



Australian Government

Great Barrier Reef
Marine Park Authority

Published March 2006

Management Status:

Shipping and oil spills

our great barrier reef
let's keep it great



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Shipping and oil spills

Summary

- Shipping is a major activity in the Great Barrier Reef Marine Park (the Marine Park) and is a significant component of Australia's national economy
- Shipping traffic in the Marine Park includes over 7000 voyages made by over 2000 ships every year
- The operation of shipping within the Great Barrier Reef (the Reef) poses a variety of environmental risks. These risks can arise from both routine shipping operations, and from major shipping related incidents arising from groundings and/or accidental spills of oil, chemicals or cargo
- There is relatively little information on the potential environmental impact of other cargo spillages by shipping plying the waters of the Reef
- The management of shipping activities and ship-sourced pollution in the Reef is implemented through Australian Government and State Government legislation. This legislation also applies the management arrangements contained in international conventions and agreements relating to commercial shipping activities
- Shipping in the Reef is managed at one of the highest standards applied to any body of water worldwide
- The Great Barrier Reef Marine Park Authority (GBRMPA) works in partnership with other Australian Government and State Government agencies, representatives from the shipping industry, and with community groups to monitor and regulate shipping activities in the Marine Park
- Management actions include improving the navigational safety of shipping in the Reef, reducing ship-sourced pollutants and ensuring an effective response to shipping incidents
- While the management of shipping is focused on preventing major incidents, oil and chemical spill contingency response plans have been developed at local, state, national and international levels.

Overview

[Shipping](#) is a significant activity within the Reef. Each year, more than 2100 individual ships undertake around 7600 voyages through designated shipping routes in the Reef. There has been slight increase in the number of ships passing through the Reef between 2000 and 2004 (see Table 1), and the global merchant vessel fleet has expanded in both the numbers and size of ships.¹⁴

Table 1: Ship traffic through the Reef between 2000 and 2004*

Traffic information	2000	2001	2002	2003	2004
Number of ships	1973	1868	1890	1984	2140
Number of ship voyages	7723	7173	7150	7336	7600
Average days per ship	5.4	5.3	4.8	4.6	4.4

Source: AMSA & MSQ, Preliminary report, ReefRep Traffic Information Module - 7 June 2005

A large number of recreational and other commercial vessels also ply the Queensland coast on a regular basis. In 2004 there were, some 59,000 [recreational vessels](#) registered in coastal communities adjacent to the Reef, and some 1,500 commercial tourism vessels permitted to operate within the Reef region.⁹

Shipping is major component of Queensland's economy with A\$1.7 billion worth of overseas commodity exports shipped through Queensland seaports in 2000/01. This represents 14.4 percent of the total value of exports from Australia.¹ The operation of ports and shipping services in the Reef region contributes to economic growth, income, export earnings, and employment. A study by Ports Corporation of Queensland found that for the year ending 30 June 2002, ports directly contributed \$720 million to the local economy, also generating flow-on effects to other sectors in the Queensland economy such as the finance and business services, wholesale and retail trade and manufacturing.¹¹



A variety of ships ply the waters of the Reef every year, including some 2,100 commercial trading ships, 1,500 tourism vessels, 1,000 commercial fishing vessels and some 59,000 private vessels.

Cargo and shipping routes

The ships transiting through the Reef carry a wide range of cargo, including bauxite and alumina, manganese, iron ore, coal, sugar, general container freight and oil. These ships navigate through a number of designated routes to reach their destinations. Most ships use the 'inner route', a shipping lane that runs between the mainland and the inner edge of the outer barrier reefs. Ships also use designated passages, including Hydrographers Passage, Palm Passage and Grafton Passage to transit between the 'inner route' and the 'outer routes' that lie outside the outer reefs.

Much of the oil carried in the inner route is in the form of refined oils such as petrol, diesel and heavy fuel oils. Tankers can carry up to 60,000 tonnes of oil through the inner shipping route, and large bulk carriers operating out of Hay Point can carry up to 4,000 tonnes of *fuel oil*[†].

Oil tankers carrying crude oil transit outside of the Reef due to sensitivity regarding oil tanker traffic within the Reef. Oil tankers only venture into the Reef on rare occasions. A further restriction is that the waters of the northern Great Barrier Reef and Torres Strait are too shallow for large vessels (such as large oil tankers) to transit.

The [Great Barrier Reef Marine Park Zoning Plan \(2003\)](#) describes designated shipping areas and general use areas where commercial trading ships can transit without requiring a permit (see *Ship management provisions under the Great Barrier Reef Marine Park Zoning Plan 2003*).

Issues, pressures and threats

Risk of ship groundings and collisions

One of the greatest risks shipping poses to the Reef is a major oil spill. Since 1987 over 700 shipping or marine pollution incidents have been reported in the GBRMPA's marine incident database. However, most of these reports involve small spills of petroleum products (for example, from bilge pump outs), sinking vessels or groundings and many reports are unsubstantiated (see Table 2). Reports of shipping or marine pollution incidents are increasing, but this may be due to improved awareness and reporting arrangements.



Shipping is a major commercial activity that is vital to exports of commodities such as bauxite, alumina, iron ore, coal and sugar. A\$1.7 billion worth of exports were shipped through Queensland ports in the 2000-01 financial year.



One of the main risks posed by shipping is a major spill of chemicals or oil resulting from a grounding or collision.

Table 2: Shipping and Pollution Incidents in the Great Barrier Reef World Heritage Area for 2000- 2004 (data from the GBRMPA marine Incident database)

Incident Type	2000	2001	2002	2003	2004
Confirmed spill – vessel	17	16	12	13	18
Unconfirmed spill origin and type	12	13	16	8	12
Ballast or sewage spills	0	0	1	2	1
Groundings	4	11	9	12	15
Sinkings (including collisions and capsizings)	10	7	9	14	19
Land sourced spills	2	0	2	3	1
Other	3	8	2	3	6
Total	48	55	51	55	72

Between 1987 and 2004, only 33 of the 700 incidents recorded (including 11 collisions and 22 *groundings*^s) were considered *significant*^{ll}, however, none of these incidents resulted in major spills of oil or chemicals. In recent years, significant ship groundings include the following:

- *MV Global Peace* – Gladstone Harbour on 24 January 2006
- *MV Karma* – stranding near Agnes Waters on 14 November 2003
- *MV Doric Chariot* – Piper Reef in July 2002 ([Media Release](#))
- *MV Bunga Terati Satu* – Sudbury Reef in November 2000 ([Media Release](#))
- *MV New Reach* – Heath Reef in May 1999 ([Media Release](#))
- *MV Peacock* – Piper Reef in July 1996
- *MV Svendborg Guardian* – Kurramine Beach in June 1995
- *MV Carola* – South Ledge Reef in March 1995

Significant shipping incidents also include situations where a ship grounding or spill does not occur. For example, in April 2004, the engine of the bulk carrier *MV Harmonic Progress* became disabled approximately 90 nautical miles north of Hydrographers Passage. The vessel drifted for 43 hours and came within 30 nautical miles of the Reef until tugs were able to stabilise the vessel's drift. While the ship was prevented from grounding, adverse weather conditions could have resulted in the disabled ship grounding on the Reef, potentially causing a major spill of oil and cargo.

In 2000, a joint study conducted by [Maritime Safety Queensland](#) and the GBRMPA identified the areas of the Marine Park at highest risk from shipping incidents (see Figure 1). This report ([Oil Spill Risk Assessment for the Coastal Waters of Queensland and the Reef Marine Park](#))¹² identified the following areas of highest risk of a shipping incident:

- Inner Route of the Reef (north of Cape Flattery)
- Port of Cape Flattery
- Whitsunday Islands (predominantly cruise shipping)
- Hydrographers Passage
- Great North East Channel

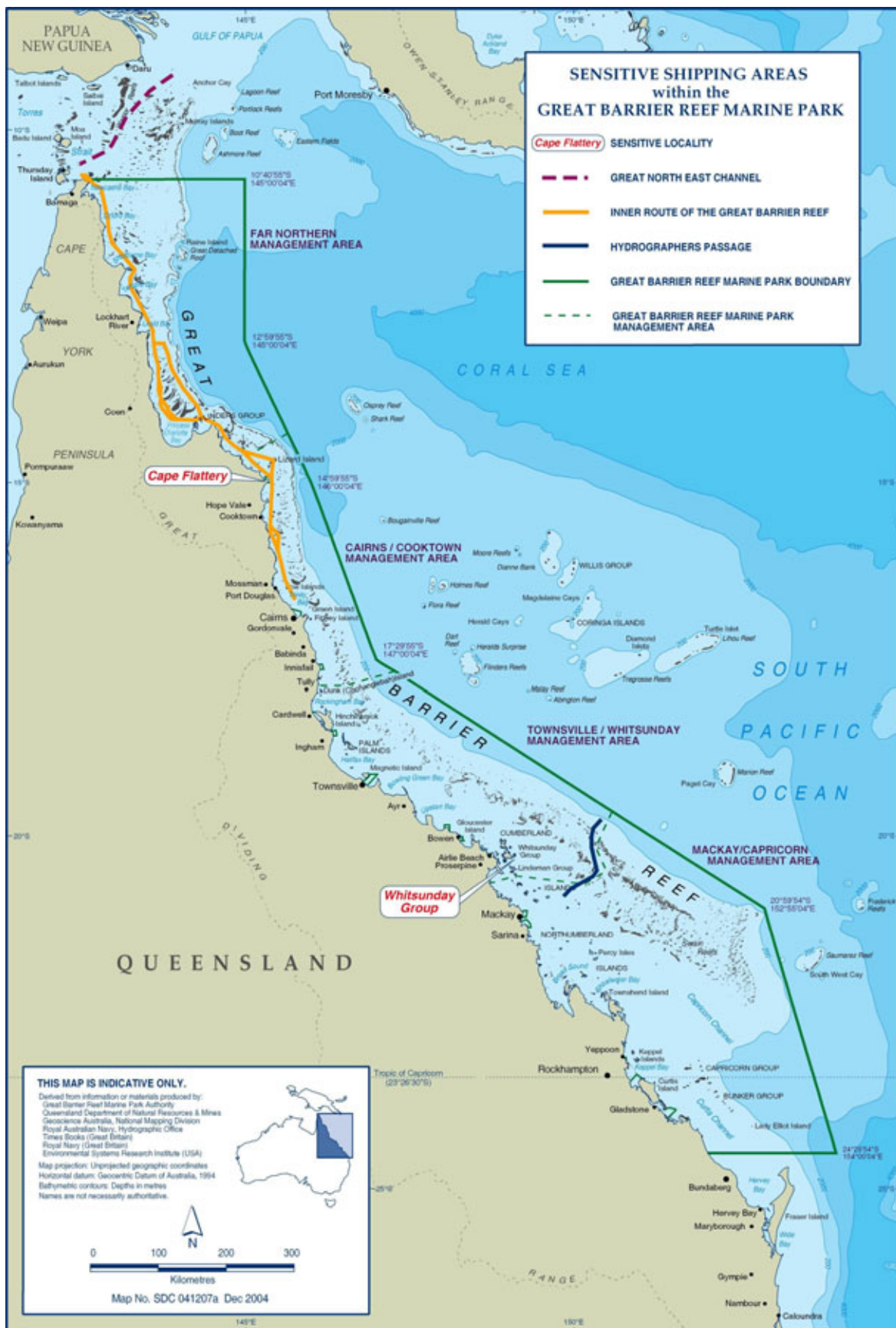


Figure 1. Map showing sensitive shipping areas within the Reef Marine Park

Consistent with national trends, ship groundings and collisions have been identified as the most likely type of shipping accident to occur in the Reef. In 1995, the Department of Transport's Great Barrier Reef and Torres Strait Shipping Study categorised the factors contributing to the risk of either collisions or groundings.² The study found that the risk of an incident may depend on how closely ships approach reefs or land, the presence of trawlers, and whether ships had *coastal pilots*[#] on board.

A study on shipping risks in the Reef suggested that a range of control measures could reduce the rate of incidents from 2.5 to 1.9 per year, with particular improvement in the Torres Strait region.³ Many of these controls were proposed as recommendations in the 2001 [Review of Great Barrier Reef Shipping Safety and Pollution Prevention Measure](#) and almost all 41 recommendations have been implemented (see *Response: Legislation, conventions and management arrangements applying to shipping in the Reef Marine Park*).

Potential impacts of ship operations

While shipping activities are a vital component of Australia's economy, shipping operations may affect the economic, environmental, social and cultural values of the Reef.

Environmental risks related to shipping within the Reef can occur from the routine discharge of [pollutants](#) during normal ship operations, or as a result of accidents or incidents. Potential impacts include:

- Spills or discharges of oil, chemicals, cargo, sewage and grey water
- Garbage and marine litter
- Collisions with marine animals
- Disturbance of marine life by noise
- Toxic effects of anti-fouling paints
- Physical damage from groundings and anchoring
- Ecosystem changes resulting from the introduction of invasive marine pests

Impacts from spills of oil or cargo

The accidental release of fuel or cargo resulting from groundings, collisions or structural failures may result in serious environmental damage to the Reef. The [environmental consequences](#) of an oil spill will likely depend on factors such as the type of oil and amount spilled, weather conditions and the habitats affected. The [main threats to wildlife](#) include the smothering of animals, plants or habitats by oil, and poisoning of animals that ingest the oil. Oil spills may also result in social and economic impacts through damage to habitats and organisms important to the Marine Park tourism and fishing industries, and the loss of access to or use of affected areas by recreational users or traditional owners.

Heavy fuel oil is the most damaging type of oil as it does not break down quickly and is difficult to disperse or remove. In contrast, light fuels such as diesel tend to be more toxic to marine life and readily disperse in the water column. This makes the containment and removal of these oils more difficult. Because most oils float, habitats that are exposed at low tide such as mudflats, mangroves and *inter-tidal*^{**} seagrass beds and beaches are especially vulnerable. However, over time oil slicks may be broken up by sunlight, bacteria and wave action, mixing oil droplets or residues through the water column.

Apart from the physical smothering of plants and animals, the toxicity of oil is likely to affect the health, growth, reproduction and development of a range of marine plants and animals for several years. The severity of such effects may depend upon oil type, concentration and the extent of exposure. Smaller accidental releases of petroleum products during fuel transfer operations and illegal discharges of bilge waste may contribute to localised impacts on habitats and fauna. These small-scale spills are relatively costly to respond to, diverting disproportionate resources from other areas or incidents.



Oil spills pose a serious potential threat to the animals and plants of the Reef. Relatively small 'operational' spills present an ongoing problem.

Little is known about the potential environmental impacts of spills of other cargoes that are carried by ships transiting the Reef. Few studies have been conducted on the sensitivity of plants and animals to chemicals transported along the Queensland coast used in the production of metals (for example, copper and nickel), industrial products (for example, cement) or agricultural products, such as sugar.

Collisions with marine animals

Collisions or 'boat strikes' between vessels and marine wildlife have been identified as a pressure on whales, dolphins, dugongs and marine turtles. These animals may be struck by ships, resulting in internal injuries, or cut by propellers. The noise generated by boats and ships may also disturb these animals and/or displace them from habitats. The impacts of shipping and boating activities on marine animals are discussed in more detail in the following chapters: [*Environmental status – marine mammals*](#) and [*Environmental status – marine reptiles*](#).



Collisions with animals such as whales and dugongs are a potential impact of shipping activity. This dugong (above) shows signs of propeller scars.

Case study: the Gladstone Harbour oil spill

At 11:54pm on the 24 January 2006, a tugboat struck the hull of the Korean bulk carrier *MV Global Peace* that was entering Gladstone Harbour to berth at the RG Tanna coal terminal. The impact ruptured a hull fuel tank and resulted in approximately 25 tonnes of heavy fuel oil spilling into Gladstone Harbour. The *National Plan to Combat Pollution of the Sea by Oil* was immediately activated with Maritime Safety Queensland leading a multi agency team to combat the spill. Expertise and assistance were sourced from around Australia and overseas. As per the National Plan, the Queensland Environmental Protection Agency and the Reef Marine Park Authority provided advice on environmental aspects of the response.

The clean up efforts were assisted with pre-positioned equipment readily available at the site. By the first day, booms and skimmers had been deployed to contain the slick and approximately two tonnes of oil and debris had been recovered. By the second day, skimmers had arrived from other locations and four skimmers were operating. Unfortunately, a storm and poor weather hindered recovery efforts and broke one of the protective booms, allowing oil to penetrate the mouth of Auckland Creek and enter the Gladstone Marina. While the slick formed a band up to 20km long and 4km wide, winds and waves contained most of the slick within the port. This concentrated the slick, making it easier for skimmers to remove it and preventing it from spreading into the Reef Marine Park.

Shoreline assessments were carried out at several locations and revealed that high tides had deposited oil on harbour breakwaters and carried it into mangroves. In affected areas, the oil covered mangrove roots and extended up trunks and leaves to the high tide mark. The oil also washed up on beach areas and penetrated the sand. Fortunately, the oil did not spread to bird foraging grounds and only a dozen birds were observed to have been oiled. No other oiled wildlife was reported. Concerns were raised about the potential for oil to contaminate seafood caught in the area, but samples analysed by the Queensland Department of Primary Industries and Fisheries and Queensland Health have not shown any signs of contamination.

Over the eight-day operation, some 8,000 litres of oil was recovered and 61 cubic meters of oily debris removed from beaches and mangroves.¹⁰

The top layers of sand were removed from the swimming beach and the marina was scrubbed clean by hand. The Queensland Environmental Protection Agency and the Queensland Department of Primary Industries and Fisheries are assessing the long-term impacts on mangroves and wildlife. Monitoring to date has found that the impact on seagrasses have been limited, with no obvious effects on seagrass beds except for small, isolated patches of dead seagrass found on Wiggins Island. Surveys of the affected area have also found signs of new seagrass colonisation. Leaf loss and mangrove dieback has occurred in patches, however the full impacts may not be known until October 2006. Aerial surveys conducted in future months will provide a more complete assessment. Samples of mangrove, algae, seagrass and sediments have been collected through the Integrated Port Curtis Monitoring Programme for signs of contamination. The rapid response in combating the oil spill has highlighted the value of thorough preparation and planning, regularly exercising of contingency plans and of having equipment and properly trained staff available to mount a prompt response.



On 24 January 2006, a tugboat struck the hull of the *MV Global Peace*. Response was rapid and together with favourable weather conditions, the oil was prevented from entering the Reef Marine Park. Image taken by Jamie Storrie, Department of Environment and Heritage

Impacts of antifoulant paint and ship groundings

The build up of organisms such as algae and barnacles on hulls and propellers can significantly reduce the speed and efficiency of vessels. Until recently, the hulls of ships were painted with antifoulant paint to reduce the growth of algae and other organisms. Antifoulant paints contain combinations of toxic chemicals such as copper, Tri-butyl Tin (TBT) and diuron. Antifoulant paint residues left behind in the ship's wake, or scraped onto the reef in the case of grounding, can result in long-term localised damage to the marine environment. During a ship grounding, significant quantities of concentrated antifoulant chemicals containing copper, zinc, TBT or other toxic chemicals can be scraped off the vessel, contaminating the sand and coral rubble. These compounds can have long-term effects, by hindering the recolonisation of the damaged site by corals and other marine organisms.^{5,13}

Ship groundings can result in significant localised damage to habitats. Groundings often leave grounding scars in the reef substrate where the coral is crushed and compacted. The instability of remaining coral rubble and changes to the water flow in the affected area have been found to hinder the settlement of new corals, delaying the recovery of the grounding scar. These physical factors, combined with the effects of antifoulant paint residues, mean that recovery of grounding scars may take decades. Grounding scars may also allow water to drain out of reef lagoons at low tide, potentially increasing erosion and exposing shallow water corals and lagoon habitats at low tide.



Ship groundings can leave large scars in the reef, as evident in the photo above of the MV Doric Chariot being pulled off Piper Reef in the Northern Great Barrier Reef, July 2002.

Ship groundings can also have significant social and cultural impacts. For example, Piper Reef and its surrounds are areas of cultural and historic importance to Indigenous communities in the region. Over the last decade, Piper Reef has sustained damage from several ship groundings and the Kuku Yau Traditional Owners from the area now consider the area to be contaminated and a place where it is bad luck to conduct diving, fishing and hunting activities (C. Turner 2005, pers. comm.).

Impacts of waste discharge

Ships transiting the Marine Park may carry anywhere from a few to hundreds of people, and can generate considerable volumes of sillage. High concentrations of nutrients in sewage and grey water can disrupt the physiological and reproductive processes of corals and ecological balance of coral reef systems. These pollutants may contribute to excessive algal blooms and weakening of the coral skeleton (see [Environmental status – water quality](#)). Although most cruise ships and cargo trading ships have sewage treatment systems on board to treat sewage, not all commercial and recreational vessels using the Marine Park manage their sewage to the same standards. However, more stringent and uniform regulations were recently introduced to regulate the discharge of sewage from all types of vessels operating in the Marine Park (see *Management actions applying to shipping in the Reef Marine Park*).

Marine debris and litter

Around the world, [marine debris](#) and [litter](#) blown, washed off or dumped from ships into the water is a growing issue. A report titled [Finding Solutions](#) commissioned by the Australian

Government [National Oceans Office](#) found that most of the debris and litter washed up on the northern Australian coast is of marine origin. This includes lost fishing gear as well as litter and debris from commercial shipping and recreational vessels. While lost fishing gear was a relatively small proportion of the debris found, it was the most significant in terms of weight and potential impact.⁷ In 1996, a [survey](#) of coral cays in the Reef identified that plastics, rubber and glass objects were the most common items washed up on beaches. However, there is little information about the volume, origins and fate of marine debris in the Reef.

The Australian Government has recognised marine debris as a [Key Threatening Process](#) for species such as whales, dolphins, birds and marine turtles. Marine debris poses a threat to wildlife through entanglement or ingestion. Entanglement in marine debris may result in the animal losing mobility, starving, losing limbs, suffering from infected wounds or drowning. Ingested debris can result in intestinal blockages or internal injuries that lead to the death of the animal.

Introduced marine species

Ships can unintentionally introduce [exotic marine plants](#) and [animals](#) to the Reef through *ballast water*^{††} exchange or hull fouling. Once introduced, these new organisms can potentially colonise an area and out-compete, overgrow and kill native plants and animals. These ‘invasions’ can lead to major ecosystem disturbances that reduce biodiversity and affect industries such as fisheries, tourism, aquaculture and port operations.

The likelihood of an exotic marine pest being introduced into local waters depends on factors such as the volume of ballast water discharged into receiving ports, and the surface area of vessels entering the port that are fouled with such organisms.⁴ However, fouling organisms are often most numerous in small nooks and crannies in and around a vessel. The degree of fouling is highly dependant on the vessels activity patterns, the time since it was last cleaned and antifouled and the type of antifoulant used.⁴ Once it arrives, the potential for an introduced marine species to survive and colonise a new area depends on factors such as ship movement patterns, how similar the receiving environment is to the port of origin, larval survival rates and larval population densities.⁴

Almost half of the 11,000 ships on international voyages that enter Australian waters are bulk carriers that generally arrive either in full ballast or with a full complement of cargo. Most of the bulk carriers arriving in Queensland ports are from Korea and Japan. These ships pose a lesser risk of introducing pest species as the ports of origin in Korea and northern Japan are in cool waters, and organisms transported in ballast water from these ports are unlikely to survive in the warmer waters of Queensland.⁶ However, ships arriving from the warmer ports of southern Japan, Singapore and Taiwan, may carry organisms that can survive in Queensland waters. The ports of Hay Point and Gladstone have the highest shipping traffic on the Reef coast, and the highest levels of ballast water discharge.

MARINE PESTS IN AUSTRALIAN WATERS

[Asian Green Mussel](#) - *Perna viridis*

[Northern Pacific seastar](#) - *Asterias amurensis*

[European shore crab](#) - *Carcinus maenas*

[Giant fanworm](#) - *Sabella spallanzanii*

[Asian mussel](#) - *Musculista senhousia*

[European clam](#) - *Corbula gibba*

[Black-striped mussel](#) - *Mytilopsis sallei*

[Toxic dinoflagellates](#)

[Japanese seaweed](#) - *Undaria pinnatifida*

[Aquarium Caulerpa](#) - *Caulerpa taxifolia*

[Broccoli weed](#) - *Codium fragile* ssp. *tomentosoides*

Hydroïdes sanctaecrucis

A recent CSIRO report found that within Australian waters, there are some 534 marine and estuarine species that have potential 'invasion characteristics'. Of these species, 100 are native; 133 are non-native; 175 are *cryptogenic*⁸⁸; whilst the invasion status of the remaining 126 species is unknown.⁴ There is relatively little information about the occurrence and distribution of introduced marine species, or their impacts on the ecosystems of the Reef. While major outbreaks of introduced marine species have not been detected in the Reef region, isolated incursions of the Asian green mussel (*Perna viridis*) and Caribbean tubeworm (*Hydroides sanctaecrucis*) have occurred in ports and harbours adjacent to the Marine Park such as Trinity Inlet in Cairns. Although both species have the potential to become serious pests, these incursions have not resulted in widespread ecological damage. Further research into the occurrence and distribution of introduced marine pests, and techniques to manage them, is underway (see *Management of introduced marine species*).



Hull fouling is a potential vector for the spread of pests. Organisms settle on the hull, propeller, sea chests and other parts of ships and are transported to other sites where they may become a pest.

Environmental management of shipping operations

The management of shipping activities is complex due to the predominately international nature of the industry. In most cases, management initiatives are implemented through international agreements and guidelines developed through the [International Maritime Organisation](#). The [Australian Maritime Safety Authority](#) represents the Australian Government in this forum. Nevertheless, shipping and boating activities are also subject to state and national level regulations that reflect or implement international conventions and regulations. In recognition of the outstanding values of the Reef, the waters of the Reef have the most stringent management arrangements for commercial shipping of any water body in the world.

Legislation, conventions and management arrangements applying to shipping in the Reef Marine Park

A number of international and national management arrangements and obligations apply throughout all Australian waters, including the Reef. The management framework for shipping activities is determined by a series of international conventions that are implemented through Australian law. These international conventions and regulations include:

- [United Nations Convention on the Law of the Sea 1982](#)
- [International Convention for the Prevention of Pollution from Ships 1973 and the 1978 Protocol](#) (MARPOL 73/78) (see *Management actions applied to shipping in the Reef*)
- [International Regulations for Preventing Collisions at Sea 1972 \(COLREGS\)](#)
- [International Convention for the Safety of Life at Sea 1974 \(SOLAS\)](#).

These conventions are implemented within Australia and the Reef region by the [Australian Maritime Safety Authority](#), the [Department of Transport and Regional Services](#), the [Department of the Environment and Heritage](#), [Maritime Safety Queensland](#) and the GBRMPA.

The following articles of legislation apply:

Australian Maritime Safety Authority

- *Navigation Act 1912*
- *Protection of the Sea (Prevention of Pollution) from Ships Act 1983*
- *Protection of the Sea (Powers of Intervention) Act 1981*
- *Protection of the Sea (Civil Liability) Act 1981*

Department of Transport and Regional Services

- *Maritime Transport Security Bill 2003*
- *Transport Safety Investigation Act*

Great Barrier Reef Marine Park Authority

- *Great Barrier Reef Marine Park Act 1975*
- *Great Barrier Reef Marine Park Regulations 1983*
- *Area Plans of Management*

Maritime Safety Queensland

- *Transport Operations (Marine Safety) Act 1994*
- *Transport Operations (Marine Pollution) Act 1995.*

Department of Environment and Heritage

- *Environment Protection and Biodiversity Conservation Act 1999*
- *Environment Protection (Sea Dumping) Act 1981*
- *Historic Shipwrecks Act 1976*
- *Sea Installations Act 1981*

Special Protective Measures

In 1990, the International Maritime Organisation declared the Reef region a '[Particularly Sensitive Sea Area](#)'. This declaration allowed for internationally recognised 'Associated Protective Measures' to be implemented in the Reef Marine Park. This measure has involved the adoption of compulsory pilotage, recommended pilotage and a mandatory vessel reporting and monitoring system in certain areas of the Reef where navigation is more difficult. These measures have been implemented to increase navigational safety and reduce the risk of ship groundings and collisions (see *Reducing the risk of shipping incidents*).



The International Maritime Organisation has declared the Reef a "Particularly Sensitive Sea Area". Accordingly, special protective measures have been implemented to reduce the risk of shipping incidents.

Great Barrier Reef Shipping Management Group

Shipping in the Reef is managed by several government agencies including the [Australian Maritime Safety Authority](#), [Maritime Safety Queensland](#), the GBRMPA and the [Commonwealth Department of Transport and Regional Services](#). These agencies have implemented the recommendations of the [2001 Review of Great Barrier Reef Ship Safety and Pollution Prevention Measures](#) including measures to improve coastal pilotage, adopting new

technology to improve safety and navigation, enhancing ship management and emergency response, and reviewing the regulation and management of shipping.

A [*Shipping Management Plan*](#) and [*Shipping Impact Study*](#) were also finalised in 2003 following broad consultation with community and industry groups. The *Shipping Impact Study* provides information about the main risks posed by shipping in the Reef. The *Shipping Management Plan* is a strategic level document that provides a vision for how shipping will be managed, and sets out common goals and understandings between the various agencies involved in the management of shipping. The Plan's objectives include reducing the environmental impacts of shipping by minimising the risks of incidents, reducing operational discharges, minimising the risk posed by introduced marine species, and enhancing incident response.

The GBRMPA's role in managing shipping activities

As the principal adviser to the Australian Government on the care and development of the Marine Park, the GBRMPA undertakes a range of activities to manage the potential impacts of shipping activities including:

- Administering legal requirements under the [*Great Barrier Reef Marine Park Act 1975*](#) and Regulations, including compulsory use of local pilots for certain ships within prescribed areas, restrictions on certain activities (for example, waste discharge, negligent shipping), wreck removal and penalties for causing environmental damage to the Marine Park
- Regulating the entry and use of the Marine Park by ships and boats through the [*Great Barrier Reef Marine Park Zoning Plan 2003*](#)
- Administering [*Plans of Management*](#) that focus on specific issues such as access, levels of use and cumulative impacts at high use or sensitive sites
- Developing and promoting [*Best Environmental Practices*](#) to help users of the Marine Park understand how they can minimise the environmental impacts of their activities. These guidelines include advice for anchoring, transferring fuel, disposal of litter and waste and watching marine wildlife.

Management actions applying to shipping in the Reef Marine Park

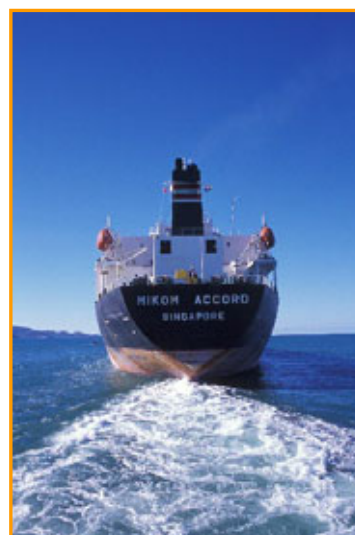
In general, the various regulations, conventions and policies applied in the Reef are aimed at:

- *Managing operational ship-sourced pollutants* to reduce the environmental impacts of issues such as operational ship-sourced pollutants, introduced marine species, and anti-foulant paint
- *Improving shipping and navigation safety* to minimise the risk of ship groundings, collisions or other incidents
- *Implementing an effective response* should a shipping incident occur.

Management of operational ship-sourced pollutants

Discharge and disposal of waste

The [*International Convention for the Prevention of Pollution from Ships \(MARPOL 73/78\)*](#) regulates the discharge of



MARPOL is the international convention on marine pollution, and is applied in the Reef through various articles of legislation.

operational ship-sourced pollutants. Within the Reef, MARPOL is implemented through the *Protection of the Sea (Prevention of Pollution) from Ships Act 1983*, *Transport Operations (Marine Pollution) Act 1995* and the [Great Barrier Reef Marine Park Act 1975](#).

MARPOL has six technical annexes, each regulating a particular type of pollution. Annexes I and II regulate oil and bulk noxious liquid substances; Annex III regulates harmful substances in packaged forms; Annex IV regulates sewage; Annex V regulates garbage; and Annex VI regulates air pollution from ships. The MARPOL annexes describe the conditions under which these substances can be discharged, as well as design specifications for ships to minimise these discharges.

MARPOL generally prohibits the discharge of oily substances and certain cargo tank washings from any vessel within 50 nautical miles from the 'nearest land', unless the residue is passed through an oily water separator and is discharged at a concentration of less than 15 parts per million. In the case of the Reef Marine Park, nearest land is a line drawn along the outer edge of the Reef. MARPOL also prohibits the disposal of any plastics at sea, and all other garbage and litter cannot be disposed into the sea within 12 nautical miles of the nearest land. These restrictions [apply to all vessels](#) including recreational vessels, yachts, dinghies and fishing vessels. Fines of up to A\$1.1 million (for companies) and A\$275 000 (for individuals) may be applied. All vessels over 12 metres long are required to clearly display these regulations on board for passengers and crew.

MARPOL places a duty on the ship's Master or operator to report any incident that involves a discharge or probable discharge of oil, noxious liquid substances or harmful packaged substances. The ship's Master or operators are also obliged to report any damage, failure or breakdown that affects the safety of the ship or reduces the ship's ability to navigate safely.

The discharge of sewage in the Marine Park is regulated under the [Great Barrier Reef Marine Park Act 1975](#). On 1 January 2005, new vessel sewage regulations for the Reef Marine Park were introduced. These new regulations implement sewage discharge requirements under Annex IV of MARPOL and complement recent changes to sewage discharge regulations under the *Queensland Transport Operations (Marine Pollution) Act 1995*. Under the new arrangements, any vessel carrying more than 15 people must discharge macerated sewage at least one nautical mile seawards from the nearest reef, island, mainland or an aquaculture facility. A boat carrying less than 15 people may pump out macerated sewage in the Marine Park anywhere outside of a boat harbour or marina or more than one nautical mile from an aquaculture facility. A vessel also has the option of discharging treated sewage into the Marine Park at varying distances from a sensitive area depending on the level of treatment received.

Introduced marine species

Prior to the mid-1990s, there were no data available about the occurrence and distribution of introduced marine species in Australian ports. However, by the late 1990s the CSIRO based [Centre for Research on Introduced Marine Pests \(CRIMP\)](#) had implemented an [Australia-wide programme](#) to assess the occurrence of [introduced marine species](#) in Australian ports, and to develop a system for their early detection. In 1998, the Australian Government announced its intention to develop a national system for addressing introduced marine species in [Australia's Oceans Policy](#). Since that time, the National Introduced Marine Pests Coordination Group (comprising representatives from the Australian Government and State and Territory Governments, marine industries, scientists and conservation organisations) has

been developing a [National System for the Prevention and Management of Marine Pest Incursions](#).

The National System has three core elements:

1. *Prevention*: mechanisms to reduce the risk of introduction and translocation of marine pests
2. *Emergency response*: systems to ensure coordinated emergency responses to any new incursions and translocations
3. *Ongoing management and control*: a coordinated management system for the ongoing management and control of introduced marine pests already in Australian waters.

In April 2005, an [Intergovernmental Agreement on a National System for the Prevention and Management of Marine Pest Incursions](#) was signed by the Australian Government and several State and Territory Governments. The Agreement was developed to ensure that measures to address introduced marine species are coordinated across jurisdictional boundaries, and that they are consistent with current or future international agreements relating to introduced marine species.



New research programmes have been implemented to detect introduced marine organisms and identify ways to prevent their release into the marine environment, especially at ports.

[Research](#) on introduced marine species is also being undertaken through the Cooperative Research Centre for Reef Research, and through the Australian Government's Natural Heritage Trust [Introduced Marine Pests and Ballast Water Mitigation Programmes](#). These programmes are focused on identifying the presence and distribution of introduced marine species, and developing systems to treat ballast water to remove these organisms.

International measures are also being taken to prevent the introduction of these species in Australian waters from ballast water. An [International Convention for the Control and Management of Ships Ballast Water and Sediments 2004](#) was recently developed to help reduce the risk of harmful aquatic organisms and pathogens being introduced by ships entering ports. Although it has yet to come into force, the Convention specifies that ballast water exchange should occur outside of the Reef Marine Park. When these requirements cannot be met, areas may be designated where ships can conduct ballast water exchange.

Anti-foulant paint

In recognition of the toxicity of tri-butyl tin (TBT) to marine plants and animals, and the chronic pollution it causes, the International Maritime Organisation has developed a protocol for banning the use of TBT on all ocean going ships by 2008. No TBT is to be applied or reapplied after 1 January 2003 and by 1 January 2008, no ships shall have TBT on their hulls, or at the least, any existing TBT must be covered. In Australia, this initiative is being



Antifoulant residues have been removed from grounding sites to help promote the recovery of grounding scars, and to reduce the impact of these residues on marine life in adjacent areas.

supported through the [Antifouling Programme](#) as part of [Australia's Oceans Policy](#). Alternative anti fouling options include copper based paints, and non-toxic silicone or fluorinated polymers that make it harder for fouling organisms to attach to ships. Most commercial trading ships use tin-free antifouling paints although some cruise ships opt to use longer lasting but more expensive silicon fouling release coatings to reduce the risks to ecologically sensitive sea areas.⁸

Research has demonstrated that residues of antifoulant paint scraped onto coral reefs during ship groundings can have a significant effect on marine organisms and may significantly delay recovery.^{5,13} Consequently, marine management agencies have coordinated the removal of contaminated sediment and antifoulant residues from ship grounding sites such as Sudbury Reef where the *MV Bunga Terati Satu* ran aground in November 2000, and at [Piper Reef](#) where the *MV Doric Chariot* ran aground in July 2002. The GBRMPA is monitoring the recovery of grounding sites to better understand the factors influencing the rate of recovery, and long-term effects of grounding incidents.

Improving shipping and navigation safety

Pilotage and vessel management systems

A variety of management initiatives have been implemented to reduce the risk of shipping incidents in the Reef. Currently, all vessels over 70 metres in length, or transporting bulk oil, chemicals and liquefied gas cargoes are required to carry a pilot when transiting the inner shipping route north of Cairns, the waters around the Whitsunday Islands and the Hydrographers Passage (off Mackay). Compulsory pilotage may reduce the risk of an accident by a factor of 30.³

A vessel management system known as the [Torres Strait and Great Barrier Reef Ship Reporting System \(ReefRep\)](#) was implemented in 1996 to increase navigational safety within an area north of Gladstone to the Torres Strait. Under this system, all vessels over 50 metres in length, special product carriers and certain vessels under tow are required to report their position at specific points along the inner shipping route. The reporting system is integrated with a system of navigation aids including VHF radio, radar monitoring and a network of differential global positioning systems and [Automatic Identification System](#) stations

situated throughout the Reef. [Automated Position Reporting](#) via Inmarsat C is now the primary means for ships to provide position reports. Improvements in the quality of ship traffic information delivered through the ReefRep system resulted in changes to its function and name. In December 2004, ReefRep was renamed [ReefVTS](#) (Reef Vessel Traffic System).



Technological advances have introduced a suite of navigation and vessel management systems to complement older lights and beacons. These systems enhance navigational safety, thus reducing the risk of shipping incidents.

Ship management provisions under the Reef Marine Park Zoning Plan (2003)

The primary management tool under the *Reef Marine Park Act 1975* is the Marine Park Zoning Plan. This plan designates where different activities may occur, and how they are to be conducted within the Reef Marine Park. In July 2004, new zoning for the Reef Marine Park came into force to better protect the range of biodiversity and ecological processes of the Marine Park. Under the [Zoning Plan 2003](#), commercial ships do not require a permit to transit through General Use (light blue) Zones and *Designated Shipping Areas* (see Figure 2). By describing *Designated Shipping Areas*, the new Zoning Plan 2003 also provides for ‘certainty of access’ for shipping in the Marine Park, and has simplified regulations governing safety, pollution prevention response, and search and rescue.

Improving shipping standards

The [Australian Maritime Safety Authority](#) also conducts a national programme known as the “[Port State Control](#)”. Under this programme, ships may be inspected to determine whether they meet international safety and environmental requirements. The programme aims to deter substandard or unsafe ships entering Australian waters. Due to international law and safety considerations, there are significant limitations that prevent the boarding and inspection of vessels at sea and thus inspections are usually carried out only after the vessel has transited through Australian waters and docked in port. Australian legislation allows for strict penalties, including the detention of substandard ships for non-compliance, and vessel operators and their agents are increasingly reluctant to bring substandard ships into Australian waters.

In early 2005, the International Maritime Organisation released new protocols for the global phase-out of single hulled oil tankers. Single hulled tankers pose a higher risk of oil spill than double hulled tankers as the oil is carried in tanks located against the hull. As a result, a hull rupture is more likely to also rupture a tank. While the new protocols are important to reducing the risk of oil spills in the world’s oceans, there are very few single hulled oil tankers operating in the Reef so the new protocols will not significantly affect shipping operations in these waters.

Enforcing shipping standards and legislation

The [enforcement](#) of local, national and international shipping laws in the Reef is carried out in conjunction with [Australian Maritime Safety Authority](#), [Maritime Safety Queensland](#), [Queensland Environmental Protection Agency](#), [Coastwatch National Marine Unit](#), [Queensland Boating and Fisheries Patrol](#), [Australian Federal Police](#) and [Queensland Police Service](#).

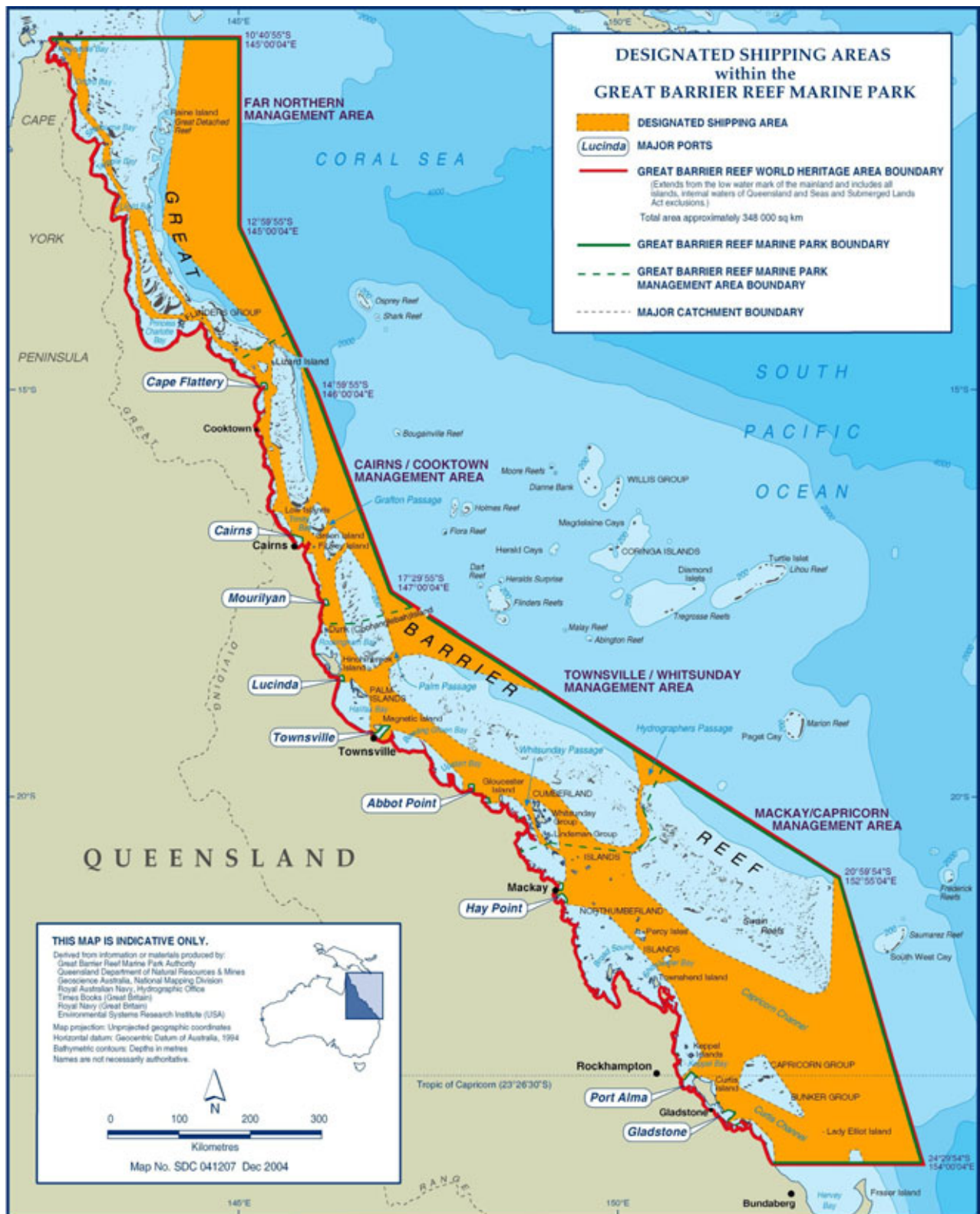


Figure 2. Ships travelling through the Reef use designated shipping areas

An investigation of a major shipping incident may involve more than one regulatory or enforcement agency, depending on the nature of the offence. Although such incidents are infrequent, the management of shipping incidents must be as effective and efficient as possible to minimise impacts and to meet Australia's international obligations. In consultation with other agencies, the GBRMPA is developing shipping incident investigation guidelines to ensure that investigations are coordinated across all agencies involved, and that the investigation considers the roles and obligations of each of these agencies.

Response to pollution incidents and accidents

The existing management arrangements are focused on preventing shipping incidents from occurring. However, management agencies regularly develop, review and practice contingency plans to ensure that an effective response is mounted to shipping incidents.

At a national level, the Australian Maritime Safety Authority manages the [*National Plan to Combat the Pollution of the Sea by Oil and Other Noxious and Hazardous Substances*](#) (the National Plan) that provides an organisational framework for ship-sourced oil and chemical spill response throughout Australia. The National Plan is implemented through various national and state level contingency plans, including the Queensland Coastal Contingency Action Plan. Most port authorities have individual Oil Spill Contingency Plans. Special oil spill contingency plans called REEFPLAN and TORRESPLAN have been developed for the waters of the Reef and Torres Strait.

Under REEFPLAN, [Maritime Safety Queensland](#) or the [Australian Maritime Safety Authority](#), are responsible for combating oil spills within the Reef World Heritage Area. The GBRMPA's role is to provide environmental and scientific advice to the agency combating the oil spill. In February 2004, the GBRMPA and the [Queensland Environmental Protection Agency](#) finalised a new Marine Pollution Response Plan that describes the responsibilities of these two agencies for providing environmental advice to oil spills and shipping incidents within and adjacent to the Marine Park.

Responding to shipping incidents and oil spills

Significant resources have been stockpiled and prepared along the Queensland coast to respond to oil spills. Most ports have been provided with resources to respond to minor incidents of pollution (up to 10 tonnes of oil). These incidents are the most likely to occur within a port (see *Case study: the Gladstone Harbour oil spill*). Larger stockpiles are located in Townsville and Brisbane to respond to spills of between 10-1,000 tonnes of oil. For very large spills of more than 1,000 tonnes, resources are available from interstate, in particular the oil industry funded [Australian Marine Oil Spill Centre](#) in Geelong, and internationally.

There are several [options for responding](#) to an oil spill, ranging from observation and monitoring while allowing the slick to disperse and degrade naturally, to full-scale response. The response initiated will depend on a large number of factors such as location, type of oil and weather conditions. Some options may include containment and recovery, which is aimed at stopping the oil from spreading and removing it from the water. A wide variety of [equipment](#) has been developed for these tasks including floating booms that prevent the spread of floating oil, and 'mops' or 'skimmers' or that soak up or pump out the oil.

The use of oil spill dispersants, while providing the most credible response option in the northern and offshore areas of the Reef, is significantly limited by the sensitivity of reef and intertidal communities. More importantly, the oil most likely to be spilled (heavy fuel oil) is not readily dispersed and in many cases, the use of dispersants may not be the most appropriate response option. The application of chemical dispersants within the Reef Marine Park must be approved by an officer prescribed within the [Great Barrier Reef Marine Park Regulations 1983](#) and is subject to conditions. For example, dispersants would not normally be used over coral reefs or seagrasses except where the oil is likely to impact upon mangroves or where water depths exceed 10 metres.



A boom being deployed near Townsville to deflect and contain oil during a training exercise. Training in the use of all oil spill combat equipment and response management is vital for effective oil spill response.

Should a shipping incident or oil spill result in the oiling of wildlife in the Marine Park, the [Day-to-Day Management](#) programme takes responsibility for coordinating the response to oiled wildlife. This may require mobilising staff, primarily from the [Queensland Environmental Protection Agency](#), to assist in the treatment and recovery of oiled wildlife.

There are several logistical considerations that affect the speed and capacity of oil spill responses within the Reef. In incidents such as the *MV Global Peace* oil spill in Gladstone, the availability and proximity of trained staff, equipment and access to the site allowed for a very rapid response (see *Case Study: the Gladstone harbour oil spill*). In other situations, the remoteness of large areas of the Reef, particularly north of Cairns, may make it difficult to rapidly deploy response personnel to spill sites. Additionally, it is not easy to transport spill response equipment to the spill site due to the limited transport infrastructure in far northern Queensland. The response to the groundings of the *MV Peacock*, *MV Bunga Teratai Satu* and *MV Doric Chariot* in the northern Great Barrier Reef posed significant logistic challenges due to the remoteness of these areas.

Given these factors and also the technological limitations of oil spill response in general, it should be recognised that a significant oil spill is likely to result in serious impacts to inter-tidal and coastal habitats on a regional scale in the short to medium term. Consequently, management efforts have focused on reducing the risk of incidents, and in terms of shipping activities, the Reef is provided with one of the highest levels of protection of any body of water in the world.



Recognising the potential consequences of a major oil spill, the Reef is afforded the highest levels of shipping related management anywhere in the world.

Further Reading

Information on ship based pollution and oil spill risks

- [About shipping activities in the Reef](#) (Great Barrier Reef Marine Park Authority)
- [Joint report on the oil spill risk in the Reef Marine Park](#) (Queensland Transport and the GBRMPA)
- [International conventions on the prevention of marine pollution](#) (International Maritime Organisation)
- [About the antifouling programme](#) (Department of the Environment and Heritage)
- [Requirements relating to the discharge of sewage in Queensland waters](#) (Maritime Safety Queensland)
- [International Tanker Owners Pollution Federation](#)

Information on litter and marine debris

- [General information about litter and marine debris](#) (Reef ED)
- [Marine debris on the Reef](#) (GBRMPA)
- [Information on beach and ocean litter](#) (Queensland Environmental Protection Agency)
- [General information about litter and marine debris](#) (US Environmental Protection Agency)
- [Marine debris as a national Key Threatening Process](#) (Department of the Environment and Heritage)
- [“Finding Solutions” report on marine debris in northern Australia](#) (National Oceans Office)

Introduced Marine Species

- [General information about introduced marine species in Australia](#) (Department of the Environment and Heritage)
- [Centre for Research on Introduced Marine Pests \(CRIMP\)](#)
- [Reports on the management and treatment of ballast water](#) (Department of Agriculture, Fisheries and Forestry)
- [Research undertaken through the Natural Heritage Trust](#)
- [Research undertaken by the Cooperative Research Centre for Reef Research](#)
- [International Convention for the Control and Management of Ships' Ballast Water and Sediments](#) (International Maritime Organisation)

Management plans and documents about shipping in the Reef and Torres Strait:

- [Shipping risks and management plans for the Reef and Torres Strait](#) (includes impact studies, risk assessment and management plans - Australian Maritime Safety Authority)
- The [National Plan to Combat the Pollution of the Sea by Oil and Other Noxious and Hazardous Substances](#) (Australian Maritime Safety Authority)

Shipping and navigation:

- [Shipping and navigation in Queensland Waters](#) (Maritime Safety Queensland)

End notes

* Reports are based on the “Reef Vessel Traffic System” area only and do not include areas of the Reef that extend southwards of latitude 22° 00' S.”

† Fuel oil is a heavy oil that ships burn to power their engines

§ Ship groundings are incidents where ships run aground on rocks or reefs

|| Resulting in the activation of contingency plans and resources

Pilots are navigators with experience in the area. In areas such as the Reef, local pilots are brought out to ships entering the area to guide the ship through the complex network of shoals and reefs


** The area between high tide and low tide. At low tide, these areas are exposed

†† Ballast water is water pumped into tanks to help stabilise the ship during transfer of cargo or steaming. Ballast water may be collected at one ocean location and pumped out at another location, potentially introducing new organisms into the natural environment

§§ Difficult to locate and identify, it is unclear whether these are native or non native species

Bibliography

1. Australian Bureau of Statistics. 5422.0 June 2001, 'International Merchandise Trade Australia'.
[http://www.ausstats.abs.gov.au/Ausstats/subscriber.nsf/0/AAB98054D0B6E0BECA256D2F0004ACEC/\\$File/54220_mar%202003.pdf](http://www.ausstats.abs.gov.au/Ausstats/subscriber.nsf/0/AAB98054D0B6E0BECA256D2F0004ACEC/$File/54220_mar%202003.pdf)
2. Department of Transport. 1995, *Great Barrier Reef and Torres Strait Shipping Study*. Great Barrier Reef and Torres Strait Shipping Study Steering Committee 1995. Volumes 1 and 2, Department of Transport, Queensland.
3. Det Norske Veritas. 2001, *Assessment of Ship Safety Controls in the Torres Strait and Great Barrier Reef*. Consultants report for the Australian Maritime Safety Authority. Det Norske Veritas, Victoria. 57pp.
4. Hayes, K., Sliwa, C., Migus, S., McEnnulty, F. and Dunstan, P. 2004, *National priority pests: part II Ranking of Australian Marine Pests*. Final Report for the Department of the Environment and Heritage. CSIRO Marine Research,
<http://www.marine.csiro.au/crimp/reports/PriorityPestsFinalreport.pdf>
5. Haynes, D. and Loong, D. 2002, 'Antifoulant (butyltin and copper) concentrations in sediments from the Reef World Heritage Area, Australia'. *Environmental Pollution* 120 (2): 391-396.
6. Hilliard, R.W. and Raaymakers, S. 1997, *Ballast water risk assessment, Stage 5 report*. Ecoports Monograph Series No. 14. Ports Corporation Queensland, Brisbane.
7. Kiessling, I. 2003, *Finding solutions: Derelict fishing gear and other marine debris in northern Australia*. National Oceans Office, Hobart.
8. Lewis, J. 2005, 'Preventive Management of Biofouling', in *Building Emergency Response Capacity for Incursions by Introduced Marine Pests workshop*, Coolangatta, 7-9 June 2005.
9. Maritime Safety Queensland. 2005, *Marine Incidents Annual Report 2005*. Maritime Safety Queensland, Brisbane. http://www.msq.qld.gov.au/qt/msq.nsf/index/incidents_annual_report
10. Maritime Safety Queensland. 2006, 'Swift response', in *Seascope*, April-July 3 (2): 7-9. Maritime Safety Queensland, Brisbane.
[http://www.msq.qld.gov.au/qt/MSQ.nsf/ReferenceLookup/seascope_vol3_issue2.pdf/\\$file/seascope_vol3_issue2.pdf](http://www.msq.qld.gov.au/qt/MSQ.nsf/ReferenceLookup/seascope_vol3_issue2.pdf/$file/seascope_vol3_issue2.pdf)
11. Ports Corporation of Queensland. 2002, *Economic Impact Study for the year ended 30 June 2002*. Ports Corporation Queensland, Brisbane.
<http://www.pcq.com.au/downloads/economicimpactstudy.pdf>
12. Queensland Transport and Great Barrier Reef Marine Park Authority. 2000, *Oil Spill Risk Assessment for the Coastal Waters of Queensland and the Reef Marine Park*. Great Barrier Reef Marine Park Authority, Townsville.
http://www.msq.qld.gov.au/qt/msq.nsf/index/oilspill_risk



13. Smith, L.D., Negri, A.P., Philipp, E., Webster, N.S. and Heyward, A.J. 2003, 'The effects of antifoulant-paint-contaminated sediments on coral recruits and branchlets'. *Marine Biology* 143 (4): 651-657.

14. United Nations Conference on Trade and Development. 2003, *Review of Maritime Transport*. Report by the UNCTAD Secretariat, Geneva.

Great Barrier Reef Shipping Review Steering Committee. July 2001, *Review of Ship Safety and Pollution Prevention Measures in the Reef*. Australian Maritime Safety Authority, 39 pp. http://www.amsa.gov.au/Shipping_Safety/Great_Barrier_Reef_and_Torres_Strait/GBR_Review_Report/