

BACKGROUND PAPER

for the

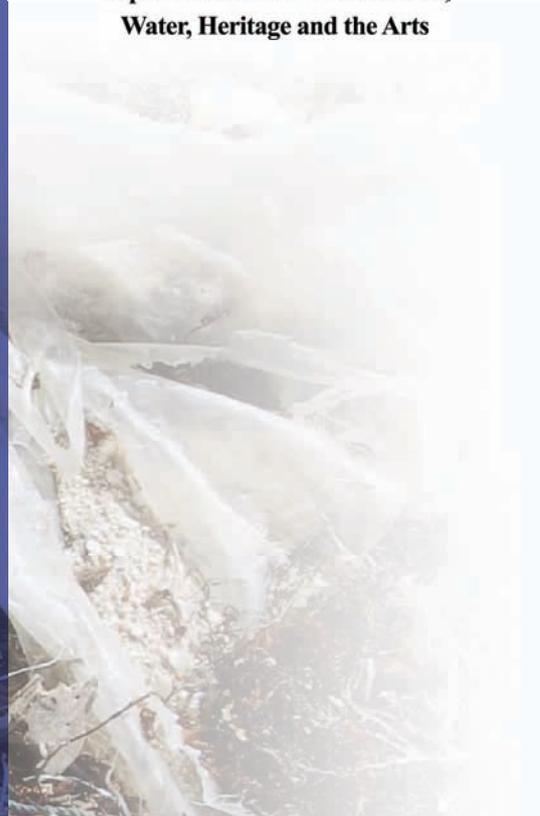
THREAT ABATEMENT PLAN

for the impacts of marine debris on vertebrate marine life

May 2009



Australian Government
**Department of the Environment,
Water, Heritage and the Arts**



Cover image (main):

Cape Arnhem, Northern Territory. Dr Ilse Kiessling.

Cover image (left-hand inlayed):

Customs officers Annette Brewer and Craig Butler disentangling a turtle from a derelict fishing net, north of Middle Island, Ashmore Reef, Craig Butler.

Cover image (centre inlayed):

Prince of Wales Island, Torres Strait. Dr Ilse Kiessling.

Cover image (right-hand inlayed):

*Nesting Gray Headed Albatross (*Thalassarche chrysotoms*) at Petral Peak (LA 420B4), Macquarie Island.*

Photographer Unknown, Australian Antarctic Division © Commonwealth of Australia.

Department of the Environment, Water, Heritage and the Arts

© Commonwealth of Australia 2009

This work is copyright. Apart from any use as permitted under the *Copyright Act 1968*, no part may be reproduced by any process without prior written permission from the Commonwealth, available from the Department of the Environment, Water, Heritage and the Arts. Requests and inquiries concerning reproduction and rights should be addressed to:

Assistant Secretary

Marine Environment Branch

Australian Government Department of the Environment, Water, Heritage and the Arts

GPO Box 787

CANBERRA ACT 2601

This publication is available at:

<http://www.environment.gov.au/biodiversity/threatened/publications/tap/marine-debris.html>

For additional hard copies, please contact the Department of the Environment, Water, Heritage and the Arts, Community Information Unit on 1800 803 772.

The contents of this document have been compiled using a range of source materials and is valid as at May 2009. The Commonwealth Government is not liable for any loss or damage that may be occasioned directly or indirectly through the use of or reliance on the contents of the document.

Preface

‘Injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris’ was listed in August 2003 as a key threatening process under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). A key threatening process is a process that ‘threatens or may threaten the survival, abundance or evolutionary development of a native species or ecological community’.

Under the EPBC Act, the Australian Government implements the threat abatement plan (TAP) as it applies to Commonwealth areas and seeks the collaboration of state, territory and local governments and other stakeholders to implement the TAP as it applies to them.

Harmful marine debris negatively impacts substantial numbers of Australia’s marine wildlife, including many protected species of birds, turtles and marine mammals. Threat abatement plans focus on strategic approaches to reduce the impacts of key threatening processes that jeopardise the long-term survival of native species and ecological communities. This TAP specifically provides a framework for the abatement of injury and fatality to marine species caused by harmful marine debris.

The Department of the Environment, Water, Heritage and the Arts is very grateful for the assistance of a number of experts, managers, and community groups who have contributed to the development of this TAP.

Contents

PREFACE	<i>iii</i>
1. INTRODUCTION	1
2. DEFINING THE KEY THREATENING PROCESS	2
2.1 Magnitude of harmful marine debris	2
2.2 Composition of harmful marine debris	2
2.3 Origin of harmful marine debris	3
2.3.1 Domestic sources and management of harmful marine debris	3
2.3.2 International sources of harmful marine debris in Australian waters	5
2.4 Impacts of harmful marine debris on marine wildlife	5
2.4.1 Entanglement	5
2.4.2 Ingestion	6
2.4.3 Other impacts of marine debris	6
2.5 Marine wildlife negatively impacted by harmful marine debris	6
2.5.1 Marine turtles	8
2.5.2 Cetaceans	9
2.5.3 Sharks	10
2.5.4 Seabirds	10
3. CURRENT MANAGEMENT OF THE KEY THREATENING PROCESS	11
3.1 Current management for the prevention of harmful marine debris	11
3.1.1 Land-based sources	11
3.1.2 Marine-based sources	13
3.2 Current management for the removal of harmful marine debris	16
3.3 Current management for the mitigation of the impacts of harmful marine debris	16
3.4 Current monitoring of harmful marine debris	17
APPENDIX A THREAT ABATEMENT PLANS AND THE EPBC ACT	19
APPENDIX B THREAT ABATEMENT PLAN ACTIVITIES	22
GLOSSARY	30
REFERENCES	31

1. Introduction

This background paper provides context to the *Threat abatement plan for the impacts of marine debris on vertebrate marine life* (Commonwealth of Australia, 2008). The threat abatement plan (TAP) provides a coordinated national approach to the implementation of measures to prevent and mitigate the impacts of harmful marine debris on vertebrate marine life. These documents have been prepared in consultation with representatives of industry, conservation groups, Indigenous organisations, community and government to meet the Australian Government's obligations under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) (Appendix A). The findings and recommendations of a number of studies (see References) and the outcomes of two stakeholder workshops held during 2004 have also informed the development of this TAP.

'Injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris' was listed as a key threatening process in August 2003. For the purposes of the TAP harmful marine debris refers to all plastics and other types of debris from domestic or international sources that may cause harm to vertebrate marine wildlife. This includes land-sourced waste and garbage (such as bags, bottles, ropes, fibreglass, piping, insulation, paints and adhesives), abandoned fishing gear from recreational and commercial fisheries (e.g. strapping bands, synthetic ropes, derelict fishing nets, floats, hooks, fishing line and wire trace), and ship-sourced, solid, non-biodegradable floating materials disposed of at sea (e.g. fibreglass, insulation) (TSSC, 2003).

The key threatening process does not include debris that is not harmful to marine wildlife such as floating wooden objects and metal objects which do not cause entanglement and are unable to be ingested. Fishing nets and lines under the control of fishers, and marine debris resulting from the legal disposal of garbage such as food, paper, rags, glass, metal and crockery at sea under the provisions of the International Convention for the Prevention of Pollution from Ships (MARPOL) are outside the scope of the TAP. The main objectives of the TAP are to:

1. Contribute to the long-term prevention of the incidence of harmful marine debris
2. Remove existing harmful marine debris from the marine environment
3. Mitigate the impacts of harmful marine debris on marine species and ecological communities
4. Monitor the quantities, origins and impacts of marine debris and assess the effectiveness of management arrangements over time for the strategic reduction of debris.

2. Defining the key threatening process

Marine debris is one of the world's five major marine pollutants (ANZECC, 1995), and it has been identified as an issue of growing concern in a number of studies and international conferences.

Information and data on the sources, magnitude and impacts of marine debris around Australia has been derived primarily from land-based coastal surveys. This information probably under-represents the actual quantity of marine debris in Australia's marine and coastal environments, as debris may sink, may become buried underground or become entangled underwater on rocky outcrops and reefs, and never float ashore. There is little information available on the magnitude of the debris that is floating in the sea or present on the seabed. In order to better understand the impact of marine debris on marine wildlife, it is important to improve information on the sources, composition and magnitude of debris. In the meantime, existing survey results and anecdotal reports provide a useful perspective on the areas and species most impacted by marine debris.

2.1 Magnitude of harmful marine debris

It is difficult to determine where debris accumulates in the highest concentrations around Australia's coastal environments, as a comprehensive assessment has not been undertaken. However, available data suggest that high concentrations of debris accumulate on parts of the coastline all around Australia. Specific areas where debris has been reported at comparatively high densities include coasts adjacent to urban centres and remote areas of northwestern Cape York, Groote Eylandt, northeast Arnhem Land, the far north Great Barrier Reef, parts of South Australia including Anxious Bay, parts of Western Australia, southwest Tasmania, and Australia's sub-Antarctic Islands (Cary et al., 1987; Slip, et al., 1990; Slater, 1991; Slip and Burton, 1992; RAOU, 1996; SDAC, 1996; Frost and Cullen, 1997; Haynes, 1997; Herfort, 1997; Sloan et al., 1998; Pryor, 1999; Kiessling, 2003; Edyvane et al., 2004; White, 2003, 2004, 2006; Eglinton et al., 2005; Roelofs et al., 2005; DTAE and DPIWE, 2007).

Quantities of debris in these areas range from more than 400 kg of debris per kilometre along remote parts of the northern Australian (White, 2006) to 15 kg of debris per kilometre or less on heavily polluted parts of more remote southern Australian coastlines including Australia's sub-Antarctic Islands (Slip and Burton, 1990; Wace, 1994; Edyvane et al., 2004).

2.2 Composition of harmful marine debris

Plastic is the most prevalent type of debris found on beaches world wide, comprising between 50 — 90% by number of all debris items recorded (Coe and Rogers, 1987; UNEP 2005). In Australia, plastic waste including derelict fishing gear (nets, lines and ropes) is one of the most harmful types of debris to marine wildlife (Pemberton et al., 1992; Slip and Burton, 1992; Chatto, 1995; Laist, 1996; Limpus et al. 2003; Roeger et al., 2005).

Plastics pose a particular threat due to their durability. While plastics do break down into smaller pieces over time, there is no mechanism for biodegradation of conventional plastic (Andrady, 2000) and plastics in the marine environment tend to break down even more slowly than they do on land (Andrady, 1990, 2000; Derraik, 2002).

As plastics are highly durable, it is often hard to distinguish those items that recently entered the marine environment from those that have been circulating for months or many years. The fate and movement of debris after it enters the marine environment is difficult to predict and is likely to depend on a number of factors including whether it is loose or bagged, and its particular physical and chemical characteristics (National Research Council, 1995). For example, large, dense items such as glass bottles and metal items tend to sink, while small, light items may remain suspended in the water column or float, often for long periods of time. Debris may remain on beaches and in coastal waters for different

time periods depending on oceanic currents and wind patterns. Debris may also wash ashore on exposed beaches and drift laterally along the coastline or wash back out to sea (National Research Council, 1995). On less exposed beaches, debris may accumulate indefinitely and become buried in coastal sediments (Gregory, 1999).

Cigarette butts are another type of debris commonly found in Australian waters. Taking up to an estimated five years to break down in seawater, cigarette butts leech toxic chemicals and can be mistaken for food items, posing a direct threat to marine wildlife (Coast keepers, 2008). The composition of land-based litter varies among survey locations and specific catchment conditions. For example, food packaging and urban litter tends to be reported in areas close to population centres (O’Callaghan, 1993), derelict recreational and commercial fishing gear is reported near popular fishing locations (Widmer, 2002). However, in remote areas of Australia, debris is largely marine based. On remote sub-Antarctic, temperate and northern Australian shores, derelict commercial fishing debris comprises the greatest proportion of debris by weight or number of items (Edyvane et al., 2004; Kiessling, 2003; Slater, 1991; Woehler, 1990; Slip and Burton, 1992; White, 2003, 2006). On sub-Antarctic and northern shores the marine-based debris is notably derelict fishing nets from foreign sources. Some studies have also shown that the composition and source of debris at a particular location may change throughout the year and over time (Edyvane et al., 2004; Page et al., 2004).

2.3 Origin of harmful marine debris

The origin of debris on Australian beaches is influenced by a number of factors including proximity to urban centres, population of surrounding areas, and vicinity of marine-based activities. Marine debris can originate from either land-based sources or activities at sea, although it is often difficult to determine how debris first entered the marine environment.

2.3.1 Domestic sources and management of harmful marine debris

The Australian coastline is around 36 700km, and approximately 86% of Australia’s total population lives in the coastal zone. The marine environment includes Australia’s exclusive economic zone (EEZ) that generally extends up to 200 nautical miles offshore.

Management of activities that may contribute to domestic sources of marine debris within Australia’s marine and coastal environments is shared between the Australian, state, Northern Territory and local governments. In general, the Australian Government has powers over activities in Commonwealth waters (the area between three nautical miles offshore and the EEZ boundary). The states and the Northern Territory have power to legislate over most activities in coastal waters (up to three nautical miles offshore). Both local governments and the state and Northern Territory governments have responsibility for many activities on land that have the potential to contribute to harmful debris in coastal waters, such as municipal waste and stormwater management.

Given the complexity of governance and management arrangements relevant to activities within Australia’s marine jurisdiction, coordination, communication and consistency between levels of government and between government and non-government groups is critical to the effective implementation of marine debris threat abatement measures.

Land-based sources

Some of the main causes for land-sourced marine debris include littering and inadequate waste management arrangements (Wace, 1994, 1995). Coastal surveys near Australian cities have shown that around 75–80% of shoreline litter items are from land-based sources (O’Callaghan, 1993; Wace, 1994, 1995; Gregory and Ryan, 1997; Haynes, 1997; Clean Up Australia, 2006; Keep Australia Beautiful, 2006). Debris from land-based sources may enter the marine environment via wind, streams and drains from streets, municipal land fills and direct littering of beaches (Keep Australia Beautiful, 1996). Urban stormwater discharge is also a major pathway for marine debris in Australia (Cunningham and Wilson, 2003).

Pre-production plastic pellets, commonly known as nurdles, are an example of marine debris originating from land. Nurdles come in a range of sizes from 5mm plastic resin pellets to plastic resin powders of around 200 micrometres. Due to their size they are easily lost during transport and handling and are too small to be stopped by litter traps, so tend to wash down waterways into the marine environment, where they are mistaken for food and eaten by marine animals. Given the ability of persistent organic pollutants to accumulate in to plastic resin pellets, the harm potential for each pollutant individually becomes significantly greater when they are combined.

Marine sources

In remote areas, marine activities tend to be the primary source of debris recorded. For example, along parts of the northern Australian coastline, between 80 and 99% of all items of debris recorded is likely to originate from marine sources (Sloan et al., 1998; Whiting, 1998; Kiessling 2003), and on Australia's sub-Antarctic islands and the Great Australian Bight, up to 100% of debris recorded is from marine activities (Slip and Burton, 1991; Edyvane et al., 2004).

On remote northern Australian coasts, derelict fishing gear, primarily from foreign fishing operations, is the most significant category of debris in terms of impact on marine species (Kiessling, 2003; Roeger et al., 2005). Fishing debris has also been found in very high levels during surveys on remote beaches of southwest Tasmania (Slater, 1991).

Fishing gear may become derelict in two ways — either inadvertently during the course of normal operations or through deliberate disposal (Minton, 2000). Factors contributing to deliberate fishing gear disposal include limitations of solid waste disposal at ports; poor understanding of and compliance with waste disposal regulations and controls; and economic pressures that promote gear conflicts, greater risk taking with gear, expansion of fishing grounds and shifts to more durable gear (Carr and Harris, 1997; Topping et al., 1997). Fishing gear may also be accidentally lost due to storms, entanglements on reefs and rocks, and other mishaps. If all reasonable precautions are taken, such losses are not a breach of domestic or international marine pollution law.

Studies in parts of Australia have found a positive correlation between litter on beaches and numbers of recreational boats (Widmer, 2002), though recreational fishers tend to produce relatively small amounts of waste per person and per vessel in comparison to commercial vessels (National Research Council, 1995). The types of litter most frequently reported as associated with recreational boats are plastic bags, aluminium cans and glass bottles (Widmer, 2002). Recreational fishers are also responsible for the loss or disposal of lines, lures, and nets (Whiting, 1998; Thompson, 2000; Kiessling and Hamilton, 2001, 2003).

Most recreational boaters and fishers operate within three nautical miles (4.8km) of shore and are obliged under law to store all waste for disposal ashore. Actual waste disposal practices at sea are unknown and likely to be variable. As waste generated on board recreational boats is often indistinguishable from that generated on shore, it is difficult to accurately determine debris originating from recreational vessels.

A large number of commercial ships operate in Australian waters including Australian and foreign flagged vessels in domestic and international trade. Evidence suggests that commercial ships are likely to be responsible for a proportion of waste in Australia's marine environment. For example, a number of syringes and glass antibiotic bottles thought to be from livestock carriers have been found during surveys on Christmas Island (Environment Australia, 2001a) and Arnhem Land (Alderman et al., 1999; Kiessling and Hamilton, 2001, 2003), and livestock feedbags such as those used in the live cattle trade have also been reported to wash ashore in northern Australia (Leitch, 1997).

Other potential sources of marine debris include recreational leisure boats; coastal barges; surveillance vessels; offshore oil platforms, rigs and supply vessels; passenger cruise ships; and research vessels. Though all are required to conform to national, state, Northern Territory and international waste management requirements, considerable amounts of debris may be generated by these vessel types.

A range of factors must be considered when determining which marine-based sectors contribute to harmful marine debris. Key factors include amounts and types of waste generated, availability and cost of waste reception facilities in ports and marinas, numbers and types of vessels, duration of voyages, and the sophistication of waste management regimes employed by the sector and by individual vessels and crews.

2.3.2 International sources of harmful marine debris in Australian waters

Harmful marine debris is an international issue both in terms of its sources and impacts. For example, the majority of derelict fishing nets washing ashore on Australia's northern coastline originate from fishing activities beyond Australia's jurisdiction (Kiessling, 2003; White, 2003, 2006). Preliminary analysis of derelict fishing nets found in the Gulf of Carpentaria suggest that foreign fishing nets from fishing operations outside Australian jurisdiction are likely to comprise the greatest proportion (around 80%) of all nets washing ashore on beaches there. Foreign nets are causing some of the greatest harm to marine animals, especially marine turtles (Chatto, 1995; Kiessling, 2003; Roeger et al., 2005; White, 2003, 2006). Debris from international shipping and fishing activities has also been found along southern Australian coastlines (Edyvane et al., 2004) including sub-Antarctic islands (Slip et al., 1990; Slip and Burton, 1990, 1992).

A proportion of debris, other than derelict fishing nets, in Australian waters could also have international origins. For example, thick rubber and plastic sheeting from which the soles of handmade thongs are made, believed to have originated from outside Australian waters, washes ashore on many parts of northern Australia, including the beaches at the Cocos (Keeling) Islands (Wace, 1995). Numerous other items such as fishing net floats, sorting baskets, crates, buckets, hand reels, light globes, ropes and gloves, which may also be directly attributed to fishing and general shipping activities, are also found (Sloan et al., 1998; Whiting, 1998; Kiessling, 2003). Given the potential for ocean currents to transport debris long distances, dumping of urban waste in waters neighbouring Australia may be a source of debris washing ashore on Australian coasts. This highlights the need for regional and international collaboration to tackle harmful debris at its source effectively.

2.4 Impacts of harmful marine debris on marine wildlife

Numerous studies have documented impacts of harmful debris on marine wildlife in all the world's oceans (See for example, Eckert and Luginbuhl, 1988; Blight and Burger, 1997; Huckle-Gaete et al., 1997; Laist, 1997; Baird and Hooker, 2000; Starbird, 2000; Barreiros and Barcelos, 2001; Eriksson and Burton, 2001; Cadee, 2002; Sazima et al., 2002). Within Australian waters, records of impacted wildlife tend to be limited to land-based observations, and in many instances wildlife found negatively impacted by marine debris is not recorded.

Marine debris may impact wildlife through entanglement and ingestion. These impacts are described in more detail below.

2.4.1 Entanglement

Entanglement of marine wildlife tends to occur when animals feed on organisms attached to or associated with marine debris, or if they swim into marine debris floating at sea.

Plastic bands or net fragments entangled around young animals' necks restrict their ability to feed properly, and as they grow, result in their strangulation and death. Derelict fishing gear, ropes, and other types of debris tangled around the bodies, flippers, tails or flukes of marine wildlife can lead to infections, restricted mobility, protracted amputation of limbs, and death through drowning, starvation or smothering.

Entanglement or entrapment can also occur onshore when marine wildlife such as seabirds and turtles are caught in beach debris.

2.4.2 Ingestion

Debris such as balloons, plastic bags and confectionery wrappers are ingested by vertebrate marine wildlife when confused with prey species. Debris such as fishing line, plastic pieces and ropes can also be ingested when wildlife eats prey that is attached to or associated with these items.

Ingested debris may starve animals by preventing ingestion of food; reducing absorption of nutrients, resulting in internal wounds and ulceration; or by causing animals to become more buoyant, thereby inhibiting diving (Beck and Barros, 1991; Bjorndal et al., 1994; Sloan et al., 1998; EPA and QPWS, 2000). There is also the potential for marine wildlife to absorb heavy metals and/or other toxic substances through ingestion of suspended 'microplastics' (Balazs, 1985; Ananthaswamy, 2001; Mato et al., 2001). Microplastics are small plastic particles that are introduced to the marine environment through cosmetic additives (plastics are added as abrasives), aeroblasting materials (plastic 'sand' is used to remove paint from ship hulls) and the weathering of larger plastic items. Within marine food webs, plastic debris can serve as both a transport medium and a potential source of toxic chemicals such as polychlorinated biphenyls (PCBs), endocrine-active substances and chemicals similar to DDT (Balazs, 1985; Ryan et al., 1988; Bjorndal et al., 1994; Faris and Hart, 1995; Ananthaswamy, 2001; Mato et al., 2001). These chemicals are known to compromise immunity and cause infertility in animals, even at very low levels (Ananthaswamy, 2001; Mato et al., 2001).

2.4.3 Other impacts of marine debris

Marine debris can have social, economic, and aesthetic impacts on marine habitats and environments, coastal communities, governments and industry as well as become a health risk, vector for invasive marine pests and navigational hazards at sea (Gregory and Ryan, 1997; Widmer, 2002; Barnes and Fraser, 2003; Lewis et al., 2005). For example, entanglement of marine species in debris can have economic implications for commercial species. In Australian and international waters 'ghostfishing' (where lost and discarded fishing gear continues to catch marine species) has caused commercial species to become entangled and die (Brown et al., 2005). Evidence from studies in other parts of the world has shown that ghost net catch rates can approach that of gear controlled by fishing operations (Laist, 1996; Bullimore et al., 2000; Donohue et al., 2000; Laist and Liffman, 2000; Brown et al., 2005).

While it is recognised that these impacts may be significant, they are not specifically addressed by the TAP, because this TAP only focuses on measures to address the impacts of harmful marine debris that jeopardise the long-term survival of protected species described in the Key Threatening Process listing under the EPBC Act.

2.5 Marine wildlife negatively impacted by harmful marine debris

Twenty species listed as threatened under the EPBC Act were identified as negatively impacted by marine debris through its listing as a key threatening process (TSSC, 2003). These species are shown in Table 2.1 in addition to other marine listed species that have been documented to be negatively impacted by ingestion of, or entanglement in marine debris. Table 2.1 is not an exhaustive list of species that may be negatively impacted by this key threatening process.

Table 2.1 Species listed under the EPBC Act included in the key threatening process listing or otherwise documented as negatively impacted by ingestion of, or entanglement in, harmful marine debris

Type	Common name	Scientific name	Current status	Identified in key threatening process listing or other reference
Turtles	Flatback turtle	<i>Natator depressus</i>	Vulnerable	Identified in KTP listing
	Green turtle	<i>Chelonia mydas</i>	Vulnerable	Identified in KTP listing
	Hawksbill turtle	<i>Eretmochelys imbricata</i>	Vulnerable	Identified in KTP listing
	Leatherback turtle	<i>Dermochelys coriacea</i>	Vulnerable	Identified in KTP listing
	Loggerhead turtle	<i>Caretta caretta</i>	Endangered	Identified in KTP listing
	Olive ridley turtle	<i>Lepidochelys olivacea</i>	Endangered	Environment Australia (2003), Greenland et al. (2004)
Cetaceans	Southern right whale	<i>Eubalaena australis</i>	Endangered	Identified in KTP listing
	Blue whale	<i>Balaenoptera musculus</i>	Endangered	Identified in KTP listing
	Humpback whale	<i>Megaptera novaeangliae</i>	Vulnerable	Identified in KTP listing
	Sei whale	<i>Balaenoptera borealis</i>	Vulnerable	Bannister et al. (1996)
	Fin whale	<i>Balaenoptera physalus</i>	Vulnerable	Bannister et al. (1996)
	Bryde's whale	<i>Balaenoptera edeni</i>	Listed cetaceans	EPA (2003, 2004)
Sharks	Grey nurse shark (west coast population)	<i>Carcharias taurus</i>	Vulnerable	Identified in KTP listing
	Grey nurse shark (east coast population)	<i>Carcharias taurus</i>	Critically endangered	Identified in KTP listing
Birds	Antipodean albatross	<i>Diomedea exulans antipodensis</i>	Vulnerable	Identified in KTP listing
	Gibson's albatross	<i>Diomedea exulans gibsoni</i>	Vulnerable	Identified in KTP listing
	Grey-headed albatross	<i>Thalassarche chrysostoma</i>	Vulnerable	Identified in KTP listing
	Indian yellow-nosed albatross	<i>Thalassarche carteri</i>	Vulnerable	Identified in KTP listing
	Northern royal albatross	<i>Diomedea epomophora sanfordi</i>	Endangered	Identified in KTP listing
	Southern royal albatross	<i>Diomedea epomophora epomophora</i>	Vulnerable	Identified in KTP listing
	Tristan albatross	<i>Diomedea exulans exulans</i>	Endangered	Identified in KTP listing
	Wandering albatross	<i>Diomedea exulans (sensu lato)</i>	Vulnerable	Identified in KTP listing
	Blue petrel	<i>Halobaena caerulea</i>	Vulnerable	Identified in KTP listing
	Gould's petrel	<i>Pterodroma leucoptera leucoptera</i>	Endangered	Identified in KTP listing
	Northern giant petrel	<i>Macronectes halli</i>	Vulnerable	Identified in KTP listing
	Pelican	<i>Pelecanus conspicillatus</i>	Listed marine	Sloan et al. (1998)
Other	Australian sea lion	<i>Neophoca cinerea</i>	Vulnerable	Page et al. (2004)
	Seals		Listed marine	Pemberton et al. (1992), DTAE and DPIWE (2007)
	Dugong	<i>Dugong dugon</i>	Listed marine	EPA (2000)

Although not specifically identified in the key threatening process listing, a number of other species are known to be impacted by harmful marine debris. For example, populations of Australian sea lions (*Neophoca cinerea*) have been impacted by harmful debris (Robinson and Dennis, 1988; Shaughnessy, 1999; Gibbs, 2000; Shaughnessy et al., 2003; Page et al., 2004). While the implementation of this plan is intended to directly contribute to the protection of marine species described in the key threatening process listing, the plan will have broader benefits for marine species and communities currently impacted by marine debris.

Australian, state and territory governments have responsibility for protecting and managing marine protected species and wildlife under Commonwealth and state and territory legislation, and also through recovery plans. To this end, this threat abatement plan complements the wide range of existing conservation monitoring, rescue, recovery, reporting and management efforts for marine wildlife.

Each species group recognised as being negatively impacted by harmful marine debris at the time of the listing of the key threatening process is discussed below.

2.5.1 Marine turtles

Marine turtles are particularly vulnerable to floating debris as some species of marine turtles are thought to mistake plastic bags and other items for jellyfish prey (Mrosovsky, 1981; Balazs, 1985; Bjorndal et al., 1994), while other turtle species, especially hawksbills, eat encrusting organisms that grow on floating plastics and nets, become ensnared when attempting to feed (Balazs 1985).

Since 1996, a monitoring program run by rangers from the Dhimurru Aboriginal Corporation in Arnhem Land (Northern Territory) and regional partners have recorded more than 360 hawksbill, olive ridley, flatback and green turtles stranded along a short stretch of coastline (Roeger et al., 2005). Approximately 30% were hawksbill turtles entangled in derelict trawl and drift nets of foreign origin, fishing line and plastic waste. Approximately 55% of turtles recorded have been found alive, but it is currently unclear how many of these stranded turtles subsequently perish due to injuries sustained by their entanglement in, or ingestion of, debris (Chatto, 1995). Most stranded turtles found during the Arnhem Land monitoring program are observed between May and June each year (Roeger et al., 2005) when onshore southeast trade winds prevail and marine debris accumulation is generally higher than at other times of the year. The high number of stranded turtles found onshore during this period may provide some indication of the number of turtles that become entangled in nets during other times of the year but never wash ashore.

A marine wildlife stranding and mortality database, maintained by the Queensland Environmental Protection Agency, highlights that significant numbers of marine turtles are also ingesting and becoming entangled in marine debris in Queensland waters each year (Greenland et al., 2004). For example, in 2001–02, 16 hawksbill, loggerhead and green turtles were found with longline or other fishing hooks, fishing line or plastic bags embedded in their flesh or trailing from their mouths. Thirteen of these animals were dead when found (Greenland et al., 2004). A total of 81 turtles (hawksbill, loggerhead, green, flatback, and olive ridley) was found during the same period entangled in rope, fishing line, plastic bags, derelict fishing nets, crabpots and floats (Greenland et al., 2004). This database relies on public reports and ad hoc sightings of stranded wildlife (rather than a dedicated survey) and in most instances it is unknown which records relate to derelict fishing gear, or gear that is in the control of fishers. Nevertheless, the numbers of animals recorded entangled in, or that have ingested debris, are likely to be less than actual numbers of turtles impacted by harmful marine debris across the Queensland coast (Miller, 1994). For example, extrapolation from counts of turtles entrapped in beach-washed nets on northwestern Cape York Peninsula suggest that several hundred marine turtles are killed annually in derelict nets along the Queensland Gulf of Carpentaria coast (Limpus and Miller, 2002).

Marine turtle populations identified within the *Recovery plan for marine turtles in Australia* (Environment Australia, 2003) as being impacted by marine debris are:

- loggerhead turtles from the eastern Australian population
- green turtles from the southern Great Barrier Reef population
- hawksbill turtles from the northeastern (Queensland) Australian population
- leatherback turtles throughout Australian waters
- olive ridley turtles from the Northern Territory
- flatback turtles from Arnhem Land
- turtle populations in Western Australian (potentially impacted, but extent unknown at present).

Research and management actions described by the Recovery Plan for Marine Turtles (Environment Australia, 2003) have guided the recommendations of the current TAP and include the following:

- monitor mortality of marine turtles due to entanglement in marine debris and identify the source of marine debris
- determine the source of nets entangling marine turtles and the magnitude of their mortality in the Cape Arnhem region
- undertake remedial action to prevent/reduce marine turtle mortality in stranding events caused by marine debris
- implement legislation for the prevention of garbage discharge from vessels of all sizes.

2.5.2 Cetaceans

Whales are prone to entanglement in marine debris, especially fishing gear. In other parts of the world, the greatest threat to cetaceans is gill nets.

The *Action plan for Australian cetaceans* (Bannister et al., 1996) and current whale recovery plans (DEH, 2005a, 2005b, 2005c) identify entanglement in derelict fishing gear and ingestion of plastics at sea as a current threat to a number of Vulnerable and Endangered cetacean species (see Table 2.1). The action plan notes several species that are not yet considered threatened (due to the lack of sufficient data on populations) as also impacted by harmful marine debris (Bannister et al., 1996).

Limited data are available on the effects of ingested plastic objects on cetaceans, but plastics and rope have been found in sufficient quantities in the intestines of a significant number of dead dolphins and whales to have caused fatal blockages (Bannister et al., 1996; Thompson 2000). Whales and dolphins have also been recorded entangled in derelict fishing gear around Australia's coasts (Chatto and Warneke, 2000; Limpus et al., 2003), though records of cetaceans seen entangled at sea tend to be poorly documented.

2.5.3 Sharks

Entanglement of Australian sharks in derelict fishing gear has been observed on numerous occasions (Sloan et al., 1998; Alderman et al., 1999), although few published records exist. Autopsies performed on grey nurse sharks in aquaria have indicated that derelict hooks may puncture the stomach, pericardial cavity and oesophagus causing infection and death (TSSC, 2003).

2.5.4 Seabirds

Ingestion of debris has a wide range of lethal or sub-lethal effects on seabirds (Ryan et al., 1988). For example, debris can cause perforation, mechanical blockage or impairment of the digestive system, resulting in starvation. Chicks appear to be at greater risk than adults because of their high rates of ingestion and low frequency of regurgitative casting of indigestible material. When plastics are regurgitated as food to chicks by their parents, physical impacts and internal ulcerations are likely to lower survival rates of chicks. In addition, the chick receives less food, lowering its nutrient intake and increasing its chances of starvation (Environment Australia, 2001b; DTAE and DPIWE, 2007).

Seabirds are also killed through entanglement in marine debris (Woehler, 1990; Nel and Nel, 1999); monofilament line and fishing net cause the most entanglements (Huin and Croxall, 1996). Fishing hooks, six-pack yokes, wire and string have also been reported as causing entanglement of seabirds. Entanglement can constrict growth and circulation of seabirds, and/or increase the bird's drag coefficient through water, causing it to die due to its reduced ability to catch prey or avoid predators. The rate of seabird mortality through entanglement is unknown.

To address the impacts of marine debris on albatross and petrels, the *Recovery plan for albatrosses and petrels* (Environment Australia, 2001b) notes the need for monitoring of the incidence of hatching failure due to eggshell thinning, and regurgitated marine debris at albatross and giant petrel breeding colonies. The recovery plan also calls for collaboration through international conservation fora to address the global sources and impacts of the problem.

3. Current management of the key threatening process

Current management of marine debris in Australia is described below under the categories of prevention, removal and mitigation. This summary of existing measures is not comprehensive, but highlights where efforts are currently being directed. Current management practices include education and awareness-raising activities; building capacity of rangers and local communities; local, state and territory Government initiatives, research and the development of legislation and policy.

3.1 Current management for the prevention of harmful marine debris

3.1.1 Land-based sources

The state and territory governments are generally responsible for the prevention and management of land-based sources of debris and all have enacted legislation prohibiting the disposal and discharge of litter. Key legislation for each state and territory is listed in Table 3.1.

Table 3.1 Legislation prohibiting the disposal and discharge of litter

New South Wales	<i>Protection of the Environment Operations Act 1997</i>
Northern Territory	<i>Litter Act 1972</i> <i>Waste Management and Pollution Control Act 1998</i>
Queensland	<i>Environmental Protection Act 1994</i> <i>Environmental Protection (Waste Management) Policy 2000</i> <i>Environmental Protection (Waste Management) Regulation 2000</i>
South Australia	<i>Environment Protection Act 1993</i> <i>Zero Waste SA Act 2004</i> <i>Fisheries Management Act 2007</i> <i>Natural Resources Management Act 2004</i>
Tasmania	<i>Environmental Management and Pollution Control Act 1994</i> <i>Litter Act 1973</i>
Victoria	<i>Environment Protection Act 1970</i>
Western Australia	<i>Environmental Protection Act 1986</i> <i>Litter Act 1979</i> <i>Conservation and Land Management Act 1994</i> <i>Conservation and Land Management Regulations 2002</i> <i>Fisheries Management Act 1994</i>

In addition, the New South Wales and Victorian governments have listed marine debris as a key threatening process under state legislation as follows:

- New South Wales — ‘entanglement in or ingestion of anthropogenic debris in marine and estuarine environments’ has been listed under the *Threatened Species Conservation Act 1995*
- Victoria — ‘the discharge of human-generated marine debris into Victorian marine or estuarine waters’ has been listed under the *Flora and Fauna Guarantee Act 1988*. This key threatening process listing identifies a suite of pelagic and inshore fauna (notably birds and mammals) that are negatively impacted by marine debris.

The Great Barrier Reef Marine Park Authority has been proactive in addressing marine litter and other waste management concerns, and a range of measures have been in place since 1975 to prevent the discharge of waste in the Great Barrier Reef Marine Park. Examples of these measures include:

- prosecution and fines of up to \$2 000 for littering offences (the *Great Barrier Reef Marine Park Act 1975* (Cwlth) provides for penalties of up to \$5 500)
- an extensive and targeted education, compliance and enforcement program relating to marine debris offences
- development and implementation of guidelines on best environmental practices in the management of marine debris
- communication and education programs such as the Reef Guardian Schools and Reef Guardian Councils; the Reef Guardian Schools program involves nearly 200 schools in reducing the use of plastic bags in the community with students educating their community on better environmental practices and developing brochures, television advertisements, radio programs and boat ramp signs to promote responsible waste management behaviour.

At the national level, Australia is a signatory to the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities and has prepared a National Programme of Action for the Protection of the Marine Environment from Land-based Activities (NPA). Australia's NPA highlights the activities of Australian, state and territory governments, local government, industry and other non-government organisations to address land-based sources of pollution. Australia's NPA is complemented by an internet searchable database of activities directed at protecting the marine environment from land-based activities and 24 case studies. Australia's NPA also builds on the framework and implementation plan for a national cooperative approach to integrated coastal zone management (NRMMC, 2006) that highlights marine debris as an issue of significant concern.

A range of other measures have been introduced at the national, state and territory, and local levels to limit the production and impact of litter and other potentially harmful waste that may end up in the marine environment. These include:

- Australian standards for biodegradable and oxodegradable materials under development by a Standards Australia Technical Committee — to complement this work, the plastics industry is developing a product stewardship commitment and guide for the use of degradable plastics in Australia that will include a labelling guide and a verification process.¹
- Australian Retailers Association Code of Practice for the Management of Plastic Bags (2003-2005) — a commitment by major retailers to work with governments, other industries and the broader community to substantially reduce the volume of plastic bags in the litter stream (EPHC, 2006). The code of practice resulted in a 34% reduction (between 2002 and 2006) in the distribution of plastic bags by the retail sector overall (Hyder, 2006). The Environment Protection and Heritage Council is currently considering options for further action on plastic shopping bags.
- The National Packaging Covenant — aimed at managing the environmental impacts of consumer packaging in Australia. It is designed to minimise the environmental impacts arising from the disposal of used packaging, conserve resources through better design and production processes and facilitate the re-use and recycling of used packaging materials. The Covenant is a voluntary agreement that currently has several hundred signatories, and is part of a co-regulatory arrangement based on the principles of product stewardship between all sectors of the packaging supply chain, consumers, collectors, reprocessors and all spheres of government. The Covenant commits signatories to a national recycling target of 65% for packaging and no further increases in packaging waste disposed to landfill by the end of 2010.²

¹ <http://www.environment.gov.au/settlements/waste/degradables/index.html>

² <http://www.packagingcovenant.org.au/>

- ‘Keep the Sea Plastic Free – Bin it’ — an educational campaign of the Department of the Environment, Water, Heritage and the Arts focused on promoting responsible disposal and recycling of plastic waste.
- Keep Australia Beautiful National Litter Index — a measure of the amounts and types of litter found during surveys of more than 800 sites across Australia. The index is funded by the Australian, state and territory governments as well as industry groups, and is closely linked with a number of community litter clean-up initiatives such as Clean Up Australia Day, Tidy Towns, Sustainable Cities, and the Clean Beach Challenge. Based on the results of the index, measures are being introduced to target certain litter types (e.g. cigarette butts) and specific locations (e.g. highways and beaches) (Keep Australia Beautiful 2006).

Prevention and management of litter on a local scale also falls within the responsibility of state, territory and local governments, many of which have implemented a range of initiatives to address littering issues. These initiatives include community recycling programs, stormwater management and clean-up of beaches and waterways. The support and contribution of local governments is critical to the success of local threat abatement measures for land-based sources of marine debris.

3.1.2 Marine-based sources

Australia has taken a lead on progressing marine debris issues in a number of international fora and considerable progress has been made in recent years in bringing international attention to the issue. In particular, at the 60th United Nations General Assembly in 2005, both the oceans and sustainable fisheries resolutions devoted several paragraphs to the prevention and management of marine debris. A number of international organisations are currently considering improved measures for tackling marine debris in the context of existing responsibilities, including:

- the Regional Seas Programme of the United Nations Environment Programme (UNEP)
- the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities led by UNEP
- the Food and Agriculture Organization of the United Nations, through its Code of Conduct for Responsible Fisheries
- the Marine Environment Protection Committee of the International Maritime Organisation.

Specifically targeting fishing related debris, the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR) has adopted and implemented measures to monitor marine debris and to mitigate its impact on marine biota in the Southern Ocean. This includes regulation of the use and disposal of plastic packaging bands on fishing vessels (Conservation Measure 25-01 [1996]).

The Convention on the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean has adopted measures to minimise waste, catch by lost or abandoned gear, and pollution originating from fishing vessels (Article 5(e)), and there are a number of other fisheries agreements that Australia is involved in specifically targeting marine debris.

There are two primary international conventions regulating the disposal of waste at sea:

- *Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972 and 1996 Protocol Thereto (The London Convention 1972)*
- *International Convention for the Prevention of Pollution from Ships (MARPOL).*

The London Convention 1972 contributes to the international control and prevention of marine pollution by prohibiting the dumping of garbage and persistent plastics (generated on land) at sea.

'Dumping' is defined in the Convention as the deliberate disposal at sea of wastes or other matter from vessels, aircraft, platforms or other artificial structures, as well as the deliberate disposal of these vessels or platforms themselves. Among other requirements, signatories undertake to designate an authority to deal with permits, keep records, and monitor the condition of the sea. The 1996 Protocol to the London Convention supersedes the 1972 Convention for Australia. The 1996 Protocol introduces the precautionary approach with respect to the dumping of wastes by introducing a blanket prohibition on dumping of all waste. Only certain wastes mentioned in Annex 1 may be dumped and even then, only with a permit.

MARPOL is the principal international measure regulating waste generated during the normal operation of a ship. Six technical annexes of MARPOL detail regulations according to the type of pollutant and prescribe construction, equipment and discharge requirements for ships. Annex V, which came into force in 1988 internationally, applies to all vessels including yachts, fishing boats and dinghies and it prohibits the disposal of plastics (including biodegradable plastics) into the ocean. Non-plastic materials that float, food wastes, and other garbage, are permitted to be discharged into the oceans so long as the vessel is a prescribed distance from shore. Annex V also requires all parties to the Convention to provide adequate garbage reception facilities at ports and terminals and to report inadequate facilities. As at February 2008, 134 states were party to Annex V of MARPOL (covering more than 96% of the world's tonnage). Regional parties include Australia, Japan, Malaysia, the Philippines, and the Republic of Korea.

A 'discharge' under MARPOL means any release howsoever caused from a ship and includes any escape, disposal, spilling, leaking, pumping, emitting or emptying. Therefore both accidental and deliberate discharges may be violations. However, exceptions apply where the disposal of garbage is necessary for the purpose of securing the safety of the ship, the escape is due to damage to the ship or equipment (i.e. a collision or major failure), or where accidental loss of synthetic fishing nets occurs, provided that 'all reasonable' precautions are taken to prevent the loss and to recover all lost and damaged gear.

In Australia, the enforcement of MARPOL within Commonwealth jurisdiction rests with the Australian Maritime Safety Authority (AMSA) under the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* (Protection of the Sea Act) and the Navigation Act 1912. Complementary legislation for the implementation of Annex V has to date implemented by the Northern Territory and all states except New South Wales and Western Australia. It is expected that New South Wales will enact complementary legislation during the next year and at present, water pollution is generally prohibited in New South Wales under the *Protection of the Environment Operations Act 1997*. It is also understood that implementing legislation is currently being developed in Western Australia.

Part IIIC (Prevention of Pollution by Garbage) of Australia's Protection of the Sea Act relates specifically to the matter of waste disposal from vessels at sea. Regulations apply to all Australian vessels under Commonwealth jurisdiction wherever they are operating or not, as well as to foreign vessels operating within Australia's jurisdiction. All vessels over 400 gross tonnes operating in the Australian EEZ are required to develop a waste management plan for collecting, storing, processing and disposing of garbage; details of garbage incineration or disposal must be recorded by such ships on international voyages in a garbage record book together with any receipts from port disposal facilities. However, most vessels operating in northern Australian waters are smaller than 400 gross tonnes and operate within state or Northern Territory jurisdiction. These vessels are not required to log waste management details. Vessels of 12 metres or more in length are required to display placards detailing waste regulations and requirements in full view of crew and/or passengers. Provisions within the Protection of the Sea Act enable foreign ships operating in Australian waters to be detained and inspected if they are suspected of involvement in pollution breaches.

Australian laws implementing MARPOL Annex V place the onus upon the defendant to prove that these exceptions apply for any discharge. Australian laws apply both deliberate and strict liability offences. Therefore, the standard of proof and the evidence required varies depending on the offence to be charged.

To date, AMSA has successfully prosecuted 11 garbage discharge violations. In all of these cases charges were laid under the strict liability provisions of the Commonwealth legislation. A major difficulty in garbage pollution investigations proceeding to prosecution is being able to directly link debris to a specific vessel. In all successful cases, evidence has linked debris directly to the vessel either through some type of identification marking being discovered on the garbage and/or through witnessing of the pollution. A number of garbage pollution cases are currently before Australian courts.

With respect to fishing vessels, compliance with the requirements of MARPOL Annex V and domestic marine pollution legislation on Commonwealth-licensed Australian fishing boats is monitored through an observer program coordinated by the Australian Fisheries Management Authority (AFMA). However, observation of compliance with MARPOL requirements are generally only a minor part of observers overall duties, which are mainly concerned with assessing compliance with fisheries management arrangements. Almost 100% compliance has been observed amongst domestic vessels while observers are present (Jones, 1994). However, a study of reports from observers on foreign vessels operating in the Australian fishing zone during the early 1990s noted that around half of the vessels carrying observers did not comply with MARPOL provisions. The reasons for non-compliance included: lack of knowledge of MARPOL regulations; the attitude of the captain and/or crew; and poor waste management practices either due to a lack of facilities on board or inadequate facilities at port (Jones, 1995).

AMSA coordinates the 'Stow it don't throw it' vessel waste management campaign to raise awareness of the impacts of harmful marine debris and to encourage prevention. The campaign includes brochures on good on-board waste management practices, and directories of waste reception facilities in ports. The campaign commenced in 1989 and is regularly updated.

Australian commercial fishers are encouraged to record loss of gear in vessel logbooks, however it is currently only compulsory for vessels operating in the Southern Ocean under the management of the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR) to report gear loss.

Australian seafood industries have been proactive in the development of industry codes of practice and waste management practices consistent with MARPOL requirements based on an internationally endorsed *Code of conduct for responsible fisheries* developed by the Food and Agriculture Organization of the United Nations).³

An notable example of industry best practice in mitigating the impacts of debris in the marine environment comes from Robe Professional Fisherman's Association which has for over a decade operated a wharf-side rubbish collection facility. This service is emptied by a roster system of fishers and has been upgraded to improve the sorting of the different types of recyclables they receive. The Association also undertakes an annual beach litter survey which is a joint venture involving the local school, the South Australian Research and Development Institute (SARDI) and Coastcare.

Another example of an industry driven process comes from the South Australia Rock Lobster Fishery which moved away from potentially harmful packaging materials (hard plastic bands) and instead use glued boxes as part of the 'clean green program'.

The voluntary *National code of practice for recreational and sport fishers* (Recfish Australia, 1996) also includes principles for protecting the marine environment through, amongst other things, removal of rubbish and proper disposal of waste. OceanWatch Australia, a not-for-profit company focused on advancing sustainable fisheries, has also conducted a feasibility study on reducing plastics in the Australian seafood industry (Oceanwatch 2006). This study has identified a range of options for improving waste management in the fishing industry as well as introducing biodegradable materials and gear recycling options.

³ <http://www.fao.org/DOCREP/005/v9878e/v9878e00.htm>

3.2 Current management for the removal of harmful marine debris

There is currently no agency or group with a clear responsibility for responding to reports of potentially hazardous debris at sea. On land there is an array of different beach clean-up and survey initiatives undertaken across Australia's coastline. Of note are:

- Clean Up Australia Day — operating since 1990 with a focus on removal of litter from urban areas. The program has been very successful at cleaning beaches across much of the Australian coastline, and marine debris is now a focus of awareness raising campaigns.
- Indigenous Sea Ranger Partnerships – a number of partnerships exist between Indigenous community groups and Australian, state and Northern Territory government agencies focused on removal and management of marine debris and wildlife impact and rescue programs, for example:
 - Carpentaria Ghost Net Programme — more than A\$2m Australian Government funds have been directed to the Northern Gulf Resource Management Group to support Indigenous coastal communities in the Gulf of Carpentaria to address derelict fishing nets (ghost nets). Throughout the project community groups around the Gulf have been cleaning beaches of ghost nets, with some recording wildlife entangled in nets. The recorded information will contribute to improved understanding of the quantities, impacts and likely origins of derelict nets in Australian waters. Areas prone to aggregation of ghost nets and other marine debris are also being identified, and
 - Dhimurru Aboriginal Corporation and a number of other Indigenous groups have been working with the Northern Territory and Australian Governments, conservation groups, industry and researchers to undertake marine debris monitoring surveys. These surveys have been instrumental in identifying the impacts of marine debris on marine species, especially turtles, in northern Australia
- Project Dolphin Safe — established in 1998 in Adelaide, South Australia to protect and monitor the dolphins and marine life of the Port River Estuary and South Australia. Working together with the Department for Environment and Heritage (SA) activities include removal of rubbish and other pollutants, education, revegetation, animal rescues and the restoration of key habitats.
- The Oceans of Blue Coast and Marine Program — initiated in 2004 by the Kangaroo Island Natural Resources Management Board in South Australia to undertake a biennial beach litter survey to coincide with Clean Up Australia Day. In 2007, 51 volunteers took part, donating over 100 person-hours to cleaning up 10 bays around Kangaroo Island — six on the north coast and four on the south.

3.3 Current management for the mitigation of the impacts of harmful marine debris

Numerous government and non-government groups undertake programs focused on the rescue and rehabilitation of wildlife stranded in and injured by harmful marine debris, but in Australia there are currently no means for collating available information on wildlife harmed by marine debris on a national scale. At the international level, guidelines in MARPOL Annex V encourage the development and use of degradable synthetic materials and nets that incorporate more readily degradable panels or sections made of natural fibres to reduce potential wildlife entanglement.

At the national level, the Australian Government is working with the commercial fishing industry to ensure that fishing equipment is whale and dolphin friendly. In collaboration with the states and the Northern Territory, the Australian Government also coordinates annual, national large whale disentanglement workshops. The objectives of the workshops are to:

- share knowledge about methods for disentangling large whales (especially southern right and humpback whales) from fishing gear, shark nets and marine debris

- raise awareness of the issues involved in large whale entanglements, and promote a safe and effective approach to dealing with entanglements
- discuss measures for minimising the occurrence of large whale entanglements
- promote the establishment of a national information-sharing network for people involved in large whale disentanglements.

Wildlife rescue and rehabilitation programs are an important source of information on marine wildlife injury and strandings resulting from harmful marine debris. A number of Australian states currently maintain databases that incorporate information on wildlife entanglements associated with marine debris. For example, in Queensland and the Northern Territory, state-wide hotlines have been set up to enable the public to rapidly report sick, injured, entangled or dead marine mammals (dugongs, whales and dolphins) and turtles. Rescue and rehabilitation of stranded wildlife in these jurisdictions are coordinated by the relevant Parks and Wildlife Service and recorded in their marine Wildlife Stranding Database (EPA, 2000, 2003, 2004). Also in the Northern Territory, Dhimurru Aboriginal Corporation has conducted stranded turtle monitoring surveys since 1996. Rangers use helicopters to survey a remote beach in Arnhem Land, Northern Territory for turtles entangled in derelict fishing gear. This survey is the only dedicated and long-term study of the impacts of marine debris on marine species in Australia.

3.4 Current monitoring of harmful marine debris

The monitoring of harmful marine debris and its impacts is a responsibility of all Australian governments. In Australia, marine debris surveys have been carried out in all states and the Northern Territory although there are few long-term monitoring programs in place. To date, most surveys have been undertaken by community or school groups, though many are funded by the state, Northern Territory and Australian governments:

- Western Australia — the Tangaroa Blue Ocean Care Society founded the South West Marine Debris Project in 2004 to focus on the issue of marine debris in the South West region of Western Australia. The aim of the project is to find ways of reducing the amount of marine debris in the ocean and impacting on marine wildlife, and involves monthly monitoring of five stretches of coastline. These surveys rely on volunteers organised through the Tangaroa Blue Ocean Care Society.
- South Australia — the South Australian Research and Development Institute established two marine debris monitoring sites in South Australia, at Anxious Bay in the Great Australian Bight (Edyvane et al., 2004; Eglinton et al., 2005). Irregular marine debris monitoring has also been conducted at Kangaroo Island. The surveys in South Australia rely heavily on support from local schools.
- Northern Territory — six sites have been established across the Northern Territory to monitor marine debris and wildlife entanglements. The program was initiated in 1999 by the World Wide Fund for Nature and transferred to the Northern Territory Government (NRETA) in 2006. The program is a partnership and relies heavily on the support of six local Indigenous communities and Conservation Volunteers Australia.
- The Net Kit — WWF-Australia, Dhimurru Aboriginal Corporation and the Northern Territory fisheries agency developed a guide for the standardised identification and reporting of derelict fishing gear. Completed in 2001, ‘The Net Kit’ includes photographs of net types, with specifications of mesh size, twine size, colour, net use and probable country of manufacturing origin. This guide is now used by community groups during marine debris surveys across northern Australia.

4. Implementation of the threat abatement plan

Harmful marine debris is a complex issue that spans geographic and political boundaries, requiring a coordinated response at all levels of government, industry and the community to effectively address its sources and impacts. There are a range of government, industry, community and research measures currently in place to control and reduce marine debris within Australia. However, marine debris continues to accumulate on the Australian coastline and negatively impact wildlife. The international origins of debris in some parts of Australia highlight a need for bilateral and multilateral measures to prevent the problem at its source.

To pursue the objectives of the plan, specific activities are outlined in Appendix B. These activities seek to build on existing initiatives and strengthen coordination and partnerships to prevent, remove, mitigate and monitor marine debris. Activities are also targeted at addressing gaps in existing measures that have been identified rather than duplicating any existing programs.

The Australian Government Department of the Environment, Water, Heritage and the Arts (DEWHA) will coordinate overall implementation of the TAP. DEWHA will work with other Australian Government agencies to implement this plan as it applies to Commonwealth areas. DEWHA will also seek to collaborate and establish partnerships with state and territory Government agencies, key stakeholder groups, researchers and Indigenous communities and organisations toward the plan's implementation. Performance criteria will be refined as part of the implementation of the TAP.

Appendix A

Threat abatement plans and the EPBC act

The following extracts from the *Environment Protection and Biodiversity Act 1999* (EPBC Act) and EPBC Regulations 2000 relate to the requirements for developing threat abatement plans:

Section 271. Content of threat abatement plans

- (1) A threat abatement plan must provide for the research, management and other actions necessary to reduce the Key Threatening Process concerned to an acceptable level in order to maximize the chances of the long-term survival in nature of native species and ecological communities impacted by the process.
- (2) In particular, a threat abatement plan must:
 - (a) state the objectives to be achieved; and
 - (b) state the criteria against which achievement of the objectives is to be measured; and
 - (c) specify the actions needed to achieve the objectives; and
 - (g) meet prescribed criteria (if any) and contain provisions of a prescribed kind (if any).
- (3) In making a threat abatement plan, regard must be had to:
 - (a) the objects of this Act; and
 - (b) the most efficient and effective use of resources that are allocated for the conservation of species and ecological communities; and
 - (c) minimising any significant adverse social and economic impacts consistently with the principles of ecologically sustainable development; and
 - (d) meeting Australia's obligations under international agreements between Australia and one or more countries relevant to the species or ecological community threatened by the Key Threatening Process that is the subject of the plan; and
 - (e) the role and interests of indigenous people in the conservation of Australia's biodiversity.
- (4) A threat abatement plan may:
 - (a) state the estimated duration and cost of the threat abatement process; and
 - (b) identify organisations or persons who will be involved in evaluating the performance of the threat abatement plan; and
 - (c) specify any major ecological matters (other than the species or communities threatened by the key threatening process that is the subject of the plan) that will be impacted by the plan's implementation.
- (5) Subsection (4) does not limit the matters that a threat abatement plan may include.

Section 274. Scientific Committee to advise on plans

- (1) The Minister must obtain and consider the advice of the Scientific Committee on:
 - (a) the content of recovery and threat abatement plans; and
 - (b) the times within which, and the order in which, such plans should be made.
- (2) In giving advice about a recovery plan, the Scientific Committee must take into account the following matters:
 - (a) the degree of threat to the survival in nature of the species or ecological community in question;
 - (b) the potential for the species or community to recover;
 - (c) the genetic distinctiveness of the species or community;
 - (d) the importance of the species or community to the ecosystem;
 - (e) the value to humanity of the species or community;
 - (f) the efficient and effective use of the resources allocated to the conservation of species and ecological communities.
- (3) In giving advice about a threat abatement plan, the Scientific Committee must take into account the following matters:
 - (a) the degree of threat that the Key Threatening Process in question poses to the survival in nature of species and ecological communities;
 - (b) the potential of species and ecological communities so threatened to recover;
 - (c) the efficient and effective use of the resources allocated to the conservation of species and ecological communities.

Section 279. Variation of plans by the Minister

- (1) The Minister may, at any time, review a recovery plan or threat abatement plan that has been made or adopted under this Subdivision and consider whether a variation of it is necessary.
- (2) Each plan must be reviewed by the Minister at intervals not longer than 5 years.
- (3) If the Minister considers that a variation of a plan is necessary, the Minister may, subject to subsections (4), (5), (6) and (7), vary the plan.
- (4) The Minister must not vary a plan, unless the plan, as so varied, continues to meet the requirements of section 270 or 271, as the case requires.
- (5) Before varying a plan, the Minister must obtain and consider advice from the Scientific Committee on the content of the variation.
- (6) If the Minister has made a plan jointly with, or adopted a plan that has been made by, a State or self-governing Territory, or an agency of a State or self-governing Territory, the Minister must seek the co-operation of that State or Territory, or that agency, with a view to varying the plan.
- (7) Sections 275, 276 and 278 apply to the variation of a plan in the same way that those sections apply to the making of a recovery plan or threat abatement plan.

Environment protection and biodiversity conservation regulations 2000

2000 NO. 181 - REG 7.12 Content of threat abatement plans

For paragraph 271 (2) (g) of the Act, a threat abatement plan must state:

- (a) any of the following that may be negatively impacted by the Key Threatening Process concerned:
 - (i) listed threatened species or listed threatened ecological communities
 - (ii) areas of habitat listed in the register of critical habitat kept under section 207A of the Act
 - (iii) any other native species or ecological community that is likely to become threatened if the process continues, and
- (b) in what areas the actions specified in the plan most need to be taken for threat abatement.

Appendix B

Threat abatement plan activities

Objective 1

Contribute to the long-term prevention of the incidence of harmful marine debris

Improve waste management practices on land and at sea

MARPOL requires all vessels over 400 gross tonnes to develop a waste management plan for collecting, storing, processing and disposing of garbage. Large vessels are required to record details of garbage incineration or disposal in a garbage record book with any receipts from port disposal facilities. Most vessels operating in Australian waters are smaller than 400 gross tonnes and are therefore not required to log waste management details. Although it is obligatory for every vessel of 12 metres or more in length to display placards detailing waste regulations and requirements in full view of crew and/or passengers, waste management aboard vessels less than 400 gross tonnes is currently poorly regulated in Australia. While there have been 11 successful prosecutions under Commonwealth legislation, with several other cases currently before the courts, there have been no prosecutions under state or Northern Territory legislation, though infringement notices have been applied under general environment protection legislation in respect of minor 'littering' offences. The large number of vessels of less than 400 gross tonnes operating in Australian waters highlights a need to examine the effectiveness and levels of compliance with Commonwealth, state and Northern Territory marine pollution laws.

Action 1.1 Australian Government in consultation with the states and territories to facilitate the review of existing arrangements relevant to the control of marine debris on vessels smaller than 400 gross tonnes (including fishing vessels).

Marine-sourced waste is processed through a number of ports around Australia. Ports generally come under the responsibility of state and territory governments.

Australia has an obligation under MARPOL to provide adequate reception facilities for waste from ships; however, only two states (Queensland and New South Wales) have legislation that can be used to place this obligation on ports. State and territory legislation requires ports to have port environment plans. However, these plans often do not require any assessment of the current or future demand for waste reception facilities by vessels, description of the details of the type and capacity of facilities (including fees for use) available, procedures for the reception and collection of wastes, or ongoing consultation with users and service providers.

Studies of waste reception facilities in Australia (AMSA, 2003; ANZECC, 2003) have identified shore-based facilities for different kinds of vessel-generated waste, including quarantine waste and garbage. Derelict fishing gear (especially nets) often needs to be disposed of through designated facilities, although it is not clear from existing studies which ports around Australia are currently equipped to deal with this waste. Anecdotal evidence suggests that many ports and land-based disposal sites discourage, or even prohibit, disposal of fishing gear, and at other ports dumping costs are prohibitive.

Action 1.2 State, territory and Australian governments and appropriate local bodies to facilitate studies of port facilities and boating hubs for the disposal of fishing gear, including assessment of availability, use, capacity and cost.

Action 1.3 State and territory governments to consider reviewing legislation to ensure that details of waste reception facilities for ships are included in port environment plans.

- Action 1.4 State and territory Governments to investigate how Australia's obligations under MARPOL (i.e. to provide adequate waste reception facilities for ship waste) is encompassed in domestic legislation and policies.
- Action 1.5 DEWHA, in collaboration with the Department of Foreign Affairs and Trade (DFAT) and AMSA, to facilitate through international fora, taking into account policies and programs of the International Maritime Organization (IMO), studies of the ability of international ports in the Asia-Pacific region to handle vessel-sourced waste, particularly derelict fishing gear, including assessment of availability, capacity and cost.
- Action 1.6 DEWHA, in collaboration with DFAT and AMSA, to facilitate through domestic and international fora, taking into account policies and programs of IMO, studies of the barriers and incentives to the use of existing port waste reception infrastructure in Australia and the Asia-Pacific region.

Large derelict fishing nets pose a significant threat to marine wildlife and are increasingly being reported by coastal communities and vessel crews in northern Australian waters. However, there is currently no Australian Government or state or territory agency with a formal responsibility to respond to these reports. There is a need to respond to community reports of hazardous debris and, where feasible, to introduce cost effective and efficient procedures for at-sea retrieval of derelict fishing gear.

- Action 1.7 Australian Government agencies in collaboration with state and territory governments to identify appropriate responses and responsibilities for recovery of hazardous debris at sea, notably large derelict fishing nets.

Fisheries management arrangements are designed to promote sustainability of operations. Given the scale of marine debris issues in Australia, loss or improper disposal of fishing gear has become a significant factor in determining sustainability at a number of levels, including additional mortality of target and non-target stocks, damage to habitats and public perceptions of the fishing industry. Management of gear is therefore a legitimate concern of fisheries managers and the management plans they prepare. Further, while Australian commercial fisheries are encouraged to record loss of gear in vessel logbooks, it is currently only compulsory for vessels operating in the Southern Ocean under the management of CCAMLR to report gear loss. To improve understanding of the amount of derelict gear in Australia's marine environment, measures for the compulsory reporting of lost gear by all Australian fisheries should be investigated.

- Action 1.8 State, territory and Australian governments, in collaboration with industry, to identify and implement appropriate measures for incorporating waste reporting and management requirements (reporting and return of rubbish, damaged gear, etc. to port for disposal) into fishery management arrangements as appropriate.
- Action 1.9 State, territory and Australian governments, in collaboration with the fishing industry, to promote best practice waste management strategies on board fisheries vessels, including the uptake of existing codes of conduct, and identify any need for the development of new codes of conduct.

There are currently few incentives to retrieve derelict fishing gear or return waste to land for disposal. Incentive-based solutions may be particularly helpful for waste management issues within marine-based industry sectors, particularly fisheries, but need to be tailored to consider local socio-economic parameters. Studies in the United States have found that some financial incentive systems are economically viable, but that they should be limited to selected items in the waste stream (Laist and Liffman, 2000). Other potential methods for economic intervention include an explicit accounting for fishing gear use, deposits on new and replacement gear, and insurance (Pooley, 2000).

A combination of economic incentives and offsets could be a powerful tool for the reduction of plastic impacts on marine wildlife by providing an incentive for reduced use as well as a funding mechanism for reducing immediate impacts. Offset or incentive schemes should take into consideration the 'Avoid, Mitigate, Offset' framework of the Convention on Biological Diversity, to which Australia is a signatory. This framework states that priority should be given to avoidance of impacts. Where avoidance is not possible, direct mitigation of the impacts should be implemented. In cases where these two measures are not completely effective in reducing impacts, offsets should be used to ameliorate any residual impacts. There are also institutional changes that may serve to maximise incentives for gear retrieval, while the economic benefits associated with gear re-use and recycling could also be investigated further.

Action 1.10 DEWHA to support an analysis of financial incentives to encourage return of waste generated at sea to land for appropriate disposal, for example:

- fishing gear inventories by port and vessel supported by deposits and bounty initiatives
- introduction of regulations relevant to insurance on lost gear and/or insurance levies to support removal of derelict gear
- repair, re-use and recycling initiatives.

There is the potential for public and private enterprise relationships between fishing gear manufacturers, the plastics and fishing industry, and port authorities to promote the responsible management of waste. For example, there is a potential for the Plastics Environment Council (of the Plastics and Chemicals Industries Association) to initiate a 'responsible use' campaign aimed at consumers and linked to educational campaigns. The Plastics Environment Council was formed by Australia's leading resin manufacturers, importers and major converters to educate the government and industry on the environmental aspects of plastics and to help implement sustainable waste management methods through research and development. Similar opportunities exist for the identification and promotion of ethical responsibilities and legal liabilities of gear manufacturers with respect to the impacts of derelict fishing gear on the marine environment.

Action 1.11 DEWHA to support feasibility studies of market/consumer/peer-based incentives to encourage responsible handling and disposal of waste fishing gear, for example:

- accreditation of sustainable practice in fisheries with specific reference to gear manufacture, use and handling
- 'stewardship' arrangements for manufacturers and users of fishing gear.

Prevention and management of litter on a local scale falls largely within the jurisdiction of local governments that have responsibility for drain and sewerage systems, management of dumpsites and local littering by-laws and mitigation measures. Local governments have given strong emphasis to community recycling programs, stormwater management and clean-up of beaches and waterways. Without reversing recent emphasis on reductions in nutrient and chemical inputs to the oceans, further consideration should be given to the pathways of litter, with a particular emphasis on litter prevention and mitigation strategies in waterways.

Action 1.12 State, territory and local governments and other relevant bodies to consider providing increased funding for the introduction of improved solid pollutant (particularly litter) control strategies in waterways.

Raise public awareness and improve education campaigns about the prevention of littering on land and at sea

Education and outreach efforts are integral components of strategies to prevent marine debris. Education and outreach programs are generally aimed at changing the behaviour of polluters, but despite the array of public awareness and education campaigns aimed at the prevention of litter and responsible waste disposal in Australia, little evaluation has been done of their effectiveness, particularly in regards to marine-based activities contributing to debris.

Action 1.13 State and territory governments to facilitate an analysis of the effectiveness of current litter public awareness and education campaigns to identify gaps and areas for improvement.

Action 1.14 State, territory and Australian governments, in collaboration with appropriate non-government organisations, to develop options for establishing a more consistent and long-term national approach to litter abatement education, particularly for marine based activities.

Different groups and sectors from several nations may be contributing to the incidence of harmful marine debris in Australian waters. There is scope for the development of awareness-raising and outreach programs between Australia and our regional neighbours. However, the success or otherwise of past approaches should be reviewed, and the feasibility and potential effectiveness of working with specific foreign sectors and groups should be examined before new initiatives are implemented.

Action 1.15 DEWHA and relevant agencies to examine introducing awareness-raising and outreach programs aimed at relevant groups contributing to marine debris in the Asia-Pacific region.

Action 1.16 DEWHA, in collaboration with DFAT, to identify opportunities for exchange visits between coastal (especially Indigenous) communities experiencing the impacts of marine debris and groups in other nations where large proportions of harmful marine debris originates.

Build and strengthen international collaboration to identify the origins and effective responses to the prevention of harmful marine debris

While many of the negative impacts of marine debris are experienced at the local level and require local action, marine debris is an international issue. Domestic efforts to prevent the incidence of marine debris (especially marine-sourced debris) are therefore ineffective without regional and international collaboration to address the sources of the problem. Australia has taken a lead on progressing marine debris issues in a number of bilateral and international fora and considerable progress has been made. Priorities for ongoing action include the following:

Action 1.17 DEWHA, in collaboration with DFAT, to strengthen relations with regional neighbours on marine debris through relevant fora, and develop collaborative project proposals to address the sources and impacts of harmful marine debris.

Action 1.18 Australian Government to encourage and assist relevant nations to sign, ratify and enforce Annex V of MARPOL.

Objectives 2 and 4

Objective 2 — Remove existing harmful marine debris from the marine environment

Objective 4 — Monitor the quantities, origins and impacts of marine debris and assess the effectiveness of management arrangements over time for the strategic reduction of debris

Development of national approach to information collection and management

A lack of information about the nature, impact and occurrence of marine debris is one of the most significant impediments to minimising the threat of marine debris to vertebrate marine life. While community clean-ups and surveys and some research have contributed significantly to our awareness and knowledge of the issue, efforts have tended to be ad hoc, isolated, and not sufficiently consistent to enable comprehensive and robust analysis of trends or patterns in data on a national scale. A

consolidation of existing data at a national level and nationally consistent data recording protocols would greatly assist prevention and remediation measures. Such an approach could build on a national survey guide developed by Australian and New Zealand Environment and Conservation Council (EPHC, 2002) and existing wildlife stranding databases. Data that are nationally comparable and may be mapped to show concentrations and distribution patterns over time is also critical to the assessment of management practices and strategies.

Action 2.1 DEWHA in collaboration with state and territory governments and other relevant stakeholders to support the development of nationally consistent, statistically rigorous data collection protocols and survey methods. DEWHA to support the development and management of national mapping of the spatial distribution and concentration of marine debris over time to assess the significance of marine debris and to reduce its occurrence.

The work undertaken by community groups around Australia has demonstrated the potential of this type of activity to generate useful information while involving those who have the greatest concern in developing solutions. Extending support for those groups who have demonstrated commitment and accrued both expertise and data are an essential element of an abatement strategy. Further, it is recognised that there is a need to ensure that community groups, including indigenous rangers and community organisations, are provided support to build their capacity to manage and prevent the occurrence and impacts of marine debris.

Action 2.2 State, territory and Australian governments to continue to provide support for community-based coastal and waterway clean-up and monitoring activities.

Action 2.3 DEWHA in collaboration with state and territory governments to facilitate the establishment of a national network of a limited number of permanent marine debris monitoring sites (including within Commonwealth Marine Protected Areas) to promote consistent monitoring and information gathering and exchange, to enable understanding of long-term trends, and to inform adaptive and effective management responses.

Improve understanding of the origins of harmful marine debris

Marine debris is directly influenced by the interactions of wind, sand and sea; however, little information exists on how debris is transported and broken down within this dynamic system. Information on the influence of ocean circulation and wind patterns on the movements and persistence of marine debris would enable a better understanding of the origins (domestic and international) of marine debris, convergence areas and accumulation sites for debris, areas of potential navigational hazard, and sites for targeting clean-up and survey efforts. The following Action has a focus on the Asia Pacific region because this is the origin of the largest proportion of foreign debris in Australian waters.

Action 2.4 DEWHA to support a study on the wind and sea circulation patterns in the Asia-Pacific region as a basis for better understanding the pathways and potential sources and sinks of harmful marine debris of foreign origins in Australian waters.

Coastal surveys of the northern Australian coastline indicate that much of the harmful marine debris found is from marine sources, particularly foreign fishing fleets. However, there is currently insufficient information to enable the identification of specific fleets or fisheries responsible for derelict gear, or the factors influencing its loss or disposal. Given this lack of information, it is currently not possible to effectively target regional or international measures for the prevention and management of derelict fishing gear and related marine debris.

Action 2.5 Australian Government to facilitate a feasibility study on the marking of fishing gear so that it may be identified as originating from a specific fishery. The feasibility study will also consider the practical implications of marking fishing gear and the implications of derelict gear being traced back to fisheries operations.

Objective 3

Mitigate the impacts of harmful marine debris on marine species and ecological communities

Facilitate implementation of wildlife research and recovery actions

Records of entangled and stranded marine wildlife are generally limited to ad hoc, land-based observations over a relatively small area of the Australian coastline. While there have been numerous reports of marine wildlife observed entangled in and harmed by marine debris over the years, there are few examples of records of these reports being maintained.

Building on existing initiatives of the state and Northern Territory governments and non-government organisations, there is a need to establish a well-maintained, long-term national record of marine wildlife killed and harmed by marine debris. Further, long-term studies on the physical interactions between marine wildlife and harmful marine debris are required in order to document the catch rates by different types of debris in different areas over multi-year periods, and to determine the effectiveness of management activities over time.

Action 3.1 State, territory and Australian governments to support expanded and consistent, long-term monitoring, investigation, recording and management of data on vertebrate marine life harmed and killed by the physical and chemical impacts of marine debris. This information will assist the impacts of different types of marine debris on vertebrates to be quantified and characterised. For example:

- DEWHA to support monitoring of regurgitated marine debris at albatross and giant-petrel breeding colonies (linked with the *Recovery plan for albatrosses and giant petrels* [Environment Australia, 2001b]).

A number of existing recovery plans for marine wildlife note marine debris as an issue of concern and recommend actions to address the impacts of debris on species. In response to recommendations of the *Recovery plan for marine turtles in Australia* (Environment Australia, 2003) for example, communities in northern Australia are involved in monitoring coastlines for marine turtles stranded in fishing nets and other marine debris. It is currently unclear whether entanglement and stranding in any way compromises the ability of recovered marine species, including turtles, to survive once they are released.

Action 3.2 DEWHA to coordinate abatement strategies identified in existing marine wildlife recovery plans. For example:

- DEWHA to support analysis of the impact of marine debris on the survival and behaviour of marine turtles (linked with the *Recovery plan for marine turtles in Australia* [Environment Australia, 2003]).

There is a lack of information on how plastics may be incorporated into the food web at the lower levels of food chains. The physical evolution of plastics and other synthetics (including biodegradable and oxodegradable plastics) needs to be better understood in order to determine the potential indirect (chemical) impacts of debris on marine environments and species over prolonged periods.

Action 3.3 DEWHA to support research on the nature of degradation pathways of synthetic debris in the marine environment (including biodegradable and oxodegradable plastics), the extent that degradation products are contaminated by other potentially toxic compounds, and the potential toxicity of debris types on marine species. For example:

- DEWHA to support monitoring of the incidence of hatching failure due to eggshell thinning (linked with the *Recovery plan for albatrosses and giant petrels* [Environment Australia, 2001b]).

Biodegradable and oxodegradable plastics have a range of potential applications, and they are currently being used in the manufacture of some shopping bags, waste and bin liner bags, composting bags, packaging and bait bags. Driven by the growing use of plastics in packaging and the perception that biodegradable plastics are ‘environmentally friendly’, their use is predicted to increase. However, issues are also emerging regarding the use of biodegradable and other degradable plastics, their potential impacts on the environment and effects on established recycling systems and technologies.

The benefits for marine species of plastics that decompose more quickly than conventional plastics have been widely promoted. As degradable plastics become more common, degradable plastic waste is more likely to be found in the marine environment. However, biodegradable plastics are also known to pose some adverse environmental risks, including trauma and death of marine species resulting from only partial or slow degradation of biodegradable plastic products in marine environments.

Further investigation needs to be given to the use and application of degradable plastics, particularly in the context of the marine environment. Links between education programs targeting littering behaviour and the use of degradable plastics could also be promoted.

Action 3.4 DEWHA to identify measures to promote the uptake and application of biodegradable and oxodegradable plastic in marine-based industries and environments where it is found to be effective.

Glossary

Critically endangered	Under the EPBC Act, a native species is eligible to be included in the critically endangered category at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
Ecological community	Under the EPBC Act, an assemblage of native species that: (a) inhabits a particular area in nature; and (b) meets the additional criteria specified in the Regulations (if any) made for the purposes of this definition
Endangered species	Under the EPBC Act, a native species is eligible to be included in the endangered category at a particular time if, at that time: (a) it is not critically endangered; and (b) it is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.
Harmful marine debris	Land sourced plastic garbage, fishing gear from recreational and commercial fishing abandoned into the sea, and ship sourced, solid non biodegradable floating materials disposed of at sea. In concordance with MARPOL plastic material is defined as: bags, bottles, strapping bands, sheeting synthetic ropes, synthetic fishing nets, floats, fibreglass, piping, insulation, paints and adhesives.
Key threatening process	Under the EPBC Act, a process that threatens or may threaten the survival, abundance or evolutionary development of a native species or ecological community.
Recovery plan	Under the EPBC Act, a document setting out the research and management actions necessary to stop the decline of, and support the recovery of, listed threatened species or threatened ecological communities.
Threat abatement plan	Under the EPBC Act, a plan providing for the research, management, and any other actions necessary to reduce the impact of a listed key threatening process on impacted species and ecological communities.
Threatened species	Refers to the Australian Government list of threatened native species divided into the following categories as per the EPBC Act: critically endangered; endangered; vulnerable; conservation dependent.
Vulnerable species	Under the EPBC Act, a native species is eligible to be included in the vulnerable category at a particular time if, at that time: (a) it is not critically endangered or endangered; and (b) it is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.

Acronyms and abbreviations

AFMA	Australian Fisheries Management Authority
AMSA	Australian Maritime Safety Authority
DEWHA	Australian Government Department of the Environment, Water, Heritage and the Arts
DFAT	Australian Government Department of Foreign Affairs and Trade
EEZ	Exclusive Economic Zone
EPBC Act	Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i>
IMO	International Maritime Organization
MARPOL	International Convention for the Prevention of Pollution from Ships 1973 as modified by the Protocol of 1978 relating thereto. MARPOL 73/78 has been changed to MARPOL in accordance with a recent International Maritime Organization decision.
NPA	National Programme of Action for the Protection of the Marine Environment from Land-based Activities
TAP	Threat abatement plan
TSSC	Threatened Species Scientific Committee
UNEP	United Nations Environment Programme
WWF-Australia	World Wide Fund for Nature, Australia

References

- Alderman R, Pauza M, Bell J, Taylor R, Carter T and Fordham D (1999). Marine debris in northeast Arnhem Land Northern Territory Australia. In: Entanglement of Marine Turtles in Netting: Northeast Arnhem Land, Northern Territory, Australia, Leitch K (ed). Dhimurru Land Management Aboriginal Corporation, Nhulunbuy.
- AMSA (2003). Waste reception facilities in Australian and New Zealand ports. Australian Maritime Safety Authority and the Maritime Safety Authority of New Zealand.
- Ananthaswamy A (2001). A diet of plastic pellets plays havoc with animals immunity, in *New Scientist* 169(2274):18.
- Andrady A (1990). Environmental degradation of plastics under land and marine exposure conditions. In: Shomura RS and Godfrey ML (eds), *Proceedings of the International Conference on Marine Debris*, Honolulu, 2–7 April 1989. US Department of Commerce. NOAA Tec. Memo. NPAA-TM-NMFS-SWFSC-154: 848-869.
- Andrady A (2000). Plastics and their impacts in the marine environment. In: McIntosh N, Simonds K, Donohue M, Brammer C, Manson S and Carbajal S. 2000. *Proceedings of the International Marine Debris Conference on Derelict Fishing Gear and the Ocean Environment*, Honolulu, Hawaii, 6–11 August 2000. Hawaiian Islands Humpback Whale National Marine Sanctuary, US Department of Commerce: 137-143.
- ANZECC (1995). Maritime accidents and pollution: impacts on the marine environment from shipping operations. Paper for public comment. Australian and New Zealand Environment and Conservation Council, March 1995.
- ANZECC (2003). Waste reception facilities in Australian and New Zealand ports. Australian and New Zealand Environment and Conservation Councils.
- Baird RW and Hooker SK (2000). Ingestion of Plastic and Unusual Prey by a Juvenile Harbour Porpoise. *Marine Pollution Bulletin*, 40(8):719–720.
- Balazs G (1985). Impact of ocean debris on marine turtles: entanglement and ingestion. In: Shomura RS and Yoshida H (eds) (1990) *Proceedings of the Workshop on the Fate and Impact of Marine Debris*, Honolulu, Hawaii, 27–29 November 1984. NOAA/NMFS-54. National Marine Fisheries Service, Honolulu Laboratory; Honolulu, Hawaii.
- Bannister J, Kemper C and Warneke R (1996). The action plan for Australian cetaceans. Wildlife Australia, Endangered Species Program, Project Number 380. Australian Nature Conservation Agency.
- Barnes D and Fraser K (2003). Rafting by five phyla on man-made flotsam in the Southern Ocean, in *Marine Ecology Progress Series* 262:289–291.
- Barreiros JP and Barcelos J (2001). Plastic ingestion by a leatherback turtle *Dermochelys coriacea* from the Azores (NE Atlantic). *Marine Pollution Bulletin*. 42(11):1196–1197.
- Beck C and Barros N (1991). The impact of debris on the Florida Manatee, *Marine Pollution Bulletin* 22(10):508–510.
- Bjorndal K, Bolten A and Lageaux C (1994). Ingestion of marine debris by juvenile sea turtles in coastal Florida habitats, in *Marine Pollution Bulletin* 28(3):154–158.

- Blight LK and Burger AE (1997). Occurrence of plastic particles in sea-birds from the eastern North Pacific, in *Marine Pollution Bulletin* 34(5):323–325.
- Bonner WN and McCann TS (1982). Neck collars on fur seals, *Arctocephalus gazella* at South Georgia, in *British Antarctic Survey Bulletin* 57:73–77.
- Brown J, Macfadyen G, Huntington T, Magnus J and Tumilty J (2005). Ghost fishing by lost fishing gear. Final Report to DG Fisheries and Maritime Affairs of the European Commission, Fish/2004/20, Institute for European Environmental Policy/Poseidon Aquatic Resource management Ltd Joint Report.
- Bullimore BA, Newman PB, Kaiser M, Gilbert S and Lock K (2000). A study of catches in a fleet of 'ghost-fishing' pots. *Fishery Bulletin* 99(2):247–253.
- Cadee G (2002). Seabirds and floating plastic debris, in *Marine Pollution Bulletin* 44:1294–1295.
- Carr A and Harris J (1997). Ghost-fishing gear: have fishing practices during the past few years reduced the impact? In: *Marine Debris. Sources, Impacts and Solutions*, Coe JM and Rogers AB (eds), Springer-Verlag, New York, 141–151.
- Cary JL, Robinson JE and Grey KA (1987). Survey of beach litter in the proposed Marmion Marine Park near Perth, Western Australia. Collected Technical Reports on the Marmion Marion Park, Perth, Western Australia, Technical Series 19, EPA, Perth, 200–209.
- Chatto R (1995). Sea turtles killed by flotsam in Northern Australia, in *Marine Turtle Newsletter* 69 (April):17–18.
- Chatto R and Warneke R (2000). Records of cetacean strandings in the Northern Territory of Australia, in *The Beagle, Records of the Museum and Art Galleries of the Northern Territory* 16:163–175.
- Clean Up Australia (2006). The rubbish report. <http://www.cleanup.org.au/au/NewsandMedia/rubbish-report.html>
- Coast keepers (2008). <http://www.coastkeepers.org.au/marine-debris.htm>
- Coe JM and Rogers AB (Eds) (1987). *Marine Debris. Sources, Impacts and Solutions*. Springer-Verlag, New York.
- Commonwealth of Australia (2008). Threat abatement plan for the impacts of marine debris on vertebrate marine life. Australian Government Department of the Environment, Water, Heritage and the Arts, Canberra. <http://www.environment.gov.au/biodiversity/threatened/tap-approved.html>
- Cunningham D and Wilson S (2003). Marine debris on beaches of the greater Sydney region, in *Journal of Coastal Research* 19(2):421–430.
- Derraik JGB (2002). The pollution of the marine environment by plastic debris: a review, in *Marine Pollution Bulletin* 44:842–852.
- DEH (2005a). Southern right whale recovery plan 2005–2010. Department of the Environment and Heritage, May 2005.
- DEH (2005b). Blue, fin and sei whale recovery plan 2005–2010. Department of the Environment and Heritage, May 2005.
- DEH (2005c). Humpback whale recovery plan 2005–2010. Department of the Environment and Heritage, May 2005.

Donohue M, Brainard R, Parke M and Foley D (2000). Mitigation of environmental impacts of derelict fishing gear through debris removal and environmental monitoring. In: Proceedings of the International Marine Debris Conference on Derelict Fishing Gear and the Ocean Environment, McIntosh N, Simonds K, Donohue M, Brammer C, Manson S, and Carbajal S (eds), Honolulu, Hawaii, 6–11 August 2000. Hawaiian Islands Humpback Whale National Marine Sanctuary, US Department of Commerce, 383–402.

DTAE and DPIWE (2007). Marine debris survey and collection project — Macquarie Island. Final report for the Department of the Environment and Heritage, Parks and Wildlife Service, Department of Tourism, Arts and the Environment, Tasmania and Biodiversity Conservation Branch Department of Primary Industries and Water, Tasmania.

Eckert KL and Luginbuhl C (1988). Death of a giant, in *Marine Turtle Newsletter* 43:2–3.

Edyvane K, Dalgetty A, Hone P, Higham J and Wace N (2004). Long-term marine litter monitoring in the remote Great Australian Bight, South Australia, in *Marine Pollution Bulletin* 48(11–12):1060–1075.

Eglinton Y, Wear R and Theil M (2005). Marine debris monitoring in South Australia: a report on the 2004 annual Robe Litter Survey. Final report prepared for ‘Envirofund’. South Australian Research and Development Institute (Aquatic Sciences), Adelaide.

Environment Australia (2001a). Students survey and clean up Christmas Island’s beach. Department of the Environment and Heritage, Canberra. <http://www.coastcare.com.au/CaseStudy.aspx?cID=23>.

Environment Australia (2001b). Recovery plan for albatrosses and giant petrels. Environment Australia in consultation with the Albatross and Giant-Petrel Recovery Team, October 2001.

Environment Australia (2003). Recovery plan for marine turtles in Australia. Marine Species Section, Approvals and Wildlife Division, Environment Australia in consultation with the Marine Turtle Recovery Team, July 2003.

EPA (2000). Stranding report — cetaceans. Environment Protection Agency and the Queensland Parks and Wildlife Service. http://www.epa.qld.gov/nature_cpnservation/wildlife/caring_for_wildlife/marine_strandings/

EPA (2003). Stranding report — dugongs. Environment Protection Agency and the Queensland Parks and Wildlife Service. http://www.epa.qld.gov/nature_cpnservation/wildlife/caring_for_wildlife/marine_strandings/

EPA (2004). Stranding report — dugongs. Environment Protection Agency and the Queensland Parks and Wildlife Service. http://www.epa.qld.gov/nature_cpnservation/wildlife/caring_for_wildlife/marine_strandings/

EPA and QPWS (2000). Killer plastic now on display, in *EQ – News from the EPA and QPWS* 5(December):13. Environment Protection Agency and the Queensland Parks and Wildlife Service.

EPHC (2002). Keeping tabs on marine debris. Environment and Protection Heritage Council (formerly ANZECC).

EPHC (2006). A national approach to the management of plastic bags. Environment Protection and Heritage Council. http://www.ephc.gov.au/ephc/plastic_bags.html

Eriksson C and Burton H (2001). Polymer types of small plastic particles in fur-seal scats from Macquarie Island. Paper presented at the Pacific Congress on Marine Science and Technology, San Francisco, 8–11 July 2001.

- Faris J and Hart K (1995). Seas of debris: a summary of the Third International Conference on Marine Debris. Alaska Fisheries Science Centre, North Carolina Sea Grant College Program, publication UNC-SG-95-01, USA.
- Frost A and Cullen M (1997). Marine debris on northern New South Wales beaches (Australia): sources and the role of beach usage, in *Marine Pollution Bulletin* 34(5):348–352.
- Greenland J, Limpus C and Currie K (2004). Queensland marine wildlife stranding and mortality database annual report 2001–2002: III Marine turtles. Conservation technical and data report. Volume 2002, No. 3, Queensland Environment Protection Agency and Parks and Wildlife Service.
- Gregory M and Ryan P (1997). Pelagic plastics and other seaborne persistent synthetic debris: a review of Southern Hemisphere perspectives. In: *Marine Debris- Sources, Impacts, Solutions*, Coe JM and Rogers DB (eds). Springer-Verlag, New York, 49–66.
- Gregory M (1999). Marine debris: notes from Chatham Island, and Mason and Doughboy Bays, Stewart Island, in *Tane* 37:201–210.
- Haynes D (1997). Marine debris on continental islands and sand cays in far northern section of the Great Barrier Reef Marine Park, Australia, in *Marine Pollution Bulletin* 34(4):276–279.
- Herfort A (1997). Marine debris on beaches in New South Wales with a special focus on fishing debris. A marine environmental study funded by the NSW Environmental Restoration and Rehabilitation Trust. OceanWatch Australia.
- Hucke-Gaete R, Torres D and Vallejos V (1997). Entanglement of Antarctic fur seals, *Arctocephalus gazella*, in marine debris at Cape Shirreff and San Telmo Islets, Livingston Island, Antarctica: 1988–1997. Ser. Cient. INACH 47, CCAMLR Scientific Committee, Hobart, 123–135.
- Huin N and Croxall J (1996). Fishing gear, oil and marine debris associated with seabirds at Bird Island South Georgia, during 1993/94, in *Marine Ornithology* 24:19–22.
- Hyder Consulting (2006). Plastic retail carry bag use 2002–2005 consumption. <http://www.environment.gov.au/settlements/publications/waste/plastic-bags/report-2005.html>.
- Jones M (1994). Fishing debris in the Australian marine environment. Bureau of Resource Sciences, Canberra.
- Jones M (1995). Fishing debris in the Australian marine environment, in *Marine Pollution Bulletin* 30(1):25–33.
- Keep Australia Beautiful (1996). Looking at litter and what's being done about it. A survey of litter in Australia, Keep Australia Beautiful Association Inc.
- Keep Australia Beautiful (2006). Marine litter index. McGregor Tan Research on behalf of Keep Australia Beautiful, June 2006.
- Kiessling I (2003). Finding solutions: derelict fishing gear and other marine debris in Northern Australia. Key Centre for Tropical Wildlife Management, Charles Darwin University.
- Kiessling I and Hamilton C (2001). Marine debris at Cape Arnhem, Northern Territory, Australia. Report on the Northeast Arnhem Land Marine Debris Survey 2000. World Wide Fund for Nature, Tropical Wetlands of Oceania Program.
- Kiessling I and Hamilton C (2003). Marine debris at Cape Arnhem, Northern Territory, Australia. Report on the Northeast Arnhem Land Marine Debris Survey 2001. World Wide Fund for Nature Australia, Tropical Wetlands of Oceania Program.

- Laist D (1996). Marine debris entanglement and ghost fishing: a cryptic and significant type of bycatch? In: *Solving Bycatch: Considerations for Today and Tomorrow*, Alaska Sea Grant (ed) proceedings of a workshop, University of Alaska, Fairbanks, September 1993, 33–39.
- Laist D (1997). Impacts of marine debris: entanglement of marine life in marine debris including a comprehensive list of species with entanglement and ingestion records. In: *Marine Debris: Sources, Impacts, and Solutions*, Coe JM and Rogers DB (eds). Springer, New York, 99–139.
- Laist D and Liffman M (2000). Impacts of marine debris: research and management needs. In: *Proceedings of the International Marine Debris Conference on Derelict Fishing Gear and the Ocean Environment*, McIntosh N, Simonds K, Donohue M, Brammer C, Manson S and Carbajal S (eds), Honolulu, Hawaii, 6–11 August 2000. Hawaiian Islands Humpback Whale National Marine Sanctuary, US Department of Commerce, 344–357.
- Leitch K (1997). Entanglement of marine turtles in netting: northeast Arnhem Land, Northern Territory, Australia. Report to Environment Australia, Dhimurru Land Management Aboriginal Corporation, Northern Territory.
- Limpus C, Currie K and Haines J (2003). Marine wildlife stranding and mortality database annual report 2002: II Cetacean and Pinniped. Conservation technical and data report. Volume 2002, No. 2. Queensland Environment Protection Agency and Parks and Wildlife Service.
- Limpus C and Miller J (2002). Beachwashed nets, Gulf of Carpentaria. Unpublished Queensland Parks and Wildlife report to the Gulf Fisheries Management Advisory Committee.
- Mato Y, Isobe T, Takada H, Kanehiro H, Ohtake C and Kaminuma T (2001). Plastic resin pellets as a transport medium for toxic chemicals in the marine environment, in *Environmental Science and Technology* 35(2):318–324.
- Miller J (1994). Status of hawksbill turtles and other flora and fauna on northern Great Barrier Reef and central Torres Strait Islands 1991. Queensland Department of Environment and Heritage and Greenpeace Australia Ltd, Townsville
- Minton M (2000). Industry considerations and action. In: *Proceedings of the International Marine Debris Conference on Derelict Fishing Gear and the Ocean Environment*, McIntosh N, Simonds K, Donohue M, Brammer C, Manson S and Carbajal S (eds), Honolulu, Hawaii, 6–11 August 2000. Hawaiian Islands Humpback Whale National Marine Sanctuary, US Department of Commerce, 364–382.
- Mrosovsky N (1981). Plastic jellyfish, in *Marine Turtle Newsletter* 17:5–7.
- National Research Council (1995). *Clean Ships, Clean Ports, Clean Oceans. Controlling Garbage and Plastic Wastes at Sea*. Committee on Shipborne Wastes, Marine Board, Commission on Engineering and Technical Systems, National Research Council. National Academy Press, Washington, D.C.
- Nel DC and Nel JL (1999). Marine debris and fishing gear associated with seabirds at sub-Antarctic Marion Island, 1996/97 and 1997/98: in relation to longline fishing activity, in *CCAMLR Science* 6:85–96.
- Nolan-ITU (2002). *Biodegradable plastics – developments and environmental impacts*. Consultancy report prepared in association with ExcelPlas Australia for Environment Australia, October 2002.
- NRMMC (2006). *Australia's National Programme of Action for the Protection of the Marine Environment from Land-based Activities*. Natural Resource Management Ministerial Council, Department of the Environment and Heritage, Canberra, ACT.
- O'Callaghan P (1993). Sources of shoreline litter near three Australian cities. Victorian Institute of Marine Science, Queenscliff, Victoria, Australia.

- OceanWatch (2006). Reducing plastics in the Australian seafood industry: Phase 1 desktop feasibility study. Fisheries Research and Development Corporation project No. 2004/410.
- Page B, McKenzie J, McIntosh R, Baylis A, Morrissey A, Calvert N, Haase T, Berris M, Dowie D, Shaughnessy P and Goldsworthy S (2004). Entanglement of Australian sea lions and New Zealand fur seals in lost fishing gear and other marine debris before and after government and industry attempts to reduce the problem, in *Marine Pollution Bulletin* 49:33–42.
- Patrick L, Riddle M and Smith S (2005). Assisted passage or passive drift: a comparison of alternative transport mechanisms for non-indigenous coastal species into the Southern Ocean, in *Antarctic Science* 17:183–191.
- Pemberton D, Brothers N and Kirkwood R (1992). Entanglement of Australian fur seals in man-made debris in Tasmanian waters, in *Wildlife Research* 19:151–59.
- Pooley SG (2000). Economics of lost fishing gear. In: *Proceedings of the International Marine Debris Conference on Derelict Fishing Gear and the Ocean Environment*, McIntosh N, Simonds K, Donohue M, Brammer C, Manson S and Carbajal S (eds), Honolulu, Hawaii, 6–11 August 2000. Hawaiian Islands Humpback Whale National Marine Sanctuary, US Department of Commerce, 59–66.
- Pryor H (1999). World heritage area beach clean up. Coastcare Information Sheet, Tasmania.
- RAOU (1996). Eyre bird observatory report 6, 1988–1992. Royal Australian Ornithologists Union, RAOU Report 97.
- Recfish Australia (1996). *National Code of Practice for Recreational and Sport Fishers*. <http://www.recfish.com.au/>
- Roeger S, Mununjurr M and Wise P (2005). Entanglement of miyapunu (marine turtles) in ghost netting: northeast Arnhem Land, Northern Territory, Australia. Report to Alcan Gove Pty Ltd, World Wide Fund for Nature Australia, Humane Society International, Northern Land Council. Dhimurru Land Management Aboriginal Corporation, Northern Territory
- Roelofs A, Coles R and Smit N (2005). A survey of intertidal seagrass from Van Diemen Gulf to Castlereagh Bay, Northern Territory and from Gove to Horn Island, Queensland – November 2004. Report to the National Oceans Office, Australian Government Department of the Environment and Heritage, Canberra.
- Ryan P, Connell A and Gardner B (1988). Plastic Ingestion and PCBs in Seabirds: is there a relationship? in *Marine Pollution Bulletin* 19(4):174–176.
- SADC (1996). State of the Environment Tasmania, Volume 1 – Conditions and Trends. State of the Environment Unit, Department of Environment and Land Management, Tasmania.
- Sazima I, Gadig OB, Namora R and Motta FS (2002). Plastic debris collars on juvenile carcharhinid sharks (*Rhizoprionodon lalandii*) in southwest Atlantic, in *Marine Pollution Bulletin* 44:1147–1149.
- Slater J (1991). Flotsam and jetsam, beach survey results January 1990–1991. *Marine Debris Bulletin* 1, Tasmania Department of Parks, Wildlife and Heritage, Hobart.
- Slip DJ and Burton HR (1990). The composition and origin of marine debris stranded on the shores of subantarctic Macquarie Island. In: *Proceedings of the Second International Conference on Marine Debris*, Hawaii, 2–7 April 1989, vol 1:403–415.
- Slip, D., Green, K. & Woehler, E.J. (1990). Ingestion of anthropogenic articles by seabirds at Macquarie Island. *Marine Ornithology* 18, 74–77

- Slip DJ and Burton HR (1991). Accumulation of fishing debris, plastic litter, and other artefacts on Heard and Macquarie Islands in the Southern Ocean, in *Environmental Conservation* 18(3):249–254.
- Slip D and Burton HR (1992). Accumulation of fishing debris, plastic litter and other artefacts on Heard and Macquarie Islands in the Southern Ocean, *Environmental Conservation*, vol. 18, pp. 249-245.
- Sloan S, Wallner B and Mounsey R (1998). Fishing debris around Groote Eylandt in the Western Gulf of Carpentaria. A report on the Groote Eylandt Fishing Gear Debris Project 1998. Australian Fisheries Management Authority, Canberra, Australia.
- Starbird C (2000). *Dermochelys coriacea* (Leather Sea Turtle) fishing net ingestion, in *Herpetological Review* 31(1):43.
- Thompson C (2000). Focus on impact of sea trash, in *Cairns Post*, Thursday 9 November 2000:12.
- Topping P, Morantz D and Lang G (1997). Waste disposal practices of fishing vessels: Canada's East Coast 1990-1991. In: *Marine Debris. Sources, Impacts and Solutions*, Coe JM and Rogers AB (eds). Springer-Verlag, New York, 253–262.
- TSSC (2003). Injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris. Advice to the Minister for Environment and Heritage from the Threatened Species Scientific Committee on a public nomination of a key threatening process under the *Environment Protection and Biodiversity Conservation Act 1999*.
<http://www.environment.gov.au/biodiversity/threatened/ktp/marine-debris.html>.
- UNEP (2005). Marine litter, an analytical overview. United Nations Environment Programme, Nairobi, Kenya.
- Wace N (1994). Beachcombing for ocean litter, in *Australian Natural History* 24:46–52.
- Wace N (1995). Ocean litter stranded on Australian coasts. State of the Marine Environment Report for Australia, Technical Annex 2. Ocean Rescue 2000 Program, Commonwealth Department of Education Science and Training, Canberra.
- White D (2003). Marine debris in Northern Territory waters 2002. WWF-Australia, Sydney.
- White D (2004). Marine debris in Northern Territory waters 2003. WWF Australia, Sydney.
- White D (2006). Marine Debris in Northern Territory Waters 2004. WWF-Australia, Sydney .
- Whiting S (1998). Types and sources of marine debris in Fog Bay, northern Australia, in *Marine Pollution Bulletin* 36(11):901–910.
- Widmer WM (2002). Recreational boating as a contributing source of marine debris, and their fouling assemblages. In: *Abstracts of the Tenth Pacific Congress on Marine Science and Technology, PACON 2002 — The Ocean Century*, Japan, 21–26 July 2002, 208.
- Woehler, E.J. 1990. Two records of seabird entanglement at Casey, Antarctica. *Marine Ornithology* 18, 72-73.

