CHAPTER 2

IMPACTS OF SHIPPING

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Introduction

Australia is the fifth largest user of shipping in the world with more than 11,000 vessels from 600 overseas ports visiting Australia's 65 major ports each year. About 98 per cent of Australia's exports (in particular, bulk mineral and agricultural commodities) are carried by ships. There are twelve significant ports in the South-east Region as illustrated in Figure 2.1.

Figure 2.1 Major port locations

Adapted from: AAPMA, 2001.

Shipping comprises about 90 percent of world trade by volume, contributing approximately twelve percent of the total marine pollution arising from human activities on the ocean. The shipping operations and associated port activities that have been identified as having the greatest potential impact on the marine environment are:

- discharge of ballast water;
- use of antifouling paints;
- disposal of marine debris;
- disposal of waste materials and sewage;
- dredging and the disposal of dredged waste (spoil);
- oil spills from routine activities or accidental incidents;
- spills of hazardous materials including chemical and radioactive materials;
- physical damage to marine habitats by ships' hulls (e.g. grounding);
- noise emissions; and
- air emissions

The potential impacts are usually greater for inshore waters and around port areas where complex ecosystems exist and there is a low water exchange rate. Port areas concentrate shipping activities in a relatively confined coastal location, resulting in a greater incidence of pollution from dredging, spills, waste disposal, exchange of ballast water, noise and air pollution.

Australia is party to a series of international conventions that deal with the control of ship-sourced pollution and environmental protection. International legislation includes the International Convention for the Prevention of Pollution from Ships 1973/1978 (MARPOL) which deals with oil, toxic liquids, sewage and garbage. The International Maritime Organisation (IMO) is a United Nations specialised agency made up of the 158 states that have accepted the Convention. It is responsible for improving maritime safety and reducing wastes from shipping (Julian, 2000). The Maritime Environment Protection Committee (MEPC) of the IMO coordinates activities to prevent and control pollution of the marine environment from ships.

In Australia, there are a number of government and industry bodies working on the issues of marine pollution from shipping including (but not exclusive to):

- Australian and New Zealand Environment and Conservation Council (ANZECC);
- Commonwealth Coastcare Program and Ocean Rescue 2000;
- Australian Quarantine Inspection Service (AQIS);
- Australian Maritime Safety Authority (AMSA);
- Australian Shipowners Association (ASA); and
- Association of Australian Ports and Marines Authority (AAPMA).

The aim of this chapter is to provide a broad understanding of shipping and port operations that may impact on the marine environment. The information is organised by port and ocean environments though some of the activities are associated with both regions. A definition of each of the relevant activities is accompanied by an explanation of the potential impacts. Where it has been possible, these impacts are related specifically to the South-east Region. Current research or legislation for each activity is also addressed.

Port Environs

Ballast water

More than 11,000 vessels from 600 overseas ports visit Australia's 65 major ports each year - and discharge more than 150 million tonnes of ballast water into Australian waters (AQIS, 2001).

The major hazard associated with the discharge of contaminated ballast water is the introduction of exotic marine species to the local marine environment, and translocations of existing marine pests to new locations (for example, transporting the North Pacific sea–star from Tasmanian waters to mainland waters)

Establishment of exotic species can cause the alteration of entire ecosystems and habitat and the extinction of indigenous species by predation or competition (ANZECC, 1996a). The effects of introduced species increase with time and are generally irreversible.

Introduced marine species include fish, invertebrates, and seaweeds. Exotic marine species that can be attributed to ballast water, and are of particular concern in the South-east marine Region, are listed in Table 2.1.

Table 2.1 Location of introduced species attributed to ballast water or sediment discharged from ships

Location	Species
Port Phillip Bay	Fish
	Tridentiger trigonocephalus (Striped goby)
	Microalga
	Alexandrium catanella (toxic dinoflagellate)
Bass Strait	Polychaete worms
	Mercierella engimatica
	Boccardia proboscidea
	Pseudopolydora paucibranchiata
Hobart – Triabunna Region	Crustaceans
	Carcinus maenas (European shore crab)
	Macroalga (seaweed)
	Undaria pinnatifida (Japanese giant kelp)
	Microalga
	Gymnodinium catenatum (toxic dinoflaggelate)
	Echinoderms
	Asterias amurensis (North Pacific sea-star)

Adapted from: Australia State of the Environment 1996

The risk of introduced exotic species is dependant on the volume and source of ballast, the number of ship visits, and the method of management. In July 2001, Australia introduced the Australian Ballast Water Management Strategy, administered by AQIS. The strategy addresses the problem of introduced marine species and employs a biological risk assessment tool, the Australian Ballast Water Decision Support System (DSS), to assess the quality of ballast water. From July 2001, all international vessels' ballast water must be managed by either (DOTRS, 2001):

- undertaking a full ballast water exchange at sea (or equivalent on-board treatment systems); or
- using the DSS to conduct a risk assessment of all ballast water intended for discharge in Australia and managing all tanks that are assessed as high risk - prior to arrival in Australia.

For high-risk ballast water, as assessed by the DSS, the approved management options will include:

- full exchange at sea (or equivalent on-board treatment systems);
- non discharge of high risk ballast water in Australian ports or waters; or
- tank to tank transfer to prevent discharge of high-risk ballast water.

Current Australian ballast water requirements for all international vessels visiting Australian ports or waters will still apply. These are:

- mandatory reporting;
- providing access to sampling points; and
- stopping sediment discharge (including tank stripping).

The Australian Ballast Water Management Strategy aims to better control the release of contaminated ballast water from international vessels, which in turn reduces the risk of introducing exotic species to Australian waters. The strategy does not, however, address the problem of translocation within Australian waters.

In the South-east Region, the Victorian government has produced its own ballast water management strategy which it is trialling in the Victorian port of Hastings.

Ballast water management and regulation continues to increase in significance, both within Australia and internationally. The IMO has been working extensively on the issues of contaminated ballast water for over a decade. Currently, Australia is working through the IMO to develop a new International Convention to manage ballast water discharge. This Convention is not expected for completion until 2003. In the interim, the new Australian arrangements are consistent with the proposed international Convention. (DOTRS, 2001).

Antifouling

Antifouling paints are designed to protect the hulls of vessels from the settlement and growth of marine organisms (ANZECC, 1996a). The toxic substances in the paints can include cuprous oxide, mercuric oxide, and tributyl tin (TBT). The paints work by slowly leaching the toxin over the life of the coating, and by 'self polishing', which requires the motion of the vessel to release the toxins.

The benefits of these antifouling paints in prohibiting organism growth is offset by the release of these same toxins to the wider marine community. Studies have shown that there is a link between TBT antifoulants and deformities in oysters (de Mora in Lewis, 2001). Shellfish cannot metabolise TBT and malformations can be induced by exceptionally low concentrations (Lewis, 2001).

The effects of antifouling compounds are of most concern in semi-enclosed bodies of water such as bays and estuaries with a high density of boats. Although in open water TBT degrades naturally to less toxic compounds and ultimately to inorganic tin, in enclosed waters, the capacity of the marine environment to degrade TBT may be exceeded by the rate of leaching from vessel hulls. This results in an accumulation of toxic substances in water, biota, and sediments.

For a number of years, the use of TBT in Australia has been banned on all vessels less than 25m in length in an effort to reduce concentrations in sheltered harbours and port areas. Studies indicate that this measure has reduced the levels of toxic contamination.

Vessels greater than 25m in length have been exempt to date because they do not stay in port or at moorings for extended periods of time. Further, less efficient antifouling paints greatly increase fuel use and running costs. Abnormalities in marine species have been detected in some offshore areas, such as in shellfish in the North Sea and in tissues of oceanic animals. These abnormalities have been attributed to the continued use of TBT antifoulants on large vessels (Lewis, 2001).

The international community has responded to the continued concern of the environmental impacts of TBT. An International Convention on the Control of harmful Antifouling Systems on Ships was adopted on 5 October 2001 by the IMO. When in force, the Convention requires a complete ban on the application of tribtyl tin paints from 1 January 2003, with the intent that no TBT will remain on vessels after 1 January, 2008. Australian Government policy has agreed to comply with the IMO ruling.

Dredging and spoil disposal

Dredging is conducted mainly as a part of port operations to construct and maintain harbours, docks and channels. Dredged material, or spoil, may be uncontaminated in areas remote from pollution sources, or contaminated if material is dredged from urbanised or industrial harbour sediments where heavy metals and a variety of organic compounds have accumulated (ANZECC, 1998). Dredging near commercial aquaculture pens may disturb sediments containing an accumulation of nutrients.

Dredging usually causes the concentration of suspended solids to rise and sediments to be disturbed both around the dredging site and at spoil disposal areas (SoE, 1996). Dredged material is disposed of in one of three ways:

- disposal of spoil on land;
- disposal of spoil at or near the dredged site; or
- disposal of spoil at sea.

As such, the impacts of dredging can affect both port and ocean environments. The potential impacts of dredging include:

- smothering seabed organisms;
- clogging fish and invertebrates' gills;
- reducing the light available to plants;
- releasing nutrients and toxic trace metals from contaminated sediments;
- bioaccumulating toxins from contaminated material in organisms and possibly the food chain;
- depleting dissolved oxygen in the water column; and
- reducing water quality.

Australia is party to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972 (London Convention) to which it acceded in 1985. The Commonwealth's *Environment Protection (Sea Dumping) Act 1981* (Sea Dumping Act) and *Environment Protection (Sea Dumping) Amendment Act 1986* aim to regulate the dumping of wastes and other matter into the sea and thereby enable Australia to fulfil its international obligations under these Conventions (ANZECC, 1998).

A permit is required from Environment Australia for all sea dumping operations. Currently about 20 permits are issued in Australia per year, mainly for the dumping of uncontaminated dredge spoil (EA, 2001) Port operations account for slightly more than half these sea dumping applications (ANZECC, 1998). ANZECC has produced 'Interim Ocean Disposal Guidelines' (1998) which provide a consistent framework to assess environmental impacts from sea dumping of dredged and excavated material in accordance with the London Convention and the 1996 Protocol to that Convention (ANZECC, 1998). The guidelines do not apply to dredging operations where material will be dumped in the vicinity of the operation, provided it is in State waters. In these incidents dredging operations are the responsibility of the States or Northern Territory.

Waste and sewage

Marine wastes from shipping operations include fuel, oil, human wastes, galley wastes, wastewater (from toilets, sinks and showers), garbage, cans, bottles and other solid wastes. In addition, waste from shipping maintenance in spillways (e.g. oils and antifoulants) often enter waterways unrestricted.

Waste and sewage discharges are of greatest concern in coastal regions and semi protected bodies of water. Low water exchange rates can result in greater adverse impacts from the accumulation of waste material.

The effects of excess nutrients and other substances, such as in human wastes from sewage, include oxygen depletion of coastal waters, promotion of potentially harmful algal blooms, and dramatic reductions in the biodiversity of sea-life communities in affected environments. The impacts of garbage are detailed in the section titled ‘Marine debris’.

To combat the illegal dumping of waste at sea, the international community has acknowledged the importance of adequate port waste facilities. MARPOL 73/78 places an obligation on parties to ensure that ports provide waste reception facilities to dispose of ships’ waste (ANZECC 1995b). Australia has ratified the annexes concerning the disposal of oils and oily residues, chemicals, sewage, and garbage (although the sewage annex is not yet in force internationally).

MARPOL (Annex V) garbage regulations apply to all vessels including dinghies, yachts, and fishing vessels. The regulations prohibit the disposal of plastics into the sea and specify that no garbage is to be discharged within 12 nautical miles from the nearest land (AMSA, 2001c). Disposal at sea is permitted for certain types of garbage subject to strict requirements.

MARPOL (Annex IV) sewage regulations are not yet in force. It is expected that when this Annex becomes effective, ship sewage discharge will be prohibited within three nautical miles of land.

In Australia, the Coast and Clean Seas component of the Natural Heritage Trust has introduced the ‘Marine Waste Reception Facilities Program’ which facilitates the identification, funding and provision of adequate disposal facilities in ports, marinas and boat harbours.

Ocean Environs

Marine debris

Marine debris is pollution sourced from human activities, notably plastics and other synthetics, as well as glass and metal. Marine debris has been identified by the International Oceanographic Commission as one of the five major marine pollutants.

Marine debris sources include vessels and discharges from urban and rural coastal catchments. Estimates of the land based contribution to marine debris vary from 60–80 percent. In areas remote from urban centres, the proportion of ship-sourced debris is much greater (ANZECC 1996b). A Tasmanian study by the Parks and Wildlife Service In Tasmania between 1990 and 1993 found that of all debris items, 23 percent could be attributed to commercial and recreational fishing and boating (DELM, 1996). In some remote areas of Tasmania, fishing and boating debris constituted the majority of the waste. For example, in the South-west of the World Heritage Area, 80 percent of debris recorded was attributed to fishing and boating (DELM, 1996).

Plastics compromise the highest percentage of marine debris items. In the same Tasmanian study noted above, of 112, 939 debris items recorded, 74 percent were plastic. Plastic includes fishing and other synthetic debris such as nets and mono-filament line, ‘six pack’ holders, fibreglass, pots, strapping bands, bags, floats and buoys, and other matter.

The potential biological impacts of marine debris in both port and ocean environments are detailed in Table 2.2. There is little evidence as to how marine debris may affect marine invertebrate species, plant life, or marine habitats in general, apart from the observation that debris can damage coral reefs, be ingested by squid, and may present a new habitat for encrusting marine species.

In 1995 ANZECC established a working party on marine debris. Between 1996 and 2005, ANZECC aims to develop changes to management practices and legislation in consultation with EPA, AMSA, industry groups, conservation groups, community groups, States and Territories (ANZECC 1996b). Australia currently has strict legislation preventing the disposal of waste at sea.

Table 2.2 Potential biological impacts of marine debris

Potential Impact	Description
Entanglement	▪ Recorded on the sea floor, ocean surfaces and surrounding terrestrial habitats such as rookeries, mudflats, mangrove habitats, and islands. ▪ Causes mortality and has a serious impact on population levels of endangered species. ▪ Impairs swimming and feeding behaviour (causes drag which results in inability to catch prey). ▪ May cause wounds that become infected.
Ingestion	▪ Ingestion material is six to seven times more abundant than entanglement material. ▪ About 166 species world wide (including 99 seabird, 24 marine mammal, and six turtle species) have been recorded to ingest debris, mainly plastic. ▪ Ingestion can cause physiological problems such as gastric blockage, starvation, ulceration, reduced absorption of nutrients, and transfer of toxins from plastics into tissues and blood.
Plastic substrates	▪ Synthetic debris provides a substrate for epiphytic organisms, potentially promoting the long distance transfer of organisms, which may contaminate foreign environments. ▪ There is concern that persistent marine debris could augment the natural processes of colonisation on islands, threatening these ecosystems.
micro plastic pieces and smothering of bottom fauna and beach infauna	▪ Micro-plastic particles can become part of beach sand and be incorporated in low trophic levels such as by benthic filter feeders. The plastic particles can transfer toxins or contain heavy metals. ▪ Debris may smother communities in soft strata and abrade against hard substratum communities. ▪ Smothering of coastline prevents establishment of flora which contributes to loss of habitat and erosion. ▪ Buried plastic may limit the vertical transfer of oxygen and water in soils and sediments.
Ecosystem health	▪ Debris may be contributing to declining ecosystem health. Evidenced by increasing numbers of species of marine vertebrates presenting with immuno-suppression disorders such as lesions, tumours, and infection.

Adapted from: ANZECC, 1996a.

Oil and noxious hazardous spills

Shipping is a major source of oil spills, both from normal operations and from accidental discharges by oil tankers (SoE, 1996). Most oil spills result from accidents during fuelling of vessels in ports (Zann in SoE, 1996). Historically, few large oil spills have occurred in Australian waters and only two major oil spill incidents (greater than 1,000 tonnes) have occurred since 1970, the Oceanic Grandeur and the Kirki. Those that have occurred are illustrated in Figure 2.2.

Figure 2.2 Major oil spill incidents in Australian waters.

Adapted from: AMSA in SoE, 1996

The impacts of spills from marine vessels will largely depend upon the geomorphology of the affected coastline environment and the sensitivity of marine species in the vicinity of the spilt material. The most sensitive habitats in the South–east Region are intertidal areas supporting sensitive marine species such as seagrass beds, marshes, kelp forests and coastal wetlands.

The potential impacts of an oil spill on the marine environment are listed in Table 2.3. Risks of a major oil spill (or other substance) from shipping around Australia are considered to be high – a 39 percent chance in any five year period or 83 percent chance in a 20 year period (BTCE, 1991). However, Australia has a comprehensive spill contingency plan, managed by AMSA. The National Plan to Combat Pollution of the Sea by Oil and other Noxious and Hazardous Substances provides a framework capable of effective response to oil or chemical pollution incidents in the marine environment (AMSA, 2001b). The implementation of this plan is designed to reduce the potential impacts of a spill.

Table 2.3 Potential biological impacts of oil spills

Marine Community	Effect of oil contamination	Impacts
Open Water Communities		
Birds	Fouling of plumage	▪ A loss of water repellence which may result in hypothermia.
	Ingestion of oil	▪ Anemia (anemic birds cannot dive for food), pneumonia, intestinal irritation, kidney damage, altered blood chemistry, decreased growth, impaired osmoregulation and decreased production and viability of eggs.
	Reproduction effects	▪ Direct exposure of eggs to oil results in a reduced survival rate. ▪ Adults that ingest oil may produce fewer eggs or cease laying eggs.
	Physical disturbance	▪ Human disturbance during clean up efforts.
Mammals	Direct surface fouling	▪ Irritation to eyes and skin. ▪ Increased metabolism. ▪ Inhibits thermoregulation.
	Direct and indirect ingestion with the affects of bioaccumulation	▪ Direct consumption may result in irritation or destruction of intestinal linings, organ damage, neurological disorders, bioaccumulation of toxins. ▪ Indirect consumption (through grooming) may result in transferral of toxins to young via lactation.
	Inhalation of toxic vapours	▪ Absorption into the circulatory system. ▪ Damage to respiratory surfaces and mucosal membranes.
Pelagic Species (plankton & fish)	(effects are difficult to document due to high seasonal and natural variability)	▪ Generally the toxic effects are short lived for plankton as regeneration time is short, though zooplankton are more sensitive than phytoplankton. ▪ Limited impacts to adult fish though eggs and larvae are more sensitive.
Nearshore communities (*Intertidal*)		
Plants (including algae and wetland plants, sea grass)	Smothering	▪ Macroalgae may be subject to smothering, although they can be quite resistant.
Infauna (animals that lived buried in sediments		▪ Some invertebrates survive in heavily oiled sediments. ▪ Polychaetes may facilitate biodegradation processes. ▪ Buried bivalves are susceptible and often bioaccumulate contaminants.

Table 2.3 Potential biological impacts of oil spills (continued)

Marine Community	Effect of oil contamination	Impacts
Nearshore communities (*Intertidal*)		
Epifauna (animals that live on the sediment surface or attached to rocks	Bioaccumulate	▪ Mussels and attached bivalves often survive but bioaccumulate.
	Behavioural changes or mortality	▪ Many crustaceans are sensitive to acute and chronic effects of oiling.
Fish (main concern for spawners)		▪ Unknown.
Nearshore communities (*Subtidal*)		
Kelp Beds	Physical disturbance	▪ Kelp beds are not generally effected by oil spills but may be affected by the clean up.
Soft bottom communities		▪ Chronic impacts can occur from repeated dosages. ▪ Some sensitive species (amphipods) may show long term effects.
Seagrass beds	Physical disturbance	▪ Usually not impacted though treatments can impact.

Adapted from: HMRAD, 1992.

The nuclear industry is subject to very tight safety controls and to date there have been no reported releases of radioactive materials in Australian waters. In the South-east Region, the Port of Hobart does accept visits by US nuclear powered military vessels, though the transport of nuclear material is not permitted through the South-east Region.

Only one major chemical spill has occurred in Australian waters involving the Sanko Harvest, a bulk carrier that grounded and sunk off the coast of WA, spilling a cargo of 30 000 tonnes of fertiliser and 600 tonnes of fuel oil. Chemical responses to container incidents have occurred in some of Australia's major ports including Fremantle and Sydney. These responses usually occur as a result of leaking containers due to poor storage or containers with leaking valves.

The transport of dangerous goods in packaged form is subject to the International Convention for the Safety of Life at Sea, 1974 (SOLAS) and MARPOL. SOLAS refers to the International Maritime Dangerous Goods Code which specifies how dangerous goods should be packaged, labelled, stowed, and segregated for transport at sea. The International Code for the Safe Carriage of Packaged Irradiated Nuclear Fuel, Plutonium, and High Level Radioactive Wastes on Board Ships is set to become part of SOLAS in January 2002 (Heathcote, 1999).

Noise emissions

Water is an efficient medium for transporting sound waves. In the marine environment sound transmission is highly variable and can be dependent on the acoustic properties of the seabed and surface, variations in sound speed and the temperature and salinity of the water (Richardson et al., 1995).

Physical shipping noises vary depending on the subject's proximity to the source. Within the immediate vicinity, sounds may be erratic, associated with machinery noises such as propellers and flow noise with a frequency between 10 Hz and 1 kHz. From a distance, ships emit a continuous, low frequency noise ranging from 1 Hz to 500 Hz with 70±5 dB (dB re 1 μPa^2/Hz over stated frequency range) (McCauley, 1994).

Many of the natural noises in the marine environment may give biological cues for marine organisms, acting as navigational guides and allowing detection of other species. Noise emissions which interfere with natural sounds in the marine environment may affect the timing of social and reproductive behaviour (McCauley 1994), particularly if the disturbance to vulnerable or endangered animals coincides with very short breeding or spawning periods.

McCauley (1994) reports that the hearing capabilities of marine invertebrates are not well known. However, there is evidence that few species can detect noise in the far field (at a distance of greater than 15 m, as in the case of studies of responses to towed seismic arrays). The level at which over-stimulation of the auditory sensors of marine invertebrates occurs is unknown, however it is likely to be at close range to the source of a noise emission (McCauley 1994).

Most fin fish species found within Bass Strait are widespread, and only a few of these species are found in localised communities. A number of species migrate seasonally into coastal and estuarine waters for the purposes of breeding or other natural behaviour. Some fin fish species are sensitive to acoustic disturbance but would likely avoid the area of disturbance.

The responses of marine mammals to noise generated by sea vessels vary. Known behavioural responses to such noise are outlined in Table 2.4.

Table 2.4 Responses of cetaceans and pinnipeds to sea vessels

Species	Response
Cetaceans	
Southern-right whale	Responses to vessels are variable; some are known to allow boats to approach, or actively approach boats themselves (slow-moving or stationary vessels), whilst others avoid them. Mother whales have been observed to position themselves between the vessel and their calf. Right whales are slow-moving animals and may be struck and killed by vessels under way.
Sperm whale	Reactions to vessels can involve course changes, shallow dives, altered surface-respiration-dive patterns, erratic surface movements and breaking up of a pod into smaller groups. Smaller non-threatening boats, such as sailing vessels do not appear to create any noticeable reactions. Collisions with ships have been known to kill animals.
Blue whale	Responses include avoidance, abrupt change in direction, diving and shorter surfacing times. Fast-moving vessels caused the most response, whilst slow-moving vessels result in little observable reaction.
Fin whale	Responses include avoidance, abrupt change in direction, diving, fewer blows per surfacing and shorter surfacing times. Fast-moving vessels caused the most response, whilst slow-moving vessels result in little observable reaction. Although fin whales have been noted to continue to vocalise in the presence of vessels, low-frequency noises from vessels may mask their sounds.
Bottlenose dolphin	Generally tolerate boats and ships, commonly approaching vessels and swimming with their bow and stern waves. Animals are often observed feeding alongside fishing boats. In some cases, dolphins were shown to actively avoid areas of heavy shipping or approaching boats, possibly due to sensitisation. Collisions with boats occasionally occur, injuring or killing animals. Other responses include shorter surface periods, longer dives and movement away from vessels at ranges of 150-300 metres2.
Pinnipeds	
Australian Sea-lion Australian Fur seal New Zealand Fur seal	Reactions of seals to ships and boats are variable. Some seals have been observed to tolerate close encounters with sea vessels whilst some have been noted to be attracted to fishing boats to feed. Seals have been reported to stampede from colonies when disturbed.

Adapted from: Richardson et al., 1995.

Physical damage

Physical damage from shipping operations refers to the grounding or sinking of vessels. The impact of physical damage include the loss of habitat at least in the short term, depending on the location of the grounding. There is also the possibility of losing cargo, including damage to fuel and bulk storage tanks.

AMSA, through its Port State Control Program, inspects international and Australian ships to ensure compliance with international and national environmental and safety laws. Australia is recognised as being vigorous in this task resulting in deterring substandard shipping from trading in this region. In many port areas, experienced marine pilots navigate vessels to ensure that ships remain in designated navigational channels and approaches.

Air emissions

Air emissions from shipping operations occur from the exhaust of diesel and fuel oil combustion engines. Fugitive emissions may also result from vapours and dusts emitted from bulk storage tanks, although these sources are controlled to avoid any significant loss of cargo.

In September 1997 IMO adopted the text of a new MARPOL 73/78 Annex (Annex VI) dealing with air pollution from ships in the form of a Protocol to the Convention (not yet entered into force).

The Protocol (AMSA, 1991c):

- sets limits on the sulphur content of fuel oil and establishes ‘So_x Emission Control Areas’;
- prohibits deliberate emissions of ozone depleting substances;
- sets limits on emissions of nitrogen oxides (NO_x) from diesel engines.
- prohibits the incineration on board ship of certain products, such as contaminated packaging materials and polychlorinated biphenyls (PCB’s).

Ship technology is contributing to improvements in engine efficiencies, hull and propeller designs and the use of ships with larger cargo capacities leading to a reduction of emissions from engine exhausts and an increase in fuel efficiency.

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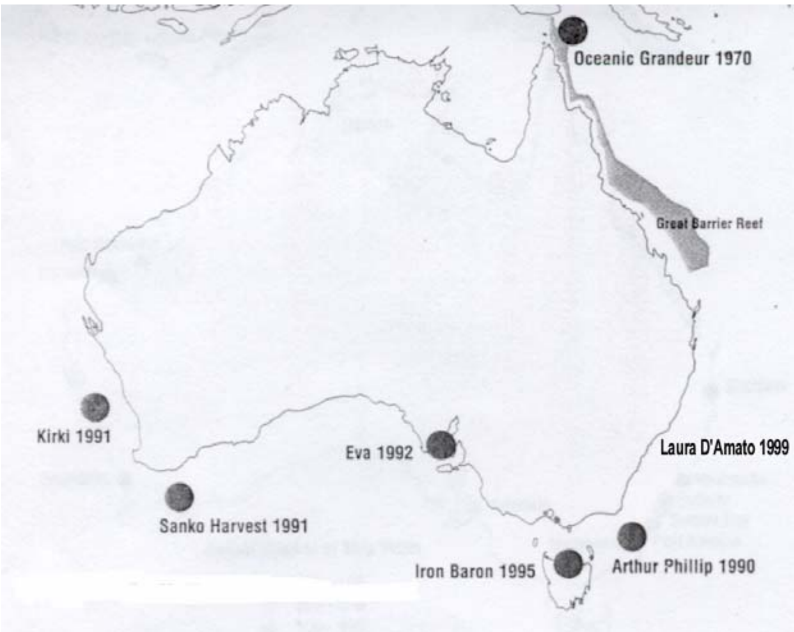
Use for Figure 2.1 or advice if you would like one of your own locality maps amended to include this information



Use for Figure 2.2

(NB the size of the spills can be added and the Port Stanvac spill has to be included)