that was mainly comprised of the common blacktip (*Carcharhinus limbatus*), Australian blacktip (*Carcharhinus tilstoni*) and spot-tail shark (*Carcharhinus sorrah*). A variety of

[9] The QLD N3 and N9 sectors are further described in Appendix D – Queensland.

other species have also been caught in varying amounts, including other whaler species and hammerhead sharks.

Demersal longline effort in the WA northern shark fisheries increased by nearly 500 per cent from 2000–01 to 2004–05. Concurrent research revealed that sandbar shark fishing mortality became increasingly unsustainable during that period (McAuley et al. 2005, 2007) and sustainability risks to several other shark catch components were unacceptably high (Salini et al. 2007). In response to this research, a large portion of the WANCSF was closed and fishing effort in the remaining area of the fisheries was limited in 2005. As a consequence, there has been little effort in either fishery since 2004–05.

The two target shark fisheries in temperate waters of WA are the Joint Authority Southern Demersal Gillnet and Demersal Longline Fishery (JASDGDLF) and the West Coast Demersal Gillnet and Demersal Longline Fishery (WCDGDLF). In 2005–06, there were 57 licences in the JASDGDLF and 26 licences in the WCDGDLF (although on average there have only been 30 active vessels in the JASDGDLF and 13 in the WCDGDLF). Reported landings from these fisheries are dominated by four species: gummy shark, 'bronze whaler' (primarily dusky whaler, *Carcharhinus obscurus*), sandbar shark and whiskery shark (*Furgaleus macki*). From 1996–97 to 2005–06, the catch of these four species ranged from 77 per cent to 83 per cent of the fisheries' annual shark catches. The temperate WA target shark fisheries have been managed since 1988 through limited entry, unitised input (effort) controls and gear restrictions. Species-specific stock assessments have been conducted for the fisheries' four key target stocks and these have provided the basis for ongoing revision of management arrangements. A package of new management measures, including introduction of a more explicit effort control system, a seasonal closure to promote whiskery shark stock recovery, Vessel Monitoring System (VMS), longline gear restrictions and a maximum size limit for dusky whalers, was agreed for these fisheries in 2006.

From 2000–01 to 2005–06, the catch of shark in WA ranged from about 1424 t in 2000–01 to a peak of about 2799 t in 2004–05. Shark catch in the temperate demersal shark fisheries was relatively stable, ranging from about 1136 t to about 1439 t. In contrast, the Western Australia northern shark fisheries (WANCSF and JANSF) showed an increase in the catch of shark up until 2004–05. The reported catch of shark in the northern shark fisheries ranged from about 288 t in 2000–01 to 1294 t in 2004–05, before declining to 189 t in 2005–06 as a result of management intervention. The state-wide reduction in shark catch in 2005–06 is attributable to the changes in the northern fisheries management arrangements.

South Australia

Refer to Appendix F for detailed information on South Australian-managed fisheries. Three SA fisheries are entitled to land shark species. These fisheries are the Marine Scalefish Fishery (MSF), the Lakes and Coorong Fishery and the Rock Lobster Fishery (northern and southern zones), which have access to the MSF species and can fish for scalefish or sharks out of season. In 2006, there were 337 licences in the MSF, 37 licences in the Lakes and Coorong Fishery and 249 licences in the Rock Lobster Fishery.

The catch of sharks in these fisheries is dominated by bronze whaler and dusky whaler. In these fisheries sharks are caught by gillnets, longlines, drop lines or hand lines. Licences can carry endorsements for a range of different gear types. All shark species (with the exception of the protected white shark (*Carcharodon carcharias*) and gummy and school shark that are managed according to OCS arrangements) are permitted to be caught by licence holders, however, the

majority are considered to be low value species when compared with target scalefish species such as snapper (*Pagrus auratus*), so there is little incentive to target shark species.

The catch of shark in SA ranged from 340 t in 2000–01 to 150 t in 2005–06. The average annual catch of shark for this period was 213 t. While gummy shark historically dominated catch records from 1996 to 1999, 'whaler' shark has since become the dominant catch category. The decrease in total shark catch and the shift to 'whaler' sharks can be attributed to the introduction of OCS arrangements in 2001 that confer the management of school and gummy sharks to the Commonwealth.

The removal of school and gummy shark as target species for SA state licence holders resulted in an increase in fishing pressure on whaler sharks in the years immediately following the introduction of OCS arrangements. Catches have since returned to levels similar to those prior to 2001.

Gummy and school shark are the major shark species caught in SA waters. In order to fish for gummy and school shark in the coastal waters of SA, operators must be dual endorsed and hold quota (i.e. hold a Commonwealth SESSF Statutory Fishing Right and a state MSF or Rock Lobster licence). The internal waters of SA (the gulfs and bays) are closed to Commonwealth shark operators.

Tasmania

Refer to Appendix G for detailed information on Tasmanian-managed fisheries. In 2000, TAS entered into an OCS arrangement with the Commonwealth transferring the management of school and gummy shark to the Commonwealth. There is now only a relatively small commercial catch of these species by fishers operating inside 3 nm, not operating under a Commonwealth licence.

The shark catch in TAS ranged from 1448 t in 2000–01 to 31 t in 2005–06. The high catch in 2000–01 is presumed to be a legacy of OCS transitional arrangements. TAS retains jurisdiction over all other shark species in state waters, which are generally incidental catch. Operators under TAS state licences have a possession limit of five sharks. The Tasmanian catch of shark is now consistently less than 100 t annually (see Table 2). Gummy shark remains the dominant catch category post OCS, with elephantfish, sawsharks and seven gill shark (*Heptranchias perlo*) also prominent in catches.

Northern Territory

Refer to Appendix H for detailed information on Northern Territory-managed fisheries. The single target shark fishery in the NT is the Offshore Net and Line Fishery (ONLF). The fishery targets blacktip sharks (*Carcharhinus tilstoni, C. limbatus* and *C. sorrah*), grey mackerel (*Scomberomorus semifasciatus*) and a variety of other sharks and pelagic finfish. The composition of 'other sharks' caught in the fishery is dominated by several species from the Family Carcharhinidae (the whaler or requiem sharks), mostly *Carcharhinus* spp. and *Rhizoprionodon* spp., as well as hammerheads (Family Sphyrnidae). Pelagic gillnet is the preferred method in this fishery, although operators may also use longlines. The use of bottom set gillnets is prohibited. Sharks are caught incidentally across a range of other NT fisheries, which on average record about five per cent of the total annual NT shark catch.

In 2006, there were 108 licence holders in the ONLF. The reported annual catch of shark in the NT ranged from about 430 t in 2000–01 to 1119 t in 2004–05, declining to 705 t in 2005–06. Until

recently NT shark catch was exhibiting a strong increasing trend with catch figures rising from about 350 t in 1998–99 to the 2004–05 high. Precautionary measures were introduced in the fishery in 2005 to contain effort, which led to reduced domestic effort in both 2005 and 2006, relative to the preceding few years. Variations in catch composition largely result from variations in targeting.

Other shark catch

Beach/bather protection programs

There are two beach protection programs operating in Australia: NSW Shark Meshing (Bather Protection) Program and the QLD Shark Control Program. Bather protection programs can show a long time series of relatively standardised catches and the information gathered from these programs can contribute to assessments of trends in species abundance over time. Bather protection programs also interact with threatened, endangered and protected (TEP) shark species.

New South Wales Shark Meshing (Bather Protection) Program

The NSW Shark Meshing (Bather Protection) Program (SMP) has nets set at 51 beaches between Wollongong and Newcastle from September to April (inclusive)–the peak bathing period. The meshing and catch recording is undertaken by contractors in accordance with protocols set by the NSW Department of Primary Industries. A scientific observer program is run in conjunction with the SMP to aid in validation of the catch data. The amount of observer coverage applied in each region is variable. Contractors and/or observers record details of target and non-target species. Since 2000–01, the average annual catch was 106 sharks (excluding rays), and the largest annual catch of sharks was 142 sharks in 2002–03, followed by 137 in 2004–05 (Green et al. 2009). Hammerhead species comprised the largest portion of the catch of sharks from 2000–01 to 2005–06. Of the non-target species interactions recorded (rays, dolphins, seals, turtles and whales), rays comprised the largest portion. From 2000–01 to 2005–06, 10 per cent of sharks and 66 per cent of rays caught were released alive.

Queensland shark control program

The QLD Shark Control Program (SCP) currently covers 72 beaches in 10 regions along the QLD coast. The SCP uses nets and drumlines to ‘reduce the possibility of shark attacks in coastal waters’. The program has caught an average of 565 sharks per annum over the last five years. The dominant species/groups of sharks were tiger shark, whaler sharks and hammerhead sharks. The catch composition varies between regions. The largest catch of sharks from 2002 to 2007 was 623 in 2005.

Recreational catch

The recreational catch of sharks is not well quantified due to the inherent difficulties of monitoring recreational fisheries. However, the gamefishing sector records some data gathered through a fishing competition framework and associated tagging programs. Some jurisdictions also conduct regular creel or angler surveys where recreational fishers are interviewed to collect data on their catch (e.g. species, length, weight) and effort (e.g. time spent fishing, boat use and distance travelled to go fishing). These surveys are typically regionally specific. A number of studies have shown that recreational fishing can account for a substantial portion of the total annual catch of fish, and the number of people involved in recreational fishing is driving management agencies to direct an increasing proportion of resources to recreational fisheries issues (Henry and Lyle 2003).

Recreational fishing regulations vary between jurisdictions, but typically limits are placed on the type and amount of gear that may be used, and bag and size limits often apply for particular species

or groups of species including sharks. Recreational fishing licences for marine waters are also required in some jurisdictions (e.g. VIC, NSW). Recreationally caught species of any type cannot be sold or traded.

The National Recreational and Indigenous Fishing Survey

The *National Recreational and Indigenous Fishing Survey* was conducted between 1999 and 2001. The survey represents the first comprehensive examination of the non-commercial components of Australian fisheries at a national level. The project comprised three separate surveys, the *National Recreational Fishing Survey*, the *Indigenous Fishing Survey of Northern Australia* and the *Overseas Visitor Fishing Survey*. The *National Recreational and Indigenous Fishing Survey* (Henry and Lyle 2003) is the only national recreational fishing survey conducted to date and remains a valuable record of the catch of sharks (and rays) by the recreational sector. There are no plans to repeat the survey nationally. However, all jurisdictions undertake recreational surveys although they vary considerably in scope and frequency.

The surveys were used to calculate estimates of the level of participation, fishing effort and catch by recreational and traditional fishers. Estimates of the total number of sharks and rays caught in each of the states and territories in Australia over the period of the survey are presented in Table 3. Of the estimated 1 252 728 sharks and rays caught annually, approximately 82 per cent were returned to the water, therefore, an estimated total of 228 319 sharks and rays were harvested (i.e. kept) annually (Table 3).

Table 3. Estimated annual harvest (numbers) of sharks and rays taken by recreational fishers aged 5 years or older by state and territory (Henry and Lyle 2003).

Fishery	Harvest of sharks and rays (numbers)	Standard error
New South Wales	30 093	6 617
Victoria	89 423	20 585
Queensland	35 899	8 095
Western Australia	24 432	3 260
South Australia	30 722	8 428
Tasmania	9 808	3 917
Northern Territory	7 942	1 391
Total	**228 319**	**25 140***

***Note:** not summed.

A recent report by McLoughlin and Eliason (2008) reviewed information on cryptic mortality and the survival of sharks and rays released by recreational fishers. As per Henry and Lyle (2003), the report highlighted that the recreational catch of sharks in Australia is significant, with most sharks released, but emphasised that the total catch levels and survival rates of released sharks are highly uncertain. Most information that is available relates to scientific tagging or to commercial fisheries. National education programs have not focused on release techniques for sharks.

To improve survival rates and maximise the benefits of tag-and-release methods, research is required into tagging and handling techniques as well as education of industry and recreational fishers (McLoughlin and Eliason 2008).

Sharks and rays have been an important protein source for Indigenous Australians for many centuries. They are still caught seasonally off northern Australia (October to April) (Last and Stevens 2009). Table 4 shows the estimated annual harvest (numbers) of sharks and rays caught by Indigenous fishers, aged 5 years or older, living in communities in northern Australia by survey region. The estimated indigenous harvest of sharks and rays was highest in the NT.

Table 4. Estimated annual harvest (numbers) of sharks and rays taken by Indigenous fishers aged 5 years or older living in communities in northern Australia by survey region (Henry and Lyle 2003).

Survey region	Harvest of sharks and rays (numbers)	Standard error
Queensland	3 819	–
Western Australia	2 011	–
Northern Territory	12 464	–
Total	**18 294**	**–**

3. Markets and trade

Global shark catch

Lack and Sant (2006) report that the global catch of shark has increased by approximately 220 per cent from 1950 (241 113 t) to 2003 (627 306 t) and numerous studies have documented dramatic declines in shark abundance indices (Baum et al. 2003; Myers and Worm 2003). The greatest increase in catch appears to have occurred in the 1960s and 1970s. From 1990 to 2003, about 20 countries accounted for 80 per cent of the reported catch; Australia was not one of these countries. The catch of shark in the Pacific Ocean was identified as the highest, estimated to be 40 per cent of the global shark catch in 1990 and 38 per cent of the global shark catch in 2003. This was followed by the shark catch in the Atlantic Ocean, which fell from 36 per cent of the global shark catch in 1990 to 32 per cent in 2003. The report identifies 106 shark catch categories in the FAO shark catch data in 2003. However, only 15 per cent of the catch reported was recorded to species-level. The reliability of catch reporting to species-level is unknown.

Global shark markets

The global trade in shark products (as distinct from shark catch categories) has increased over time. Lack and Sant (2006) report that total global imports of shark products have more than doubled from 50 540 t in 1990 to 107 192 t in 2003. Similarly, global exports of shark products have increased from 42 144 t in 1990 to 86 521 t in 2003. Global import and export figures should be about the same, however, in 2003 there was approximately a 20 000 t difference. Lack and Sant (2006) use the discrepancies between these figures to highlight that there are problems with the accuracy of shark import and export data at a global scale. Table 5 presents the shark product categories recorded by the FAO as reported in Lack and Sant (2006). Note that there are no species-specific categories.

Table 5. Shark 'product' categories recorded by the FAO (Lack and Sant 2006).

Dogfish and catshark fillets fresh or chilled	Sharks fresh or chilled
Dogfish and catshark fillets frozen	Sharks dried, salted or in brine
Dogfish fresh or chilled	Sharks frozen
Dogfish frozen	Sharks, rays etc., dried, salted or in brine
Shark fillets fresh or chilled	Sharks, rays or chimaeras fillets fresh or chilled
Shark fillets frozen	Sharks, rays or chimaeras fillets frozen
Shark fins dried and salted	Sharks, rays or chimaeras frozen
Shark fins dried and unsalted	Sharks, rays or skates fresh or chilled
Shark liver oil	Skates fresh or chilled
Shark oil	Skates frozen

Australian markets

Almost all shark landed in Australia is used for domestic consumption, much of it sold in Victoria under the marketing name of 'flake' (Last and Stevens 2009). In some fisheries, only the meat is retained while the rest of the animal is discarded, in other fisheries, only the fins, or liver or skin are retained; few fisheries utilise all parts of the animals (Walker 1999). Squalene extracted from shark livers, particularly from deepwater sharks, is exported and has many commercial applications. It is used as a fine grade machine oil in high-technology industries, as a skin rejuvenator in the cosmetics industries, and for pharmaceutical products requiring a non-oily base (Walker 1999). Several jurisdictions have noted an increase in the harvest of some sharks, principally for their fins, to take advantage of Asian export markets. Shark fins are considered an aphrodisiac in parts of Asia, and shark fin soup has been regarded as a delicacy by the Chinese for more than 2000 years (Walker 1999).

The Australian Bureau of Agricultural and Resource Economics (ABARE) produce an annual Australian fisheries statistics report detailing historical trends in Australian fisheries. The reports contain data on the volume and value of production from state and Commonwealth fisheries and on the volume and value of Australian fisheries trade by destination, source and product. Shark catch is broadly covered in these reports.

Catch data for Commonwealth fisheries are provided to ABARE by AFMA. The data are derived from either logbook data (catch data recorded by operators, generally at sea) or catch disposal records (catch data recorded in port by fishers and fish receivers/buyers). Catch disposal record data, if available, are the preferred source as it is weighed and can be verified with processor records and is therefore more accurate than estimated weights provided in logbooks.

The value of catch for Commonwealth fisheries is estimated by ABARE by multiplying a total catch figure for a given year by an estimated average beach price[10] for each species group. In many Australian fisheries, sharks are landed trunked (the head and tail are removed) and this is reflected in the market price data as a price per trunked kilogram. For Commonwealth fisheries, ABARE applies a general whole weight conversion factor to the price information to account for this; the estimated prices are then used to estimate Gross Value of Production (GVP). The methods used to obtain catch and value data for state and territory-managed fisheries are similar to those used for Commonwealth fisheries, although the state/territory management authorities provide the price estimates and the estimated value of the catch to ABARE.

Trade (export and import) data

Fisheries trade data are sourced from the Australian Bureau of Statistics (ABS) and are derived using the harmonised system of tariff codes, which forms the basis for administering Australia's imports and exports and the collection and dissemination of detailed international trade statistics (Australian Bureau of Statistics 2006). ABARE collates and summarises ABS data into, for example product, export destination and origin of import categories.

[10] The beach price is the price received for fish at its first landing point, excluding payments for freight, marketing and processing. In order to estimate these prices, ABARE contact operators, processors and other industry members to collect a sample of price estimates. From this sample, an average annual price is estimated and used to calculate a gross value of catch for each ABARE shark catch category (Vieira, S. pers. comm. 2008).

There is some concern that the information that is currently collected on the trade in shark products is too open to misinterpretation, making it of limited value for management purposes. Reports on trade in the current product categories mask some of the trends in the most popular exported and imported shark products such as shark trunk pieces, shark fin and shark liver oil. Both the ABS and ABARE aggregate some shark product data into broad, generalised categories. For example, there is no specific category for shark liver oil. Instead, imports of shark liver oil may be classified under a more generic category such as 'fish-liver oils and their fractions'.

Market and trade data has the potential to provide valuable information about the sustainability and economic status of fisheries. It can be used to help identify market influences on catches and assist in decisions about the need for management measures. Market and trade data also have the potential to be used as indicators of changes in the availability of popular species. There is also a range of international and domestic reporting obligations to consider that rely on the collection and summary of market and trade data.

The value of Australian shark catch

From 2000–01 to 2006–07, the value of Australian shark catch has varied markedly. The value of catch peaked in 2004–05 at approximately $48 m. The value of catch has since declined, with a decline in catch and price, to a value of approximately $31 m in 2006–07. The decline in 2006–07 is thought to be attributable to reductions in overall catch, rising fuel price at the time, fluctuations in the Australian dollar, and low prices for some shark products.

The highest individual unit value recorded by ABARE for a shark product over the reporting period was for shark fin at $130 per kg in 2000–01. The market price of shark fin is dependent upon the source species, state of processing and market demand (Clarke 2004). Anecdotal reports from NSW suggest in recent years the beach price for shark fin has ranged from $100 to $250 per kg. Reports from QLD suggest that 'white fin' from guitarfish and sawfish fetch much higher prices than shark fin commonly derived from other species (e.g. whalers).

Exported product

The Australian Quarantine and Inspection Service (AQIS) and ABARE hold data on exports. There is a substantial difference between the quantity of export product identified as shark product by ABARE and AQIS. This is likely due to shark products being attributed to more generic export product catergories.

The Australian Quarantine and Inspection Service (AQIS) houses export data on behalf of the Australian Government. These data are based on export documentation. Shark product export categories as of October 2007 are presented in

Table **6**. Exported products are allocated product codes to help differentiate their origin (e.g. SH for shark) and records typically also include some information on the state of processing or a product descriptor (e.g. 'angel shark gutted').

The total weight of exported shark product recorded in the AQIS Export Documentation system (EXDOC) database from 30 September 2006 to 31 October 2007[11] was approximately 569 t. Products attributed to the category 'shark trunk pieces' (~260 t) were the most popular products

[11] The AQIS EXDOC database houses data for a rolling 13 month period. Data older than the most recent 13 months is transferred to another database. However, once data are transferred they are more difficult to access. As a consequence, further analysis of these data was outside the scope of this report.

exported (by weight), followed by ‘shark fin’ (~121 t), ‘dried shark fin’ (~63 t) and ‘shark liver oil’ (~53 t) (see Figure 2).

Table 6. Shark export products recorded in the AQIS EXDOC database for the period 30 September 2006 to 31 October 2007.

Angel shark gutted	Sawshark headed and gutted
Angel shark headed and gutted	Shark barrels
Canned shark fin in seasoning	Shark cartilage powder
Dried shark cartilage powder	Shark fillets
Dried shark fin	Shark fins
Ghost shark head off gutted and tailed	Shark headed and gutted
Ghost shark skin off fillets	Shark liver oil
Ghost shark skin off fillets - block	Shark trunk pieces
Gummy shark skin off fillets	Squalene

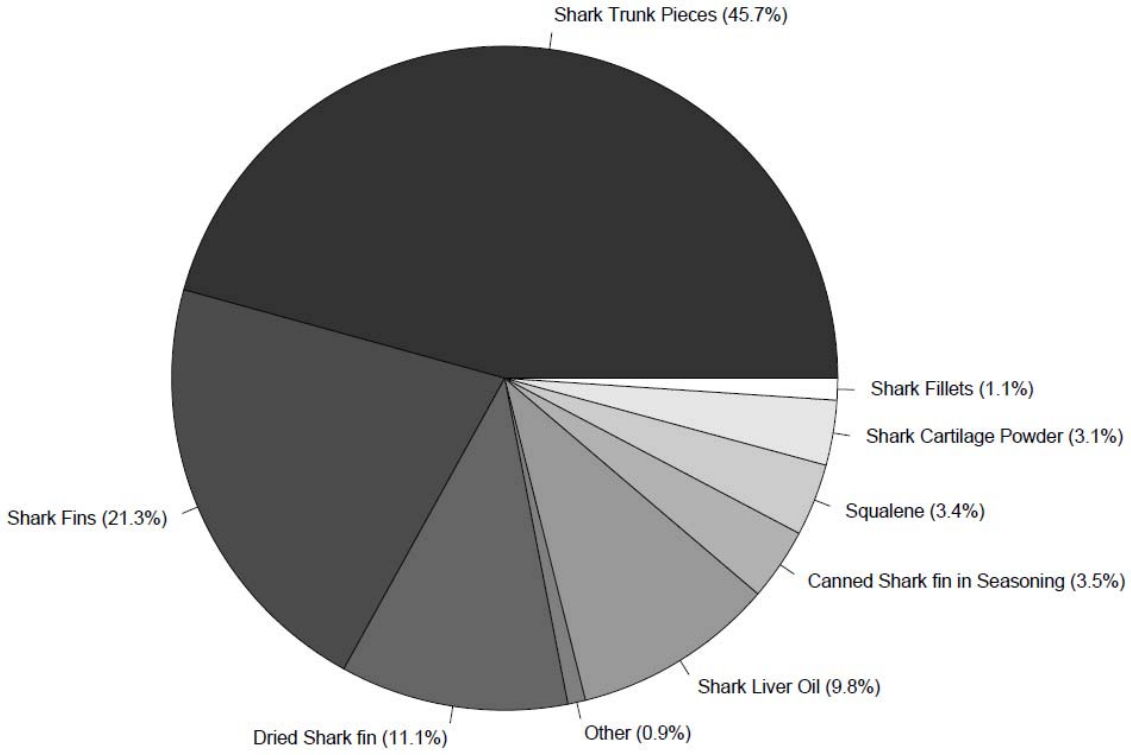

Figure 2. Product categories for exported Australian shark products (30 September 2006 to 31 October 2007; Source: AQIS 2008).

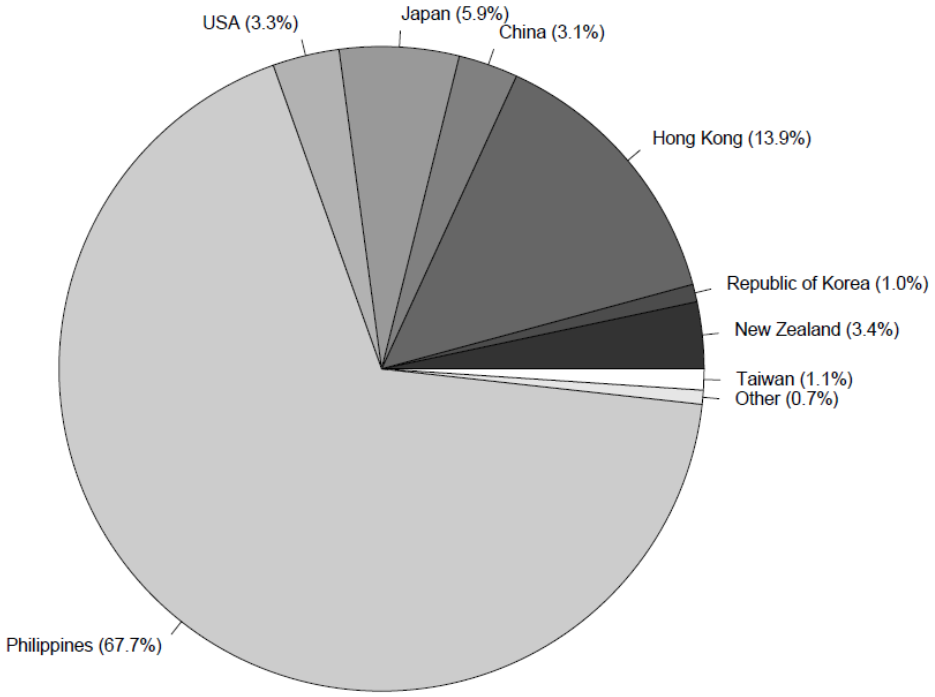

Figure 3. Export destination for Australian shark product (30 September 2006 to 31 October 2007; Source: AQIS 2008)**.**

The largest export destination over the period was the Philippines (385 t; Figure 3). All recorded exports of 'Shark trunk pieces' were exported to the Philippines, with the majority of this product leaving via Darwin[12]. 'Dried shark fin' and 'shark fins' were also important product categories exported to the Philippines. Hong Kong was the next most popular destination for exported shark product and received approximately 79 t of product. The most frequently exported products to Hong Kong were 'dried shark fin' followed by 'canned shark fin in seasoning'. The majority of 'shark liver oil' was shipped to Japan, China and the United States.

The annual total value of shark product exports from 1996–97 to 2006–07, as recorded by ABARE, ranged from approximately $2 300 to $142 000. The annual total quantity of shark products exported for the same period ranged from 0.2 t to 69 t.

There are only two explicit shark product export categories reported by ABARE:

- dogfish and other sharks, fresh or chilled (excl. fish fillets, other fish meat, livers and roe)
- dogfish and other sharks, frozen (excl. fish fillets, other fish meat, livers and roe).

These two categories only include whole shark, although it is presumed that in practice this refers to trunked carcasses. Therefore, shark products subject to further processing are not being identified as shark products, but are being attributed to more generic categories (e.g. fish oil).

There is a substantial difference between the quantity of export product identified as shark product for similar periods in the ABARE and AQIS data sets. For example in 2006–07, the quantity of

[12] Note: the point of export for a product is not indicative of its point of extraction or port of landing.

export product identified as shark product by ABARE was approximately 23 t. The figure derived from the AQIS dataset for the 13 month period (30–09–2006 to 31–10–2007) was 569 t, more than 500 t greater than the amount recorded by ABARE. The difference in these amounts raises some questions over the representativeness of the ABARE shark product categories. The much lower ABARE figure is most likely attributable to shark products being attributed to more generic export product categories. This coarse analysis indicates a review of the use and relevance of shark product export categories may be necessary.

Imported product

From 1996–97 to 2005–06 the quantity of imported shark product recorded by ABARE has ranged from 108 t in 1996–97 to 746 t in 2000–01, although this estimate is potentially constrained by the issues discussed above for exported product. The shark product classifications reported are:

- dogfish and other sharks, fresh or chilled (excl. fish fillets and other fish meat)
- dogfish and other sharks, frozen (excl. fish fillets and other fish meat)
- dried shark fins (excl. smoked).

Over the period 1996–97 to 2005–06, ‘dogfish and other sharks, fresh or chilled (excl. fish fillets and other fish meat)’ was the dominant category (by weight) followed by ‘dogfish and other sharks, frozen (excl. fish fillets and other fish meat)’.

In the late 1990s, the value of shark imports was dominated by ‘dried shark fins (excl. smoked)’; dominance switched back and forth between ‘dried shark fins (excl. smoked)’ and ‘dogfish and other sharks, fresh or chilled (excl. fish fillets and other fish meat)’ between 2000–01 to 2003–04, with ‘dogfish and other sharks, fresh or chilled (excl. fish fillets and other fish meat)’ the dominant category in 2005–06.

The total value of imported shark product has ranged from a low of $2.12 million in 1996–97 to a high of $6.99 million in 2000–01, declining to $3.99 million in 2005–06.

4. Data collection, analysis and research

All Australian commercial fisheries that catch shark employ some form of mandatory logbook system to record commercial catch and effort information. The level of information required in logbooks varies between fisheries and jurisdictions. In the case of target shark fisheries, logbooks usually provide for the recording of catch and effort information at a species or species-group level. Catch disposal records may also be used to verify catch and to support stock assessments and quota monitoring. The catch recording requirements in target and non-target shark fisheries can be highly variable and discards are often not recorded.

Stock assessment processes are typically overseen by expert-based and fishery-specific resource assessment groups. In Commonwealth-managed fisheries, this role is undertaken by advisory groups/bodies such as the SESSF Shark Resource Assessment Group (SharkRAG). Other jurisdictions have a mix of research and management groups to provide assessment-related advice on fisheries. These include the use of a regular resource assessment workshop in NSW, management advisory committees and technical/scientific advisory committees in QLD, and the WA Demersal Net and Hook Fisheries Management Advisory Committee, which provides advice on the WA southern and northern shark fisheries. In addition the Northern Australian Fisheries Committee (NAFC) and its subgroup, the Northern Management and Science Working Group (NMSWG), provides a forum for coordination of fisheries research and management issues for shared shark stocks across jurisdictions in northern Australia.

A number of jurisdictions use observer programs and scientific research to gather additional data and validate logbook information. The use of Vessel Monitoring Systems (VMS) is mandated in all Commonwealth fisheries and a specific observer program, the Integrated Scientific Monitoring Program (ISMP), monitors catches in the SESSF. However, the ISMP concentrates on discards of quota-managed species and does not seek to verify the catch of target species. The objectives of the ISMP program are currently under review. The Commonwealth also has observer programs in operation in a number of other fisheries, with the objective of validating logbook catch and effort data, including interactions with Threatened, Endangered and Protected (TEP) species. A number of other jurisdictions have observer and other programs aimed at collecting and/or validating catch and effort data for both target and non-target species. For example, NT runs a collaborative shark tagging program with commercial fishers and QLD uses Species of Conservation Interest logbooks. Observer programs provide valuable information, however, observer programs are not part of routine monitoring for many fisheries, nor are they necessarily designed to capture shark catch data accurately, particularly data on unwanted catch and other bycatch.

The degree to which shark catch data are recorded and validated is dependent on the fishery and objectives of any monitoring programs in place. It should not be assumed that observer programs monitor shark catch as a matter of course. Improved catch data in recent years has been important in enabling a better understanding of shark catch in Australia. However, the need for the collection of species-specific catch and bycatch data and improved data validation processes is an issue in many jurisdictions.

Data processing, storage and accessibility

All jurisdictions store commercial catch data in computer databases that allow efficient use of the information by the management agency while maintaining the security and privacy of commercial information. However, there are differences in the data collected, data management and storage facilities, as well as different methods for data entry, quality control and analyses. The

inconsistency in data protocols makes national reporting and reporting across the jurisdictions difficult. A number of jurisdictions produce public data summaries of catch and effort information.

In most fisheries, paper-based logbook returns are the principal data recording method. There are initiatives in some jurisdictions to implement electronic logbooks. The electronic submission of data can reduce the costs of data acquisition and enable real time catch reporting. To improve access to information, internet-based tools for accessing catch and effort data have been trialled in QLD fisheries and at a national level a prototype is initially being developed as part of a BRS and the Australian Fisheries Management Forum Fisheries Statistics Working Group (FSWG) project to construct a national Australian Fisheries Information System.

Reference points

Table 7. Reference points used by each jurisdiction in determining catch levels and managing shark catch.

Jurisdiction	Reference points
Commonwealth	Since 2008 fisheries are required to be managed in accordance with the HSP. A key objective of the policy is to achieve long-term maximum economic yield for fisheries, while maintaining stocks at safe and productive levels. In the SESSF, reference points have been set for school shark, gummy shark, sawshark (*Pristiophorus nudipinnis* and *P. cirratus*) and elephantfish. Note: the policy only applies to key commercial species[13].
NSW	Relative catch rates are used as the main indicator of stock status, together with an assessment of the relevant biological factors for the species. This qualitative system uses the concept of a 'reference direction', where the direction towards a desirable stock status (e.g. recovery) is identified, rather than quantitative reference points.
QLD	The determination of species-specific biological reference points will rely heavily on fishery data obtained in the coming years. In the interim, a precautionary total allowable catch of 600 tonnes applies to the commercial fishery (all shark species) and those species identified as having higher risk status have incidental catch and possession limits. Additional performance measures are specified in a Performance Measurement System for the ECIFFF.
VIC	No specific biological objectives, performance indicators or reference points are set for state fisheries as these are considered too small to justify the development of formal harvest strategies.
WA	Biomass reference points of 40% of virgin biomass have been set for gummy shark, whiskery shark and dusky whaler. The tools used to monitor stock performance include empirically measured age-specific fishing mortality rates, population growth rates, catch and effort triggers and monitoring of CPUE trends.
SA	General performance indicators with limit reference points are set for 'whaler' sharks and a grouped category of rays and skates (associated with catch and effort). These are reported in the annual MSF stock status report. No formal stock assessment has been undertaken on these species.
TAS	No formal stock assessments or management reference points in use for fisheries that catch shark.
NT	Management trigger reference points have been introduced for the combined blacktip shark species complex and byproduct shark species. Shark stock assessments are conducted every three years.

[13] The HSP defines a key commercial species as 'a species that is, or has been, specifically targeted and is, or has been, a significant component of a fishery.

Each jurisdiction uses different reference points to manage targeted shark fisheries. Depending on the objective of the reference points they maybe based on management targets (e.g. catch, effort, CPUE) or biological targets (e.g. biomass). The reference points currently used or being developed by each jurisdiction are described in Table 7.

Measures of stock abundance

Fisheries agencies in Australia invest significant resources in fisheries research, however, quantitative stock assessments are typically only conducted for the more valuable species or species seen to be at higher risk. A lack of focus on data collection for sharks in the past currently limits the scope for quantitative assessments for the majority of shark species caught.

Commonwealth-managed stocks

The most extensively researched shark stocks harvested in Commonwealth-managed fisheries are the school shark and gummy shark. Management changes in recent years have led to difficulties in interpreting catch and effort trends and surveys have been initiated to provide fishery-independent data on school and gummy shark abundance. These surveys will provide additional data on byproduct and bycatch composition and rates, as well as better inform school and gummy shark stock assessments and ultimately management decisions. The surveys will also enable comparison with data from previous shark surveys undertaken during 1973–76, 1986–87 and 1998–2001. The status of the two other prominent species groups harvested in the GHAT, sawsharks and elephantfish, is poorly understood and assessments to date are considered preliminary.

There is a lack of formal assessments of shark species harvested in the Coral Sea Fishery, some of which are targeted, and in the tuna longline fisheries which can catch large numbers of sharks as byproduct or bycatch. Assessments of pelagic shark stocks harvested in the tuna fisheries also need to account for the impacts of fishing that occurs beyond the AFZ on straddling and highly migratory stocks in the Pacific and Indian Oceans.

School shark

A 2006 update of the 2001 school shark stock assessment (incorporating 2000–2005 data) provided no evidence of an increase in the abundance of school shark since 2000, yet there is some evidence that the biomass and pup production have stabilised. The level of pup production is used as a reference point and is estimated to be below 20 per cent of the pre-fishing (1927) level. Surveys were initiated in 2007 to monitor the recovery of the stock. The results of these surveys will be crucial as there is considerable uncertainty about how representative logbook derived CPUE data is of stock abundance since the 2001 introduction of quotas and subsequent changes in targeting. School shark has been listed as conservation dependent under the *EPBC Act*, and is subject to a stock rebuilding strategy that precludes targeted fishing for this species.

Gummy shark

Indications are that gummy shark recruitment to the fishery has been relatively stable for more than 20 years, despite marked changes in levels of fishing effort. A 2006 assessment indicated that pup production in 2005 was well above 48 per cent of the 1927 level in TAS (when fishing is assumed to have commenced), between 40 per cent and 48 per cent in Bass Strait, and below 40 per cent in SA. The Recommended Biological Catch (RBC) from this assessment is calculated using simulations of future catch scenarios that comply with the harvest strategy for the fishery.

Sawsharks

An initial assessment of sawsharks was conducted in 2004 and suggested pup production was about 30 per cent of the 1950 level, however, the SharkRAG considers the level of uncertainty in this

assessment too great to be used in providing RBCs. Catch per Unit Effort (CPUE) trends are the major source of information on abundance, though interpretation of these is complicated as the two species of sawshark are not differentiated in catch records and are managed under a combined quota. There is also a lack of data on length and age composition and discarding rates of historical catches.

Elephantfish

An initial assessment of elephantfish was conducted in 2004 and suggested that pup production was about 20 per cent of the 1950 level. Similar to the sawshark assessment, the SharkRAG considers the level of uncertainty in this assessment to be too high to provide an RBC and has instead used trends in catch rates as an indicator of stock status. There is also a lack of data on length and age compositions of historical catches for elephantfish and reported catches are likely to be underestimated because of large catches by recreational fishers and discarding of elephantfish by commercial fishers owing to its low price.

State/territory-managed stocks

To date, stock assessment efforts in state/territory managed fisheries have focused on target species.

Northern Australian blacktip shark

A collaborative approach is being taken between QLD, NT and WA to ensure that an appropriate assessment is undertaken on the shared blacktip stock (three species: common blacktip, Australian blacktip and spot-tail shark). The assessment is likely to build upon the tagging program currently being trialled in the NT through Charles Darwin University. A stock assessment for blacktip sharks in northern Australia was developed in the mid–1990s and has been updated with recent data. However, due to uncertainty in the CPUE time series and biological parameters on which the model is based, the model's outputs may not be sufficiently reliable for setting fishery management reference points.

Western Australian gummy shark

The WA component of the gummy shark stock is assessed and monitored through a combination of biomass estimates and trends in 'effective' CPUE. Stock status is currently inferred from recent CPUE trends relative to a 1997–98 biomass estimate (42.7 per cent of virgin biomass). Upward trends in CPUE since 1997–98 suggest increased abundance.

Western Australian whiskery shark

The biomass of whiskery shark is estimated every one to three years as dependent on financial resources and staff availability. This is done using an age-structured model and a time series of 'effective' demersal gillnet CPUE taken from the area of the fishery that overlaps the stock's primary distribution. Additional information on the size-frequency of whiskery shark catches, derived from research sampling, assists in interpretation of model results, however recent size composition data have yet to be formally incorporated into the model. The most recent (2007) assessment suggests that total biomass in 2005–06 was 38.3 per cent of its unfished level but had increased by an average of 3.4 per cent per year over each of the previous two years.

Western Australian dusky whaler and sandbar shark

The available CPUE time series for the long-lived dusky whaler and sandbar shark stocks are currently too short for developing dynamic age-structured models and therefore biomass (stock abundance) cannot be reliably estimated. These stocks have therefore been assessed using empirical estimates of fishing mortality rates (from tagging) to determine point estimates of

population growth rates from stochastic demographic analysis models. Recent assessments of stock status have relied on analyses of effective demersal gillnet CPUE trends (relative to demographic model results) from 28° S on the mid-west coast to 120° E on the south coast for dusky whaler shark and from 26° S to 118° E for sandbar shark.

Sandbar sharks were used as the indicator species for the general status of shark stocks caught in the WA tropical shark fishery prior to 2005 with commercial and fishery independent CPUE trends for a number of other species also monitored. However, as the fishery has since been excluded from most of the sandbar shark stock's known range, this species is no longer an appropriate indicator for the general status of the fishery.

Although targeted demersal gillnet catches primarily of neonate dusky whalers have previously been assessed as sustainable, model results and subsequent CPUE trends suggest that unreported catches of older sharks have caused a gradual decline in stock recruitment over the last 15 years. Demographic modelling also suggested that combined levels of sandbar shark fishing mortality became increasingly unsustainable between 2001 and 2004. Although fishery-independent survey data indicate that breeding stock biomass may have declined by 58 per cent between 2002 and 2005, the full extent of reductions in stock recruitment may not become evident in gillnet catches of 3–10 year old fish for several years.

Australian shark research

This section provides examples of conservation and management research projects relevant to sharks currently underway or that have been undertaken since 2001. The information is presented by jurisdiction. The lists are not comprehensive–they are intended to illustrate the breadth of relevant research conducted in recent years and to assist in identifying additional sources of information that may contribute to a review of the NPOA-Sharks.

Commonwealth

In recent years the Commonwealth, States and Northern Territory have supported research into protected shark species with the guidance of the National Shark Recovery Group (NSRG). Priority work has focused on undertaking research to support the Recovery Plans for protected shark species. Additional funding has been provided by AFMA and the Fisheries Research and Development Corporation (FRDC), as well as the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and other State, Northern Territory and Commonwealth agencies.

Examples of projects include:

- assessing extinction risk, threat assessment and priority management actions for the east coast population of greynurse shark
- developing a population estimate protocol and undertaking a study to provide estimated east coast population numbers for greynurse shark
- determining population size and structure of greynurse shark in east and west Australia
- determining spatial dynamics and habitat preferences of juvenile white shark
- assessing migration patterns and population status of whale shark at Ningaloo reef
- assessing traditional ecological knowledge of whale shark in eastern Indonesia
- determining effective size and intra-species relationships of Gulf of Carpentaria populations of freshwater sawfish (*Pristis microdon)*
- determining spatial distribution and habitat utilisation of sawfish in relation to fishing in northern Australia

- determining habitat associations of freshwater sawfish and northern river shark in the Kimberley
- determining distribution and abundance of *Glyphis* spp. in northern Australia and their potential interactions with commercial fisheries
- furthering identification and genetics of Australian *Glyphis* spp.
- developing options for fisheries managers to mitigate chondrichthyan bycatch through the Chondrichthyan Technical Working Group
- habitat mapping in the Great Australian Bight; this research should identify critical habitats and provide insight into action required to minimise threats to both sharks and habitats
- a project which aims to developing national guidelines to improve the application of risk-based methods with regard to stock assessments for data-poor species
- Ecological Risk Assessments (ERAs) have been conducted in all Commonwealth fisheries to identify high-risk species on which to formulate priorities and associated management responses. The results of the assessments are being integrated into ecological risk management frameworks being developed by AFMA
- review of information on cryptic mortality and the survival of sharks and rays released by recreational fishers
- information to support management options for upper–slope gulper sharks (including Harrisson's dogfish and southern dogfish)
- a southern shark survey, conducted in 2007–08, was designed to provide a fishery-independent survey of school and gummy shark stocks which will be used in shark stock assessments. The results will provide indices of population abundance of target, byproduct and bycatch species adjusted for effects of gillnet selectivity, as well as indices of fishery-wildlife interactions which can be compared with indices from previous shark surveys
- CSIRO is currently undertaking research that involves acoustically tagging sharks (family Centrophoridae) in the gulper shark closed areas of the Great Australian Bight Trawl and Scalefish Hook sectors (R. Daley pers. comm.). A network of 24 moored acoustic receivers will monitor the movements of the tagged gulper sharks for the next three years.

New South Wales

Concern over the conservation and management of sharks has seen an increase in shark research in NSW in recent years, including, but not limited to:

- investigating how greynurse sharks approach baits and lures used by recreational fishers to develop suitable techniques and/or gear that will reduce bycatch
- examining the reproduction of greynurse sharks in an attempt to develop useful measures to enhance their reproductive potential, assisting in the conservation of this species
- investigating the potential role of captive-bred animals in replenishing populations of wobbegong sharks by acoustic tagging and releasing captive-born wobbegongs into the Cabbage Tree Aquatic Reserve
- tagging and tracking juvenile dusky whalers to better understand their movements and responses to changes in environmental conditions
- tagging and tracking movements of four bull sharks (*Carcharhinus leucas*) within estuaries and along the coast in the northern rivers region
- tagging and tracking sandbar shark to better understand its biology, abundance and distribution; information obtained from this study will assist in developing strategies for the sustainable management of this species
- investigating shovelnose ray reproductive biology to ensure it is sustainably harvested.

Queensland

Current research includes:

- investigating the species diversity of sharks in the Great Barrier Reef and their interaction with the east coast net fishery
- a project looking at investigating the stock structure of blacktip, scalloped hammerhead and milk shark (*Rhizoprionodon acutus*)
- a project investigating the diversity of carcharhinids in Moreton Bay
- a fisheries-independent assessment of shark stocks in far north Queensland using Queensland Shark Control Program data
- spatial ecology of inshore sharks.

In addition, recent studies have reported on the interaction of reef sharks with the Coral Reef Fin Fish Fishery and the abundance of reef sharks on the Great Barrier Reef (Robbins et al. 2006; Ayling and Choat 2008; Heupel et al. 2008).

Western Australia

In addition to ongoing stock assessment and fishery monitoring activities, research completed or commenced in Western Australia since the 2001SAR includes:

- Life history parameter estimation (age, growth, reproductive and natural mortality rates) for Western Australian dusky and sandbar shark stocks
- Estimation of dusky and sandbar shark fishing mortality rates from tag recaptures
- Development of stochastic demographic analysis techniques for assessing long-lived shark stocks
- Determination of sandbar shark gillnet mesh selectivity parameters
- Further evaluation of targeted shark catch composition in the temperate demersal gillnet and northern shark fisheries
- Evaluation of non-targeted shark catch composition in the Pilbara Fish Trawl, Kimberley Gillnet and Barramundi, Eighty Mile Beach gillnet and Commonwealth Southern and Western Tuna and Billfish Fisheries through scientific research and observer programs
- Development of a forensic DNA database and sampling protocols for compliance and management of Western Australian sharks
- Investigations of Western Australian greynurse shark movements (PAT-tagging) and aggregation site locations (visual surveys)
- Acoustic telemetry studies of sawfish movements and habitat use in the Fitzroy river and marine waters of the Pilbara and Kimberley regions
- Genetic population structure of sawfish
- Ecology of tiger sharks in Shark Bay
- Life histories and ecology of the southern fiddler ray (*Trygonorrhina dumerilii*), Port Jackson shark (*Heterodontus portusjacksoni*), Australian angel shark (*Squatina australis*), southern eagle ray (*Myliobatus australis*) and the western shovelnose ray (*Aptychotrema vincentiana*)
- Distribution, abundance and habitat associations of elasmobranchs in Ningaloo Marine Park
- Reef shark movements and ecology in Ningaloo Marine Park
- Whale shark distribution, movements and ecology
- Monitoring white shark movements in near-shore metropolitan Perth waters.

Northern Territory

Research that has recently been undertaken in the NT includes:

- research to improve interactions with coastal indigenous communities on fishing and related matters; this will be incorporated into an annual review of NT shark fishing and results shared with other northern Australian jurisdictions for advice
- developing a tagging protocol for monitoring the harvest rates for the principal target shark species, as well as indicator species
- a project entitled N*orthern Australian sharks and rays: the sustainability of target and bycatch species, phase II* was recently completed (Salini et al. 2007). The project has provided comprehensive data on species composition and biological characteristics of sharks and rays harvested in northern Australian fisheries, including those fisheries for which the sharks and rays are bycatch
- other projects include studies of the distribution and abundance of *Glyphis spp*., and the genetics and biology of bull sharks and pig eye sharks (*Carcharhinus amboinensis*).

NAFC and its subgroup, the NMSWG, provide a forum for coordination of fisheries research and management issues across jurisdictions in northern Australia. Over the past three years NAFC member agencies have considered the current and future requirements for research and have assisted in the development of projects to investigate the impacts of Illegal, Unreported and Unregulated (IUU) fishing.

South Australia

Research that has recently been undertaken in SA, and some projects currently being undertaken, include:

- a review of the fishery status for whaler sharks (*Carcharhinus spp*.) in south Australian and adjacent waters
- a project about prawn fishery bycatch and discards: marine ecosystem analysis – population analysis. This report includes chapters focused on sharks in Spencer Gulf
- an Australian acoustic tagging and monitoring system project
- a study on white shark biology
- a study on the population structure, movement and foraging of coastal and oceanic pelagic sharks in the southern ocean.

Other states

In TAS research is underway to assess the impact of shark management and conservation measures on ecosystem structure and function.

In VIC, more intense monitoring of the Western Port Bay recreational elephantfish fishery has commenced to provide improved data for stock assessment purposes. Estimates of total catch are not available, however, it is thought that the total annual recreational catch of elephantfish is now comparable to total annual commercial elephantfish catches from south-east Australian waters.

5. Legislation and policy

Fisheries management arrangements

All jurisdictions have specific fisheries and conservation legislation that determines fisheries management arrangements (Table 8).

Commonwealth

Responsibility for the setting of management objectives in Commonwealth shark fisheries rests with AFMA and DAFF and in the case of joint authorities, the relevant state and territory jurisdictions. In managing Commonwealth fisheries, AFMA has an obligation to develop plans and implement policy in the performance of its functions and the pursuit of its objectives. Direction is provided by the *Fisheries Management Act 1991* and *Fisheries Administration Act 1991* (www.afma.gov.au).

AFMA is implementing an overarching Ecosystem Based Fisheries Management (EBFM) approach. EBFM considers the impact fisheries have on all components of the broader marine ecosystem. This framework aims to minimise the impacts of fishing on the marine environment and ensure that wild capture fisheries remain sustainable. EBFM measures include the use of ERAs to help determine management and research priorities, and management responses for these priorities, initiatives for the appropriate management of bycatch and an increased focus on spatial management, such as the establishment of fisheries closures.

International fisheries

Australia shares responsibility for the management of fish stocks with neighbouring countries in the Asia-Pacific, Indian Ocean and Southern Ocean regions. Australia engages in international fisheries issues on a bilateral, regional and global level, in order to promote more sustainable fisheries management practices worldwide and to achieve long-term and commercially viable access to regional migratory and straddling stocks for Australian fishers.

In pursuit of these goals, DAFF develops policies and programs to address Australia's international rights and obligations, and represents Australia's interests in a number of international fora, including the Commission for the Conservation of Southern Bluefin Tuna, Indian Ocean Tuna Commission, Western and Central Pacific Fisheries Commission, Convention for the Conservation of Antarctic Living Marine Resources, FAO, CMS and CITES.

The Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act performs a number of important roles in fisheries managed by all jurisdictions. These roles include the listing and regulation of TEP species and communities, the preparation of recovery plans for TEP species, the identification of key threatening processes and, where appropriate, the development of threat abatement plans and the direction of assessment and export approval processes for all fisheries (i.e. includes state and NT fisheries) with an export component. All Commonwealth fisheries are subject to an independent assessment under the EPBC Act regardless of the export assessment requirements. These assessments help ensure that, over time, fisheries are managed in an ecologically sustainable way.

Fishing activities in the Great Barrier Reef Marine Park

Subject to meeting the requirements of the *Great Barrier Reef Marine Park Act 1975*, the OCS arrangement between the Commonwealth and QLD provides for fishing activities that occur within the Great Barrier Reef Marine Park to be managed by the QLD government. The primary objective of the *Great Barrier Reef Marine Park Act* is to provide for the long term protection and conservation of the environment, biodiversity and heritage values of the Great Barrier Reef World Heritage Area (GBRWHA). The secondary objectives include allowing multiple uses of the GBRWHA in so far that these uses are consistent with the primary objective of conservation. While fishing is not explicitly mentioned in the objectives of the Act, it is generally accepted that fishing is both a recreational and economic use.

States and Northern Territory

Responsibility for setting management objectives in state and NT fisheries rests with the relevant state and territory fisheries and/or environment agencies. Each state and the NT have complementary legislative frameworks in place (i.e. fisheries and environment legislation).

Table 8. Principal fisheries management and conservation legislation

Jurisdiction	Principal fisheries management and conservation legislation
Commonwealth	*Fisheries Management Act 1991* *Fisheries Administration Act 1991* *Torres Strait Fisheries Act 1984* *Environment Protection and Biodiversity Conservation Act 1999* *Great Barrier Reef Marine Park Act 1975*
New South Wales	*Fisheries Management Act 1994* *Environment Planning and Assessment Act 1979* *Threatened Species Conservation Act 1995*
Victoria	*Victorian Fisheries Act 1995* *Victorian Flora and Fauna Guarantee Act 1988*
Queensland	*Queensland Fisheries Act 1994* *Queensland Nature Conservation Act 1992* *Queensland Marine Parks Act 2004* *Great Barrier Reef Marine Park Act 1975*
Western Australia	*Fish Resources Management Act 1994* *Fish Resources Management Regulations 1995* *Wildlife Conservation Act 1950*
South Australia	*Fisheries Management Act 2007* *Fisheries (General) Regulations 2000* *National Parks and Wildlife Conservation Act 1975* *Marine Parks Act 2007*
Northern Territory	*Northern Territory Fisheries Act 1988* *Territory Wildlife and Conservation Act 2000*
Tasmania	*Fisheries (Scalefish) Rules 2004* *Fisheries (General and Fees) Regulations 2006* *Living Marine Resources Management Act 1995*

Fisheries policy

At the national level, the coordination of fisheries management between the Commonwealth, state and territory fisheries is facilitated through the Natural Resource Management Ministerial Council (NRMMC), and its sub-committees. Membership of the NRMMC comprises the Commonwealth, state and territory Ministers with the responsibility for fisheries and/or environment portfolios.

The Australian Fisheries Management Forum addresses national strategic fisheries management and research issues, and provides a forum for jurisdictions to share information and address issues of common concern. It has representatives from all jurisdictions' fisheries management agencies and meets quarterly.

Australia's NPOA-Sharks

The NPOA-Sharks was developed through the NRMMC process to support Australia's commitment to the IPOA-Sharks. It is designed to help fishers and managers make decisions about the long-term management and conservation of Australia's shark resources. The plan contains 43 actions divided among 6 themes:

1. Review existing conservation and management measures
2. Improve existing conservation and management measures
3. Improve data collection and handling
4. Undertake targeted research and development
5. Initiate focused education/awareness raising programs
6. Improve coordination and consultation.

Australian fishery and environmental agencies are assigned responsibilities for attributing resources and implementing relevant actions. The nature and extent of that responsibility and the priority of specific actions varies across jurisdictions and agencies.

Commonwealth

The primary policy drivers for Commonwealth fisheries are the objectives of the *Fisheries Management Act 1991* and the *Fisheries Administration Act 1991*, the Ministerial Direction issued by the then Minister for Fisheries, Forestry and Conservation on 14 December 2005, the HSP, the *Commonwealth Policy on Fisheries Bycatch* (2000) and *Australia's Oceans Policy* (1998).

The objectives set for AFMA under the *Fisheries Management Act 1991* include:

- pursuing the objectives of efficient and cost-effective fisheries management
- ensuring that the exploitation of fisheries resources and the carrying on of any related activities are conducted in a manner consistent with the principles of ecologically sustainable development (which include the exercise of the precautionary principle), in particular the need to have regard to the impact of fishing activities on non-target species
- maximising the net economic returns to the Australian community from the management of Australian fisheries
- ensuring accountability to the fishing industry and to the Australian community in the management of fisheries resources
- achieving government targets in relation to the recovery of the costs of AFMA.

Ministerial Direction

The 2005 Ministerial Direction was issued to AFMA as a consequence of the poor biological and economic status of a number of fisheries. AFMA was directed to undertake action to, among other things:

- cease overfishing and recover overfished fish stocks to levels that will ensure long term sustainability and productivity
- avoid further species from becoming overfished in the short and long term
- manage the broader environmental impacts of fishing, including on threatened species or those otherwise protected under the EPBC Act.

AFMA's response to the Ministerial Direction is detailed in the 2006 AFMA report titled 'Future Operating Environment for Commonwealth Fisheries'.

Commonwealth Fisheries Harvest Strategy Policy and Guidelines

An important component of Commonwealth fisheries management is implementation of the 2007 HSP. The policy provides a framework to manage fish stocks sustainably and profitably, to put an end to overfishing and to ensure that overfished stocks are rebuilt in reasonable timeframes.

The HSP provides a framework for the development of harvest strategies for key commercial species in Commonwealth fisheries. A harvest strategy sets out management actions that monitor, assess and control fishing intensity to achieve defined biological and economic objectives for a fishery. In doing so, harvest strategies must contain a process for monitoring and conducting assessments of the biological and economic conditions of the fishery; and rules that control the intensity of fishing activity according to the biological and economic conditions of the fishery (defined by the monitoring and assessment components of the strategy). Harvest strategies have been developed for the majority of Commonwealth fisheries, including those that catch sharks.

Commonwealth Policy on Fisheries Bycatch

The over-arching objective of the *Commonwealth Policy on Fisheries Bycatch* is 'to ensure that bycatch species and populations are maintained'. Many of the requirements of the policy are now formally integrated into fisheries management plans/arrangements and bycatch and discarding work plans are the primary tools through which AFMA outlines management actions to address bycatch issues. Sharks have been identified as significant bycatch species in many fisheries.

Australia's Oceans Policy

Australia's Oceans Policy was released in 1998 to guide the direction of the Australian Government's programs in the marine environment. The policy provides national coordination and consistency for marine planning and management, while allowing for regional diversity.

A change in policy direction by the Government in 2004 brought about significant changes to the manner in which the Oceans Policy is delivered. These changes include the Minister for the Environment taking lead responsibility for *Australia's Oceans Policy* in consultation with Ministerial colleagues where required and, in particular, the decision to bring regional planning under section 176 of the EPBC Act. Marine bioregional planning is now a statutory component of the sustainable management of Australia's marine environment at the Commonwealth level.

New South Wales

Management advisory committees (MACs) have been established for each of the State's commercial fisheries, and the MACs have assisted NSW DPI in the development of management strategies for their fisheries. Management strategies contain a number of management responses to ensure sustainable harvest of the resource, including sharks. The formulation of management responses was guided by a risk assessment framework that examined the likelihood of overharvesting, and identified aspects of the fishery to be modified to reduce the risk. Draft management responses were developed with the MACs and other stakeholders, and publicly exhibited to enable broader consultation. Some examples of the policies that were specifically implemented through that process to improve the conservation and management of sharks include: fishing area and gear restrictions, implementation of circle hooks, trip limits, capping the catch of school and gummy sharks and a scientific observer program.

Victoria

Fisheries Victoria, a division of the Department of Primary Industries (DPI), undertakes fisheries management, administration and research. Fisheries Victoria also undertakes monitoring and assessment of fisheries resources in consultation with stakeholders and in accordance with Government policy. The Minister for Agriculture receives advice on policy and strategic issues related to fishing from DPI and three recognised peak bodies: Seafood Industry Victoria; the Victorian recreational fishing peak body (VRFish); and the Victorian National Parks Association.

Although not specifically targeted at sharks, Victoria also has a number of fishery assessment groups that undertake stock/fishery/fish habitat assessments for the major fisheries.

Various other processes affect the way Victorian fisheries are managed. These include no-take marine protected areas aimed at contributing to the protection of biodiversity. VIC also participates in regional fisheries issues through participation in forums associated with the SESSF, including the Southern Shark Fishery MAC and SharkRAG.

Queensland

Shark management policies are developed in consultation with stakeholders and fisheries scientists, using a risk-based management approach. As QLD fisheries management continually moves towards an EBFM approach, the challenge is to assess the risks of each of QLD's fisheries on target, byproduct and bycatch species, in the face of at times high levels of uncertainty and using the precautionary principle as a basis for change. As further information is collected, management decisions can be made with greater certainty (e.g. using outputs from stock assessments).

The objectives of fisheries subordinate legislation are developed in consultation with stakeholders; usually through advisory committees. In regard to the GOCIFFF, policies are developed and implemented through the QLD Fisheries Joint Authority, established under an OCS between QLD and the Australian Government.

As a result of the recent review of the ECIFFF QLD has introduced a range of new management arrangements for sharks. For example, a total allowable commercial catch of 600 t has been introduced for sharks taken on the east coast, in addition to a maximum size limit of 1.5 m for shark taken by recreational and commercial fishers (other than those using nets under a shark endorsement), a possession (bag) limit of one shark for recreational fishers, and all sawfish and speartooth sharks have been listed as 'no take' species. QLD initiated the management review, developed and consulted on proposals and then those proposals were subsequently reviewed by Gunn et al (2008).

Western Australia

The management policies for WA shark stocks are generally identified from stock assessment advice provided by the Department of Fisheries Research Division. In addition, policy issues are also identified through consultation with stakeholders including MACs, industry associations, industry stakeholders, and non-government organisations. Broader national and state policy initiatives such as the EPBC Act strategic assessment process, the NPOA-Sharks, marine planning, integrated fishery management and EBFM processes also feed into the policy framework. Formal advice provided through the department's annual *State of the Fisheries* report series, fisheries research reports, project reports, unpublished report series on the status of the target shark fisheries, other research documents and publication of local research in international journal articles are also used to inform the management and policy development framework in WA.

The Western Australian Demersal Net and Hook Fisheries Management Advisory Committee is the peak body through which advice is provided to the Minister on matters relating to the management of shark fishing in WA. The Western Australian Demersal Net and Hook Industry Association also provides representative industry advice to the Department of Fisheries and acts as a forum for industry-wide dissemination of research advice and consultation in relation to setting management objectives for shark stocks in WA.

South Australia

SA applies a co-management approach under the *Fisheries Management Act 2007* and has established a Fisheries Council to support this approach and to provide advice to the Minister on the management of fisheries (commercial, recreational and traditional fishing). The Fisheries Council is expert-based and has nine members appointed by the Governor, plus the Director of Fisheries. The Council has a broad advisory role and key responsibility for the preparation and maintenance of fishery management plans. Under the new co-management framework, industry associations take on a stronger role in the provision of industry advice in relation to fisheries management issues.

The MSF management plan (in which the majority of commercial shark harvest occurs) identifies goals for the management of the fishery. However, the management plan does not set out specific objectives for the harvest of shark species, as shark make up a small component of the multi-species, multi-gear fishery.

Tasmania

In TAS, shark species other than school and gummy shark (managed by the Commonwealth under OCS) are managed by the *Fisheries (Scalefish) Rules 2004*. The Tasmanian Minister for Primary Industries and Water receives advice from Fishery Advisory Committees (FACs) for fisheries in which shark species can be caught. These are primarily the Scalefish FAC and to a lesser extent the Recreational FAC. The harvest of all shark species, except school and gummy shark, are managed as part of the Scalefish Fishery Management Plan.

TAS participates in setting objectives for fisheries that harvest sharks at state and Commonwealth levels. The Scalefish FAC includes representatives from the Tasmanian industry, research, and conservation sectors. At the Commonwealth level, TAS has three representatives (a permanent state observer and two industry members) on the GHAT Management Advisory Committee (GHATMAC), which provides advice to AFMA regarding shark matters in the SESSF.

Northern Territory

In the NT the ONLF uses regular communication and consultation between stakeholders to discuss matters of concern within the ONLF. Stakeholders involved in such discussions include the Northern ONLF Licensee Committee, the Northern Territory Seafood Council, neighbouring jurisdictions, other extractive stakeholders and wider interest groups. The Offshore Net and Line Fishery Management Advisory Committee feeds into the policy development framework, with membership comprising a wide range of stakeholder interest groups to provide expert advice to the Director of Fisheries.

In addition, the NAFC, and its sub group, the NMSWG provide a forum for coordination of fisheries research and management issues across jurisdictions in northern Australia.

Regulatory challenges

There are a range of regulatory challenges that are common across jurisdictions. For example, identification of sharks to species and in some cases group level is a problem shared by state, territory and Commonwealth fisheries. The problem is exacerbated as most retained sharks undergo some degree of processing at sea and compliance work at sea is logistically difficult. This has a bearing on the ability of processors, compliance officers and researchers to accurately identify sharks and record catch numbers and weights of landed product.

Management tools used to ensure fisheries management arrangements are adhered to include inspections by fisheries compliance officers of both commercial and recreational fishers, catch and landing reporting systems for quota managed fisheries and the use of risk assessments to target compliance programs.

A recent report into crime in Australia's domestic fisheries identified that shark is perceived as one of three priority species groups in Australia identified as attractive to international illegal markets (Putt and Nelson 2008). Heavy fishing pressure in Indonesian waters has also made fishing in the AFZ increasingly attractive. Illegal foreign fishing activity in northern Australian waters appeared to be showing an increasing trend until the Australian Government intervened with an IUU Task Force in 2003. The response led to a major increase in the level of surveillance and policing. Shark fin is a major target for many of the apprehended vessels because of its high value and ease of storage. Significant reductions in IUU fishing in Australia's northern waters have been reported annually since 2006. Research is underway to examine the fishing effort by illegal fishers and the species composition of confiscated catches (McLoughlin 2008).

Shark finning is banned in Commonwealth waters and similar arrangements exist in state and territory fisheries. Measures are also in place to encourage the full utilisation of landed sharks. However, due to the high value of some shark fins, illegal finning at sea remains a concern in some fisheries. This is despite the introduction of more stringent finning restrictions since 2001.

In 2001, Rose and McLoughlin conducted a review of shark finning in Australian fisheries and found the finning of shark is poorly documented and estimates are likely to be incorrectly viewed as indicative of the scale of the issue. The reports of increases in shark finning activity and the general problems with shark data found during this review indicates that in domestic fisheries there is still likely to be a level of unreported and illegal harvest of shark occurring for their fins. If the level of unrecorded catch is high it may be impacting on the accuracy of stock assessments and risk assessments for some species. To address this issue, priority should be given to improving the recording of bycatch information–including validation (Rose and McLoughlin 2001).

6. Threatened, endangered and protected sharks

All jurisdictions have fisheries management and conservation legislation that establish the authority and management frameworks to protect shark species of conservation or management concern. The criteria and management measures used to identify and protect a species or species group from a particular threat may be determined by predefined criteria in the case of TEP species or via other policy/management initiatives. Table 9 presents Australian TEP shark species and their conservation status by jurisdiction. There are various categories of protection and their meaning is determined by the respective legislative instrument. Associated legislative requirements may direct the implementation of a stock rebuilding strategy, catch limits or no-take restrictions, or the development of recovery plans.

There are 15 shark TEP species listed in one or more Australian fisheries jurisdiction[14]. Some species are listed in more than one jurisdiction due to their wide distribution and concern over the population status or threats to the species in more than one jurisdiction. For example, the greynurse shark is protected in six out of the eight jurisdictions (see Table 9).

Currently there are nine TEP shark species listed under Commonwealth legislation and to date three national recovery plans have been prepared, two of which are currently under review:

- Whale Shark (*Rhincodon typus*) Recovery Plan 2005–2010 (2005)
- White Shark (*Carcharodon carcharias*) Recovery Plan (2002) (under review)
- Recovery Plan for the Greynurse Shark (*Carcharias taurus*) in Australia (2002) (under review).

Shark recovery plans in preparation include a multi-species recovery plan encompassing freshwater sawfish (*Pristis microdon*), green sawfish (*P. zijsron*), speartooth shark (*Glyphis glyphis*) and northern river shark (*G. garricki*).

Five shark species are currently being considered for threatened species listing under the EPBC Act, three species of gulper sharks (Harrisson's dogfish, endeavour dogfish and southern dogfish), the dwarf sawfish (*Pristis clavata*) and the coastal stingaree (*Urolophus orarius*). In 2009, school shark was listed as conservation dependent and is subject to a rebuilding strategy. State and territory jurisdictions have complementary TEP species listing processes and management frameworks but they are not necessarily consistent. In addition, several species of shark are protected within the Great Barrier Reef Marine Park, including greynurse shark, whale shark, white shark, freshwater sawfish, green sawfish and speartooth shark.

National Shark Recovery Group

The NSRG is an advisory group established to assist DEWHA with the design and implementation of recovery plans for EPBC Act listed shark species. Membership of the NSRG comprises Commonwealth and state government agencies, Indigenous representation, commercial fishing industry, conservation and recreational sector representatives and scientific experts.

The SIRC and the NSRG are complementary, and collaboration between the two advisory bodies is maintained through mutual representation and standing agenda items for reporting on the outcomes of each meeting.

[14] Note: in addition, all sharks and rays are commercially protected in WA (with some fishery-specific exceptions).

Table 9. Listed threatened, endangered and protected Australian shark species[15]. Shaded cells indicate jurisdictions that are generally considered beyond the normal distribution of the species (Source: Last and Stevens 2009).

	Commonwealth	NSW	VIC	QLD	WA	SA	TAS	NT
Basking shark *Cetorhinus maximus*							Protected	
Dwarf sawfish *Pristis clavata*				No-take	Totally protected fish			
Freshwater sawfish *Pristis microdon*	Vulnerable			No-take	Totally protected fish			Protected *Under review*
Green sawfish *Pristis zijsron*	Vulnerable	Presumed extinct		No-take	Totally protected fish; Specially protected fauna			Protected *Under review*
Greynurse shark *Carcharias taurus*	East-coast: Critically endangered; West-coast: Vulnerable	Critically Endangered	Threatened; Protected aquatic biota	Protected Endangered	Specially protected fauna		Protected	
Maugean skate *Zearaja maugeana*	Endangered							
Megamouth shark *Megachasma pelagios*							Protected	
Narrow sawfish *Anoxypristis cuspidata*				No-take	Totally protected fish			
Northern river shark *Glyphis garricki*	Endangered				Totally protected fish			
Sand tiger shark *Odontaspis ferox*		Protected						
School shark *Galeorhinus galeus*	Conservation dependent							
Speartooth shark *Glyphis glyphis*	Critically endangered			No-take	Totally protected fish			Protected *Under review*
Whale shark *Rhincodon typus*	Vulnerable	Vulnerable			Totally protected fish; Specially protected fauna		Protected	
White shark *Carcharodon carcharias*	Vulnerable	Vulnerable	Threatened; Protected aquatic biota	No-take	Totally protected fish; Specially protected fauna	Protected	Protected	
Dusky whaler *Carcharhinus obscurus*					Totally protected fish (over 70cm inter-dorsal length)			
All sharks and rays					Commercially protected fish (fishery-specific exceptions)			

[15] **Note:** Listing categories differ between legislation and some species are listed under more than one piece of legislation. **C'wealth**: EPBC Act 1999; **NSW**: FM Act 1994; **VIC**: FFG Act 1998 & Fisheries Act 1995; **QLD**: Fisheries Act 1994 (Fisheries Regulation 2008) & NC Act 1992; **WA**: FRM Act 1994 & WC Act 1950; **SA**: FM Act 2007; **TAS**: Fisheries (General & Fees) Regulations 2006; **NT**: TPWC Act 2001 (The conservation status of the NT species listed are currently under review). See Table 8 for full titles of the legislation.

International instruments

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

Australia is one of 175 countries that are party to CITES. Each member country places predefined controls on the import and export of an agreed list of species that are endangered or at risk of becoming endangered from the threat of international trade.

CITES places species into three categories based on their conservation status and the risk from trade. Lists of species in each category are compiled as three separate appendices to the Convention. The wildlife provisions of the EPBC Act consolidate the CITES appendices into a single list that identifies the trade conditions or restrictions that apply to each specimen, the appendix under which it has been listed and the date of listing.

Appendix I lists species threatened with extinction that are, or may be, affected by trade. The sawfish family (Pristidae spp. excluding the freshwater sawfish *Pristis microdon)* is listed in Appendix I, and are the only Chondrichthyan species with Appendix I listing.

Appendix II lists species that, although not threatened with extinction now, might become so unless trade is strictly controlled and monitored. There are four shark species listed in Appendix II (see Table 10). Appendix II can also include some non-threatened species, in order to prevent threatened species from being traded under the guise of non-threatened species that are similar in appearance. There are currently no shark species listed in Appendix II on this basis, however, due to the difficulty in distinguishing some shark species the issue is under scrutiny by some CITES parties.

Appendix III lists species that any CITES party identifies as being subject to regulation within its jurisdiction for the purpose of preventing or restricting exploitation and that require the cooperation of other countries in the control of trade. Currently no shark species are listed in Appendix III.

Table 10. Shark species listed on appendix I, II and III of CITES

Appendix I	**Appendix II**	**Appendix III**
Sawfishes [Pristidae spp. (Except the species included in Appendix II)]	Basking shark (*Cetorhinus maximus*)	*No shark species are listed on Appendix III of CITES*
	White shark (*Carcharodon carcharias*)	
	Whale shark (*Rhincodon typus*)	
	Freshwater sawfish (*Pristis microdon*)[16]	

[16] The freshwater sawfish is included in Appendix II 'for the exclusive purpose of allowing international trade in live animals to appropriate and acceptable aquaria for primarily conservation purposes' (see CITES, Appendix II).

Convention on the Conservation of Migratory Species of Wild Animals

The *Convention on the Conservation of Migratory Species of Wild Animals* (also known as the CMS or Bonn Convention) aims to conserve terrestrial, marine and avian migratory species throughout their range. 'Migratory species' means the entire population or any geographically separate part of the population of any species or lower taxon of wild animals, a significant proportion of whose members cyclically and predictably cross one or more national jurisdictional boundaries (Article I, CMS). Australia is a party to this intergovernmental treaty, which is conducted under the aegis of the UN Environment Program.

Migratory species threatened with extinction are listed in Appendix I of the CMS. Migratory species that need or would significantly benefit from international cooperation are listed in Appendix II of CMS. There are two shark species listed in Appendix I, and seven in Appendix II (see Table 11). The basking shark and white shark are listed in both Appendices.

The EPBC Act provides that all species listed in CMS appendices are to be listed as migratory species under the Act and therefore considered matters of national environmental significance. It is an offence under the EPBC Act to kill, injure, take, trade, keep or move a member of a listed migratory or marine species in a Commonwealth area (s 254) unless the action is covered by a permit issued by the Environment Minister or is otherwise exempt. The Act specifies that certain actions are not offences (s 255). These include actions authorised by a permit, taken in accordance with a wildlife conservation plan made under the Act, covered by an approval in operation under Part 9 of the Act or undertaken in accordance with an accredited management plan or regime – for example, fishery management plans or management arrangements.

The Minister for the Environment, Heritage and the Arts has agreed to defer listing of Porbeagle, Shortfin Mako and Longfin Mako as migratory species under the EPBC Act until after the current review of the EPBC Act is concluded.

Table 11. Shark species listed in Appendix I and II of CMS

Appendix I	**Appendix II**
Basking shark (*Cetorhinus maximus*)	Basking shark (*Cetorhinus maximus*)
White shark (*Carcharodon carcharias*)	White shark (*Carcharodon carcharias*)
	Whale shark (*Rhincodon typus*)
	Shortfin mako (*Isurus oxyrinchus*)
	Longfin mako (*Irurus paucus*)
	Porbeagle (*Lamna nasus*)
	Spiny dogfish (*Spualus acanthias*)[17]

[17] This listing refers to the Northern Hemisphere population of spiny dogfish only.

7. Ecosystem-Based Fisheries Management

This report is primarily focussed on direct and indirect fisheries impacts, however, there is a much broader scope of impacts that must be considered to fully understand and sustainably manage Australian shark populations (e.g. habitat degradation, trophic level impacts, and climate change impacts). Australia has committed to pursuing an ecosystem-based approach to fisheries management in all Australian fisheries. The principles of an EBFM approach require a move away from the traditional target species driven management focus to consider a wider range of impacts such as bycatch, and impacts on habitats and the broader ecosystem. The need for the effective implementation of EBFM approaches is of particular importance to sharks given the diversity of Australian shark species, the range of fisheries they interact with, and the ecological niches they occupy. Chondrichthyan fishes, particularly sharks, contain many species at or near the top of the marine food chain and thus play an important role in the ecosystem (Last and Stevens 2009).

The impetus and resources required to design and implement EBFM approaches are variable across jurisdictions and fisheries. This is expected due to the variable scale and impact of different fisheries but it also due to the challenges such an approach poses for existing policy and management frameworks. It is a complex and uncertain management goal that will, over time, require new research, new management, and in some cases new fishing practices.

In the interim, and particularly in fisheries where resources or regulatory frameworks limit the capacity of management agencies to mitigate known threats to shark species, precautionary management approaches are required. Identifying those species at most risk is a critical first step.

Risk assessment

Risk assessments are increasingly being used in Australia to identify shark species in need of fisheries and/or conservation management attention (e.g. Stobutzki et al., 2003; Salini et al., 2007; Walker et al., 2008). All jurisdictions use forms of risk-based approaches to assess and manage shark resources (Table 12). The risk assessment methodologies employed vary considerably both within and across fisheries and jurisdictions. How well risk assessments identify the likelihood and consequence of impacts (both direct and indirect) to any one species is dictated by the objectives and scope of individual assessments. As such, it can be difficult and/or inappropriate to directly compare the results of risk assessments.

To help address this issue, the FRDC is currently funding a project entitled *Development of national guidelines to improve the application of risk-based methods in the scope, implementation and interpretation of stock assessments for data poor species.* The results of this project should assist in the development of a more unified approach to the application of risk-based methods in Australian fisheries. Two examples of key contemporary risk assessment projects focussed on shark conservation and management are provided below.

A semi-quantitative risk assessment has been conducted for sharks in all northern Australian fisheries. The method used a combination of catch data, fishing methods and biological data. A total of 72 species in 29 fisheries on a per fishery basis were assessed, followed by a cumulative risk assessment for the northern fisheries. The risk assessment identified shark species least likely to be sustainable in northern fisheries. The assessment revealed 14 ‘high-risk’ species, with susceptibility to fishing gear and low productivity, the major factors contributing to this status. As a result, it was recommended that the outcomes of the risk assessment project be incorporated into management and used to prioritise research needs (Salini et al. 2007).

In the southern Australia region, a rapid risk assessment of fisheries for sharks, rays and holocephalans has been undertaken. The project contributes key data inputs to aid in the development of management plans and the application of conservation and management legislation in the SESSF. A major outcome of this project to date has been an improved understanding of chondrichthyan species, generally, throughout Australia. The data have also been made readily accessible to assist in addressing a wider range of shark management issues in Australia and internationally (Walker et al. 2008).

Table 12. Number of shark risk assessments undertaken by fisheries jurisdiction. The species/groups assessed includes both target and non-target species

Jurisdiction	No. of species/ groups assessed
Commonwealth	152
NSW	24
VIC	6
QLD	53
WA	75
SA	7
TAS	5
NT	72

Cumulative impacts

The fishery-specific nature of fisheries management arrangements allow for both target and non-target (byproduct and bycatch) catch to be assessed within individual fisheries. However, there is a risk that the cumulative (i.e. combined) impacts of fisheries (and other effects) on some species are not adequately considered. It is also widely recognised that many shark species are more vulnerable to fisheries impacts than scalefish, due to their slow growth, late maturity and low fecundity. These traits in concert with fishery-centric management leave some shark populations vulnerable to potentially unsustainable cumulative impacts.

Species-specific differences in distribution (spatial, seasonal and ontogenetic) abundance, life history, localised density, propensity to follow fishing boats, catch rate and vulnerability to other sources of mortality means that the risk posed by fishing to one species will differ from the risk posed to another. By extension, an assessment calculated for a species group (which is characteristic of some risk assessments in some jurisdictions) is unlikely to represent the real risk posed to any one species (Phillips et al. 2009).

The OCS arrangements put in place for gummy shark and school shark are an example of where some of the traditional cross-fishery and cross-jurisdictional boundaries to fisheries management have been overcome. However, the management of these species is still largely restricted to traditional target and byproduct species considerations.

Zhou and Griffiths (2008) have developed a Sustainability Assessment for Fishing Effects (SAFE) method that has the potential to study the cumulative impacts from fisheries and possibly other anthropogenic activities. As a result of their recent work the authors conclude that there is an urgent need to assess the cumulative impacts of fisheries on elasmobranch populations. Because

the SAFE method can quantify the fishery impact on hundreds of species, it may serve as a 'filtering' mechanism, identifying species potentially at risk, which can become candidates for monitoring (Zhou and Griffiths 2008).

Many shark species in Australian fisheries are caught as bycatch or harvested as byproduct species and as a consequence are typically afforded a lower fisheries management priority. This situation reaffirms the need to concentrate on ensuring, as a priority, that management measures aimed at protecting 'high-risk' species are effectively implemented. Mitigating impacts to high-risk shark species is also likely to have flow on benefits for a range of other species. Risk assessment work recently completed or currently underway will be essential references to consider during the review of the NPOA-Sharks.

8. Discussion

Catch and effort data are fundamental to key fisheries management functions. For example, stock assessments rely upon high quality catch and effort data, these data are also required to calculate economic performance measures such as GVP, and may be used to assess the impact of fisheries on non-target species. The higher the data quality, the better they can support decision-making. In the absence of good quality data, fisheries management necessarily relies on more precautionary and less flexible management options to ensure the sustainability of target and non-target stocks. This report highlights the issue that relatively poor species-specific catch and effort data are more the norm than the exception for the majority of shark species that interact with Australian fisheries.

Data collection and management protocols are inconsistent across fisheries and jurisdictions. This situation makes the aggregation or comparison of catch records across fisheries and jurisdictions difficult. There is also a reliance on generic 'processed weight' to 'whole weight' conversion factors to enable catch comparisons between fisheries. This generic approach is likely to lead to inaccuracies in catch estimates and may significantly over- or under-estimate catches for some species. This situation is maybe allowing significant impacts to some species to remain undetected.

Although the number of shark species recorded to species-level has increased, there remains significant scope for more specific, more consistent, routinely validated reporting across jurisdictions, particularly in fisheries that interact with TEP or high-risk species. Data validation initiatives (e.g. observer programs, scientific research programs) are (or can be) used to address some of this concern, however, catch validation is not carried out in many fisheries. It is often not possible to determine how accurately catch records reflect the actual catch composition or quantity and bycatch species (including discards) may not be recorded at all. It is not possible to account for these recording discrepancies using logbooks alone.

The interpretation of catch data presented here has been done largely in the absence of fishing effort data. CPUE trends are a common fisheries management tool and may be used to provide indices of abundance in the absence of independent surveys, stock assessments or other means of calculating species abundance information. Fishing effort information is also required to standardise catch rates across operators and fisheries. However, given the diversity of shark catches in some fisheries, and the generic approaches commonly applied to the recording of byproduct and bycatch species catch data, it can be difficult to assess trends in shark catches in many fisheries.

The number of shark stock assessments conducted in Australia is low given the well documented concerns about the sustainability of a range of shark populations plus their potential vulnerability to a range of fisheries. There are numerous fishing controls (input and output) designed to restrict the harvest levels of sharks generally but in many cases the effectiveness of these arrangements are difficult to measure. Reliable estimates of total fishing mortality for sharks at the species and group level (taking account of all sources of fishing mortality) are likely to be possible for only a few species. Information requirements to fill this gap for high-risk species should be addressed as a priority.

To counter this situation a range of risk assessment and management methods are being applied in many Australian fisheries (e.g. McAuley et al. 2007, Salini et al. 2007, Zhou and Griffiths 2008). This is a positive development and one that is increasingly being used to support the introduction of shark-specific management measures for a range of target and non-target fisheries. In addition, there is work underway to improve consistency in the application of risk-based management approaches both within and across jurisdictions. How successful these approaches are, or will be,

and any impediments to them should be an important consideration during a review of the NPOA-Sharks.

There is little regular quantitative data collected on the scale and significance of non-commercial (i.e. recreational and traditional) shark catch. There are exceptions such as the ongoing bather protection programs in NSW and QLD, and creel surveys that are conducted on a regular basis in some jurisdictions. Information on the non-commercial catch of sharks in Australia is predominately gathered at regional or state/territory levels. Research indicates recreational anglers catch a large number of sharks (e.g. Henry and Lyle 2003) and that some recreational catches may come close to commercial catches of some species in some areas. However, there is still limited information on the species composition of recreational shark catches and post-release mortality. Further research may be required to identify and assess the impact of recreational and traditional fishing in areas that overlap with the distributions of TEP and high-risk shark species.

Market and trade data can provide valuable information about the sustainability and economic status of fisheries. It can be used to help identify market opportunities and assist in decisions about the need for management measures. For example, an increasing trade in shark fin was highlighted in a number of jurisdictional reports as one of the reasons for introducing management measures to curb the targeting of sharks in a number of finfish fisheries. Market and trade data also have the potential to be used as indicators of changes in the availability of popular species. There is also a range of international and domestic reporting obligations to consider that require the collection and summary of market and trade data.

However, this report has shown that the current reporting requirements may not be adequate for these purposes. Broad reporting categories are typically used that often bear little resemblance to fisheries reporting categories and species, taxa or products being traded. As a consequence, both shark product export and import quantities and values bear little resemblance to actual quantities and values of shark product traded. This is occurring due to the aggregation of data under a small number of broad shark-specific reporting categories, and other shark products are being attributed to other generic product categories. A review of shark import and export data quality and data protocols may need to be considered. A review of this type should also consider the feasibility of any alternative approaches.

Progress from 2001 to 2009

Since 2001, a wide range of shark resource conservation and management measures have been progressed. This can in part be attributed to the development of the NPOA-Sharks, a range of targeted research and management actions and increased domestic and international attention over the period. For example, several new shark species have been identified as a result of taxonomic work, identification guides have been expanded or changed in an effort to improve the quality of data, and a range of shark-specific research projects have provided an improved understanding of the ecology of some shark species.

Fisheries management agencies, generally, have increased the application of risk assessments and risk-based management approaches. These approaches have helped identify shark species that are at the greatest risk of adverse fisheries impacts. Thus, the information base upon which to design sustainable shark management measures including mitigation methods, where necessary, has improved for many species. However, the development and implementation of management measures capable of addressing identified risks in a measurable way still requires attention in many fisheries.

Examples of how management agencies have responded to the increasing concern for some sharks include:

- an increase in surveillance and enforcement contributed to reducing illegal foreign fishing in Australian northern waters. Sharks are a key target for illegal foreign fishers and this in combination with historic and recent levels of domestic fishing mortality has significantly contributed to concern over the sustainability of northern species
- the development of a Commonwealth fisheries managers guide to sustainable shark management in response to concerns about the population status of a range of shark species that interact with Commonwealth fisheries
- the introduction of a rebuilding strategy for school shark in the SESSF
- the introduction of daily shark catch limits in the NSW OTLF to address increased targeting of sharks
- introduction of a state-wide shark-fishing management arrangements in WA, including (but not limited to): closures of large areas in northern WA to targeted shark fishing; prohibition on retention of shark catch in most WA-managed commercial fisheries; prohibition on taking whaler sharks in the recreational fishery; increased penalties for contravention of shark-management regulations and increased compliance activities related to shark fishing
- QLD government changes to management arrangements in the ECIFFF focused on shark harvests, including limiting commercial catch and effort, restricting recreational catch, and collection of data from a range of sources to inform future assessments and harvest strategies.

Conclusions

Although it is evident there has been considerable work on shark conservation and management since 2001, this report has highlighted that there are a range of issues that are yet to be addressed, many of which were identified in the 2001SAR. Resolving many of these issues relies on the basic need for a general improvement in the quality of shark harvest and bycatch data. Significant data gaps and constraints to improve shark data collection and validation remain in all jurisdictions. Thus, if significant progress is to be made in resolving many of the issues in the long-term there needs to be a general improvement in the quality of data in the short-term.

As a priority in the short-term, there is a general need for:

- an improved application of data validation methods (observer programs, targeted research and analysis, etc.) in target and non-target shark fisheries.
- the effective implementation of robust management measures and recovery actions to mitigate threats to high-risk and TEP species, and to rebuild over-exploited stocks.
- adequate precautionary measures to prevent any further declines in shark species.

It is recommended that the development of actions to address these issues should be a priority for consideration during the review of the 2004 NPOA–Sharks. Addressing, these issues should facilitate more rapid progress towards assessing a wider range of threats to Australian shark resources and the ecosystem services that depend on them.

In the longer-term, there is a need to:

- develop abundance or fishing mortality indices and conduct stock assessments for significant target and byproduct species
- ensure further and more consistent application of risk-based approaches to shark conservation and management
- assess the significance of cumulative fisheries impacts (and other impacts) on high-risk species
- review the need for and, where necessary, methods to obtain accurate market and trade data
- examine the need for improved management measures to reduce or restrict the targeting of sharks for the purpose of supplying shark fin export markets
- support the development of more effective shark bycatch mitigation methods
- conduct assessments of the risk non-commercial fisheries pose to sharks
- continue to encourage the effective monitoring and management of the harvest and bycatch of pelagic shark species on the high seas
- assess the sustainability of imported shark products.

The issues listed are principally fisheries focussed and the list is not exhaustive. Creating a shared understanding of what are the highest priority actions, and what is achievable in the short-term will be a key challenge for management agencies.

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10. Acronyms

ABARE	Australian Bureau of Agricultural Resource and Economics
ABS	Australian Bureau of Statistics
AFMA	Australian Fisheries Management Authority
AFZ	Australian Fishing Zone
AQIS	Australian Quarantine and Inspection Service
BMP	Beach Meshing Program
BRS	Bureau of Rural Sciences
CITES	Convention on International Trade of Endangered Species
CMS	Convention on the Conservation of Migratory Species of Wild Animals
CPUE	Catch Per Unit Effort
CSF	Coral Sea Fishery
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CT	Commonwealth Trawl Sector
DAFF	Department of Agriculture, Fisheries and Forestry
DEWHA	Department of the Environment, Water, Heritage, and the Arts
DPI	Department of Primary Industries
EBFM	Ecosystem-based Fisheries Management
ECIFFF	East Coast Inshore Fin Fish Fishery
EEZ	Exclusive Economic Zone
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
ERA	Ecological Risk Assessment
ETBF	Eastern Tuna and Billfish Fishery
EXDOC	AQIS Export Documentation system
FAO	United Nations Food and Agriculture Organisation
FACs	Fishery Advisory Committees
FRDC	Fisheries Research and Development Corporation
FSWG	Fisheries Statistics Working Group
GAB	Great Australian Bight
GBRWHA	Great Barrier Reef World Heritage Area
GHAT	Gillnet, Hook and Trap Fishery
GHATMAC	Gillnet, Hook and Trap Fishery Management Advisory Committee
GOCIFFF	Gulf of Carpentaria Inshore Fin Fish Fishery
GVP	Gross Value of Product
HSP	Commonwealth Harvest Strategy Policy 2007
ISMP	Integrated Scientific Monitoring Program
IUU	Illegal, Unreported and Unregulated fishing
IPOA-Sharks	International Plan of Action for the Conservation and Management of
JANSF	Joint Authority Northern Shark Fishery

JASDGDLF	Joint Authority Demersal Gillnet and Demersal Longline Fishery
MAC	Management Advisory Committee
MACC	Natural Resource Management Marine and Coastal Committee
MSF	Marine Scalefish Fishery
NAFC	Northern Australian Fisheries Committee
NMSWG	Northern Management and Science Working Group
NPOA-Sharks	National Plan of Action for the Conservation and Management of Sharks
NRMMC	Natural Resource Management Ministerail Council
NSRG	National Shark Recovery Group
NSW	New South Wales
NT	Northern Territory
OCS	Offshore Constitutional Settlement
ONLF	Offshore Net and Line Fishery
OTLF	Ocean Trap and Line Fisheries
QLD	Queensland
RBC	Recommended Biological Catch
RFMO	Regional Fisheries Management Organisation
SA	South Australia
SAR2001	Shark Assessment Report 2001
SCP	Shark Control Program
SESSF	Southern and Eastern Scalefish and Shark Fishery
SharkRAG	Shark Resource Assessment Group
SIRC	Shark-plan Implementation and Review Committee
SMP	Shark Meshing (Bather Protection) Program
TAS	Tasmania
TEP	Threatened, Endangered and/or Protected species
UN	United Nations
VIC	Victoria
VMS	Vessel Monitoring System
WA	Western Australia
WANCSF	Western Australian North Coast Shark Fishery
WCDGDLF	West Coast Demersal Gillnet and Demersal Longline Fishery
WTBF	Western Tuna and Billfish Fishery

11. Shark names

Common name(s) and scientific name of shark species and groups of species referred to in this report.

Fish name/group name	Scientific name
Allen's Skate	*Pavoraja alleni*
Angel Shark [NSW]	*Squatina australis* and *Squatina albipunctata*
Argus Skate	*Dipturus polyommata*
Australian Angel Shark	*Squatina australis*
Australian Blacktip Shark	*Carcharhinus tilstoni*
Australian Butterfly Ray	*Gymnura australis*
Australian Cownose Ray	*Rhinoptera neglecta*
Australian Sharpnose Shark	*Rhizoprionodon taylori*
Banded Catshark	*Atelomycterus fasciatus*
Banded Eagle Ray	*Aetomylaeus nichofii*
Banded Numbfish	*Narcine westraliensis*
Banded Stingaree	*Urolophus cruciatus*
Banded Wobbegong	*Orectolobus ornatus*
Banded Wobbegong [WA]	*Orectolobus halei*
Bareskin Dogfish	*Centroscyllium kamoharai*
Basking Shark	*Cetorhinus maximus*
Bentfin Devilray	*Mobula thurstoni*
Bigeye Sixgill Shark	*Hexanchus nakamurai*
Bigeye Thresher	*Alopias superciliosus*
Bight Skate	*Dipturus gudgeri*
Bignose Shark	*Carcharhinus altimus*
Bigspine Spookfish	*Harriotta raleighana*
Black Shark	*Dalatias licha*
Black Stingray	*Dasyatis thetidis*
Blackbelly Lanternshark	*Etmopterus lucifer*
Blackfin Ghostshark	*Hydrolagus lemures*
Blackmouth Lanternshark	*Etmopterus evansi*
Blackspotted Catshark	*Aulohalaelurus labiosus*
Blackspotted Whipray	*Himantura toshi*
Blacktip Reef Shark	*Carcharhinus melanopterus*
Blacktip Shark	*Carcharhinus, Loxodon* & *Rhizoprionodon spp.*
Blind Shark	*Brachaelurus waddi*
Blotched Catshark	*Asymbolus funebris*
Blotched Fantail Ray	*Taeniura meyeni*
Blue Shark	*Prionace glauca*
Bluespotted Fantail Ray	*Taeniura lymma*
Bluespotted Maskray	*Dasyatis kuhlii*
Bluntnose Sixgill Shark	*Hexanchus griseus*
Boreal Skate	*Amblyraja hyperborea*
Bramble Shark	*Echinorhinus brucus*

Fish name/group name	Scientific name
Brier Shark	*Deania calcea*
Broadgilled Hagfish	*Eptatretus cirrhatus*
Broadnose Shark	*Notorynchus cepedianus*
Bronze Whaler	*Carcharhinus brachyurus*
Bronze Whaler Shark	*Carcharhinus brachyurus & C. obscurus*
Brown Stingaree	*Urolophus westraliensis*
Bull Shark	*Carcharhinus leucas*
Circular Stingaree	*Urolophus circularis*
Coastal Stingaree	*Urolophus orarius*
Cobbler Wobbegong	*Sutorectus tentaculatus*
Coffin Ray	*Hypnos monopterygium*
Colclough's Shark	*Brachaelurus colcloughi*
Collar Carpetshark	*Parascyllium collare*
Common Blacktip Shark	*Carcharhinus limbatus*
Common Sawshark	*Pristiophorus cirratus*
Common Stingaree	*Trygonoptera testacea*
Coral Sea Stingaree	*Urolophus piperatus*
Cowtail Stingray	*Pastinachus sephen*
Creek Whaler	*Carcharhinus fitzroyensis*
Crested Hornshark	*Heterodontus galeatus*
Crocodile Shark	*Pseudocarcharias kamoharai*
Darksnout Houndshark	*Hemitriakis abdita*
Draughtboard Shark	*Cephaloscyllium laticeps*
Dusky Whaler	*Carcharhinus obscurus*
Dwarf Catshark	*Asymbolus parvus*
Dwarf Sawfish	*Pristis clavata*
Dwarf Spotted Wobbegong [WA]	*Orectolobus parvimaculatus*
Eastern Looseskin Skate	*Notoraja laxipella*
Eastern Shovelnose Ray	*Aptychotrema rostrata*
Elephantfish	*Callorhinchus milii*
Endeavour Dogfish	*Centrophorus moluccensis*
Endeavour Dogfish (common grouping)	*Centrophorus harrissoni, C. moluccensis &*
Epaulette Shark	*Hemiscyllium ocellatum*
Estuary Stingray	*Dasyatis fluviorum*
False Catshark	*Pseudotriakis microdon*
Floral Banded Wobbegong [WA]	*Orectolobus floridus*
Fossil Shark	*Hemipristis elongata*
Freshwater Sawfish	*Pristis microdon*
Freshwater Whipray	*Himantura chaophraya*
Frill Shark	*Chlamydoselachus anguineus*
Galapagos Shark	*Carcharhinus galapagensis*
Ghostshark	*Chimaera argiloba, C. fulva, C. macrospina,*
Giant Chimaera	*Chimaera lignaria*
Giant Shovelnose Ray	*Rhinobatos typus*

Fish name/group name	Scientific name
Giant Stingaree	*Plesiobatis daviesi*
Ginger Carpetshark	*Parascyllium sparsimaculatum*
Goblin Shark	*Mitsukurina owstoni*
Golden Dogfish	*Centroscymnus crepidater*
Goldeneye Shovelnose Ray	*Rhinobatos sainsburyi*
Graceful Shark	*Carcharhinus amblyrhynchoides*
Great Hammerhead	*Sphyrna mokarran*
Green Sawfish	*Pristis zijsron*
Greenback Stingaree	*Urolophus viridis*
Greeneye Dogfish	*Squalus mitsukurii*
Grey Carpetshark	*Chiloscyllium punctatum*
Grey Gummy [WA]	*Mustelus ravidus*
Grey Reef Shark	*Carcharhinus amblyrhynchos*
Grey Sharpnose Shark	*Rhizoprionodon oligolinx*
Grey Spotted Catshark	*Asymbolus analis*
Greynurse Shark	*Carcharias taurus*
Eastern fiddler ray	*Trygonorrhina fasciata* [formerly *sp. A*]
Gulf Catshark	*Asymbolus vincenti*
Gulper Shark	*Centrophorus granulosus*
Gummy Shark	*Mustelus antarcticus*
Hardnose Shark	*Carcharhinus macloti*
Harrisson's Dogfish	*Centrophorus harrissoni*
Indian Dogshark	*Scoliodon laticaudus*
Japanese Devilray	*Mobula japanica*
Javanese Cownose Ray	*Rhinoptera javanica*
Jenkins' Whipray	*Himantura jenkinsii*
Largetooth Cookiecutter Shark	*Isistius plutodus*
Leafscale Gulper Shark	*Centrophorus squamosus*
Lemon Shark	*Negaprion acutidens*
Leopard Whipray	*Himantura undulata*
Lined Lanternshark	*Etmopterus dislineatus*
Lobed Stingaree	*Urolophus lobatus*
Longfin Hagfish	*Eptatretus longipinnis*
Longfin Mako	*Isurus paucus*
Longnose Houndshark	*Iago garricki*
Longsnout Dogfish	*Deania quadrispinosa*
Magpie Fiddler Ray	*Trygonorrhina melaleuca*
Mandarin Shark	*Cirrhigaleus barbifer*
Mangrove Whipray	*Himantura granulata*
Manta Ray	*Manta birostris*
Marbled Catshark	*Atelomycterus macleayi*
Masked Stingaree	*Trygonoptera personata*
Maugean Skate	*Zearaja maugeana*
Megamouth Shark	*Megachasma pelagios*

Fish name/group name	Scientific name
Melbourne Skate	*Dipturus whitleyi*
Milk Shark	*Rhizoprionodon acutus*
Mitotic Stingaree	*Urolophus mitosis*
Moller's Lanternshark	*Etmopterus molleri*
Narrow Sawfish	*Anoxypristis cuspidata*
Nervous Shark	*Carcharhinus cautus*
Non-parasitic Lamprey	*Mordacia praecox*
Northern River Shark	*Glyphis garricki*
Northern Wobbegong	*Orectolobus wardi*
Oceanic White tip Shark	*Carcharhinus longimanus*
Ogilby's Ghostshark	*Hydrolagus ogilbyi*
Orange Spotted Catshark	*Asymbolus rubiginosus*
Ornate Angelshark	*Squatina tergocellata*
Ornate Eagle Ray	*Aetomylaeus vespertilio*
Owston's Dogfish	*Centroscymnus owstoni*
Pacific Spookfish	*Rhinochimaera pacifica*
Paddlenose Spookfish	*Rhinochimaera africana*
Painted Maskray	*Dasyatis leylandi*
Pale Skate	*Notoraja ochroderma*
Pale Spotted Catshark	*Asymbolus pallidus*
Patchwork Stingaree	*Urolophus flavomosaicus*
Peacock Skate	*Pavoraja nitida*
Pelagic Stingray	*Dasyatis violacea*
Pelagic Thresher	*Alopias pelagicus*
Pencil Shark	*Hypogaleus hyugaensis*
Pigeye Shark	*Carcharhinus amboinensis*
Pink Lanternshark	*Etmopterus dianthus*
Pink Whipray	*Himantura fai*
Plain Maskray	*Dasyatis annotata*
Plunket's Dogfish	*Centroscymnus plunketi*
Porbeagle	*Lamna nasus*
Porcupine Ray	*Urogymnus asperrimus*
Port Jackson Shark	*Heterodontus portusjacksoni*
Portuguese Dogfish	*Centroscymnus coelolepis*
Pouch Lamprey	*Geotria australis*
Prickly Dogfish	*Oxynotus bruniensis*
Prickly Shark	*Echinorhinus cookei*
Purple Eagle Ray	*Myliobatis hamlyni*
Pygmy Devilray	*Mobula eregoodootenkee*
Pygmy Lanternshark	*Etmopterus fusus*
Pygmy Shark	*Euprotomicrus bispinatus*
Longnose skate [formerly Raja sp. A]	*Dipturus confusus*
Grey skate [formerly Raja sp. B]	*Dipturus canutus*
Reticulate Swellshark	*Cephaloscyllium fasciatum*

Fish name/group name	Scientific name
Reticulate Whipray	*Himantura uarnak*
Roughskin Dogfish	*Centroscymnus spp.*
Rusty Carpetshark	*Parascyllium ferrugineum*
Sandbar Shark	*Carcharhinus plumbeus*
Sandtiger Shark	*Odontaspis ferox*
Sandyback Stingaree	*Urolophus bucculentus*
Sawshark	*Pristiophorus spp.*
Sawtail Catshark	*Galeus boardmani*
Scalloped Hammerhead	*Sphyrna lewini*
School Shark	*Galeorhinus galeus*
Shark Ray	*Rhina ancylostoma*
Sharpnose Sevengill Shark	*Heptranchias perlo*
Shortfin Mako	*Isurus oxyrinchus*
Shorthead Lamprey	*Mordacia mordax*
Short-tail Lanternshark	*Etmopterus brachyurus*
Short-tail Torpedo Ray	*Torpedo macneilli*
Sicklefin Houndshark	*Hemitriakis falcata*
Silky Shark	*Carcharhinus falciformis*
Silvertip Shark	*Carcharhinus albimarginatus*
Sixgill Stingray	*Hexatrygon bickelli*
Skate	*Notoraja azurea*
Slender Lanternshark	*Etmopterus pusillus*
Slender Sawtail Catshark	*Galeus gracilis*
Sliteye Shark	*Loxodon macrorhinus*
Smalleye Pygmy Shark	*Squaliolus aliae*
Smalleye Stingray	*Dasyatis microps*
Smallspine Spookfish	*Harriotta haeckeli*
Smalltooth Cookiecutter Shark	*Isistius brasiliensis*
Smooth Hammerhead	*Sphyrna zygaena*
Smooth Lanternshark	*Etmopterus bigelowi*
Smooth Stingray	*Dasyatis brevicaudata*
Smoothbelly Catshark	*Apristurus longicephalus*
Southern Dogfish	*Centrophorus zeehaani* (formerly *uyato*)
Southern Eagle Ray	*Myliobatis australis*
Southern Fiddler Ray	*Trygonorrhina dumerilii*
Southern Lanternshark	*Etmopterus granulosus*
Southern Round Skate	*Irolita waitii*
Southern Aawshark	*Pristiophorus nudipinnis*
Southern Sleeper Shark	*Somniosus antarcticus*
Sparsely-spotted Stingaree	*Urolophus paucimaculatus*
Speartooth shark	*Glyphis glyphis*
Speckled Carpetshark	*Hemiscyllium trispeculare*
Speckled Catshark	*Halaelurus boesemani*
Spikey Dogfish	*Squalus megalops*

Fish name/group name	Scientific name
Spinner Shark	*Carcharhinus brevipinna*
Spot-tail Shark	*Carcharhinus sorrah*
Spotted Shovelnose Ray	*Aptychotrema timorensis*
Spotted Stingaree	*Urolophus gigas*
Spotted Wobbegong	*Orectolobus maculatus*
Striped Stingaree	*Trygonoptera ovalis*
Sydney Skate	*Dipturus australis*
Tasmanian Numbfish	*Narcine tasmaniensis*
Tasselled Wobbegong	*Eucrossorhinus dasypogon*
Tawny Shark	*Nebrius ferrugineus*
Thornback Skate	*Dipturus lemprieri*
Thresher Shark	*Alopias vulpinus*
Tiger Shark	*Galeocerdo cuvier*
Torpedo rays, coffin rays and numbfishes	Torpedinidae, Narcinidae, Hypnidae
Varied Carpetshark	*Parascyllium variolatum*
Variegated Catshark	*Asymbolus submaculatus*
Velvet Dogfish	*Zameus squamulosus*
Weasel Shark	*Hemigaleus australiensis*
Western Looseskin Skate	*Notoraja subtilispinosa*
Western Numbfish	*Narcine lasti*
Western Shovelnose Ray	*Aptychotrema vincentiana*
Western Shovelnose Stingaree	*Trygonoptera mucosa*
Western Spotted Catshark	*Asymbolus occiduus*
Western Wobbegong [WA]	*Orectolobus hutchinsi*
Whale Shark	*Rhincodon typus*
Whiskery Shark	*Furgaleus macki*
White Shark	*Carcharodon carcharias*
Whitecheek Shark	*Carcharhinus dussumieri*
Whitespotted Dogfish	*Squalus acanthias*
Whitespotted Eagle Ray	*Aetobatus narinari*
Whitespotted Guitarfish	*Rhynchobatus australiae, R. laevis*
Whitespotted Gummy Shark [WA]	*Mustelus stevensi*
Whitespotted Skate	*Dipturus cerva*
Whitetail Dogfish	*Scymnodalatias albicauda*
White tip Reef Shark	*Triaenodon obesus*
Wide Sawfish	*Pristis pectinata*
Wide Stingaree	*Urolophus expansus*
Winghead Shark	*Eusphyra blochii*
Wobbegong [NSW]	*Orectolobus ornatus, O. maculatus* & *O. halei*
Yellowback Stingaree	*Urolophus sufflavus*
Zebra Hornshark	*Heterodontus zebra*
Zebra Shark	*Stegostoma fasciatum*