



PART 1: BUILDING RESILIENCE

1. Introduction, Part 1 Building Resilience

Marine ecosystems and processes are some of the least understood natural features in our world. Very little information is available on Australia's marine biodiversity. It has been estimated that less than 5% of marine biodiversity has been discovered or described for the Australian marine jurisdiction.¹

Despite this lack of understanding, most of our coastal activities rely on diverse marine ecosystems and the healthy waters on which they depend. As the ocean recycles sewage into nutrients, scrubs toxins out of the water, and converts carbon dioxide into food and oxygen, marine ecosystem health and viability are essential to our way of life. But in order to provide these services, the ocean and estuaries need all their working parts.²

A recent study concludes that marine biodiversity loss is increasingly impairing the ocean's capacity to provide food, maintain water quality, and recover from perturbations.² It is even suggested that unless we fundamentally change the way we manage all the ocean's species together, as working ecosystems, this may be the last century of wild seafood.² The impacts of species loss have been shown to go beyond declines in seafood. Human health risks increase as depleted coastal ecosystems become vulnerable to invasive species, disease outbreaks and harmful algal blooms.²

Marine ecosystems are experiencing accelerating loss of populations and species, the consequences of which are only beginning to be fully comprehended. Detailed studies of a number of large marine ecosystems around the world show that fisheries are collapsing at a higher rate in species-poor ecosystems than in species-rich ecosystems.²

Available data suggest that at this point, these trends are still reversible. An overwhelming body of scientific literature describes the benefits of no-take marine sanctuaries.³ It has been shown that on average, creating a no-take marine sanctuary can double the density of fish and invertebrates, triple the biomass and increase the mean size of fish by 20-30% relative to fished areas.⁴ Closing fisheries and establishing protected areas has been shown to boost the number of species by an average of 23%, increase catch-per unit effort four-fold in nearby waters and make marine ecosystems 21% less susceptible to environmental and human caused fluctuations.²

The buffering impact of marine sanctuaries on species diversity also generates long term insurance value that must be incorporated into future economic valuation and management decisions. Although there are short-term economic costs associated with the preservation of

¹ Newton, 2007

² Worm *et al* 2006

³ See for example Alcala, 1979; Salm and Vlark, 1984; Alcala & Russ, 1990;; Bennett & Attwood, 1991; Fairweather, 1991; Jones *et al.*, 1992; Hilborn & Kennedy 1992; Agardy, 1993; Bohnsack, 1994; Agardy, 1994; Davis & Tisdell, 1995; Harmelin *et al.*, 1995; Davis & Harriot, 1996; Clark, 1996; McClanahan & Kaunda - Arara, 1996; Russ & Alcala, 1996; Lauck *et al.*, 1998; Mangel, 1998; Sladek *et al.*, 1998; Sumaila, 1998; Lauck *et al.*, 1998; Guénette *et al.*; 1998; Bohnsack 1998; Conrad, 1999; Badalamenti *et al.*, 2000; Caddy, J., 2000; Mangel 2000b; Li, 2000; NRC, 2001; Ward *et al.*, 2001; Gell & Roberts, 2002; Pauly *et al.*, 2002; Hannesson, 2002; Russ *et al.*, 2003; Halpern, 2003; Grafton *et al.*, 2004; Greenville & MacAulay, 2005; Worm *et al.*, 2006; Helfman, 2007; Roberts, 2007; Conover, 2007.

⁴ Halpern, 2003



marine biodiversity and the establishment of marine sanctuaries, over the long term, biodiversity conservation and economic development are complementary goals.

The species that constitute marine biological communities have adapted to natural disturbances over evolutionary time scales, making intact ecosystems more resilient to environmental disturbance. Loss of biodiversity increases ecosystem stress and decreases resilience of the system. Ecosystems that are already stressed are at far greater risk of collapse when faced with the rapid alterations to ocean temperature and current regimes predicted to occur with the onset of climate change. As temperate southern Australian waters have been geographically and climatically isolated for at least 65 million years, most known marine species (i.e. 60–95%) are endemic or restricted to the area.⁵ It is, therefore, a global imperative that measures are implemented to protect this internationally significant biological storehouse.

New South Wales waters are strongly influenced by the mixing of the warm tropical waters via the East Australian Current and cooler Tasman Sea waters of southern Australia.⁶ The seasonal north-south migration of the boundary between the warm East Australian Current and the cooler Tasman Sea waters and the diversity of habitats found in the coastal zone of NSW, give rise to rich fish and invertebrate faunas.⁷ For example, almost 600 species of finfish have been recorded from Sydney Harbour alone, which far exceeds the number of species (around 200) described from the marine waters surrounding the British Isles.⁷

As with global marine ecosystems, NSW coastal waters remain vulnerable. They require a comprehensive, adequate and representative network of marine protected areas that are functionally connected, adequately replicated, large enough and evenly distributed along our coastal fringe to ensure a viable future for marine and coastal communities, economies, ecosystems and species.

While recognising that the Department of Primary Industries (DPI) Fisheries has responded to some degree to gross historical overfishing, habitat loss and alteration in NSW managed marine waters, management responses have generally been slow and poorly implemented. It is clear that a great deal more is required. Given the lack of meaningful stock assessments undertaken for most fished populations, no-take marine sanctuaries are a logical necessity to provide a buffer against stock collapse and biodiversity decline.

The NSW government has publicly committed to the establishment of a comprehensive system of representative Marine Parks. These commitments have led to significant increases in the area of marine ecosystems and habitats protected in marine sanctuaries ('no-take' marine protected areas – IUCN Category Ia reserves) since the introduction of the *Marine Parks Act 1997*. However, in light of recent studies, these measures account for only a fraction of what is required.

Part 1 of this report critiques existing marine protected areas in NSW, sets out a methodology for a gap analysis undertaken in Part 2, and provides an over-view or macro-scale gap analysis.

Part 2 of this report will set out meso- and micro-scale gap analyses of the NSW Biogeographic Regions (Bioregions) and makes recommendations for additions to the NSW marine protected area system.

⁵ Poore, 1995; Phillips, 2001; Poore, 2001; Williams *et al.*, 2006

⁶ Godfrey *et al.*, 1980

⁷ Rowling, 2001



1.1 Global Warming

As Australia's estuarine and near-shore marine systems are generally low in productivity and may not be as resilient to stress and disturbance as more productive systems, climate change impacts are likely to be greater than in other parts of the world with more productive marine environments.⁸ Fishing stress has decreased the resilience of populations and communities to impacts such as climate changes and exacerbated the low productivity of Australian marine environments.⁹

In Australian waters, the marine groups most affected by climate change are likely to be tropical coral reefs, cold water coral reefs, rocky reefs and kelps, plankton and species that live on or near the sea floor.⁹ The Australian marine biodiversity that has been estimated to be most vulnerable to climate change impacts is that of the East Central Marine Domain - the four marine Bioregions off NSW: the Tweed-Moreton, Manning, Hawkesbury and Batemans Marine Bioregions.⁹ This region is also most vulnerable with respect to climate change indicators, including changes in sea surface temperature, subsurface temperature and surface winds.¹⁰ The biodiversity of the Twofold Shelf Marine Bioregion (south of Tathra on the NSW Far South Coast), which forms part of the South East Marine Domain, is estimated to be the second most vulnerable to climate change impacts.⁹

It has been conservatively projected that the expected increases in Australian ocean temperatures from climate change will have a 35% overall economic impact on Australian fisheries by 2070, and that temperate Australian fisheries, such as those of NSW, will be more vulnerable than tropical ones.⁹ Local and regional strategies that protect or increase the resilience of marine ecosystems will help to minimise the overall impacts of climate change. Immediately easing local and regional scale over-fishing, pollution, habitat destruction, and other anthropogenic effects may be our best management option for addressing these impending consequences on marine ecosystems. There is a growing consensus that marine sanctuaries are the best way of recovering marine ecosystems and building resilience to minimise some of the worst impacts of climate change.¹⁰

1.2. International Recommendations and Commitments to Marine Protected Areas

Serious marine ecosystem decline and fishery collapses have prompted a growing global focus and appreciation of the need for more marine protected areas and for better management generally of coastal and marine environments.

In 1988, the World Conservation Union (IUCN) General Assembly called upon national governments, international agencies and the non-governmental (NGO) community to:

Provide for the protection, restoration, wise use, understanding and enjoyment of the marine heritage of the world through the creation of a global, representative system of marine protected areas and through management in accordance with the principles of the World Conservation Strategy of human activities that use or affect the marine environment.

In 1994, the Australian and New Zealand Environment Conservation (ministerial) Council (ANZECC) adopted the IUCN definition of a 'protected area' to apply to MPAs as follows:

⁸ Hobday *et al.*, 2006

⁹ *ibid*

¹⁰ Hartley *et al.*, 2006; Hobday *et al.*, 2006; UNEP, 2006; IES, 2006



*An area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means.*¹¹

In 1995, the United Nations Food and Agriculture Organisation's (FAO) *Code of Conduct for Responsible Fisheries* emphasised the integration of marine protected areas into the sustainable use of marine natural resources.¹²

The 2002 *World Summit on Sustainable Development Johannesburg* emphasised the need to maintain the productivity and biodiversity of important marine and coastal areas, and set target dates of:

2012 for the establishment of representative MPA networks based on scientific information and consistent with international law;
2015 for the restoration of depleted fish stocks; and
2010 for the application of the ecosystem approach to ocean and fisheries management.

The IUCN suggested that:

*Urgent action is required to restore fisheries that have collapsed, avoid overfishing of stocks already fully utilised, minimise the ecological effects of by-catch, to species and ecosystems and limit habitat destruction. Marine protected areas (MPAs) have been shown to be an effective means to support biodiversity and species conservation as well as supporting ecologically and economically sustainable fisheries when managed in the context of human societies that are dependent on marine ecosystems.*¹³

In 2003, the IUCN called on the international community as a whole to:

Establish by 2012 a global system of effectively managed, representative networks of marine and coastal protected areas, consistent with international law and based on scientific information, that:

*Greatly increases the marine and coastal area managed in marine protected areas by 2012; these networks should be extensive and include strictly protected areas that amount to at least 20-30% of each habitat, and contribute to a global target for healthy and productive oceans....*¹⁴

This recommendation was subsequently adapted by a technical advisory body to the Convention on Biological Diversity in 2003, that recommended a target of 10% effective protection globally, with a longer-term goal of 20-30% of each habitat type protected within effectively managed protected areas.¹⁵

In May, 2008, the Australian Marine Sciences Association (AMSA) NSW issued a position statement in full support of marine protected areas and no-take marine sanctuaries. AMSA is Australia's largest association of marine scientists.

¹¹ IUCN, 1994

¹² FAO, 1995

¹³ IUCN, 2003

¹⁴ *ibid*, Rec. 22

¹⁵ UNEP, 2003, Item 7



Experience in two Australian MPAs - the Great Barrier Reef and the state waters of the Ningaloo Marine Park - resulted in an outcome of about 33% high level protection (IUCN Category Ia).

1.3. Government Commitments, Agreements and Considerations

Commonwealth, State and Territory Governments have committed to a comprehensive, adequate and representative system of marine protected areas, but none have as yet met those commitments.

In 1991, the Commonwealth Government launched *Ocean Rescue 2000*,¹⁶ the first national marine conservation program aimed at developing a comprehensive system of marine protected areas.

The Commonwealth Government and State and Northern Territory agencies have begun to jointly develop this system through the implementation of a National Representative System of Marine Protected Areas (NRSMPA) and the establishment of a comprehensive, adequate and representative (CAR) system of marine protected areas.¹⁷

The establishment of the NRSMPA supports the program of the World Conservation Union's (IUCN) World Commission on Protected Areas (WCPA) to promote the establishment of a global representative system of marine protected areas (MPAs).

The key characteristics that define the MPAs that form the NRSMPA, as compared to other managed marine areas, are that the MPA:

- *has been established especially for the conservation of biodiversity (consistent with the primary goal);*
- *is able to be classified into one or more of the six IUCN Protected Area Management Categories [see Appendix 1] reflecting the values and objectives of the MPA;*
- *must have secure status which can only be revoked by a Parliamentary process; and*
- *contributes to the representativeness, comprehensiveness or adequacy of the national system.*¹⁸

In 1992, the National Strategy for Ecological Sustainable Development¹⁹ was released, which has as an objective:

to establish across the nation a comprehensive system of protected areas which includes representative samples of all major ecosystems, both terrestrial and marine; manage the overall impacts of human use on protected areas; and restore habitats and ameliorate existing impacts such that nature conservation values are maintained and enhanced.

In 1992, the Commonwealth, States and Territory Governments signed the *Intergovernmental Agreement on the Environment*²⁰ that acknowledged:

¹⁶ See OR, 1997

¹⁷ See for example ANZECC TFMPA, 1999

¹⁸ ANZECC TFMPA, 1998a, p.5

¹⁹ Commonwealth of Australia, 1992

²⁰ Commonwealth of Australia, 1992a



the important role of the Commonwealth and the States in relation to the environment and the contribution the States can make in the development of national and international policies for which the Commonwealth has responsibilities...

In 1993, Australia ratified the *International Convention on Biological Diversity* following agreement by the Council of Australian Governments.

In 1995, the NSW Carr Labor Government promised to establish a 'comprehensive system of Marine Parks'.

In 1996, the National Strategy for the Conservation of Australia's Biological Diversity (Commonwealth of Australia 1996) set as an objective to:

Establish and manage a comprehensive, adequate and representative system of protected areas covering Australia's biological diversity.

In 1997, the New South Wales Government passed the *Marine Parks Act* to establish a comprehensive system of Marine Parks in New South Wales. In the second reading speech on the *Marine Parks Bill*, the then Environment Minister Pam Allan stated that:

The Government will establish a world-class system of Marine Parks to protect and manage our unique marine environment.

However, unlike National Parks on the land, these areas are not dedicated to the conservation of animal and plant life, but rather to support a 'multiple use' plan, of which full protection (IUCN Category Ia sanctuaries) is but one small part.

After a battle between government agencies, the management and establishment of Marine Parks was given over to a triumvirate of Fisheries NSW (now DPI Fisheries), the NSW National Parks and Wildlife Service (subsequently the Department of Environment and Conservation and most recently the Department of Environment and Climate Change) and the NSW Premier's Department. A handful of new staff was appointed to the new Marine Parks Authority.²¹ An agency restructure in April 2007 saw the Marine Parks Authority and its directorate transferred to the Parks and Wildlife Division of the new Department of Environment and Climate Change (DECC). Operational staff, particularly those involved in regulation and compliance under the *Fisheries Management Act*, remain with DPI Fisheries.

The National Strategy for the Conservation of Australia's Biological Diversity²² signed by all State and Territory Governments and the Federal Government committed to "Establish and manage a comprehensive, adequate and representative system of protected areas covering Australia's biological diversity" (Objective 1.4 page 9). This commitment includes the Australian and NSW managed marine environments, and was reflected in the *Draft Biodiversity – Life's Variety: New South Wales Biodiversity Strategy (1997)*²³ which set a performance target of:

a comprehensive, adequate and representative reserve system established for terrestrial (other than forest reserves) and marine ecosystems by 2010.

However, the draft *NSW Biodiversity Strategy (1999)* only commits this government to:

²¹ Anderson, 2005

²² Commonwealth of Australia, 1996

²³ NPWS, 1997



Continue [the] establishment of a comprehensive system of Marine Parks to conserve marine biodiversity and provide protection for unique and representative areas.

National Objectives and Targets for Biodiversity Conservation 2001-2005 (Commonwealth of Australia June 2001) was signed by NSW Environment Minister, Bob Debus, on behalf of the NSW Government. This commits to “by 2003, substantial progress has been made towards the establishment of the National Representative System of Marine Protected Areas” (Target 3.1.2) and a performance indicator of “Progress towards the establishment of a comprehensive, adequate and representative system of marine protected areas by jurisdiction”.

The NSW Government document *Developing a Representative System of Marine Protected Areas* (Nov 2001) states that the primary goal of the system is to “establish a comprehensive, adequate and representative system of marine protected areas that includes a full range of marine biodiversity at ecosystem, habitat and species level” (page 10). Both Ministers administering the *Marine Parks Act* - Minister for Environment and Minister for Fisheries – endorsed this document.

Since the introduction of the *Marine Parks Act* in 1977, progress towards a comprehensive, adequate and representative (CAR) system of marine protected areas has been made. However, only about 6.5% of the total marine waters of NSW have been secured in IUCN Category Ia sanctuaries.

The 2006 *State Plan* identifies the actions the NSW Labor Government are “already committed to,” as including:

*Building a network of marine protected areas to comprehensively represent marine biodiversity.*²⁴

The *State Plan* also identifies that the Government will consider :

*Building and managing a comprehensive, adequate and representative reserve system which includes both terrestrial and Marine Parks to protect the State’s unique biodiversity from current and future pressures.*²⁵

However, in the NSW Government response to the pre-election questionnaire submitted by NPA, the Premier’s Office in their response received 13 March 2007 said:

The Government is strongly committed to establishing a comprehensive, adequate and representative (CAR) system of marine protected areas. This was legislated for under the Marine Parks Act 1997 by this Government, and the framework for its implementation and management was detailed in a policy paper in 2001 titled developing a representative system of marine protected areas in NSW.

To date, the Government has put in place 6 major Marine Parks covering over 33% of state waters. Included within these parks are over 100 sanctuary zones buffered by habitat protection areas. A gap analysis of habitat representation is a priority for the Marine Parks Authority who advises the government on the establishment of new Marine Parks. Priorities for new marine protected areas will be those ecosystems, habitats and species that are not represented in existing marine protected areas.

²⁴ NSW State Plan, 2006, p.123

²⁵ *ibid*, p.124



A number of priority targets of the *State Plan* apply to the marine environment. These include that by 2015 there will be:

- *an increase in the number of sustainable populations of a range of native fauna species.*
- *an increase in the recovery of threatened species, populations and ecological communities.*
- *a reduction in the impact of invasive species.*
- *no decline in the condition of marine waters and ecosystems*
- *an improvement in the condition of important wetlands, and the extent of those wetlands is maintained.*
- *an improvement in the condition of estuaries and coastal lake ecosystems.*²⁶

To fulfil these targets with respect to the NSW marine jurisdiction, a CAR system of MPAs is essential.

It is a concern, however, that the *State Plan* does not commit this Government to the establishment of a CAR reserve system established for marine ecosystems, and now will only 'consider' such a target. Indeed, apart from the targets set out in the *State Plan*, there is no longer even a deadline for the current commitments regarding marine conservation. Of greatest concern is that the crucial term 'adequate' no longer forms part of this Government's marine conservation policy commitment.

A commitment by the NSW government to the establishment of a full CAR reserve system for marine areas is essential if marine ecosystems, habitats and species are to be secured in the face of continued population increases and global threats such as climate change.

In April 2007, responsibility for Part 7 (Aquatic Reserves and Habitat Protection) of the *Fisheries Management Act* was given to the Ministers responsible for DECC. While the Marine Park Authority remains a triumvirate of DECC, DPI and Premiers, staffs are employed by DPI.

It is hoped that with responsibility for this important area now laying with the NSW environment portfolio, "adequate" marine conservation in NSW will now be possible.

Recommendation 1:

That the NSW Government implement its policy on a comprehensive adequate and representative system of marine protected areas by agreeing to establish 10% of all comprehensively mapped NSW marine habitats and ecosystems in marine sanctuaries by 2011 and 20% by 2020.

²⁶ *ibid*, p.120



1.4. Economic Benefits of Sanctuary Zones

The State of the Environment Advisory Council noted that the loss of biodiversity is one of the most serious environmental problems affecting Australia.²⁷ Marine environments contain an enormous diversity of flora and fauna, which is essential for the environment to function. A review of estuaries and other coastal ecosystems found that those with more species had lower rates of collapse of valuable fisheries than systems that were relatively species-poor.²⁸

When biodiversity declines, ecosystems and the services they provide become increasingly threatened. As industries such as commercial and recreational fishing, aquaculture and coastal tourism rely on healthy marine environments, declining biodiversity will have considerable economic impacts. Regional biodiversity loss in coastal ecosystems impairs at least three ecosystem services that are critical to human society. These include the number of viable fisheries, the provision of nursery habitats such as reefs, seagrass beds and wetlands, and the filtering and detoxification services provided by suspension feeders, submerged vegetation, and wetlands.²⁸

Loss of filtering services contributes to declining water quality and the increasing occurrence of harmful algal blooms, fish kills, beach closures, oxygen depletion and invasive species.²⁸ Marine sanctuaries (IUCN Category Ia “no-take” areas) have been shown to significantly enhance biodiversity in the areas where they have been established. However, the benefits of marine sanctuaries go well beyond the protection of biodiversity.²⁹ They can also add considerable economic value to the region where they are established.³⁰

Marine sanctuaries have been shown to benefit tourism,³¹ the replenishment of fisheries and the protection of the natural resource bases of fisheries,³² as well as the protection of nursery and recruitment habitats.³³

Marine sanctuaries have been shown to lead to an increase in the abundance of spawners providing insurance against recruitment failure and the maintenance or enhancement of yields in fished areas.³⁴ Marine sanctuaries mitigate biological losses that may arise due to recruitment failure,³⁵ and can generate significant economic benefits by reducing the degree of fluctuation in populations of fished species.³⁶

While the use of marine sanctuaries cannot guarantee that a fished population will not collapse, they can generate economic benefits through the buffer effect of higher fish stocks. The establishment of marine sanctuaries has been shown to reduce the effects of random negative shocks on fisheries, effectively smoothing the harvest variability³⁷ and improving the resource rent generated.³⁸

²⁷ State of the Environment Advisory Council, 1996

²⁸ Worm *et al.*, 2006

²⁹ Brunckhorst & Bridgewater, 1995

³⁰ See for example Farrow, 1996; Ribera, 1992, Capellà *et al.*, 1998; Badalamenti *et al.*, 2000

³¹ See for example Agardy, 1993; Davis & Tisdell, 1995; Davis & Harriot, 1996;; Badalamenti *et al.*, 2000

³² See for example Hilborn & Kennedy 1992; Harmelin *et al.*, 1995; Lauck *et al.*, 1998; Caddy. J., 2000; Pauly *et al.*, 2002.

³³ See for example Alcala & Russ, 1990; Bohnsack, 1994; Bennett & Attwood, 1991; Fairweather, 1991; Jones *et al.*, 1992; Agardy, 1994; Clark, 1996; McClanahan & Kaunda - Arara, 1996; Russ & Alcala, 1996

³⁴ See for example Alcala, 1979; Salm and Vlark, 1984; Bohnsack 1998; Russ *et al.*, 2003

³⁵ Sumaila, 1998

³⁶ Conrad, 1999

³⁷ See for example Sladek *et al.*, 1998; Mangel 2000b; Hannesson, 2002

³⁸ See for example Grafton *et al.*, 2004; Greenville & MacAulay, 2005



It has been shown that as the size of the area protected from fishing increases, the probability of stock collapse decreases.³⁹ It has further been suggested that the level of stock uncertainty should determine the size of marine sanctuaries to ensure sustainable fished populations.⁴⁰

The lack of accurate stock assessment for the majority of NSW fished species leaves these populations at considerable danger of being overfished and therefore at greater risk of stochastic or random events such as climate change impacts and pathogenic infection. Without a buffer against stock collapse provided by the establishment of marine sanctuaries to an adequate proportion of NSW waters, stable fished populations cannot be assured.

1.5 Threatened Marine Species

The *Fisheries Management Act 1994* (FM Act) provides for the listing of threatened aquatic species, populations and ecological communities, and key threatening processes, and their management through recovery plans and threat abatement plans in NSW. The Act covers the listing of extinct, endangered and vulnerable fish, invertebrates (including molluscs and crustaceans) and marine vegetation. Less than 1% of NSW marine species are listed as threatened under the FM Act. However, this is likely to reflect the lack of substantive studies and thus poor documentation and a paucity of data available for most marine species. Invertebrates and algae have been particularly poorly documented and are very likely to be under-represented in threatened species listings.⁴¹

Table 1: Marine species listed as threatened in the *Fisheries Management Act*

Category	Bony fish	Sharks and rays	Macro algae
Presumed extinct			Bennetts seaweed
Endangered sp.	southern bluefin tuna	grey nurse shark	
		green sawfish	
Vulnerable sp.	black cod	great white shark	marine brown alga
Total	2	3	2

The Commonwealth *Environmental Protection and Biodiversity Conservation Act* (EPBC Act) lists a number of NSW threatened species; the grey nurse shark - east coast population (*Carcharias Taurus*) as Critically Endangered, the great white shark (*Carcharodon carcharias*) as Vulnerable and the orange roughy or deep-sea perch (*Hoplostethus atlanticus*) as Conservation Dependant.

On top of the species listed as threatened in the FM Act and EPBC Act the IUCN Red List of threatened species⁴² lists harrisons dogfish (*Centrophorus harrissoni*), southern dogfish (*Centrophorus uyato*), knifetooth sawfish (*Anoxypristis cuspidatae*) as Critically Endangered, the endeavour dogfish (*Centrophorus moluccensis*), purple eagle ray (*Myliobatis hamlyni*), hammerhead shark (*Sphyrna sp*) and the green-eye spurdog (*Squalus mitsukurii*) as Endangered, and 21 other Australian finfish, shark and ray species as Vulnerable. In all 16 species of Australian finfish and 110 species of Australian sharks and rays appear on the IUCN threatened species list. While many of these are deep-sea species, some would be likely to inhabit NSW managed waters.

³⁹ Li, 2000

⁴⁰ Mangel, 1998 and 2000a; Lauck *et al.*, 1998

⁴¹ NSW SOE, 2006

⁴² IUCN Red List, 2007



The EPBC Act list three key marine threatening processes:

Incidental catch (bycatch) of sea turtle during coastal otter-trawling operations within Australian waters north of 28 degrees South,
Incidental catch (or bycatch) of seabirds during oceanic longline fishing operations,
Injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris.

Three marine threatening processes are currently listed under the FM Act :

- *hook-and-line fishing in areas important for the survival of threatened fish species, introduction of non-indigenous fish and marine vegetation to the coastal waters of NSW the current shark meshing program in NSW waters.*

There is some overlap between these and the two marine key threatening processes - to Threatened birds, mammals and turtles - listed under the NSW *Threatened Species Conservation Act* (TSC Act):

- *death or injury to marine species following capture in shark control programs on ocean beaches, and*
- *entanglement in, or ingestion of, anthropogenic debris in marine and estuarine environments.*

Under recent legislative changes, the preparation of recovery plans is no longer mandatory for all species listed as threatened under the FM or TSC Acts. While *Threat Abatement Plans* must be consistent with the *Priorities Action Statements*, no recovery plans have been finalised under the FM Act for threatened marine species, none are recommended to be prepared for key threatening marine processes under the TSC Act and no threat abatement plan are outlined to eliminate or manage the key threatening process under the FM Act. Recovery programs are, however, underway for the grey nurse shark and great white shark, involving tagging, tracking, documentation of reproductive cycles and a project to examine the feasibility of a breeding program for grey nurse sharks and some fishing restriction in listed Critical Habitat (see chapter 3.5).

A range of marine species has also been listed under the TSC Act, including 37 species, mainly birds, but also seven mammals (the dugong, two fur seals and four whales), three turtles and a saltmarsh plant. The shorebird community occurring on the relict tidal delta sands at Taren Point is listed as an Endangered Population and coastal saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions is listed as an Endangered Ecological Community.



Table 2: Marine species listed as threatened in the Threatened Species Conservation Act

Category	Marine Mammals	Marine Reptiles	Marine Birds
Endangered sp.	dugong	loggerhead turtle	southern giant petrel
	blue whale		gould's petrel
			wandering albatross
			beach stone-curlew
			little tern
End. Populations			little penguin -Manly Point area
Vulnerable sp.	New Zealand fur-seal	green turtle	northern giant-petrel
	Australian fur-seal	leathery turtle	kermadec petrel
	sperm whale		black-winged petrel
	humpback whale		providence petrel
	southern right whale		masked booby
			little shearwater
			flesh-footed shearwater
			antipodean albatross
			Gibson's albatross
			sooty albatross
			black-browed albatross
			shy albatross
			white-bellied storm-petrel
			osprey
		sooty oystercatcher	
		pieb oystercatcher	
		greater sand-plover	
		lesser sand-plover	
		white tern	
		grey ternlet	
		sooty tern	
Total	7	3	27



1.6. Fishing

While the impacts on water quality from development and urbanisation resulting in eutrophication, sedimentation and local pollution from sewage and stormwater overflow are serious issues facing estuaries, collection and fishing practices pose possibly the most serious threats to the health of most marine ecosystems. Indeed overfishing is considered by some to be the most significant adverse anthropogenic impact today on marine ecosystems.⁴³ Eutrophication and sedimentation have led to serious impacts on, for example, seagrass communities in some estuaries. However, despite these impacts on estuarine ecosystems in highly developed catchments, marine waters in NSW are generally considered to be in relatively good condition, as currents, wave action and tides are usually able to dilute pollution, making them less vulnerable to degradation.⁴⁴

Nevertheless, many fish stocks in NSW have, over the last 50-100 years, been significantly 'fished down'.⁴⁵ 'Fishing down' occurs when a stock has been driven to a state of low recruitment, and therefore low production compared to what it could be if the stock was permitted to recover.⁴⁵ The diversity of wild fish species exploited by NSW commercial and recreational fishers, together with the limited knowledge of the biology and dynamics of fished populations, means that most of our fisheries fall into the 'data-limited, multi-sector' category. Declining commercial catches, increased catch variability and reductions in the size of fish caught in NSW managed waters are testament to the paucity of data and the difficulty in managing the multi-sector NSW fishery with its significant cross-fishery issues. These difficulties are a likely result of mismanagement of the resource in previous decades, poor stock assessment, and a lack of regional ecosystem assessments of fishery impacts.

According to DPI Fisheries catch statistics,⁴⁶ the NSW commercial catches of 18 species have been in decline for more than 10 years. In response, DPI Fisheries have instituted performance indicators and triggers for 34 species based on historical catch trends. These measures are, however, often based on flawed assumptions and even when fishing closures are triggered - based on recent stock and catch developments - they cannot guarantee a stocks recovery, as long-term damage to stock recruitment potential may have already occurred.

NSW fisheries differ from those in other states in that all commercial fishers were not subject to restricted entry until 1997, decades after other states of Australia.⁴⁷ The advent of limited entry in commercial fisheries in Australia in the 1960s, 70s and 80s was resisted by the fishery managers in NSW at that time. By the 1990s, it was clear that the legacy of 'laissez faire' was over-exploited fisheries and poor economic earnings in the commercial sector.⁴⁸ The economic impact of the lack of capacity restraining measures in previous decades now haunts most fishery management decisions in NSW.⁴⁹ Indeed, the common characteristic of commercial fisheries in NSW is low economic returns.

In response, the number of fishing businesses in NSW has been halved over the last decade. However, this has not led to a significant improvement in profitability and the resource rent provided by commercial fishing in NSW. The likely reason for this is that many of the fishing businesses bought-out by DPI Fisheries have been inactive. While latent commercial fishing

⁴³ Pauly *et al.*, 2002

⁴⁴ NSW SOE, 2006

⁴⁵ Stevens, 2005

⁴⁶ Scribner & Kathuria, 1996; Tanner & Liggins, 1999, 2000 and 2001; Anon, 2004

⁴⁷ McIlgorm, 2006; Dominion Consulting, 2002

⁴⁸ McIlgorm, 2006

⁴⁹ Dominion Consulting, 2002



effort must be removed from NSW fisheries, removing them does little for sustainability and therefore the profitability of the industry.

According to DPI Fisheries' EIS supporting documents, few commercial fishing businesses turn a profit. Low declared returns and high operating costs of commercial fishing businesses are similar across all NSW fisheries. The proportions of fishing businesses declaring a profit in the various NSW fisheries are as follows:

- Estuary General 20%.⁵⁰
- Ocean Haul Fishery 25%.⁵¹
- Ocean Trap and Line Fishery 28%.⁵²
- Ocean Trawl Fishery 41%.⁵³
- Abalone Fishery 50%.⁵⁴

Even the heavily regulated Rock Lobster fishery fails to generate any significant reported profit for fishers.⁵⁵ The decline in the profitability of Rock Lobster endorsements is reflected in the share price which has declined from \$2,400 per share in 1998 to \$800 in 2003.⁵⁶

These unacceptably low returns for the private exploitation of public resources mean that it is difficult for DPI Fisheries to recover full management costs of the NSW fisheries. The most recent DPI Annual Report (2005/2006) states that:

*Of the eight commercial fisheries only two, abalone and rock lobster, are subject to full cost recovery of attributable costs, although there is still some degree of government contribution.*⁵⁷

The excessive cost of buying back unsustainable fishing businesses, and the lack of a profitable industry from which to levy the full cost of management, has contributed to the inability of DPI Fisheries to adequately assess stocks and set sustainable catch limits for even the most heavily targeted commercial species. DPI Fisheries states in an EIS that there is "very little specific knowledge on the ecological processes that are important for the ecological sustainability".⁵⁸ This EIS also states that there is "an inadequate knowledge base on which to determine effective management action".⁵⁹

In another EIS, DPI Fisheries states that: "The overall impact of the Estuary General Fishery on the environment is largely unknown..."⁶⁰ Such comments and admissions are common in the EISs and supporting documents prepared for individual commercial fisheries in NSW.

The DPI Fisheries' Fishery Management Strategy for the Estuary General Fishery admits that:

Little research has been done anywhere to assess the impacts that fishing has on the structure of estuarine ecosystems and none has been undertaken in relation to the Estuary

⁵⁰ Dominion Consulting, 2001, p.28

⁵¹ Dominion Consulting, 2002, p.21

⁵² DPI Fisheries, 2006, p.672 - 673

⁵³ Dominion Consulting, 2004, p.26

⁵⁴ Dominion Consulting, 2005a, p.22

⁵⁵ Dominion Consulting, 2004a, p.173

⁵⁶ Dominion Consulting, 2004a, p.177

⁵⁷ DPI Fisheries, 2006b, p.214

⁵⁸ DPI Fisheries, 2005, p.146

⁵⁹ *ibid*, p.95

⁶⁰ DPI Fisheries. 2001, p.214



General Fishery. ...However, such work has shown that fishing can significantly affect the structure and function of ecosystems (Hall, 1999; Kaiser and de Groot, 2000).⁶¹

Indeed very little is known about the trophic interaction,⁶² how many of the retained species interact with their habitats... and what habitats are important to them,⁶³ or the status of most of the principal retained species of the NSW fisheries.⁶⁴

Of even greater concern is DPI Fisheries admission that:

Little is known about the biology and ecology of many of those species listed as endangered or threatened, and the potential impacts of commercial fishing on these species are even less understood.⁶⁵

Despite the lack of adequate stock assessments and detail about the impacts on marine ecosystems of commercial fishing, or indeed because of it, commercial catches continue to decline. For example, since the early 1990s, there has been a significant decline in total catch within the Ocean Fish Trawl Fishery, which DPI Fisheries admits can be attributed to the collapse of the eastern gemfish stock and the impact of fishing on a number of secondary species, among other factors.⁶⁶

Commercial overfishing and by-catch has led to the gemfish (*Rexea solandri*) being recommended by the Fisheries Scientific Committee as 'Endangered' as it is 'facing a very high risk of extinction in New South Wales in the near future.'⁶⁷

The demise of the eastern gemfish population should act as a warning to fishery managers. Yet for the Estuary General Fishery, DPI Fisheries admits that knowledge of the current stock status is poor or non-existent⁶⁸ for the 29 primary species targeted, a further 12 are assessed as having a decreasing five year catch trend and the exploitation status is unknown for another 16 species.⁶⁹

⁶¹ DPI Fisheries, 2001, p.214, Ch C-p.49

⁶² *Ibid*, Ch F-p.301

⁶³ *Ibid*, Ch F-p.346

⁶⁴ *Ibid*, Ch E-p.193

⁶⁵ DPI Fisheries, 2001, Ch C-p.159

⁶⁶ DPI Fisheries, 2004a, p.50

⁶⁷ NSW Fisheries Scientific Committee, 2006

⁶⁸ DPI Fisheries, 2001, p.193

⁶⁹ *ibid*

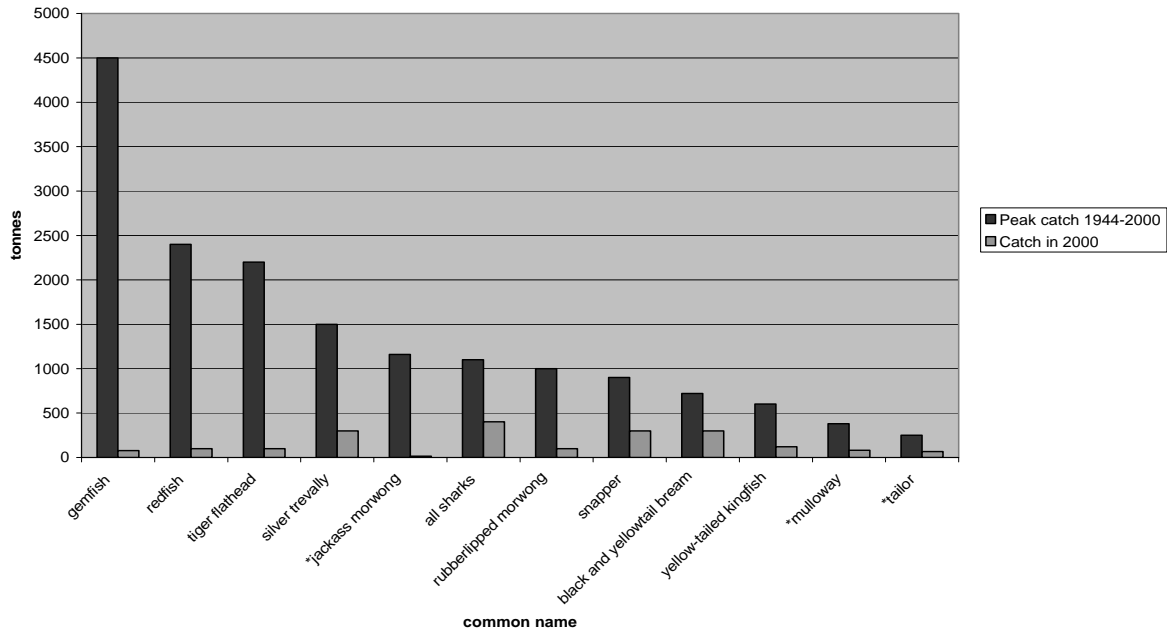


Fig. 1: Commercial landings of historical catches of selected NSW marine fishes.⁷⁰

* Indicates more taken by recreational fishers than commercial fishers - not included in this chart.

The Rock Lobster Fishery for eastern and southern rock lobsters is fully fished. A number of by-catch species that are marketed by this fishery are overfished, including silver trevally. However, a great deal of uncertainty is associated with other by-catch species such as wobbegong shark, blind shark, eastern red scorpion cod, painted lobster, slipper lobster, catsharks and swell sharks, maori wrasse and crimson-banded wrasse.

DPI Fisheries states in the assessment for the Ocean Trawl Fishery that:

*It is concerning that a large proportion of the primary and key secondary finfish species have shown declines or have started to decline in the Ocean Trawl Fishery in the last decade.*⁷¹

DPI Fisheries states that: 'Production across all commercial fisheries has declined over the long-term [30 years] for eight of the 11 primary species' and 'catch-per-unit-effort had declined for six of the 11 primary caught species.'⁷²

⁷⁰ Based on Pease and Grinberg, 1995; Scribner and Kathuria, 1996; Tanner *et. al.*, 1996; Tanner and Liggins, 1999; Tanner and Liggins, 2001

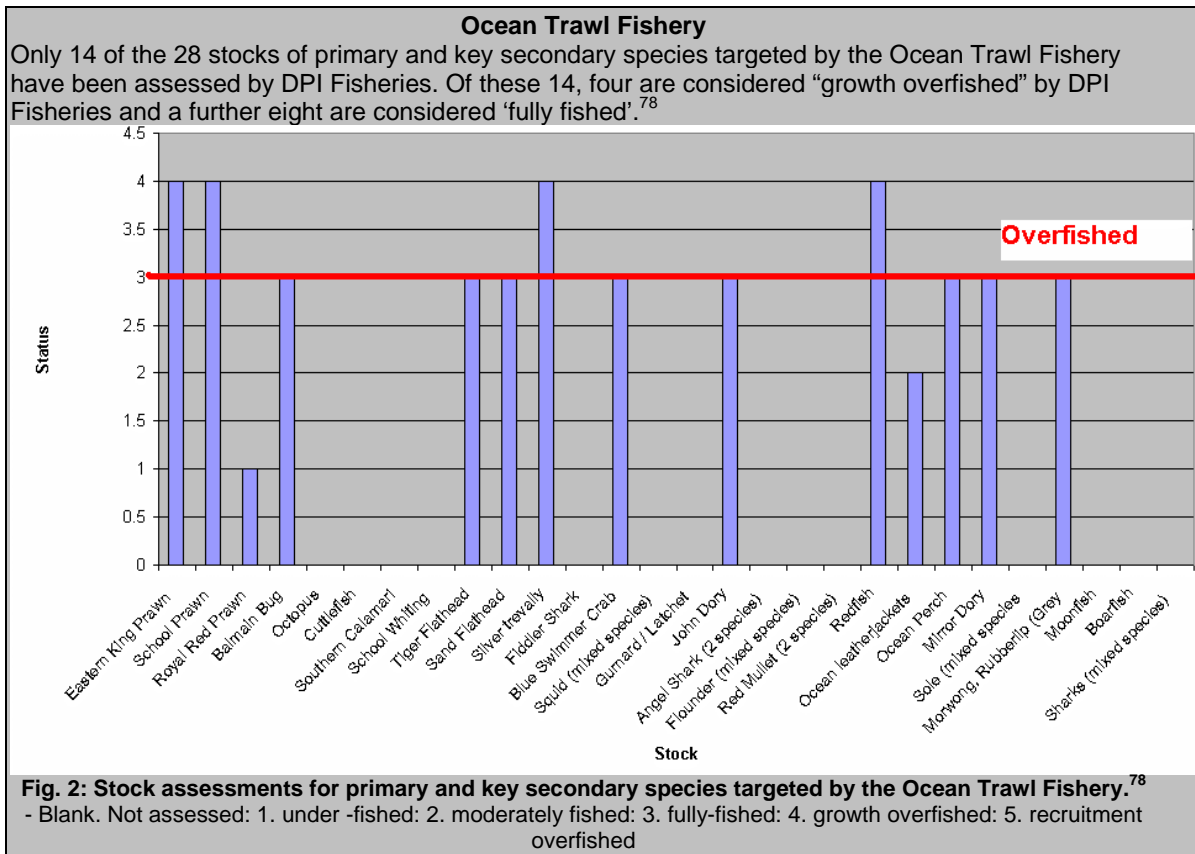
⁷¹ DPI Fisheries, 2004a, Vol 1-p 114

⁷² DPI Fisheries, 2006, p.122

DPI Fisheries identify nine species targeted by commercial fishers as being overfished:

- school prawn (*Metapenaeus macleayi*),⁷¹
- eastern king prawn (*Penaeus plebejus*),⁷³
- sea garfish (*Hyporhamphus australis*),⁷²
- silver trevally (*Pseudocaranx dentex*),⁷⁴
- yellowtail kingfish (*Seriola lalandi*),⁷³
- mulloway (*Argyrosomus hololepidotus*),⁷³
- snapper (*Pagrus auratus*),⁷³
- gemfish (*Rexea solandri*)⁷⁵ and
- redfish (*Centroberyx affinis*).⁷⁶

The average age of sea mullet (*Mugil cephalus*) - which makes up 80% of the Ocean Haul Fishery catch - has also been declining, as have spawning stock levels.⁷⁷



⁷³ DPI Fisheries, 2007, p.27

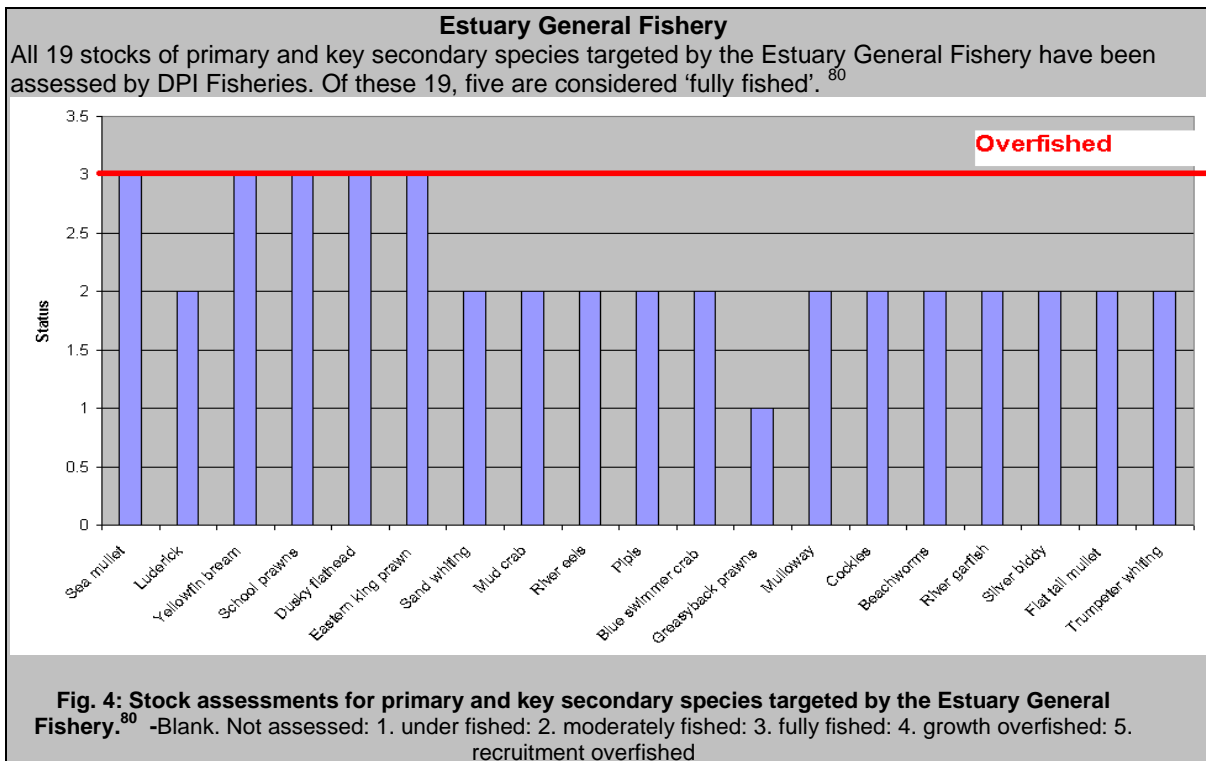
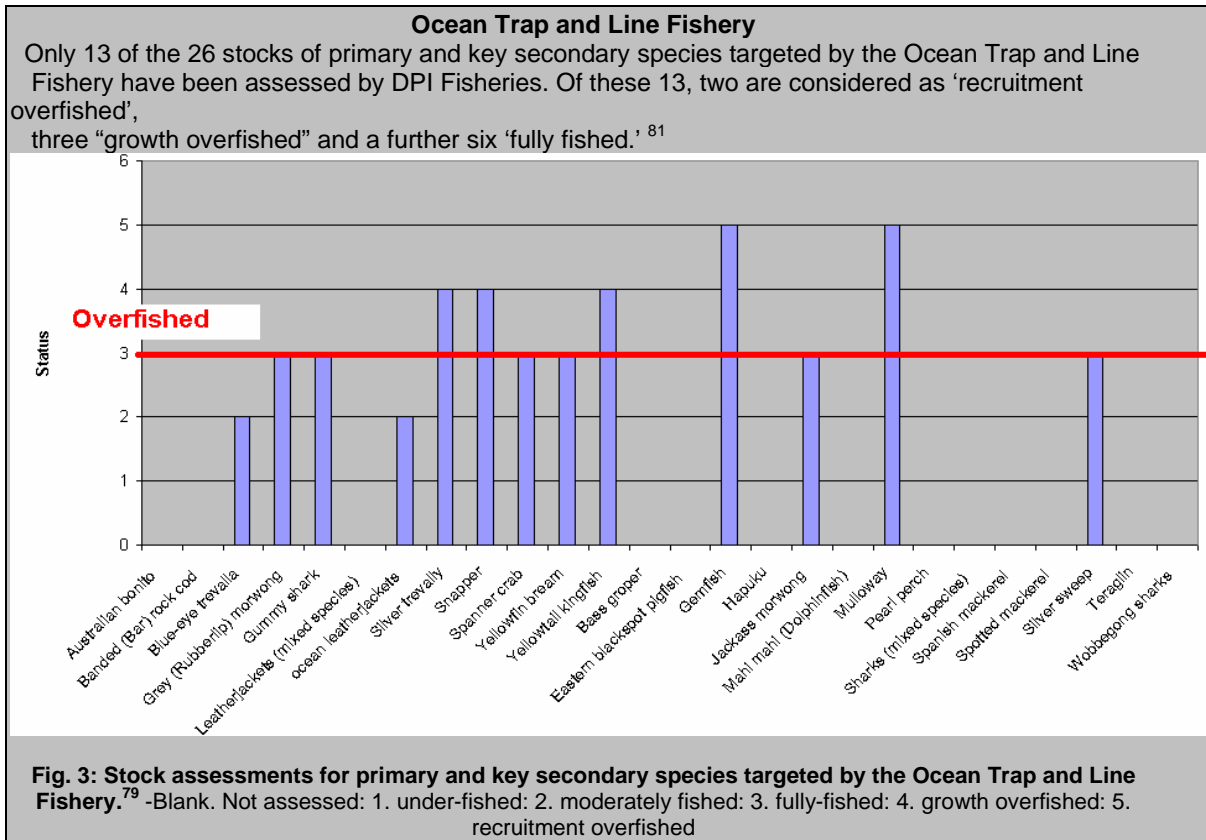
⁷⁴ *ibid*, p.22

⁷⁵ DPI Fisheries, 2006, p.685

⁷⁶ DPI Fisheries, 2004, p.114

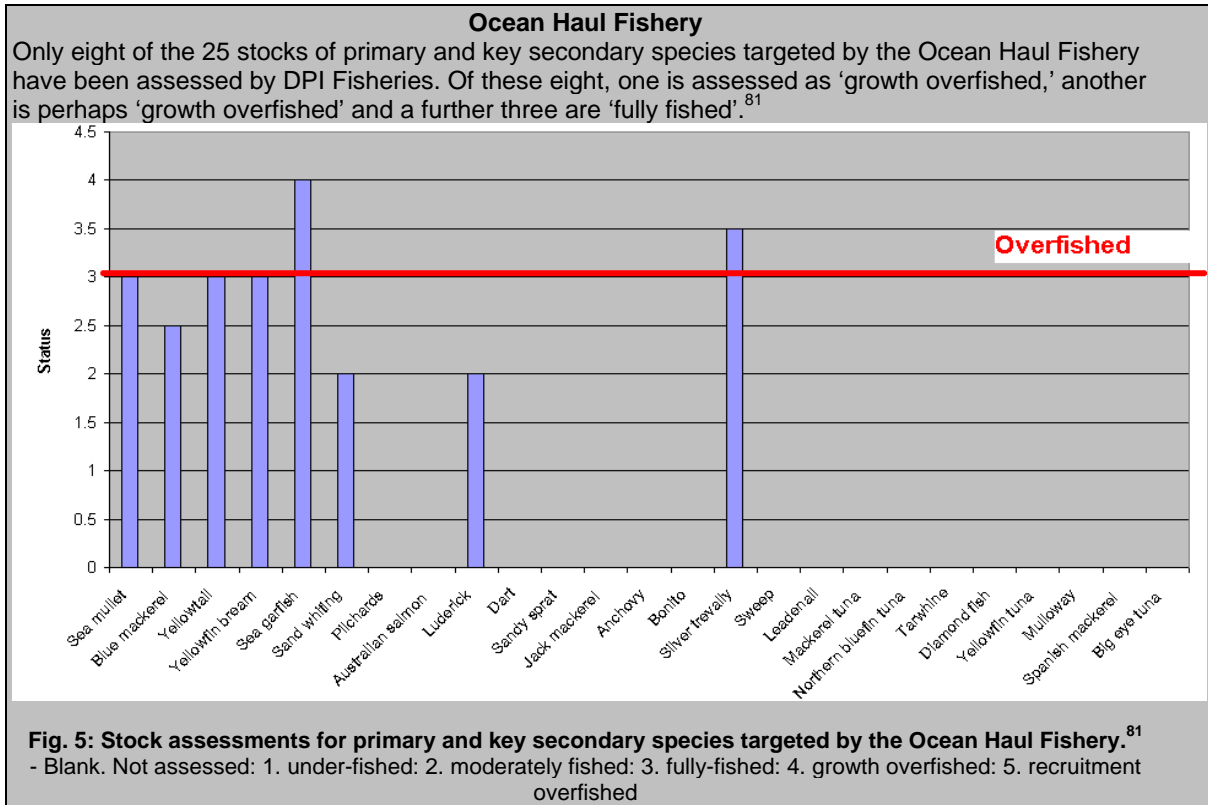
⁷⁷ DPI Fisheries, 2002a, Ch E-p.195

⁷⁸ DPI Fisheries, 2007



⁷⁹ DPI Fisheries, 2006a

⁸⁰ DPI Fisheries, 2003



Overfishing is only one severe impact of current commercial fishing in NSW. Another is habitat alteration and the incidental catching of unwanted species or 'by-catch'. A study published in 1998 found that between 1990 and 1992, 74.7% of the total catch in the Ocean Prawn Trawl fishery was discarded.⁸² Of this discarded catch, 13.9% were commercial species and 60.8% were non-commercial species.⁸² In recent years, DPI Fisheries have endeavoured to enforce by-catch reduction devices on commercial trawl nets in an attempt to reduce by-catch. By-catch, however, remains a serious problem, particularly for the juveniles of species targeted by other fisheries.

Quite apart from overfishing and by-catch, the impact of bottom trawling has a great impact on some marine ecosystems. DPI Fisheries in their EIS for the Ocean Trawl Fishery states that:

*It is noted that a 'significant component' of the catches are sessile invertebrate species (sponges and bryozoans, for example) but that the impacts of trawling on these species has not been studied.*⁸²

While little assessment of the effects of bottom trawling on benthic (sea floor) ecosystems has been undertaken in NSW, those impacts that have been identified are likely to have been significantly underestimated, as impacts have generally been determined by the number and mass of detached organisms retained in nets. More recently, it has been found that while in some areas the standard demersal trawl reduced benthos (benthic organisms) density by 15.5% (mainly sponges, soft corals, and gorgonians) on each tow, only 4% of the benthos detached was actually retained in the net.⁸³

⁸¹ DPI Fisheries, 2003a

⁸² DPI Fisheries, 2004a, Vol 1, p.121

⁸³ Moran & Stephenson, 2000



One study that has attempted to estimate the impact of demersal trawling suggests that the amount of the least resilient benthic fauna removed each year in trawl grounds is likely to be more than 80%.⁸⁴ The overall impact is related to the resilience of benthic fauna and its degree of aggregation within the trawled areas, as well as the intensity of trawling.⁸⁴ Nevertheless, fauna with no capacity for recovery will eventually be completely removed from all trawled areas (these would include sponges and corals).⁸⁴ In high-effort trawling grounds, aggregated trawling may remove smaller amounts of benthos than if effort were distributed randomly or uniformly.⁸⁴ The implication is that removing trawling from certain areas and aggregating trawling in other areas may be more beneficial than reducing intensity and allowing trawling to continue across larger areas.

To mitigate the impacts of trawling in southern NSW ocean waters, the Fishery Management Strategy for the Ocean Trawl Fishery developed by DPI Fisheries states that:

*Under this management response, 75% of all State waters located south of Barrenjoey Point will be closed to all trawling. Industry representatives and NSW Fisheries will work together to identify and map those areas...*⁸⁵

Why this management response has not been introduced to northern NSW waters, where the NSW managed fishery extends to between 60nm and 80nm, is not explained in the Management Strategy. However, trawling in south coast waters is suggested to be far more intensive than that of northern NSW waters.

The disruption of trophic cascades (food chains) is another significant impact of fishing. Fishing has been shown to disproportionately reduce abundances of predators,⁸⁶ leading to concern about their conservation and the indirect effects that may result from their removal. Evidence of an oceanic ecosystem transformation resulting from the removal of predators such as large sharks is suggested to have contributed to the proliferation of smaller species that have cascaded down the food web leading to an impact on benthic organisms such as bivalves.⁸⁶ Warnings have been expressed of the potential for this cascade to extend to benthic habitats such as seagrass, exacerbating stresses on already highly degraded coastal benthic systems.⁸⁷

It is suggested that such 'top-down effects' must be widely expected whenever entire functional groups of predators are depressed, as can occur with industrial fisheries.⁸⁸ The removal of predators from ecosystems appears to be having just such an effect in NSW due to an increase in biomass of prey species, such as sea urchins, as they are released from predation pressure.⁸⁸

In addition to commercial fishing, there is a burgeoning recreational catch that is currently not adequately addressed in any impact assessments. In NSW, a survey of recreational fishing⁸⁹ revealed that in the twelve months prior to May 2000, approximately 1 million people or 17.1% of the population over the age of 5 years fished at least once. In one year, it has been estimated that these fishers harvested 33.4 million individual marine organisms.⁸⁹ It is further estimated that the recreational fishing catch is approximately 30% (by weight) of the commercial catch.⁸⁹ This indicates a strong contribution to pressures on resources from recreational fishers. As recreational fishing is difficult to manage through input controls such

⁸⁴ Pitcher *et al.*, 2000

⁸⁵ DPI Fisheries, 2007, pp 35-36.

⁸⁶ Pauly *et al.*, 1998; Jackson *et al.*, 2001

⁸⁷ Myers *et al.*, 2007

⁸⁸ Reynolds *et al.*, 2002

⁸⁹ DPI Fisheries, 2002

as regulating the numbers of those who fish, and output controls such as bag limits, which are difficult to monitor and enforce, marine sanctuaries provide one of the few available means of maintaining a proportion of unfished biomass to replenish fish stocks elsewhere.

As recreational fishers preferentially target larger aggressive predatory fish, their relative impacts on trophic cascades are likely to be high. Recent studies have suggested that targeting the largest and most aggressive fish in a population is leading to maladaptive genetic selection for smaller, slower maturing less aggressive fish, which has profound evolutionary implications for productivity and population recovery.⁹⁰

For example, the long-lived and slow-growing snapper reportedly lives up to 35 years,⁹¹ and is recognised as being ‘growth over-fished’ by NSW Fisheries, where the average size of fish landed is declining. Each year NSW anglers catch about 117 tonnes of snapper (300,000 fish) of an average weight of about 400 grams (the legal weight is about 600 grams).⁹² However, in Victoria the average snapper caught is almost 700grams. In Queensland, the average snapper caught by anglers is 1.5 kilograms, and in South Australia the average snapper caught is 3.7 kilograms. The Australian record snapper (18.4kg) was caught in South Australia in 1994. The NSW State record (13.2kg) was caught at Kiama in 1975. However, the species is reported to grow up to 20kg and 1.3m.

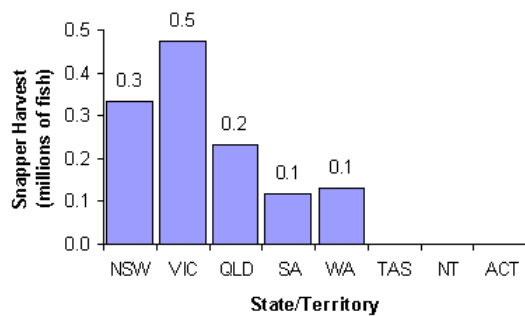


Fig. 6: Estimated recreational harvest of snapper (numbers) by State or Territory.⁹²

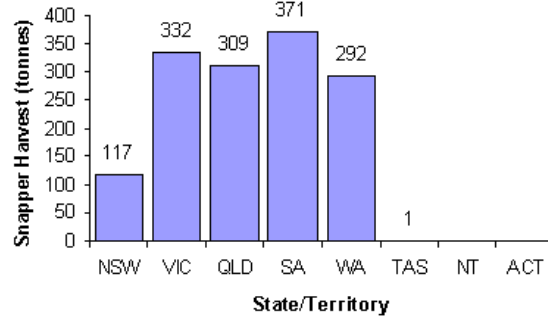


Fig. 7: Estimated recreational harvest of snapper (tonnes) by State or Territory.⁹²

Studies have found that fishing tends to amplify both the peaks and the troughs of population numbers, and can potentially not only lead to declining stock levels, but actually cause populations to fluctuate more through time, putting them at greater risk of collapse than previously thought.⁹³

The reason fished populations become more variable may be a consequence of fishing selectively culling the larger, older individuals, thereby removing the fish that are better able to buffer random environmental variation and add year to year continuity to the population.⁹³ These individuals also tend to be the most reproductively active in their populations.⁹³ As fishing proceeds, there is a tendency for the size and age of individuals in the population to decline, potentially leaving a stock of near juveniles that is less able to cope with environmental pulses such as El Niño events and climate change.⁹³ The most immediate implication for fisheries management is that beyond the potential for causing a decline in abundance, fishing – even at so-called ‘sustainable’ levels - can provoke greater variability in exploited populations (and therefore reduced resilience), increasing the risk of collapse of a fishery from random environmental events.⁹³

⁹⁰ Walsh *et al.*, 2006

⁹¹ Bureau of Rural Sciences and Fisheries, 1993

⁹² DAFF, 2007

⁹³ Hsieh *et al.*, 2006



New findings have suggested that size-selective harvesting can cause genetic changes inducing fish to grow slower and mature at smaller sizes and at younger ages.⁹⁴ Of particular concern are indications that these evolutionary changes may happen quickly. Recent results suggest that this effect can lead to fishery yields dropping by as much as 50% within only a few generations.⁹⁴ For non-migratory species, no-take marine sanctuaries have been recommended as one of the best ways of addressing such affects, as the full range of sizes and ages of a given species can thrive in such protected areas.⁹⁴

Protecting representative habitats within biogeographic regions offers benefits to stocks that cannot be achieved by any other means.⁹⁵ It has been suggested that no other method of management, even size limits, can preserve the potential for longevity as well as marine sanctuaries and allow the unique contributions of older fish to accrue to the population.⁹⁵ Scientists suggest that the implementation of marine sanctuaries, combined with conventional fisheries management approaches, is essential for the replenishment and sustainability of reef fish stocks.⁹⁵

In NSW, recovery of wild fish stocks requires very significant reductions in all types of fishing effort and will take many years.⁹⁶ However, once NSW stocks have recovered, they will support more viable fisheries because the same catch can be harvested with less effort.⁹⁶ Nevertheless, without adequate assessments and appropriate catch limits, some NSW fisheries resources are exposed to collapse through overfishing. In such a situation, the public interest would dictate a precautionary approach.

The objects of the FM Act are as follows:

- (1) The objects of this Act are to conserve, develop and share the fishery resources of the State for the benefit of present and future generations.*
- (2) In particular, the objects of this Act include:*
 - (a) to conserve fish stocks and key fish habitats, and*
 - (b) to conserve threatened species, populations and ecological communities of fish and marine vegetation, and to promote ecologically sustainable development, including the conservation of biological diversity,**and, consistently with those objects:*
 - (d) to promote viable commercial fishing and aquaculture industries, and to promote quality recreational fishing opportunities, and*
 - (f) to appropriately share fisheries resources between the users of those resources,**and*
 - (g) to provide social and economic benefits for the wider community of New South Wales.*

The promotion of ecological sustainable development is set out in the *Protection of the Environment Administration Act* as requiring the effective integration of economic and environmental considerations in decision-making processes, and can be achieved through the implementation of the following principles and programs:

- (a) the precautionary principle - namely that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.*
- In the application of the precautionary principle, public and private decisions should be guided by:*

⁹⁴ Conover, 2007

⁹⁵ Berkley *et. al.*, 2004

⁹⁶ Stevens, 2005



- (i) careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment, and*
- (ii) an assessment of the risk-weighted consequences of various options,...*

The Precautionary Principle plays a pivotal role in the application of ecological sustainable development in NSW. However, DPI Fisheries refuse to apply the Precautionary Principle to fisheries management, claiming that to apply it to NSW fisheries “would mean that all species for which biological knowledge gaps exist would be assessed as having a high level of risk”,⁹⁷ and that such an approach would mean that most species of economic importance in NSW could not be commercially harvested. This is an alarming admission. Such a rejection of a fundamental principle of resource management and sustainability should be of profound concern to scientists, resource managers and policy makers everywhere.

NPA believes that the precautionary principle should be partly implemented into NSW fisheries through establishing marine sanctuaries over adequate representative samples of habitats and ecosystems in NSW managed marine waters. It has been shown that marine sanctuaries can reduce the chances of overfishing of some fish species by providing refuges from population exploitation. Compared to having all areas exploited under one set of regulations, sanctuaries can provide greater fishery yields in the long-term by having a larger and more dependable supply of eggs and larvae dispersed to fishing grounds.⁹⁸

⁹⁷ DPI Fisheries, 2001, p.67

⁹⁸ Bohnsak *et. al.*, 2004