Australian Government
Department of Agriculture, Fisheries and Forestry
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Domestic vessel movements and the spread of marine pests

Risks and management approaches

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List of Acronyms

AAPMA	Association of Australian Ports and Marine Authorities Incorporated
ACS	Australian Customs Service
ACV	Australian Customs Vessel
ADI	Australian Defence Industries Ltd
ADF	Australian Defence Force
AGM	Asian Green Mussel (*Perna viridis*)
AFMA	Australian Fisheries Management Authority
AFP	Australian Federal Police
AHTS	Anchor Handling Tug Supply Vessel
AMPA	Australian Marine Pilots Association
AMSA	Australian Maritime Safety Authority
ANZECC	Australian and New Zealand Environment and Conservation Council
AQIS	Australian Quarantine and Inspection Service
ASA	Australian Shipowners Association
ASRO	Australian Shipping Registration Office
AUSREP	Australian Ship Reporting System (operated by AMSA)
AUSTA	Australian Sailing Training Association
AVCG	Australian Volunteer Coastguard
BIA	Boating Industry Association
BRS	Bureau of Rural Sciences
BSM	Black Striped Mussel (*Mytilopsis sallei*)
BWDSS	Ballast Water Decision Support System (operated by AQIS)
CoC	Code of Conduct
CoP	Code of Practice
CRIMP	CSIRO Centre for Research on Introduced Marine Pests
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAFF	Australian Government Department of Agriculture, Fisheries and Forestry
DBIRD	Department of Business, Industry and Resource Development (Northern Territory)
DEH	Australian Government Department of Environment and Heritage
DIMIA	Australian Government Department of Immigration & Multicultural Indigenous Affairs
DMS	Defence Maritime Services Pty Ltd
DPIWE	Department of Primary Industries, Water and Environment (Tasmania)
DSE	Department of Sustainability and Environment (Victoria)

DSTO	Defence Science and Technology Organisation
EEZ	Exclusive Economic Zone
EPA	Environment Protection Agency (or Authority)
EPBC (Act)	Environment Protection and Biodiversity Conservation Act 1999
ETBF	Eastern Tuna and Billfish Fishery
GEBCO	General Bathymetric Chart of the Oceans
GBR	Great Barrier Reef
GBRMPA	Great Barrier Reef Marine Park Authority
GLOBALLAST	Global Ballast Water Management Programme (IMO)
ICPC	International Cable Protection Committee
IMO	International Maritime Organization
IMP	Introduced Marine Pest(s)
ISM	International Safety Management (ISM) Code 2002
LUB	Light utility boat
MAA	Marinas Association of Australia
MAFRI	Marine and Freshwater Resources Institute (Victoria)
MAST	Marine and Safety Tasmania
NIMPCG	National Introduced Marine Pests Coordination Group
NIMPIS	National Introduced Marine Pest Information System
NRIFS	National Recreational and Indigenous Fishing Survey
OCS	Offshore Constitutional Settlement
OSV	Offshore Support Vessel
PIRSA	Primary Industries and Resources South Australia
PSV	Platform Supply Vessel
PWC	Personal Water Craft
QDPI	Queensland Department of Primary Industries
QE2	Queen Elizabeth II (Cunard cruise ship)
RAN	Royal Australian Navy
SAR	Search and rescue
SASRS	South Australian Sea Rescue Squadron
SEMR	South East Marine Region
SIEV	Suspected Illegal Entry Vessel
SMS	Safety Management System
VMRA	Volunteer Marine Rescue Association
WADF	Western Australian Department of Fisheries
WATC	Western Australian Tourism Commission

Glossary

Australian Fishing Zone (AFZ) – Australia has proclaimed a zone 200 nautical miles wide around its mainland and territories coasts, within which it controls domestic and foreign access to fish resources.

Asian Green Mussel (*Perna viridis*) – a large mussel with a brown shell and a green lip. It is native to south-east Asia and an introduced marine pest in Australia.

Bareboat (charter) **–** a vessel, typically a yacht, that is available for charter without skipper or crew. The individuals hiring the vessel must provision and sail it themselves.

Benthic – relating to, or inhabiting, the seabed.

Bilges – the lowest internal portion of a vessel's hull.

Biofouling – an encrustation of living marine organisms on the hull, or inside the plumbing system, of a vessel.

Black Striped Mussel (*Mytilopsis sallei*) – a fingernail-sized mussel that is an introduced marine pest. It was successfully eradicated from Darwin Harbour in 1999.

Bow (or stern) thruster – a device set into the hull of a ship to assist with accurate positioning. Sea water is sucked into the ship with a high pressure pump and then jetted out through a rotatable grid with angled louvres.

Bund – low retaining wall to prevent slipway waste from washing back into the sea.

Burley – material that is cast upon the surface of the water and used as bait to attract fish. Commonly consists of minced or chopped fish offal.

***Caulerpa taxifolia* -** a light green seaweed. The aquarium strain of *C. taxifolia* is an introduced marine pest.

Endemic - native to, or characteristic of, a particular region.

Entrainment - the uptake of a marine pest by a vector.

Exclusive Economic Zone – a 200-nautical mile zone declared in August 1994 by Australia in accordance with the provisions of the United Nations Convention on the Law of the Sea. Australia has the right to explore and exploit, and the responsibility to conserve and manage, the living and non-living resources within this area.

Gravid - carrying developing young or eggs.

Gunwales - the upper edges of the sides of a vessel.

Hopper - a funnel-shaped container used to filter water from and store wet products such as sediment (ie on a dredge) or fish (ie on a fishing vessel).

Inoculate – introduce or infect a locality or agent (in this case, a node or vector) with an invasive marine pest. This process usually occurs through reproduction and spawning rather than direct transfer of individuals.

Introduced marine pest (IMP) – an invasive, exotic marine organism that has been brought to Australian waters and has been declared a noxious species.

Node – "a point in a network at which lines intersect or branch"(Oxford Concise Dictionary); used in the current context to denote places or features along the routes that vessels travel where journeys begin and end, and at which they cross paths with other vessels. Common examples of vessel nodes are ports and marinas.

Primary invasion – the initial incursion of a marine pest into Australian waters.

Pelagic – relating to, or inhabiting, open oceans or seas as opposed to the seabed.

Pathway – a route, consisting of a combination of vector(s) and node(s), connecting two disjunct sites along which marine pests are translocated by vectors.

Reservoir – a term derived from epidemiology to denote sites where marine pests can build up their numbers and breed undisturbed forming a source of new recruits that can infect other locations or structures.

Sea chest – a recess built into a ship's hull beneath the waterline near the engine room and surrounding a seawater inlet pipe that is designed to reduce water cavitation and increase pumping efficiency.

Secondary invasion – the subsequent infestation of a new locality by a marine pest after the initial (primary) incursion.

Square-rigged - a sailing-ship rig in which the principal sails are extended on yards fastened to the masts horizontally and at their centre.

Topsides - the surface of a vessel's hull above the water line.

Translocation – the transport of an organism between disjunct sites by a vector.

Undaria pinnatifida - a brown Japanese seaweed and an introduced marine pest.

Vector – an agent (eg a vessel) with the potential to transport marine pests from one place to another.

Vessel – used in this report to mean all ships, boats and other types of marine craft.

Warps – thick ropes or cables use to tie up or tow a vessel.

<u>Units</u>

m – metre(s)

km – kilometre(s)

nm – nautical mile(s)

t – tonne(s)

hp - horsepower

Summary

Overview This report reviewed the potential for **non-trading vessels** to act as vectors for the spread of marine pests around Australia. Vessel types from 23 government, industry and community sectors were examined in the review, together with their associated voyage nodes. The aim of the review was to identify sectors that pose the highest risk of translocating marine pests from one site to another, and to suggest ways of managing and mitigating risks across all sectors. Existing sources of information published on the World Wide Web, in the scientific literature or obtained through interviews with government and community stakeholders and industry representatives were drawn together to provide an information base that was used to assess the threats posed by each sector and rank them relative to one another (ie, on a scale of 1 – 23) for risk. Ranking was done on the basis of factors relating to vessel characteristics and the nature and intensity of vessel activity in the sector. The results of the risk assessment are presented in Table 1 below, together with suggestions for management actions that could be applied to reduce translocation potential.

Vectors The report estimates that close to a million non-trading vessels comprise the combined fleet of all 23 sectors. While the vast majority of these are privately owned recreational boats such as yachts and cabin cruisers, almost 15 000 vessels are owned and operated by government agencies, community associations or the private sector. Most of the vessels are based permanently in Australia but some, such as cruise ships and seismic survey vessels, are occasional visitors to our waters and belong to a multinational global fleet. Some sectors were easier to assess for risk than others, depending on (1) the availability and accessibility of information on the sector, which was related to factors such as dispersed vessel ownership or governance arrangements and 2) the heterogeneity of the sector, some being very diverse in terms of vessel design and activity.

Nodes The review also examined and discussed the role of ten types of nodes in the translocation process. Nodes are the origin and destination points of vessel voyages and places where pest reservoirs are formed, and are therefore locations where vessels are most likely to pick up marine pests. Few records are kept on the utilisation of these facilities by different sectors and, in many cases, it is not known exactly how many there are of them. Key secondary invasion issues relate to colonisation of the waters in and

around nodes by marine pests and the necessity for general sanitation and monitoring measures such as bunding and waste disposal for boat ramps, slipways and dry docks, inspection and treatment regimes for pontoons, moorings and buoys and surveys of fishing harbours, marinas and anchorages. It was recognised also that some nodes might themselves become vectors, capable of translocating pests to a new environment, if they are either accidentally or deliberately moved. This applies to features such as pontoons, moorings and buoys, which may be colonised by pests whilst stationary, and is a factor that must be taken into consideration in terms of their management.

Risk Assessment

The sectors identified as **highest risk** for domestic translocation of marine pests were:

1. **Commercial fishing boats**
2. **Dredges**
3. **Offshore (petroleum) support vessels**.

A number of other industrial vessels such as **barges and lighters**, **harbour services craft** and **mobile drilling rigs** were also ranked as **high risk**. Factors that contributed to an estimate of high risk were the large number of voyages these vessels undertake, the amount of time they spend in and around ports, where introduced marine pests are commonly found, and their high level of interaction with the seabed.

Ranked **lowest** in the **risk** assessment were recreational and community vessels that are stored out of the water, used only for short voyages and washed down after use, ie **personal water craft, trailer sailers**, **cabin cruisers and tinnies** and **coastguard vessels**. Also considered low risk were **customs launches** and **seismic survey ships**, which spend most of their time out at sea, often far from the coast, and make infrequent visits to port.

Sectors in the **intermediate risk** category include most of the enforcement agencies (**Defence, Water Police, fisheries patrol**), the larger recreational and tourism vessels that are stored in the water such as **yachts, motor cruisers, charter boats, cruise ships** and **sail training vessels,** as well as **ferries, research vessels** and **cable ships.** Most of these vessels are either a) in frequent use, b) undertake long, meandering voyages to numerous locations (often of high environmental value), c) deploy gear or equipment that comes into contact with the seabed or d) spend significant time in ports or marinas, where fouling rates are high and marine pests typically occur.

Risk Rank	Sector	Suggested management approaches
1	Commercial fishing vessels	Development of industry codes of conduct and education
2	Dredges	Development of national guidelines
3	Offshore support vessels	Extension of current industry environmental policies
4	Barges and Lighters	Mandatory inspections and certification; voluntary CoC
5	Harbour services craft	Development of guidelines relating to inspections and antifouling in consultation with AAPMA, AMPA & ASA
6	Mobile drilling rigs	Development of best management practice in consultation with industry bodies such as APPEA
7	Ferries and Water taxis	Voluntary guidelines
8	Defence vessels	Education and training of vessel crews
9	Yachts	Voluntary voyage reporting; education campaign coordinated through BIA and Yachting Australia; promotion of best practice for vessel cleanliness
9	Sail training vessels	Education campaign coordinated through AUSTA
11	Charter boats	Education through industry associations; mandatory inspections and certification
12	Cable ships	Cleaning of deployed gear; distribution of educational materials through ICPC
13	Cruise ships	Permit conditions relating to hull cleanliness
14	Research vessels	Education; voluntary inspection and vessel/gear cleanliness guidelines
15	Water Police	Education incorporated into professional training
16	Motor cruisers	Voluntary voyage reporting; education campaign coordinated through BIA; promotion of best practice for vessel cleanliness
17	Fisheries patrol boats	Education incorporated into current training courses
18	Seismic survey ships	Education campaign coordinated through APPEA
19	Customs launches	Education incorporated into professional training
20	Coastguard patrol boats	Education incorporated into current training courses
21	Small powered craft	Education campaign; boat ramp signage
22	Trailer sailers	Education campaign; boat ramp signage
23	Personal water craft (PWC)	Education campaign

Table 1: Summary of risk assessment results and suggested management approaches. Sectors are ranked in descending order from highest (1) to lowest (23) risk.

Management Existing arrangements within each sector for controlling the spread of marine pests were documented and future management options recommended. None of the sectors is currently subject to any mandatory risk reduction measures, although some have adopted voluntary practices. A number of leverage points are available within the system, however, at which management action could be applied. For example, most or all of the commercial and industrial vessels are subject to government licensing and registration requirements, or are obliged to apply for permits to conduct certain activities. These requirements could be exploited by, for example, requiring the production of documentary evidence that the vessel has been slipped and antifouled within an appropriate period and has had its internal plumbing systems treated prior to the granting of a licence, permit or vessel registration. Other options include encouraging voyage reporting for vessels berthed in marinas to permit vessel tracking in the event of an emergency response to a pest outbreak.

There are a large number of organisations representing the various sectors that can and should be utilised to raise awareness of marine pest issues and develop appropriate mitigation strategies. The importance of working collaboratively with relevant industry bodies, government agencies and community associations to identify high-risk activities and develop best practice guidelines, either mandatory or voluntary for each sector is strongly emphasised.

Education is required across all sectors in order to raise awareness of marine pest issues and ways to minimise translocation risks. This should be targeted at different levels depending on the sector (industry, community or government). Suggestions include running an organised publicity campaign; incorporating brochures, posters and identification guides into vessel registration packages; distributing an information kit through industry bodies; and incorporating education and awareness of marine pests into existing curricula or courses undertaken by vessel owners/operators and run by professional or volunteer organisations. Education and training is especially recommended for sectors such as Water Police, fisheries patrol and coastguard as they come into regular contact with another large sector that is relatively difficult to target - recreational boaters. Some sectors can therefore provide a point of contact for management and control with other, less accessible ones.

Introduction

Background

Primary Invasions

Concern is mounting over the introduction of marine pests into Australian waters from overseas. A primary mechanism for this international transfer of species, in recent times, has been the discharge of foreign ballast water into Australian ports. In response to such threats, in 2001 Australia put in place regulations, under the powers of the *Quarantine Act 1908,* to manage ballast water sourced from overseas ports. Management is underpinned by the Ballast Water Decision Support System (BWDSS) operated by the Australian Quarantine and Inspection Service (AQIS), which assesses ballast water exchange risks for each vessel arriving in Australia. High-risk ballast water is prohibited from discharge in Australian territorial waters. These arrangements will be augmented by the introduction of an international convention for the control and management of ships' ballast water and sediments in 2004 (International Maritime Organization (IMO) 2003), which will supplement the current voluntary guidelines (IMO 1997).

There is increasing recognition, however, that ballast water is not the only means by which marine pests are introduced into Australia. They have also been imported in biofouling communities attached to the hulls of vessels or secreted in other wet spaces such as sea chests and internal plumbing systems. Around 250 exotic marine species have been identified in Australia, of which more than 75% are believed to have been introduced through biofouling rather than in ballast water (Bax et al. 2003).

In light of mounting threats to Australia's marine ecosystems posed by escalating pest incursions, Australian Governments recently agreed to implement the National System for the Prevention and Management of Marine Pest Incursions ('the National System') that will put in place a range of measures to deal with all aspects of the prevention, management and control of marine pest introductions. This will include arrangements to reduce the risk of primary invasions via ballast water or biofouling, as well as measures to control the spread of existing introduced marine pests (IMP) as a result of secondary invasions.

Secondary invasions

In the event of an IMP population becoming established in an Australian port and reproducing successfully, second (and later) generation individuals may be transported to other suitable sites where they can found new populations, each of which, in turn, may breed many more (Figure 1). This process of secondary invasion is analogous to the spread of a disease through an animal population, and indeed much of the terminology associated with it is borrowed from epidemiology. **Vectors**, in this case vessels, are responsible for pest transmission between "hosts", which are sites that harbour the pest, allowing it to establish populations and infect passing vessels. In the context of secondary invasions of marine pests, these host sites are typically maritime hubs or centres of boating activity such as ports, harbours and marinas, but the term may also be applied to boat repair and maintenance facilities such as slipways and dry docks. These sites have the potential to act as distribution centres, where IMP can be picked up or deposited by vectors, and are termed **nodes** to reflect the fact that they are points in a transport network. Nodes are both the origin and destination points of voyages, as well as places or features where vector pathways (vessel routes) intersect.

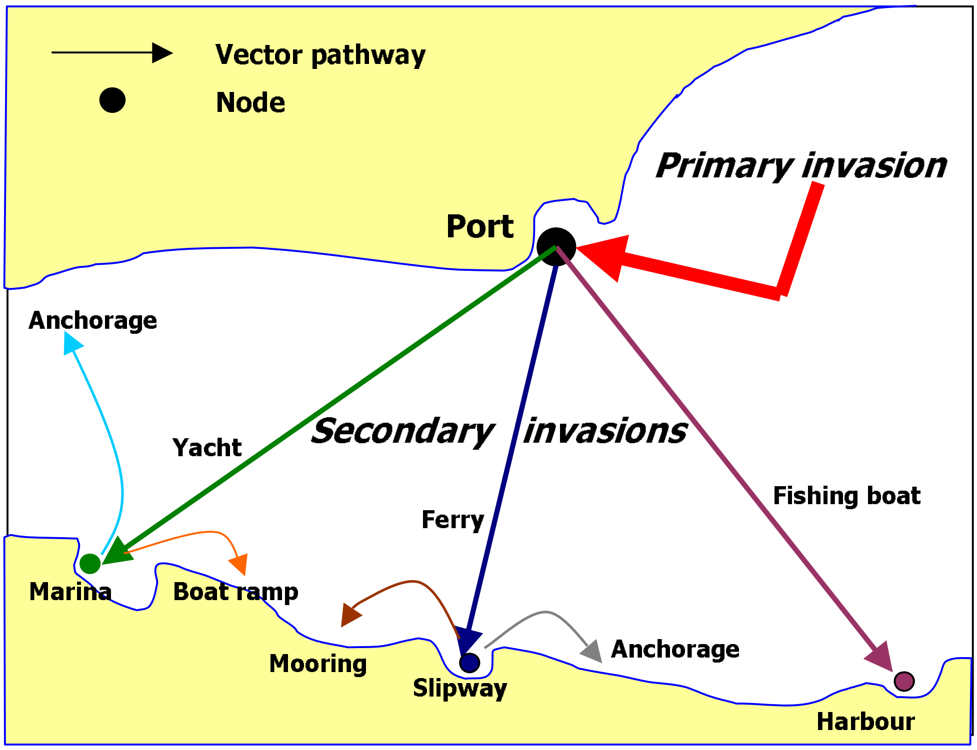


Figure 1: Schematic representation of secondary invasion process. It should be noted that not all primary invasions occur in ports; there have been instances of marine pests being introduced into Australian marinas on the hulls of international cruising yachts.

In addition to acting as distribution centres and the sources of new infections, nodes may become pest **reservoirs**, providing a beneficial environment for IMP populations to become established in, build up their numbers undisturbed and infect vectors trafficking through the node. Nodes typically contain substantial quantities of infrastructure such as pilings, pontoons, wharves and other surfaces that provide artificial substrate for IMP to settle on and colonise. These man-made structures also often alter the patterns of water circulation and temperature and salinity ranges within nodes. The environmental complexity of nodes increases the available range of microhabitats and microenvironments, thereby offering a diversity of ecological niches for pest survival.

Thus, a secondary invasion occurs when a vector **entrains** an IMP at a node and **translocates** it to a new site (generally another node), a process that may be repeated endlessly (see Figure 1). **Entrainment** refers to the process of uptake or attachment of an IMP to a vector (in this case, either a vessel or its gear) and **translocation** means the transport of the entrained IMP to a geographically separate locality (in particular, one that it would not be expected to reach by natural dispersal). Entrainment may occur by several mechanisms, including:

- ballast water uptake
- hull fouling
- fouling of internal plumbing systems and spaces such as sea chests, which, because of reduced water flow, often harbour larger and more motile organisms
- entrapment in wet-wells, buckets and bilges
- entanglement in deck, fishing gear or warps (eg nets and coils of rope)
- embedding in mud attached to anchors
- boring into the hulls of wooden vessels.

Translocation results in a pest population recruiting to a new location and is dependent upon:

- effective entrainment and journey survival
- the pest reaching reproductive maturity and being capable of producing viable offspring
- the pest either reproducing asexually, being a gravid female or individuals of both sexes being translocated
- the receiving environment providing suitable habitat.

Repeated secondary invasions have the potential to result in the widespread distribution of exotic species throughout Australia's unique, and often highly endemic, marine ecosystems. Concern over this issue has been galvanised in recent times by the spread of the Northern Pacific Seastar, *Asterias amurensis,* from the Derwent estuary in Tasmania across Bass Strait to Port Phillip Bay. This species now has the potential to invade the entire southern Australian coastline – a scenario that could have disastrous consequences for Australia's marine biodiversity and maritime industries. Almost invariably, these dramatic species range expansions are mediated by shipping rather than occurring through natural dispersal. *A. amurensis* for example was almost certainly transported across Bass Strait by vessel traffic between Tasmania and the mainland.

Increasing attention is therefore being paid to the domestic translocation of IMP. The National System proposes to manage coastal shipping using coordinated and consistent state and territory legislation. This includes assessing vessels carrying ballast water on domestic trading voyages using the BWDSS. Scheduled arrangements for biofouling management on international merchant vessels will be extended to domestic trading vessels also. Nevertheless, there are a large number and variety of other, non-trading vessels operating in Australian waters, all of which have the potential to act as vectors for the spread of marine pests.[1] Thousands of pleasure craft and large commercial fishing fleets ply our coastal and oceanic waters. Numerous maritime industries, including petroleum, tourism and ports, employ vessels continuously in carrying out their business and various government agencies are involved in defence, search and rescue and enforcement activities right around the coast and out to the edges of the Exclusive Economic Zone (EEZ). This report has identified 19 categories of vessel belonging to government, community and industry sectors that are active in Australia's marine waters in a non-trading capacity. All of these vessels have the potential to effect secondary invasions, and thereby be responsible for increasing the distribution, and hence the impacts, of marine pests.

Aims and scope

This report is intended to provide information to support the National System. Its aims are:

- to identify and describe the full range of domestic, non-trading vessels that have the potential to act as vectors for secondary invasions of marine pests.
- to document and discuss the activities and operational characteristics of each vessel sector.
- to assess the risk of secondary invasion posed by each sector, and identify the factors that contribute to this risk.

[1] Risks associated with other possible vectors, such as the movements of gear and stock in the mariculture industry, are the subject of a companion report (Williams 2003).

- to evaluate approaches to managing and mitigating secondary invasion risks and make recommendations regarding the development of management arrangements for each sector.
- to identify gaps in information, knowledge and understanding of sectoral activities.
- to discuss the role of nodes in the translocation pathway.

The report is intended as an initial, scoping document and not a comprehensive review. The scope of the report specifically excludes merchant shipping and commercial trading ports, instead focusing on non-trading vessels and non-port nodes. It should be noted, however, that some types of vessel such as barges and ferries, whilst not strictly speaking merchant ships, may carry freight. In the interests of completeness, these have been included in the report.

Commercial trading (or cargo) ports are outside the scope of this report and, as such, have not been explicitly discussed in the section on nodes. However, some references to them have been unavoidable in the section on vectors for two reasons: firstly, a number of the sectors assessed in the report are either based permanently in commercial trading ports (eg harbour services craft) or make use of them for short visits (eg cruise ships) and second, primary invasions are most likely to take place in or near first ports of call for merchant shipping arriving in Australia. For this reason, time spent in or around commercial ports was one of the factors used in assessing entrainment risk.

Methods

The primary source of information for this review was the World Wide Web, although this was augmented by the authors' significant personal and professional experience of vessels and maritime activities. Industry, government and community web sites relating to each sector were identified and accessed using Internet search engines and browsers. More detailed information relating to the activities of the sector was acquired via e-mail correspondence or telephone interviews with stakeholder contacts. The information obtained in this manner was used to define and describe each sector and provide an indication of its size and distribution in the form of a table, graph or map. Translocation and entrainment issues pertaining to each sector were deduced from information gained on operational practices, and examples of situations where the sector has been implicated in the spread of a marine pest were obtained from literature searches. Relevant management documents such as existing environmental guidelines or industry Codes of Conduct were obtained and used to evaluate existing management arrangements within each sector. On the basis of this information, a preliminary assessment of the relative entrainment and translocation risks posed by each of the 19 sectors was conducted. For the purposes of the risk assessment, the recreational sector was divided into 5 sub-sectors because of its diversity, resulting in 23 sectors/sub-sectors being ranked. This process is described in more detail below.

Risk Assessment

Each sector (and sub-sector in the case of recreational vessels) was formally assessed by the authors for its potential to translocate marine pests, based on the following four factors[2]:

1. the total **Volume** of the sector (ie number of vessels)
2. the **Range** (average distance) over which vessels in the sector travel
3. the **Frequency** with which vessels are in use
4. the **Promiscuity** of the sector (ie the number of discrete locations vessels visit).

The assessment of risk was made on a relative, not absolute, basis, therefore the 23 sectors and sub-sectors were ranked from highest (23) to lowest (1) risk for each of the factors and the ranking scores for all four factors were summed. For example, a sector that was ranked 9th in terms of Volume, 3rd for Range, 12th for Frequency and 16th for Promiscuity obtained a total translocation score of **40** (9 + 3 + 12 + 16).

In the same manner, the potential for vessels within a particular sector to entrain a marine pest was ranked according to:

1. the size of vessels in the sector (an index of the surface area available for fouling)
2. the degree of contact between vessels and/or their gear and the sea or seabed
3. the amount of biofouling likely to be carried by vessels
4. the availability of suitable refugia for harbouring a pest organism
5. the degree of activity in inshore waters
6. the number and duration of visits to nodes (in particular, ports and marinas).

Again, all sectors were ranked from 1 (lowest risk) to 23 (highest risk) for each of these factors and the six rankings were summed.

The total translocation and total entrainment scores for each sector were added together to arrive at an aggregate secondary invasion score. This process results in entrainment being weighted more heavily than translocation (six factors compared with four). However, this was considered appropriate in view of the fact that a vector must actually entrain a marine pest in order to translocate it to a new site.

All sectors were then assigned a final rank according to their aggregate score for the 10 factors. This provides an assessment of the relative risk each sector poses to the spread of marine pests around Australia.

[2] This is based on a method developed by CRIMP and used at an expert workshop to assess risks for the spread of *A. amurensis* (DSE 2002).

Part I: VECTORS

1. Barges and Lighters

Description of sector

Barges are defined here as flat-bottomed, square-fronted craft designed to carry freight and characterised by having bow doors that can be lowered onto land to facilitate the loading and discharge of cargo [3]. In the past, the front of these vessels would typically be run up on a beach and the bow doors lowered onto the sand (see photo above), giving rise to the term landing barge. This rarely occurs nowadays, however, due to the increasing use of infrastructure such as barge loading ramps and wharves. When using a loading ramp, the barge remains afloat in shallow water whilst the bow doors are dropped forward onto the ramp and cargo is loaded or unloaded with forklift trucks. Barges operated by Sea Swift in the Torres Strait use barge ramps at most localities they visit, however, on occasion, this infrastructure is not available, in which case the vessel will be run onto land (B O'Halloran *pers. comm.* 2003). There are 25 landing barges registered as Australian vessels; these have a mean length of 32 metres (m), and a maximum length of 50 m (ASRO 2003).

Typical barge activities include supplying goods to remote communities. Thus, Perkins Shipping, an Australian company based in Darwin, operates a fleet of six landing barges on a scheduled service to remote coastal communities around the Northern Territory and north-western Australia. Similarly, Riverside Marine uses landing barges to operate a freight service in the Gulf of Carpentaria and Sea Swift operates a barge freight service in far north Queensland and the Torres Strait. It should be noted that some barges may carry passengers as well as freight but these are not, strictly-speaking, considered as ferries (see Part I: Section 10).

Lighters, in the strictest definition, are vessels used to load and unload cargo ships that are unable to reach the container wharves at the port of shipment or delivery. As most ships can access wharves nowadays, and commercial vessels have become more specialised to carry out this sort of function, lighters have been somewhat superseded. Defence Maritime Services (see Part I: Section 8) still operate a fleet of at least 10 lighters, however. Lighters are usually relatively small (< 25 m) but may reach a length of 50 m. They tend to operate within smooth waters only.

[3] Canal barges and ceremonial barges are not included in this report

Both barges and lighters are also used for the carriage of bulk materials such as oil (for re-fuelling large ships or offshore base stations), dredge spoil and construction materials such as sand and gravel. They may also be equipped with cranes or pile drivers to support construction activities.

Issues associated with sector

Entrainment

Loading and unloading cargo brings barges into close proximity, and sometimes contact, with the seabed in inshore waters, presenting an opportunity for fouling organisms to settle on the vessel. However, these activities are carried out rapidly and no anchors or ropes are used, minimising the risk of entraining pests in the process. In the occasional case where a barge is run ashore, it may be necessary to wait several hours for the incoming tide to refloat the vessel. The extended period of time spent inshore may increase the risk of entrainment of IMP.

Barges remain stationary in port between trips for varying lengths of time (some are used daily and others only weekly) and may therefore acquire biofouling. Sea Swift barges are typically slipped and cleaned every two years, although this may occur more frequently if the vessel is heavily fouled (B O'Halloran *pers. comm.* 2003). Some barges also tranship cargo from vessels operating out of larger (and possibly infected) ports and this presents a risk of marine pests being transferred during the exchange of cargo. For example, the MV *Malu Warrior* tranships cargo at Thursday Island from the MV *Trinity Bay*, which arrives from Cairns twice per week. Trinity Inlet in Cairns has recently been invaded by the Asian Green Mussel. There is therefore a possibility that the *Malu Warrior* could be infected with pests brought from Cairns on the *Trinity Bay*.

As lighters are no longer commonly used they are likely to remain immobile in ports and harbours for long periods gathering fouling. When lighters are operating they are slow moving, so any pests that have become attached to the vessel are not likely to be dislodged.

Translocation

Barge schedules and services are variable. Depending on the region of operation, a barge may service one, or several different, localities. For example, one Sea Swift barge operates solely between Thursday Island and Horne Island, whereas another visits up to 15 different islands in the Torres Strait (Figure 2).

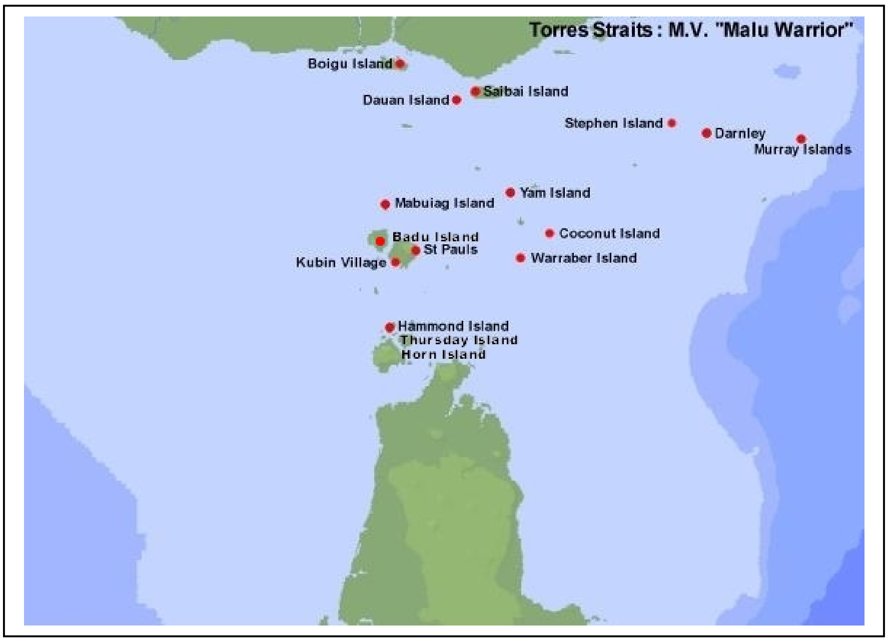


Figure 2: Area of operation of the MV "Malu Warrior" in the Torres Strait. It operates a weekly service from Thursday Island to Badu Island and Kubin Village (Moa Island) and an on-demand service to all the outer Torres Strait Islands shown above. (Source: Sea Swift Pty Ltd).

Barges operating in Northern Australia tend to voyage through inshore waters between populated centres and remote island communities. This presents the risk of IMP being translocated from the mainland to one or more islands, which raises several concerns including:

- the potential for spread to other, nearby islands either through natural dispersal or inter-island traffic
- the potential for a marine pest to become widely distributed throughout the shallow water habitat which surrounds islands in the Torres Strait and is suitable for colonisation by marine pests
- islands are often high in natural heritage and aesthetic values so the incursion of a marine pest may have more significant impacts on biodiversity in these environments than elsewhere
- due to the lack of infrastructure and resources, a marine pest incursion has the potential to remain undetected for long periods and may be difficult to eradicate.

It is probable that lighters move very short distances and are therefore unlikely to translocate a marine pest far outside the range of natural dispersal.

Examples

- In CRIMP Technical Report No. 2, barges were implicated as a major vector in the spread of the European Fanworm (*S.spallanzanii*) from port to port in Western Australia (Clapin & Evans, 1995). This was largely based on the fact that *S.spallanzanii* was found on the hull of the steel barge *Gemini* after it was moved 50 km north and sunk off Mindarie Keys. The barge was moved there after being moored at Cockburn Sound. It was towed at a slow speed (7 to 8 knots), which presumably prevented the tubeworms being washed off during transit. *S.spallanzanii* is now well established in Cockburn Sound and the *Gemini* is still supporting live sabellids.
- In New Zealand, a barge originally from Wellington that had been moored in Nelson Haven since 1997 was one of the first structures on which *Undaria pinnatifida* was found in the harbour. "[It is not known whether] the barge did indeed act as a vector but such vessels, if transferred from one locality to another, could easily carry *Undaria* with them and eventually release spores to the new environment" (Sinner et al. 2000).

Risk assessment

Results

Entrainment	Translocation	Overall Rank
2	**10**	**4**

Barges and lighters have been ranked relatively high risk overall (4). The sector was ranked high for entrainment risk (2) due to the relatively long periods spent in port or operating in inshore waters, as well as their occasional interaction with the seabed. The sector was ranked intermediate for translocation risk (10) because only a portion of vessels in this sector undertake frequent or long voyages or could be considered promiscuous (ie some barges).

Gaps and Uncertainties

This sector is not represented by a unified peak industry body that could be contacted about routine barge operations, maintenance practices or environmental Codes of Conduct. It was particularly difficult to obtain information about lighters. These are lowly, work-a-day, uninteresting craft and as such are not well documented.

Management Approaches

Existing

The barge company Sea Swift is very aware of marine pests due to the high profile of Black Striped Mussel and Asian Green Mussel outbreaks in the "Top End" (B. O'Halloran *pers. comm*. 2003). However, this company is not aware of any current management arrangements aimed at minimising the translocation of marine pests during domestic voyages, nor do they have their own company policy. Under Queensland survey requirements, however, barges are required to be slipped every two years. Lighters do not appear to be subject to much regulation. In New South Wales, for example, it is not necessary for lighters to be registered under survey.

Proposed

Barges will be included under the regulatory regime for coastal shipping that is proposed for the National System. As they are slow-moving vessels and have the potential to come into contact with the seabed, it may be appropriate to suggest more frequent inspections than for other commercial craft, particularly for barges operating in environmentally sensitive areas. Barges should also be subject to any antifouling certification standards that are developed as part of the National System.

Barge companies should be encouraged to develop their own policies or Codes of Conduct to minimise the spread of marine pests through fouling management. The two large barge companies that operate in northern Australia (Perkins and Sea Swift) are both members of the Australian Shipowners Association (ASA), which is already involved in stakeholder consultations for the National System and should therefore provide a first point of contact. Lighters are an obscure sector with few operators. Further research is necessary to determine what management arrangements, if any, are necessary for these vessels.

2. Cable Ships

Description of sector

Cable ships are one of six sectors[4] dealt with in this report that represent both a primary and a secondary invasion risk. These are vessels that originate from overseas but carry out periodic work in Australian waters. They may combine several contracts into one visit and may therefore have the potential not only to bring about new marine pest introductions to Australia, but also to spread existing pests around. There are no cable ships based permanently in Australia; instead vessels come here to work under contract to the owners/operators of submarine cables in several localities in Australian waters. There were about four visits per year from cable ships to Australia in the period 1999 – 2002, from various ports of departure (AMSA 2003). The cable ship *Pacific Guardian*, owned and operated by Global Marine Systems, is an exception to this rule, however, being based in Australia from time to time on a rotating basis with Fiji and New Zealand.

Most cable ships are ocean-going vessels of about 120 – 150 m in length. They are specially constructed or modified to either lay submarine cables (installation vessels) or carry out repairs and maintenance on existing cables (maintenance vessels). They are usually readily identifiable by the distinctive sheaves at the bow or stern (or both) over which the cable is raised or lowered (see photo above). They are also characterised by having precision dynamic positioning systems comprising Global Positioning Systems coupled with bow and stern thrusters to maintain position while working on cables. Furthermore, cable ships are equipped with a variety of devices to locate, raise, lay or bury cables. Most of these devices are built into remotely operated vehicles (ROV), though in shallow waters a diver may manually control them. Cables in water depths of less than 2000 m are routinely buried either with a cable plough or water jetting. In shallow waters with a rocky seabed, a rock saw might be deployed by a diver to cut a channel in which to lay the cable, thereby securing it from ships' anchors and fishing nets. The International Cable Protection Committee website has an illustrated list of cable ships in operation worldwide, which includes some specifications of these vessels (ICPC 2003).

[4] The other sectors are cruise ships, mobile drilling rigs, seismic survey ships and some research vessels and offshore support vessels.

Both types of vessel (installation and maintenance) carry ballast water. Installation vessels may carry up to 8000 tonnes of cable (≡ 8000 km), which is replaced with ballast water as it is laid. Maintenance vessels carry ballast water only to maintain trim and so rarely exchange it (B Barnes *pers. comm*. 2003).

Many submarine cables have been laid around the coast of Australia. There are seven international communications cables, four of which come ashore at Sydney; the remainder come ashore at Cairns, Port Hedland and Perth (ICPC 2003). There is also a communications cable linking the mainland (Sandy Point, Victoria) and Tasmania (Boat Harbour) and an offshore power cable ("Basslink") is being installed to link Tasmania with the mainland electricity grid. A plethora of communications and power cables link offshore islands with the mainland and cross bays and other waterways.

Issues associated with sector

Entrainment

Cable ships may entrain marine pests when taking on ballast water (most likely on installation vessels during cable laying operations), on remotely-deployed equipment when they are working in nearshore areas of the continental shelf or through biofouling, as they are large vessels with sea chests and extensive seawater plumbing systems, including bow and stern thrusters. IMP are more likely to be entrained in the environs of a port and AMSA data show that these vessels spend several days or weeks at a time in Australian ports, both before and between jobs. Figure 3 shows the AUSREP (AMSA 2003) daily position reports from two vessels operating near Sydney during 2001. The map shows that there is a substantial amount of cable laying and maintenance activity in water depths of less than 200 m, which is within the depth limits of *Asterias amurensis*, for example (CRIMP 2000). In the case illustrated, activity with submarine cables is partially within areas enriched with effluent from deep ocean sewage outfalls. Such areas are highly suitable for colonisation by pest organisms. It is understood (B Barnes *pers. comm*. 2003) that remotely deployed equipment does entrain various marine organisms from time to time but, since all equipment is routinely washed down with a high-pressure hose before the vessel leaves each work site, they are almost certainly removed.

Translocation

The most likely routes by which translocation could take place, in order of decreasing risk, is from a port to a work site, from one work site to another or from a work site to a port. Most shallow water (< 200m) sites are in the vicinity of port cities so it seems unlikely that a work site would be infested while the port nearby was not. Interpretation of the cable ship position reports mapped in Figure 3 demonstrate the potential for IMP to be translocated from port to work site and from work site to work site. This map shows both a cable being laid (the green triangles) and maintenance work being carried out (red squares). (The cable being laid is probably the Australia-Japan Cable, installed in 2001 (ICPC 2003).) Both vessels visited a port, in this case Sydney, at least once during cable operations before returning to shallow water work sites. The vessels also moved over a considerable area of seabed from one work site to another.

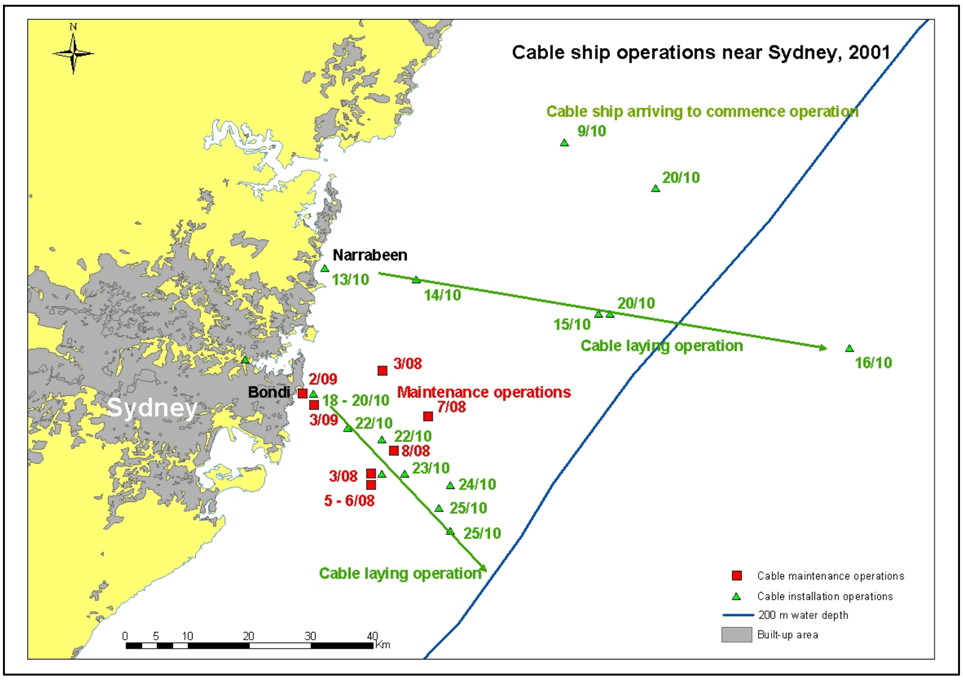


Figure 3: Cable ship operations near Sydney during 2001. (Data sources: AMSA, GEBCO).

Examples

There are no specific examples demonstrating the spread of marine pests by this vector.

Risk assessment

Results

Entrainment	Translocation	Overall Rank
5	**22**	**12**

Cable ships were ranked as moderate risk overall (12). Entrainment risk was high (5) because vessel activity involves bringing gear into contact with the seabed and because of idle time spent in ports, but they were ranked almost last (22) for translocation risk because there are so few of them (see Appendix 1) and they do not appear to move between ports.

Gaps and Uncertainties

This is rather a small and specialised sector and owners and operators are not based in Australia, making it difficult to obtain information on specific vessel activities, such as ballast water exchange.

Management Approaches

Existing

From an analysis of AUSREP position reports for the period 1999 – 2002 (AMSA 2003), it appears that most contracts in Australian waters have been carried out by three vessels. It is not known, however, who the operators of these vessels are. Global Marine Systems owns and operates the world's largest fleet of cable laying and maintenance vessels, including in Australian waters, so it may be assumed that they own at least one of these vessels. They advise that they are aware of the risks of translocation of IMP and are actively monitoring the development of the *International Convention for the Control and Management of Ships' Ballast Water and Sediments* being drawn up by the IMO, which is scheduled for adoption by IMO members in February 2004 (B Barnes *pers. comm.* 2003). As outlined above, the company's own procedures ensure that organisms entrained in remotely deployed equipment are dislodged when the equipment is retrieved.

Under the terms of the *Quarantine Act 1908*, all vessels entering the Australian EEZ from international waters are required to submit a quarantine pre-arrival (pratique) form to AQIS and this includes questions about ballast water treatment. No such regime exists yet, however, for movements from one location to another within Australian waters (but see below). There are currently no mandatory or voluntary protocols in place to minimise the translocation of marine pests through biofouling, either from international or domestic sources, including cable ships.

Proposed

With regards to domestic translocation issues, the proposed extension of the BWDSS to vessels engaged in domestic voyages may provide a point of intervention where ballast water is involved. Nevertheless, it seems appropriate to raise the awareness of cable ship operators on the risks of entrainment and translocation of IMP through an information package. The IMO distributes a package of material through its Global Ballast Water Management Programme (GLOBALLAST) and this could form the basis of further educational efforts. The International Cable Protection Committee could be an appropriate forum through which to distribute such a package as cable ships working in Australia may come from any one of several overseas operators.

The procedure of washing down equipment that has been in contact with the seabed before the vessel leaves the locality is one that should be universally adopted, not only by cable ships but also by other vessels deploying remotely operated equipment, such as research vessels.

3. Charter Boats

Description of sector

Charter boats are commercially owned, passenger-carrying vessels offering voyages to tourists and holiday-makers or available for hire by the general public for recreational activities. In the former case, the boat is operated by a professional skipper and crew. Most of the whale or dolphin-watching cruises (see photo above) and big game fishing charters operate in this mode. In the latter, the boat is hired and skippered by an individual or group of individuals. Bareboat yacht charters fall into this category, with Queensland and the Gippsland Lakes being popular locations for this activity.

Charter boats are small to medium sized vessels of varying design, depending upon function. They range from small (~ 4 m) punts operating in sheltered estuarine waters to large motor cruisers and yachts (up to 35 m) designed for offshore fishing and cruising. Catamarans are also a common design, as they remain upright and stable, providing a more comfortable ride for passengers, as well as being more fuel-efficient. Table 2 below lists the number of charter boat operators per state in Australia.

STATE	NO. OF OPERATORS
Queensland	557
New South Wales	641
Victoria	185
Tasmania	46
South Australia	97
Western Australia	216
Northern Territory	29
TOTAL	**1771**

Table 2: Number of charter boat operators per state. (Data source: Yellow Pages®).

Issues associated with sector

Entrainment

There are three potential entrainment pathways associated with charter boats, involving the vessel, the gear and the passengers:

<u>Vessel</u>

Charter boats typically work on a seasonal basis and remain in the water during the off-season, either on a mooring, in a marina or alongside a dock in the environs of a port. These environments encourage the accumulation of biofouling and are high risk for the presence of marine pests. Charter boats typically visit sites of high aesthetic or biodiversity value and may therefore congregate or anchor en masse at the same site, presenting the possibility of cross-infection between vessels that are anchored in proximity to one another.

<u>Gear</u>

Entrainment potential from gear will depend on the type of activity being conducted. Deep-sea game fishing or whale watching is unlikely to entrain marine pest but reef fishing and scuba diving may result in pests being entangled in fishing or diving gear. The spread of *Undaria sp.* at Bicheno (Tas.), for example, is attributed to scuba diving activities (A Brown *pers. comm*. 2003). A vessel that anchors (eg dive boats) may entrain pests through fouling of the anchor or chain.

<u>Passengers</u>

As charter boats carry passengers, there is the possibility that they could deliberately (but in ignorance) pick up pest organisms and later redeposit them in another locality.

Translocation

Charter boats almost invariably return to their point of departure, thus minimising the likelihood of translocating a marine pest to another port or marina. However, charter boats generally operate in inshore areas and frequently visit scenic locations (eg offshore islands) and areas of high conservation significance (eg marine parks). They therefore pose a serious risk of translocating an IMP to an anchorage or pontoon located in a pristine marine environment. Distances over which charter boats may translocate pests will vary according to the charter destination but are typically intrastate and for most tourism charter voyages will generally be within a half-days travel. Bareboat yacht charters are a different case, however, with vessels capable of cruising over long distances to multiple localities.

Examples

There are no specific examples demonstrating the spread of marine pests by this vector.

Risk assessment

Results

Entrainment	Translocation	Overall Rank
11	**13**	**11**

Charter boats were ranked in the middle for entrainment (11) and slightly lower for translocation (13) and assessed as medium risk overall (11). This reflects the fact that charter boats do not typically venture far from port as they often have quite circumscribed itineraries (eg dolphin watching in Jervis Bay) and in many cases operate for only part of the year. However they are based in ports and marinas and some deploy fishing tackle and anchors.

Gaps and Uncertainties

Comprehensive, consolidated data on charter boat activities and practices in Australia was difficult to obtain, as there are many types of charter boat and each state regulates them differently. There is also no national charter boat association and New South Wales is the only state with a well-established peak body for this sector. Consequently, there was no single point of contact for information on the sector as a whole. Furthermore, the heterogeneity of the sector, both in terms of vessel design and activity, presented difficulties in assigning a single value for each of the risk factors.

Management Approaches

Existing

Charter boat operators are conscious of maintaining vessel cleanliness both on deck (for safety and aesthetic reasons) as well as below the waterline (for economic performance reasons) (D Cribb *pers. comm*. 2003). There are management arrangements in place that target these aspects of vessel maintenance, however these have generally been developed to reduce pollution rather than the spread of marine pests. For example, the Charter Vessel Association of NSW, Waterways Authority of NSW and NSW EPA developed a joint Code of Practice (CoP) to minimise the amount of detergents entering New South Wales waterways. They raised awareness of this issue through a “wash your boat” campaign and information was disseminated to charter boat operators through membership newsletters.

All boat owners in New South Wales, including charter boat operators, are subject to the *Protection of the Environment Operations Act 1997*, which prohibits any type of discharge to the marine environment. This includes cleaning of boats/ships hulls. Such cleaning must take place at EPA-licensed premises. This Act is consistent with the *ANZECC Code of Practice for Antifouling and In-Water Hull Cleaning and Maintenance* (ANZECC 2000) which each state and territory has signed. The ANZECC CoP recommends that maintenance and antifouling of small craft (< 25 m), should take place above the tidal zone at an appropriately equipped and approved facility to prevent the return of hull scrapings, including fouling communities, to the marine environment. Charter vessels are therefore generally cleaned at a slipway. On average this takes place every two years (D Cribb *pers. comm.* 2003). The Charter Vessel Association of NSW plays a role in informing its members of the recommended practices. However, they have not explained the benefits in terms of reducing the spread of marine pests and were not previously aware of this issue (D Cribb *pers. comm.* 2003).

Proposed

As this sector interacts with the general public, it is vital that charter boat operators understand marine pest issues. An awareness campaign similar to the "wash your boat" campaign mentioned above could be run for IMP at the national scale. The development of such a campaign could be effected through the Charter Vessel Association of NSW, which has one quarter of industry membership in that state. The Executive Officer, David Cribb, has already expressed an interest in including information on marine pest issues in the Association's next newsletter.

In addition, it would be possible to utilise the licensing process and work in conjunction with the marine safety authorities, to achieve compliance with mandatory inspection regimes particularly for states where a peak industry body no longer exists (eg Tasmania) or has low membership. For example, it may be desirable, for those vessels that remain in the water during the off-season, to be subject to a regime requiring that the underside of the vessel be inspected and, if necessary, cleaned before the next season commences. This may be particularly appropriate for charter boats operating within marine parks, especially the GBR. The Association of Marine Park Tourism Operators in Queensland would be a useful peak body to work with to develop such a regime.

4. Coastguard Patrol Boats

Description of sector

This sector provides volunteer seamanship training and search and rescue services to the recreational boating and fishing sector and is made up of three separate major organisations, and at least one minor one, with a combined fleet of approximately 250 boats. The Australian Volunteer Coastguard (AVCG) commands a fleet of 95 rescue boats (see photo above) distributed among 63 flotillas based between Cape York, Qld and Port Augusta, SA and servicing an area from Thursday Island to Eyre Peninsula (AVCG 2003). The Royal Volunteer Coastal Patrol (RVCP) is the oldest volunteer sea rescue organisation in Australia. It has 34 operational divisions and a fleet of 62 lifeboats throughout New South Wales, Victoria, Tasmania and South Australia (RVCP 2003). The Volunteer Marine Rescue Association operates in both Western Australia and Queensland. In Western Australia, the organisation has 56 operational boats stationed at 40 locations around the state (P Kimber *pers. comm.* 2003). VMRAQ in Queensland has 25 affiliated squadrons located throughout the state from Pt. Danger on the southern Queensland border, to the Gulf of Carpentaria, Thursday Island and the Torres Strait region (VMRAQ 2003). Finally, the South Australian Sea Rescue Squadron (SASRS) has two vessels based on the Adelaide metropolitan coastline and a flotilla of privately owned volunteer craft at its disposal at Edithburgh on Yorke Peninsula (SASRS 2003).

The distribution of coastguard vessels belonging to all of these organisations is shown in Figure 4. This map illustrates that coastguard patrol boats are distributed around most of Australia, barring the largely uninhabited coast of the Great Australian Bight. They are concentrated, however, on the eastern seaboard (particularly around the major recreational boating regions of the Gold Coast and the New South Wales south and central coasts) and the southern coast of WA and are much sparser in remote parts of north-western Australia and the "Top End". The Northern Territory does not have a volunteer coastguard organisation *per se*. Marine search and rescue services in the NT are carried out by the Water Police and by volunteer units of the State Emergency Services department.

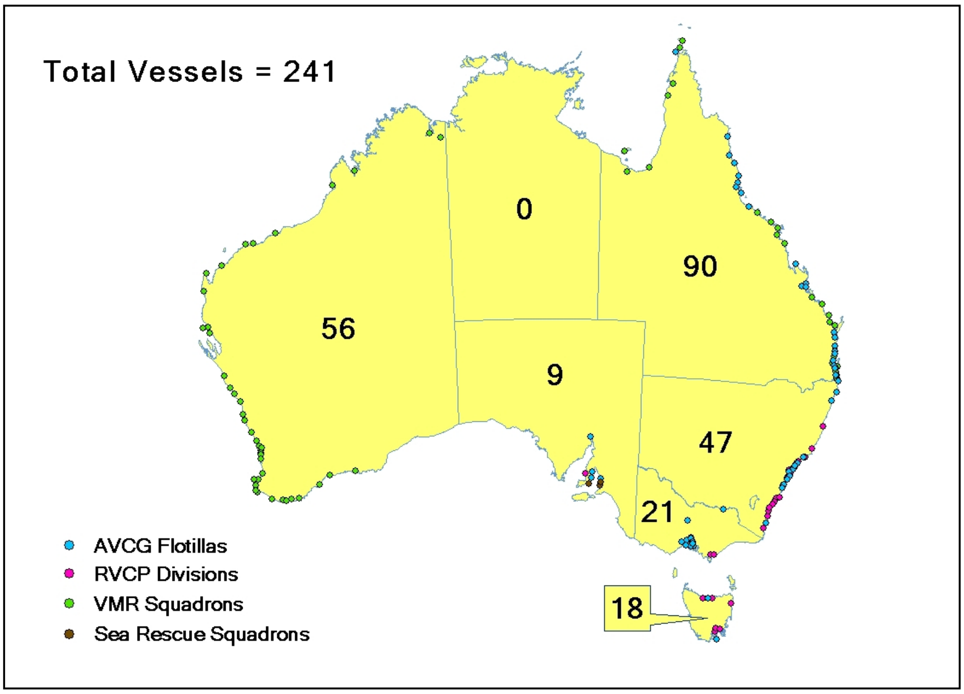


Figure 4: Distribution of coastguard vessels around Australia, indicating total vessel numbers per state. (Data sources: AVCG, RVCP, VMRA and SASRS).

Issues associated with sector

Entrainment

Coastguard patrol boats are generally small (5 - 20 m), well-maintained craft that are inspected and cleaned regularly to ensure they remain seaworthy. Approximately half of the fleet is kept 'on the hard' (ie out of the water) at a coastguard station base. These vessels are washed down after each trip and drained of water and would therefore be unlikely to carry much biofouling. The other half of the fleet remains in the water but is slipped at frequent intervals. The AVCG, for example, slips their vessels every 6 - 8 months (C Gillet *pers. comm.* 2003). Coastguard vessels invariably have planing hulls and travel at high speed, which also reduces the likelihood of settlement of biofouling organisms. By virtue of their maritime safety role, coastguard vessels do, however, come into close contact with many other recreational vessels during rescue incidents, at boating day events, regattas etc. so could potentially be infected with a pest from another vessel. Anchors, anchor wells and ropes also offer entrainment opportunities, especially as there is a good chance of them remaining damp, due to the high frequency of use of these vessels.

Translocation

Coastguard patrol boats are in frequent, sometimes daily operation throughout coastal waters, up to a distance of around 50 nautical miles (nm) offshore, although the majority of operations occur within 15 nm of the coast. However, individual coastguard vessels operate within a defined radius of their home base, to which they return upon completion of their daily patrols. They do not generally move between base locations or visit other nodes, (particularly not ports) nor do they travel interstate, so IMP would be translocated over short distances from base ports to inshore habitats, anchorages and possibly boat ramps.

Examples

There are no specific examples demonstrating the spread of marine pests by this vector.

Risk assessment

Results

Entrainment	Translocation	Overall Rank
21	**6**	**20**

Coastguard vessels were ranked low for entrainment (21) as most of these vessels are trailered and well maintained and all are planing hull vessels that travel at high speed. Translocation risk was high (6) however, because these vessels are used frequently and visit many inshore habitats. Overall risk ranking was very low (20).

Gaps and Uncertainties

This sector is not consolidated, there being several separate organisations around the country, many of which are regionalised. This made it difficult to obtain consolidated information for the sector as a whole.

Management Approaches

Existing

None of the coastguard organisations has any specific guidelines, protocols or Codes of Conduct with respect to marine pests, nor does education on this issue form part of their formal training. However, whilst there is a low level of awareness of marine pests within this sector, there are indications of a great deal of willingness to become better informed (C Gillet *pers. comm.* 2003).

Proposed

Education and awareness-raising are likely to be profitable with this sector as members of the coastguard are dedicated and motivated mariners with a keen interest in the marine environment. Coastguard volunteers undertake formal training for their role, therefore it would be possible to liaise with the national boards of the various coastguard organisations to encourage them to incorporate marine pests awareness sessions into their existing training programs. As coastguard members are out on the water a great deal in many parts of the country and are in regular contact with the recreational boating public, they could serve a useful role in educating other boat owners on issues concerning marine pests. If they are trained to identify potential marine pests in their region, they could also have a role in surveillance.

5. Commercial Fishing Vessels

Description of sector

There are approximately 25 Australian Government and 120 State/Territory fisheries operating in Australian marine waters with a combined fleet of nearly 12 000 vessels. These vessels are distributed all around Australia, although by far the greatest number is located in Queensland and other east coast states (Figure 5). Australia's commercial fishing fleets voyage throughout State and Australian Government waters to fishing grounds on the continental shelf and slope. They fish in waters from 5 - 5000 m deep and from the coastline to more than 1000 km offshore (Figure 6). Many of Australia's most productive fishing grounds lie along the 'shelf break', that is the edge of the continental shelf where the seafloor begins to slope sharply downwards (Figure 6).

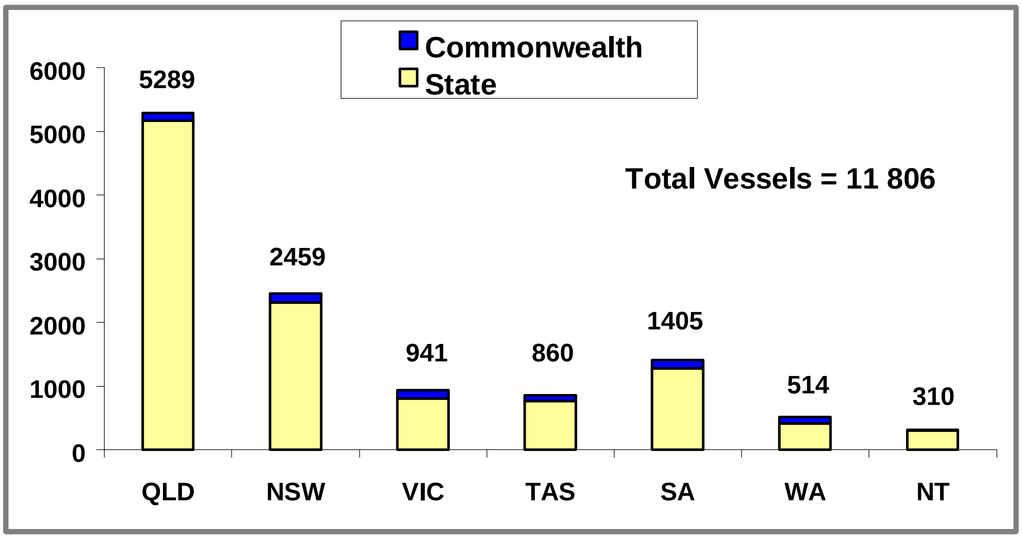


Figure 5: Numbers of State/Territory- and Australian Government-licensed fishing vessels per state. Figures above bars represent total vessel registrations per state. (Data sources: AFMA, DBIRD, MAFRI, MAST, NSW Fisheries, PIRSA, QDPI and WADF).

The commercial fishing sector is very heterogeneous, with vessels varying in their size, design and construction depending on the fishery in which they operate, ie the species being targeted, the gear type used and the location of fishing grounds. Commercial fishing vessels therefore range from small, open aluminium dinghies powered by outboard motors and launched and retrieved at boat ramps to large, deep-water trawlers with wheel- and deckhouses that remain at sea for several days or even weeks at a time (see photo above). In size they range from less than one tonne (t) to over 2 000 t and from around 5 to over 80 m in length. State-licensed vessels, generally speaking, are smaller and operate in inshore (state) waters (ie within 3 nm of the coast) whereas Australian Government-licensed vessels are larger and operate further offshore.

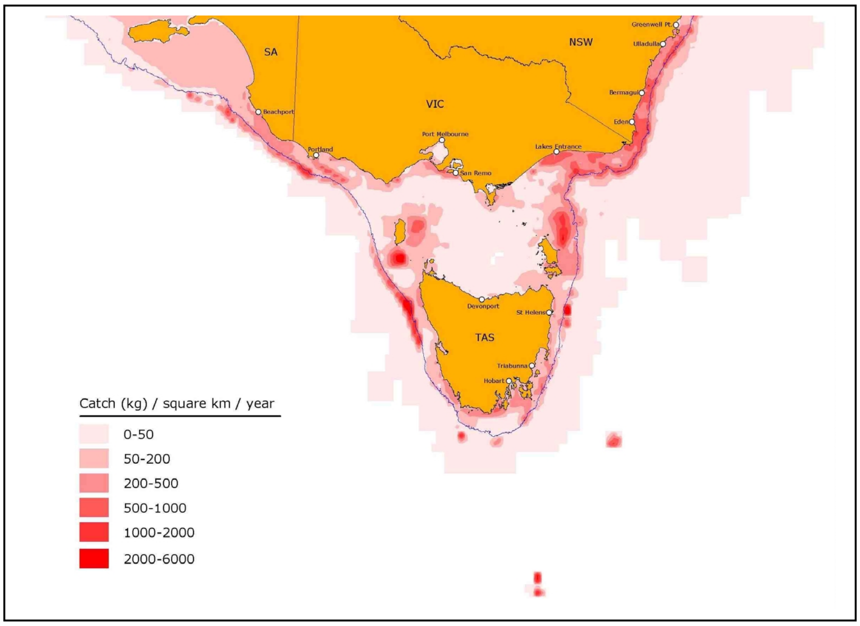


Figure 6: Distribution of fishing grounds in south-eastern Australia. Blue line indicates the 200-metre depth contour, which marks the approximate boundary between the continental shelf and slope. (Source: Larcombe et al. 2002).

Nearly 40% of Australian Government-managed commercial fishing vessels (237) are licensed to operate in the Eastern Tuna and Billfish Fishery (ETBF) that occupies much of Australia's east coast and just over 30% (199) in the gillnet, hook and trap fishery that operates in south-eastern Australia. Other large sectors are the South-East Trawl fishery, with 105 vessels and the Northern Prawn Fishery (96 vessels) in the Gulf of Carpentaria.

Issues associated with sector

Entrainment

Fishing vessels, and their gear and deck equipment, offer a number of opportunities for the entrainment of marine pests. Fishing naturally involves prolonged periods of contact between fishing gear and the marine environment. Marine pests may therefore be physically harvested by or entangled in fishing gear. As fishing vessels are in frequent use, this gear may remain damp, permitting pests to survive. Alternatively, they may be transferred or escape from gear into seawater wet wells, fish slurries or onto the deck. Fishing vessels typically carry a lot of gear and equipment on deck and therefore offer a number of damp crevices where marine pests may be able to find refuge.

Entrainment potential will vary from fishery to fishery however, depending on gear type, vessel design, the location of fishing grounds and the level of usage of infected nodes, in particular fishing harbours located within the boundaries of commercial trading ports. Gear that remains submerged for some length of time, is unselective (ie prone to harvesting by-catch) and/or comes into contact with the seabed will run a higher risk of entraining a marine pest. This applies to trap and pot fisheries (eg octopus, rock lobster), gill nets, bottom trawls and scallop dredges. Thus, in an assessment of IMP translocation risks associated with commercial fishing vessels carried out at a series of expert workshops, traps and pots and their associated ropes and floats, followed by beach seine, purse seine, gill and trawl nets were ranked as the most likely components for entraining marine pests (Hayes 2002). Vessels such as abalone dive boats may be anchored whilst fishing, presenting opportunities for pest entrainment in anchor mud, on chains and warps and in anchor wells. Other vessels, such as rock lobster boats, are fitted with wet wells for the transport of live fish or crustaceans, thus offering habitat to larvae, planktonic algae and motile organisms. Finally, approximately 35% of Australian Government-licensed fishing vessels are made of wood, which can be penetrated by boring organisms. This type of construction also has a tendency to result in permanently wet bilges.

Whilst entrainment of marine pests in fishing gear is equally likely for State- and Australian Government-registered vessels, the former tend to be smaller vessels that are stored either out of the water or in isolated bays when not fishing whereas the latter are commonly based in man-made harbours, many of which are located within the environs of commercial trading ports. This significantly increases the risk of IMP entrainment through biofouling on submerged surfaces while the vessel is inactive. As fishing harbours are often crowded with vessels from different fleets, there is also plenty of opportunity for cross-infection.

Translocation

Fishing vessels are wide-ranging, regular and frequent users of the marine environment. There are also large numbers of them and they are highly promiscuous. There is virtually no part of the continental shelf of Australia that is not occupied by fishing grounds (see, for example, Figure 6). Certain sections of the fleet are highly mobile and may land their catch at a different port from their port of origin or home port. Furthermore, some vessels operate out of different home ports at different times of the year or have multiple licence endorsements and therefore visit several fishing grounds. These factors combine to present ample opportunity for translocation of pests between harbours, boat ramps and fishing grounds leading potentially to the widespread distribution of pests throughout many suitable, shallow-water habitats. These movements are difficult to quantify and map, as no records are kept of vessel movements or port visits, except in the case of a small proportion of the Australian Government-managed fleet that uses VMS. Translocation risks are probably highest in eastern and south-eastern Australia however and lowest in Western Australia due to the greater number and variety of fishing fleets on the eastern seaboard (Figure 5). In addition, Australian Government-licensed vessels probably represent a higher translocation risk as state fishing vessels are on the whole more restricted in their movements and, particularly if trailered, more likely to return to their harbour or boat ramp of origin. Whilst predominantly used for fishing in bays, estuaries, gulfs and other inshore waters, state vessels are not restricted to fishing only in state waters as Offshore Constitutional Settlement (OCS) arrangements permit State registered vessels to fish for certain species, or with the use of certain gear, in Australian Government-managed waters as well.

Examples

- Fishing trawlers are the major vector contributing to the spread of *Caulerpa taxifolia* in the Mediterranean as a result of entanglement of the alga on trawl gear (otter boards, ropes and nets). It has been discovered that fragments of algae caught in nets or on anchors that remain moist can survive and regenerate a new plant when redeposited in the marine environment (Relini et al. 2000).
- A survey of southern ports in New Zealand in 1999 found that 16% of the hulls of fishing vessels were fouled with the IMP *Undaria pinnatifida* (New Zealand Department of Conservation 1999 cited in Sinner et al. 2000).
- There has been speculation that *U. pinnatifida* was introduced to remote parts of Tasmania via fishing nets and anchors (Sinner et al. 2000).

Risk assessment

Results

Entrainment	Translocation	Overall Rank
6	**1**	**1**

Commercial fishing vessels were ranked highest for secondary invasion risk of all the sectors examined here, echoing earlier results (DSE 2002). Entrainment was ranked high (6) due to the interaction of fishing gear with the sea and seabed and the large number of refugia offered on fishing vessels. Translocation risk was ranked highest of all sectors assessed (1) due to the large size of the fleet (see Appendix 1) and high activity level of the sector.

Gaps and Uncertainties

This sector is very heterogeneous, presenting difficulties in assessing the risk of the sector as a whole. Future risk assessments should consider commercial fishing vessels on a sub-sectoral basis according to the fishery they operate in and gear type they deploy.

Management Approaches

Existing

The peak national body representing the commercial fishing sector, the Australian Seafood Industry Council, has prepared a *Code of Conduct for a Responsible Seafood Industry,* which enshrines the principles of striving to conserve and protect aquatic ecosystems and minimising impacts on the environment through harvesting activities. There is no mention of marine pests in the Code, however. Nonetheless, individual fisheries are being proactive and developing their own codes that address the issue; for example, the ETBF, in conjunction with SeaNet, have produced an *Industry Code of Practice for Responsible Fishing* that mentions both ballast water and hull fouling as potential sources of contamination by marine pests. The potential entrainment of pests by other components of the vessel is not discussed in the ETBF Code though.

Proposed

The SeaNet/ETBF initiative could provide a basis for other fisheries to develop similar Codes of Practice, particularly those that pose high entrainment or translocation risks. To this end, management agencies and the fishing industry should collaborate to identify the fisheries, vessels and gear types that present the highest risks in terms of harbouring and spreading marine pests, based on the work of Hayes (2002) and develop consistent management approaches to address these risks. Management should address risks associated with both vessels and gear ie nets, traps, pots, live wells, etc. as appropriate. Education programs directed at fishers should include components relating to the spread of marine pests, as well as training in the recognition of marine pest organisms so that fishers could adopt a surveillance role.

6. Cruise Ships

Description of sector

Cruise ships are large, luxury, passenger-carrying vessels nowadays used solely for tourism (see photo above). They vary enormously in size from the 293-metre long QE2 to the 35-metre long Coral Princess, which operates between Townsville and Cairns. The largest cruise ships can carry over 2500 passengers. Unsurprisingly, visits by these vessels are highly sought after by port cities as their passengers often spend considerable sums of money when they visit. Figure 7 shows the number of visits by cruise ships to Australian ports in 2000/01 (AAPMA 2003). Sydney has by far the largest number of visits, no doubt because it is the hub for three types of cruise: cruises in south-eastern Australia, cruises that include a leg through the Great Barrier Reef and round-the-world cruises. According to recent announcements (WATC 2003), Western Australia is working hard to capture a larger share of the cruise ship market. Hence the *Superstar Virgo* was based in Fremantle during April and May 2003, for a series of six cruises along the Western Australian coast.

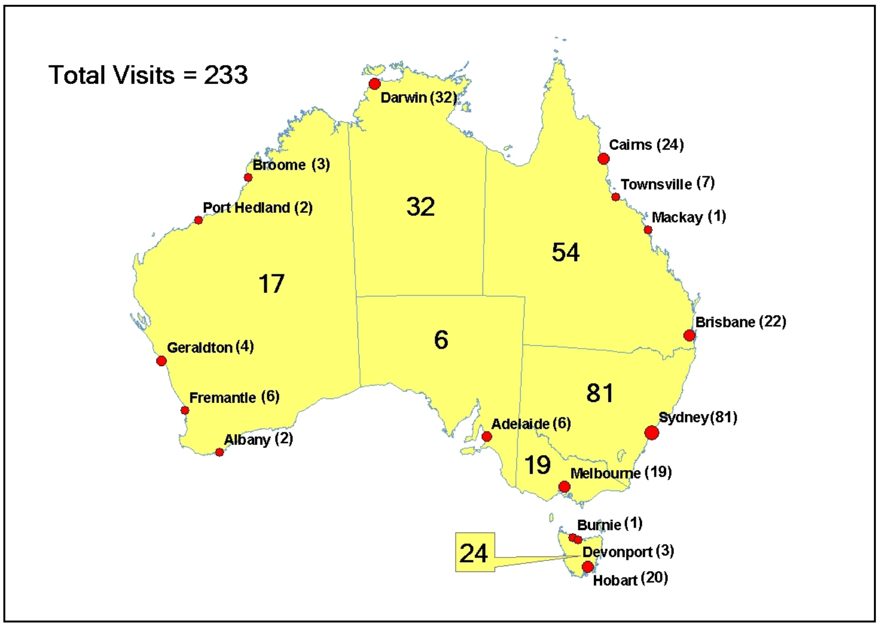


Figure 7: Cruise ship visits to Australian ports in 2000/01. (Data source: AAPMA).

There appear to be four main cruising grounds in Australia:

1. South-eastern Australia. Many ships cruise the route Sydney – Melbourne – Hobart (incl. Port Arthur) – New Zealand (and vice versa).

2. Great Barrier Reef (GBR). There appear to be two main types of cruise, those operating entirely within the region (eg Coral Princess Cruises between Cairns and Townsville) and those that are part of a longer itinerary, for example many of Cunard's round-the-world cruises include the GBR. In 1998, twelve cruise ships anchored in the Whitsunday Islands for a total of 16 visits (GBRMPA 1999).
3. Northern Australia, in particular, Darwin. Many cruises visit Darwin on itineraries that include Bali and Cairns.
4. North-western Australia, in particular Broome and the Kimberleys.

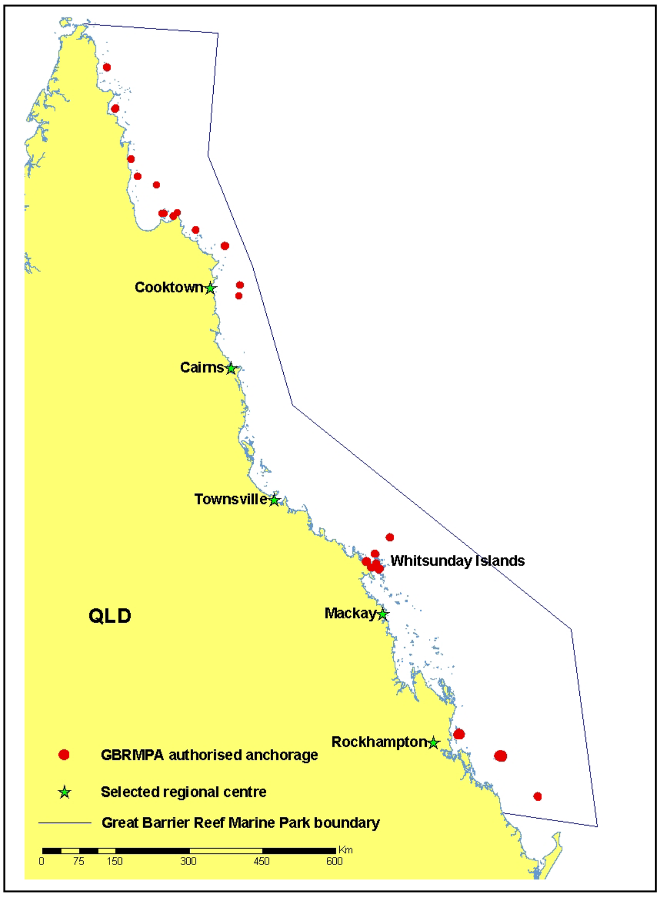


Figure 8: Cruise ship anchorages authorised by the Great Barrier Reef Marine Park Authority. (Data source: GBRMPA).

Issues associated with sector

Entrainment

Cruise ships may carry ballast water for stabilisation and trimming but, if uptake or discharge is required, they can generally afford to hold ballast water onboard or delay exchange until they are outside port waters (T Hatch *pers. comm.* 2003). However, these vessels are generally comparatively large, thus providing ample surface area for biofouling. Indeed, Coutts et al. (2003) warn that the sea chests of cruise ships "should be considered a serious biosecurity risk", especially given that these vessels visit and anchor in World Heritage Areas, such as the GBR, and in excess of 16 ports in Australia (Figure 7). Port visits, however, tend to be of short duration, ie one day or less, thus minimising the likelihood of entraining IMP. Larger cruise ships rarely anchor but make their way from port to port, taking the most scenic routes, as far as possible. In the Great Barrier Reef Marine Park and in north-west Western Australia, however, the smaller "expedition-style" cruise ships routinely anchor and use tenders to ferry passengers to sites of interest, eg cays or islands and to transport them to floating pontoons (see Part II: Section 9) which are used as a base for snorkelling and diving activities. There are risks of entrainment of pests by cruise ships and their tenders both at pontoons and at anchorages. The tenders are, however, hauled on board on completion of such activities where there is a strong likelihood that they will dry out completely in the tropical sun. Most marine organisms are unlikely to survive even quite short exposure to such conditions.

Translocation

Cruise ships are, by their very nature, itinerant, visiting several places of interest during a voyage; they are therefore capable of inoculating multiple sites. The larger ships may visit several ports along their route, some of which are widely separated, so they are capable of long-range, interstate translocations. The smaller "expedition-style" cruise ships on the other hand visit a greater number of locations and anchor in remote sites – offshore islands for example. More importantly, these anchorages are generally in sensitive locations, for example within the GBR Marine Park (see Figure 8) and around Ningaloo Marine Park in WA.

Examples

There are no specific examples demonstrating the spread of marine pests by this vector.

Risk assessment

Results

Entrainment	Translocation	Overall Rank
8	**20**	**13**

Cruise ships were ranked relatively high for entrainment (8) due to the large size of vessels, the fact that they carry ballast water and make use of ports and their practice of anchoring and using tenders to visit pontoons. They were ranked low for translocation risk (20), largely because of the relatively small size of the sector (see Appendix 1) and their infrequent domestic voyages. Overall, these vessels were ranked as medium risk (13).

Gaps and Uncertainties

Cruise ships are not represented by a peak industry body, rendering it difficult to obtain general information on management practices. The mechanism, timing and quantities of ballast water taken up and discharged are also not well known.

Management Approaches

Under the terms of the *Quarantine Act 1908*, all vessels entering Australian waters from international waters are required to submit a quarantine pre-arrival (pratique) form to AQIS that includes questions about ballast water management. No such regime exists, however, for voyages within Australian waters, nor are there any mandatory protocols in place to minimise the risk of translocation of marine pests through biofouling or in ballast water on domestic voyages, and this includes tourist cruises. The IMO currently has voluntary guidelines for the management of ballast water and sediments (IMO 1997), which are applicable to all ships, regardless of whether they are engaged on international or domestic voyages. Furthermore, the *International Convention for the Control and Management of Ships' Ballast Water and Sediments* (IMO 2003) is in preparation and is due to be ratified at the International Conference on Ballast Water Management for Ships in February 2004. Once this convention comes into force, it will be mandatory for all vessels, including cruise ships, to manage ballast water under the terms of this convention.

Proposed

Ships carrying ballast water will need to be managed in accordance with international and domestic requirements. With regards to biofouling, the grant of permits to operate in Australian waters could be contingent upon certification measures, or some other method of providing evidence that the vessel has had appropriate biofouling treatment, or has been inspected recently. Since many cruise ships visit marine parks such as Ningaloo and the Great Barrier Reef, the Great Barrier Reef Marine Park Authority (GBRMPA) and other management authorities may wish to be consulted in the development of such certification or inspection regimes.

7. Customs Launches

Description of sector

The National Marine Unit of the Australian Customs Service ("Customs") operates a fleet of Australian Customs Vessels (ACVs) that are used to enforce border safeguards by maintaining a strategic presence around the Australian coastline and responding to known or suspected breaches of Australia's border and offshore sovereignty rights (Australian Customs Service 2003). ACVs carry out a diverse range of tasks including:

- gathering information and intelligence
- intercepting vessels suspected of carrying illegal entrants
- intercepting vessels carrying drugs, other prohibited or restricted goods or vessels suspected of illegal fishing
- assisting with search and rescue activities
- checking on environmental pollution (such as oil spills)
- assisting with park management of offshore marine reserves eg. patrolling Torres Strait Protected Zone and external territories.

These tasks are initiated not only by Customs but also by other Federal agencies including the AFP, AQIS, AMSA, DIMIA, AFMA and DEH (see List of Acronyms). ACVs may also operate in conjunction with Customs Coastwatch aircraft and are often deployed in joint operations involving Navy patrol vessels. They also assist state-based law enforcement agencies.

The Customs fleet consists of eight 35-metre Bay Class, sea-going vessels (see photo above), each of which carries two 6.4-metre aluminium high-speed tenders used for conducting boarding, surveillance and interception operations (Australian Customs Service 2003). All Bay Class vessels are capable of patrolling out to, and sometimes beyond, the 200 nm limit of the EEZ anywhere around Australia's 37 000 km coastline. They have a range in excess of 1000 nm when travelling at 20 knots and considerably more at slower speeds. Each tender is powered by twin 90 hp outboards and has a cruising range of 150 nm.

Customs vessels are not based at to a particular home port but are instead positioned strategically around the Australian coastline to provide an effective and efficient response to areas of greatest risk to border security. Their location is entirely dependent on where interceptions take place. Sometimes vessels operate in harbours and at other times they operate in waters hundreds of kilometeres offshore. The vessels, therefore, utilise the closest available port at the time for fuel and re-supply purposes. The frequency of port calls is predominantly determined by crew changes which, for logistical reasons (ie flight arrivals) take place at capital city ports.

Issues associated with sector

Entrainment

It is difficult to determine the potential for customs vessels to entrain pest organisms, as the proportion of activity spent in inshore waters is highly variable and their operations are so diverse and relatively little understood. There are only eight Bay Class vessels so they are in high demand. Consequently, they are used continually and spend very little time stationary in ports, where there is potential to gather fouling. Furthermore, Bay Class vessels have a hard, smooth, clean surface providing few refugia for marine organisms. To maintain high performance, ACVs are slipped at least annually and antifouling paint is renewed.

Despite their much smaller size, the high-speed tenders are probably at higher risk of entraining pests purely because they spend more time in inshore environments and may anchor in bays (E Kennedy *pers. comm*. 2003). However, tenders are brought on board the Bay Class vessels after use so any pests that may be entrained are unlikely to survive.

Translocation

ACVs can potentially pose a high risk to translocating marine pests as they are almost constantly mobile and are very wide-ranging. The vessels go all around Australia and occasionally to neighbouring countries such as Papua New Guinea and New Zealand. However, as they rarely visit ports, or utilise other nodes with the exception of slipways or dry docks, they are unlikely to carry pests from node to node and are more likely to voyage from a port to offshore waters where marine pests are far less likely to establish populations. As they travel at high speeds (20 knots for Bay Class vessels) organisms are also likely to be dislodged.

Examples

There are no specific examples demonstrating the spread of marine pests by this vector.

Risk assessment

Results

Entrainment	Translocation	Overall Rank
18	**10**	**19**

This sector was ranked low risk overall (19). Entrainment risk was ranked very low (18) because ACVs spend very little time stationary in ports and substantial amounts of time in offshore waters. Although they travel around the whole country into many marine environments, translocation risk was ranked as medium (10), as there are very few of them (see Appendix 1).

Gaps and Uncertainties

ACVs are constantly on patrol and have no fixed schedule of visits to ports or anchorages. It was therefore difficult to assess many of the translocation risk factors. Furthermore, Customs supplied only limited information about their activities.

Management Approaches

Existing

Customs is aware of the issue of marine pests (E Kennedy *pers. comm.* 2003) but they do not have their own practices in place to reduce the chance of marine pest translocation. However, as mentioned above, these vessels are constantly mobile and slipped and antifouled annually, thus minimising the risk of fouling. In addition, this sector complies with Black Striped Mussel Control requirements when entering Darwin, thus their hulls, pipe outlets, rudders and keel are inspected by divers. Customs launches are Australian Government vessels so they are not subject to the same regulations as commercial vessels.

Proposed

As ACVs were ranked low risk, an education and awareness campaign would be a sufficient management approach for this sector. However, Customs officers could play a role in surveillance and emergency response if they are trained in the identification of marine pests and briefed on the issues surrounding an incursion event. This need only be an additional element to the professional training they already undertake. As ACVs are very wide-ranging and Customs officers generally deal with vessels at their first port of call, they may be an important sector to utilise for surveillance of primary invasions of marine pests.

8. Defence vessels

Description of sector

The Australian Defence Force (ADF) has a large and diverse presence in the marine environment. The largest is, of course, the Royal Australian Navy (RAN), which currently maintains a fleet of at least 60 vessels. The RAN fleet comprises warships (see photo above), amphibious vessels (including six heavy landing craft), three transport vessels, two replenishment vessels, six submarines, fifteen patrol boats, six mine counter-measures vessels and six survey vessels. The RAN also operates the sail training vessel *Young Endeavour* (see Part I: Section 17). The Army also operates a number of watercraft, including fifteen landing craft. Table 3 lists some information on the types and numbers of different vessels in these two Services. The fleet is constantly being upgraded so this information will go out of date quickly.

VESSEL TYPE	NUMBER	VESSEL SIZE (LENGTH)
Frigates (ANZAC & Adelaide Classes)	14	8 x 118 m (ANZAC) 6 x 138 m (Adelaide)
Submarines	6	77 m
Patrol boats (Fremantle Class)	15	41 m
Mine Counter Measures	6	52 m
Amphibious support ships	3	2 x 160 m (Kanimbla) 1 x 126 m (Tobruk)
Heavy landing craft	6	44 m
Replenishment vessels	2	157 m (Success) 171 m (Westralia)
Hydrographic survey	6	2 x 71 m (Leeuwin) 4 x 35 m (Survey Motor Launch)
Sail training vessel	1	44 m
Landing Craft Medium (Army)	15	22.4 m
TOTAL	**59 (+)**	

Table 3: Royal Australian Navy and Army vessels. (Data sources: RAN and Army).

Note: This does not include the many inflatable boats and launches kept at shore establishments and onboard ships.

Defence vessels engage in a wide range of activities, from port visits to full-scale military operations. The majority of ADF vessel maritime activity occurs in and around the fleet bases (see Figure 19, Part II: Section 3) at:

- Darwin
- Cairns
- Garden Island (Sydney)
- Garden Island (near Fremantle, WA)
- Point Wilson ammunition depot (Vic.) (soon to be replaced by the new facility at Eden NSW)
- the Army Landing Craft base near Townsville.

Vessels may also visit the construction and maintenance facilities in Adelaide (SA), Newcastle (NSW), Cockburn Sound (WA) and Williamstown (Vic.). Table 4 outlines seven levels of activity and some typical actions that may take place at each level.

ACTIVITY LEVEL	ACTIONS
Maintenance	Vessel in port, dry dock or similar facility. May be incapable or partially capable of movement
Training	Vessel may move and practice navigation, weapons firing, and other drills and manoeuvres. Training activities for ADF vessels most frequently occur in designated Australian Maritime Exercise Areas around the coast. These are usually close to Fleet Bases to minimise transit-associated costs. The main training areas are: • south-east of Sydney • west of Perth • south of Adelaide • west of Darwin • Shoalwater Bay in south-east Queensland. Other smaller training areas are located around the coastline catering to specific requirements such as mine warfare or gunnery. Training is also necessarily conducted routinely during vessel transits and operations.
Replenishment/Ammunitioning	Visits to ports distant from home bases for replenishment or for embarking or disembarking ammunition
Routine transit	RAN vessels routinely transit between ports within Australia.
Public Relations	Visits to civilian ports, which may be some distance from the vessel's home port.
Exercises	Vessel practices operational procedures, often in conjunction with other vessels and other Services, may involve weapons firing.

Operations	• Hydrographic surveys; • Border protection patrols; • Search and Rescue (SAR); and • Participation in multinational operations

Table 4: Defence Force vessel activities.

The RAN is supported by Defence Maritime Services (DMS), a company formed by P&O Maritime Services and Serco Asia-Pacific Pty Ltd to provide training, logistic and non-combat services. DMS operates a fleet of over 120 vessels of many different types, distributed across each of the state capitals and Cairns (Table 5). Although it is a private company, it has been included with Defence vessels for two reasons, the first being that the services it provides are dedicated to supporting the RAN and secondly, many of these vessels were, until recently, operated by the RAN itself. DMS also offers services under contract to external agencies and foreign navies, notably in provision of tugs and port services support. Services provided to the RAN include:

- Tug support and target services eg towing targets
- Submarine trials and support services, including rescue ship operations
- Diving support and training
- General harbour services, including supply and operation of ferries and workboats
- Training services, eg in navigation, hydrography and Reserves training
- Consorts for nuclear ship visits
- Management of naval moorings
- Fuel, explosives and ammunition supply services
- Maintenance and management of all RAN ship's boats (DMS 2003).

VESSEL TYPE[1]	SIZE (LENGTH)	NUMBER
Multi-purpose support vessels	72 m	2
Training vessels	41.7m, 32.5 m	2
Lighters	18 - 39 m	10 (+)
Torpedo recovery vessels	27 m	3
Tugs	15 – 25 m	7
Diving support vessels	20 m 5 m	4 launches 2 (+) boats

Landing craft	13 – 16 m	5
Admirals' barges[2]	11 m, 12 m	2
Launches (general harbour services)	c. 12 – 13 m	48
Hydrographic survey launches	9 – 10 m	9
Towed targets	6.4 m	8 (+)
Recreational vessels	20 m 11 m 6 m 4.25 m	1 sail training ketch 5 yachts 6 fast runabouts 6 (+) dinghies
TOTAL		**120**

Table 5: Defence Maritime Services vessels. (Data source: Defence Maritime Services).

Note. This list includes all vessels that are kept permanently in the water. It does not include the plethora of rigid-hulled inflatable boats, general-purpose inflatable boats and light utility boats kept at shore establishments and on board ships.

[1]Most of these vessels are multi-purpose and are used for a variety of tasks depending on the vessel characteristics.

[2]A launch used for ceremonial purposes, particularly ferrying high-ranking naval officers to and from warships in port.

Issues associated with sector

Entrainment

There are a number of entrainment risks associated with ADF vessels. These include:

- Vessels remaining inactive in port for long periods.
- Navy vessels contain saltwater cooling and fire-fighting systems for damage control and provision of cooling for engines, sensors and air-conditioning systems. These present biofouling risks.
- Some Navy vessels utilise ballast water for management of stability and trim. Ballast water can be embarked in specialised tanks, or used to flood empty fuel tanks.
- The retrieval of equipment that has been left *in situ* for long periods, either on or attached to the seabed, accumulating biofouling, eg acoustic monitoring equipment and moorings. When such equipment is brought aboard a Defence vessel, pest organisms may come with it unless the equipment is thoroughly cleaned.
- Activities involving close interaction with poorly maintained foreign vessels such as SIEVs, especially where such vessels are detained for lengthy periods near an ADF base.

Translocation

This sector is involved in a huge range of activities, some of which are very wide-ranging. Defence force vessels often operate or conduct exercises in remote locations before returning to home ports. Navy vessels also often make visits to other ports; these are highly sought after by port cities in the same way as visits by cruise ships are. There were a total of 563 visits to Australian ports by Navy vessels in 2001/02 (Figure 9) compared with the 196 visits made by cruise ships in the same period (AAPMA 2003). Navy vessels may therefore translocate pests between ports, from ports to naval bases or vice-versa and from either of these to locations offshore.

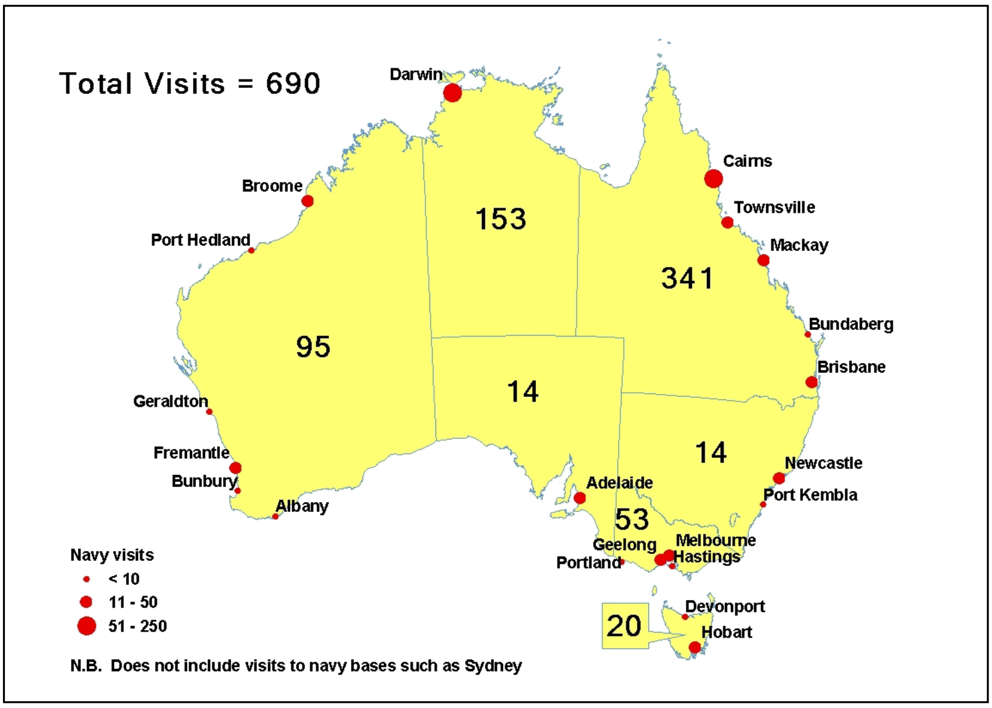


Figure 9: Numbers of navy ship visits to Australian ports 2000-01. (Data source: AAPMA).

Note. Visit data for ports such as Darwin, Cairns, Townsville, Mackay, Brisbane, Fremantle and Hobart are biased toward foreign warship visits. The RAN may facilitate such visits but their management is the responsibility of the Australian Government and the government of the sovereign power concerned.

Risk assessment

Results

Entrainment	Translocation	Overall Rank
16	**5**	**8**

Overall risk was ranked relatively high (8), largely due to the fact that translocation factors were ranked high (5). This is because Defence vessels are used constantly in all parts of the country and in both inshore and offshore waters. The risk assessment is based on the entire fleet of ADF and DMS vessels. As a consequence it is highly generalised. A working group set up by the Department of Defence is planning to conduct a risk assessment on individual classes of vessels within the ADF, using the technique developed during this project, in order to identify particularly high risk sectors. Such an approach is likely to be much more useful.

Gaps and Uncertainties

Information about Defence activities is necessarily confidential so there are bound to be gaps in our knowledge of vessel numbers, characteristics and activities. Furthermore, this sector is very heterogeneous and some vessel class activities are better understood than others. Gathering detailed information about the whole sector was beyond the scope of this study. The exact role of Defence Maritime Services and the status of vessels acquired from the RAN are also unclear.

Management Approaches

Existing

The Department of Defence ("Defence") strongly supports management of threats posed by marine pests and has initiated responses to risks posed by ADF vessels as described in the Defence Environmental Policy:

- Defence has developed management, prevention and, when needed, response actions to marine pest infestations and incursions.
- The RAN has commenced training and awareness programmes for all ships' command teams. There is also a high awareness of marine pests within Defence generally and procedures are in place to ensure a rapid response if a threat is recognised.
- The RAN, through the Defence Science and Technology Organisation (DSTO), has supported a comprehensive program of research on antifouling performance and efficacy.
- The RAN has an active monitoring program to assess potential marine pest risks across the fleet, through mandatory hull and plumbing system inspections and sampling.
- A commissioned report has been delivered to Defence on the management of biofouling and fouling control coatings on submarines and other fleet elements at

Fleet Base West, near Perth. This report is the basis for developing national guidelines for Defence vessels.

- Fouling monitoring studies are soon to commence beneath wharves at both Fleet Base East (Garden Island, Sydney) and Fleet Base West (HMAS Stirling, Garden Island, near Fremantle).
- A Defence Biofouling Working Group has been established to address IMP issues and operational risks of biofouling.
- Trials of systems to prevent marine growth in seawater systems are underway on RAN ships.
- Defence is an active member of the National Introduced Marine Pests Coordination Group (NIMPCG), including their Biofouling Working Group.
- DSTO have Navy-sponsored programs on biofouling control and potential marine pest issues and a research program investigating innovative methods for biofouling control on surfaces and in pipe-work.

(Compiled from information supplied by J Lewis and S Cole *pers. comm.* 2003)

Proposed

Additional training is recommended, targeting the crews of vessels with the potential to translocate marine pests, including training on the identification of IMP and the development of best practice to avoid entrainment and translocation.

9. Dredges

Description of sector

Dredges are flat-bottomed, steel-hulled vessels specially constructed to excavate the seabed (see photo above). Typical dredge operations include: maintenance of shipping channels, excavation of sand bars, beach replenishment, marine construction and pipeline laying. There are various types of dredges used for different purposes. The two most common types are the grab bucket dredge and the suction dredge. Grab bucket dredges operate in a similar manner to bulldozers. A grab bucket is lowered from a floating dredge to the seabed and closes on contact with the substrate. Sediment is brought up and loaded into a hopper (see Glossary) and the water from this material drains through filters into a well, from which water is pumped overboard at regular intervals. The dredge spoil can be either dumped directly from underneath the vessel by opening doors in the hopper or can be pumped out either through a pipe or with a jet. Suction dredges act like underwater vacuum cleaners, sucking material from the seabed into the dredge. Mechanical loosening of the substrate using a cutterhead at the suction mouth (a cutter suction dredge) can enhance the action of the suction dredge. The main difference between the two types of dredging is that removal of large materials such as rock and debris is not possible with a suction dredge. It slurries the sediments in the water, whilst during grab dredging, the sediment remains close to its original state.

There are several dredging companies in Australia and dredging operations are quite widespread; one company lists over 60 dredging operations over the past 30 years, mainly in Queensland and New South Wales. The Australian Register of Shipping (ARS) lists 18 Australian-registered dredges; these vessels have a mean length of 47 m and a maximum length of 84 m. The largest vessel the "*Brisbane*" undertakes lengthy domestic voyages as it annually services Queensland ports (ie Brisbane to Karumba) and works in Eden (NSW) and Devonport (Tas.).

Issues associated with sector

Entrainment

Dredges, by their very definition, are equipped with gear that is in almost continuous contact with the seabed, usually in inshore, shallow marine environments, and often around ports. It is therefore possible that they may suck or grab benthic marine pests off the seabed. Gratings, or other exclusion devices, are unlikely to prevent any but the largest organisms from being entrained. They do not use ballast water but these vessels may become fouled on the hull and other submerged spaces, particularly as they spend much time in and around ports and shipping channels. Marine pests are more likely to be entrained by a grab dredge, where they could find refuge in the water-filled hopper. Species of particular concern include cyst-forming dinoflagellates and infaunal invertebrates. However, it is not known to what extent they can survive the dredging process or dump site environments (Environment Australia 2002).

Translocation

Most dredging operations are carried out by chartered dredges that move around regularly from one locality to another. Dredges may therefore translocate IMP from one job to the next, either as fouling on the vessels themselves or as part of the dredge 'spoil' (the material excavated when dredging). However, dredges are often cleaned and maintained between jobs (A Jackson *pers. comm*. 2003) and dredge spoil is generally not moved very far from the site of dredging operations, thus minimising translocation potential. Nonetheless, both spoil dumps and dredge sites are areas of disturbance and are therefore more susceptible to colonisation by IMP. It may also be possible for pests inside the hopper to be deposited in a new environment along with the water that overflows as the hopper is filled or moved.

Examples

- In 1993, the dredge, *Kingfisher*, was found in Bunbury Harbour to be carrying many worms matching the description of *S.spallanzanii* on its hull. This dredge has often been towed between Cockburn Sound and other ports (Clapin & Evans 1995). Consequently, it is thought that dredges have been a major factor in spreading the European fanworm (*Sabella spallanzanii*) down the Western Australian coastline as biofouling (Cappo et al. 1998).
- Evidence from the US shows dredging activities have distributed exotic species from the point of introduction (Robinson & Wellborn 1998; Rosenfield & Mann 1992 *cited in* Environment Australia 2002).

Risk assessment

Results

Entrainment	Translocation	Overall Rank
1	**18**	**2**

Dredges were ranked highest of all the sectors for entrainment risk (1) because they interact constantly with the seabed and spend all their time in coastal waters. They are also rich in refugia among the pumps, piping and hoppers and at risk of heavy biofouling because they work constantly in shallow, productive inshore waters travelling at slow speeds. They were ranked relatively low for translocation risk (18), due to the small number of vessels in the sector (see Appendix 1) and the high port fidelity of some dredges. Overall, dredges were ranked second highest (2) of all the sectors in terms of secondary invasion risk.

Gaps and Uncertainties

This sector does not a have a peak industry body in Australia, making it difficult to obtain operational information for the sector as a whole. Given the high risk assessment for dredges, more research is warranted.

Management approaches

Existing

Responsibility for regulating dredging operations and the disposal of dredge spoil in coastal waters lies with state and territory governments (Environment Australia 2002). However, the Australian Government's responsibilities under the *EPBC Act 1999* include provisions for dealing with invasive species.[5] Consequently, the Department of Environment and Heritage (formerly Environment Australia) has developed a set of guidelines that provide a national framework for assessing the environmental impacts of the disposal of dredged material at sea, including the disposal of sediment that may contain exotic species (Environment Australia 2002).

The Victorian EPA has also issued a set of dredging guidelines (EPA 2001) that includes a section on Biological Contamination by Exotic Species (pp 18 – 19). The guidelines include the following points:

- An assessment of the likelihood of introductions from trailing suction hopper dredges should be undertaken well before the dredge leaves its previous dredging location. This assessment should consider the climatic similarity of the location of the previous dredging project compared to the new dredge location.
- The last few dredge loads in the previous location should be deep abiotic sediments from greater than 50 cm and preferably deeper. Surface sediments must be avoided.
- Hoppers should be cleaned as thoroughly as possible at the completion of the last dredging operation.
- Overseas vessels should be cleaned while outside coastal temperate Australian waters.
- Hoppers of vessels considered a risk should be inspected before dredging commences, and, for overseas vessels, preferably before they depart for Australian waters.

Proposed

National guidelines for the prevention of IMP translocation by dredges should be developed from the Victorian EPA guidelines described above, in association with vessel owners and/or through port (or channel) authorities. The International Association of Dredging Companies (http://www.iadc-dredging.com/index2.html) includes at least one company with operations in Australia (N.V. Baggerwerken Decloedt en Zoon) and should therefore also be consulted.

[5] For a detailed description of this issue, see Environment Australia 2002.

10. Ferries and water taxis

Description of sector

Ferries are vehicle- and passenger-carrying vessels with regular operating routes and schedules. Well known examples include the Sydney Harbour ferries used by commuters and tourists and the Bass Strait ferries (*Spirit of Tasmania I* and *II* (see photo above) and the *Devil Cat*) that run between Victoria and Tasmania. There are many others linking mainland Australia with its offshore islands, for example, Bruny and Maria Islands in Tasmania, Rottnest Island in Western Australia and Magnetic and Fraser Islands in Queensland. Ferry services operate a diverse array of vessels in terms of their size and type. These vary from the elderly, tug-like vessels used on Sydney harbour to modern, streamlined, high-speed catamarans (eg Brisbane River Cats). The ARS lists 145 vessels categorised as ferries[6] (Table 6).

Water taxis are generally small, high-speed passenger craft that operate in urban waterways such as Sydney Harbour. The name 'water taxi' is a slight misnomer, as their role is more commonly akin to that of a charter boat providing scenic tours for small groups, than strictly that of a taxi. Table 6 lists the number of water taxi operators per state in Australia. They appear to be limited exclusively to the east coast, particularly New South Wales and Queensland.

STATE	NO. FERRIES [1]	NO. WATER TAXI OPERATORS [2]
Queensland	59	15
New South Wales	40	30 (25 in Sydney)
Victoria	10	5
Tasmania	14	0
South Australia	3	0
Western Australia	17	0
Northern Territory	2	0
TOTAL	**145**	**45**

Table 6: Numbers of ferries and water taxis per state. (Data sources: [1]Australian Register of Shipping and [2]Yellow Pages®).

[6] This section excludes the slab-sided landing barges used to service remote communities in the Northern Territory, northern Queensland and the Torres Strait, which are discussed in Part I: Section 1.

Issues associated with sector

Entrainment

Typically, ferries operate between ferry terminals either within the environs of the same (eg Sydney Ferries) or a different port (eg the *Spirit of Tasmania*). In the latter case, ferries are much larger and may carry ballast water, of which small volumes may be exchanged, thus increasing the risk of IMP entrainment. Biofouling can accumulate when ferries remain stationary, which occurs between voyages and overnight. Most ferries operate on a daily basis but some operate many times a day. Coutts et al. (2003) estimate that the *Spirit of Tasmania* spends approximately 10 hours a day in port providing opportunity for fouling organisms to attach to the vessel. It is not likely that many ferries in Australia would spend longer than 10 - 12 hours in port however.

When not in port, ferries tend to be constantly on the move at relatively high speed (eg 18 knots) limiting opportunities for accumulating biofouling except in areas protected from strong laminar water flow such as sea chests and the undersides of bilge keels. There are not many other places for marine pests to find refuge as ropes are typically kept dry and anchors are not used. All ferries take time off their routes periodically for maintenance and refit.

Water taxis are small vessels more confined to shallow, sheltered waters. They may anchor while their clients are sightseeing and can spend periods of time stationary while waiting for work as they often rely on passing trade. They generally tie up to pontoons (see Part II: Section 9) or jetties whilst awaiting custom and these may be reservoirs of marine pests.

Translocation

Most ferries have high route fidelity so the risk of translocation is between one of two ports. However, ferries may share terminals with other ferries on different routes so there is potential for marine pests to spread through a network of ferry routes to different localities. Ferries potentially pose the highest risk of spreading marine pests from the mainland to offshore islands, many of which have high conservation significance. Water taxis have limited range, usually within one waterway so translocations will be short range.

Examples

- A large fouling community of sabellid polychaetes (a form of marine worm) was found on the passenger ferry *Spirit of Tasmania* during a survey in the late 1990s but the genus *Sabella* itself was not found (C Sliwa pers. comm. 2003). The *Spirit of Tasmania* is not, however, the only vessel that plies regularly between Melbourne & Devonport; there is also a daily freight service. The establishment of *Sabella* in Devonport cannot therefore be attributed to the *Spirit of Tasmania* alone.

- A survey of sea chests in the hull of the *Spirit of Tasmania* in 1997 revealed the presence of a number of introduced marine pests including European clams (*Corbula gibba*) and European green crabs (*Carcinus maenas*) (Coutts et al. 2003).

Risk assessment

Results

Entrainment	Translocation	Overall Rank
9	**9**	**7**

Ferries and water taxis were ranked moderately high for both entrainment (9) and translocation (9) risk and moderately high risk overall (7). They are in very frequent use and ferry terminals are often situated with the environs of a port. However they have high port fidelity and are therefore not very promiscuous and, on the whole, make short voyages.

Gaps and Uncertainties

The heterogeneity of this sector presented difficulties when assessing risk. For example, water taxis are quite different in design and operations from ferries but the two sectors were assessed as one. Furthermore, the Bass Strait ferries operating between Melbourne and Tasmania have different characteristics to the ferries on Sydney Harbour for example.

Management Approaches

Existing

There are currently no mandatory or voluntary protocols in place to minimise the translocation of marine pests through biofouling from domestic sources. However, ferry operators do inadvertently protect their vessels from spreading marine pests through their regular cleaning and maintenance regime. For example, Sydney Ferries have their own policy of cleaning the underwater hull area of JetCats whilst they are afloat (Waterways 2001). Hulls are scrubbed by divers at approximately six weekly intervals. The vessels are dry docked annually at which time the underwater hull coatings are also refurbished. In the future, Sydney Ferries aims to send the vessels to dry dock more frequently than once per year. The motivation for this, however, is to maintain the efficiency of the antifouling coatings and so decrease fuel consumption, rather than to minimise the spread of marine pests.

Proposed

Given the limited number of ferry operators in Australia, it would be plausible to approach each individually and develop voluntary guidelines to minimise the translocation of marine pests. Ferry operators could be encouraged to send their vessels to dry dock more frequently (similar to the JetCats described above). This should be done in conjunction with an education campaign. The development of the National System for the Prevention and Management of Marine Pest Incursions will extend the development of the BWDSS to domestic voyages by vessels carrying ballast water. It is assumed that the Bass Strait ferries, which carry ballast water, will come within the jurisdiction of this system.

11. Fisheries Patrol Boats

Description of sector

Fisheries patrol boats (see photo on right), manned by enforcement officers from a variety of state and Australian Government agencies, are used to carry out fisheries monitoring and compliance activities in Australian waters. These activities include: advising the general community of fishing rules and restrictions, enforcing fisheries regulations and promoting conservation of fisheries resources. Fisheries officers check fishing licences and make sure recreational anglers are complying with bag and size limits and using legal fishing equipment. They also carry out surveillance of commercial fishing operations to ensure fishers are complying with the conditions of their licence, and their catch, equipment and vessels are legal.

Fisheries officers use a range of different vessels to carry out their duties. The exact number of vessels in this sector is difficult to quantify, however, as fisheries compliance is undertaken by a number of different government agencies, depending on the State and circumstance. For example, Australian Government-managed fisheries compliance in inshore waters is primarily undertaken by state fisheries agencies, but work that is further offshore and in remote areas is carried out by Customs, Defence and private companies such as P&O Maritime. These arrangements are necessary because AFMA does not have its own patrol vessels. In some states, fisheries patrols are not carried out by officers of the fisheries department. In Tasmania, for example, the Water Police carry out this function. In other states (eg NT), vessels are shared between the fisheries, police and search and rescue organisations. Taking these factors into account, it has been estimated that there are around 200 vessels that are used solely as fisheries patrol boats (Table 7). Western Australia has a significantly lower number of vessels (3) compared with the eastern states, for example, Queensland (92) and New South Wales (~60) (Table 7).

Most fisheries patrol vessels are small craft less than 10 m in length, but some of the vessels used for monitoring Australian Government-managed fisheries or patrolling long stretches of coastline can be up to 20 m in length. An exception to this is the MV *Southern Supporter*, based in Fremantle, which is owned by P&O Maritime and chartered by AFMA and Customs to patrol the Southern Ocean for illegal fishing. This vessel is 75 m in length and carries ballast water for stability. Most of the larger fisheries patrol vessels are kept in the water, tied up to wharves, whereas the smaller vessels are removed from the water and kept on trailers.

STATE	NO. OF BOATS
Queensland	92
New South Wales	60*
Victoria	15*
Tasmania	NA
South Australia	25
Western Australia	3
Northern Territory	8**
TOTAL	**~ 203**

Table 7: Number of fisheries patrol boats per state. (Data sources: State fisheries departments).

*Estimated only.

** To avoid duplication, the *Arnhem* (7m) has been included in the Water Police section of this report (Part I: Section 19), although this vessel is used for both fisheries enforcement and general policing purposes.

Issues associated with sector

Entrainment

Most fisheries compliance work is undertaken in coastal waters where marine pests are most likely to occur. Fisheries patrol boats that are operated by the states do not take up ballast water so biofouling remains the major risk for entrainment. However, there are a number of mitigating factors that reduce entrainment potential. Firstly, smaller patrol boats are trailered and stored out of the water, thus reducing the accumulation of biofouling and second, fisheries officers are very aware of marine pest issues, as they, or the agencies they work for, are often involved in either dealing with incursions or disseminating information about them to the public. Their boat cleaning practices are therefore of a high standard. In New South Wales, for example, smaller boats are washed down thoroughly when removed from the water and vessels that remain in the water are taken out and cleaned on a weekly basis (A Mclean *pers. comm*. 2003).

The MV *Southern Supporter* does carry ballast water and is berthed in a commercial trading port and therefore presents additional entrainment risks. However, risks are minimised through the requirement that operators comply with the ballast water management plan on board the vessel. This vessel is dry-docked for cleaning and maintenance on average every five years (R Burgess *pers. comm*. 2003), which is relatively infrequent, therefore biofouling accumulation may be significant.

Translocation

Fisheries patrol boats typically operate solely within their own state waters and nearby Australian Government-managed waters so IMP translocations will generally be intrastate rather than interstate. However, these vessels may visit a number of other nodes such as marinas, fishing harbours, boat ramps and anchorages before returning to base. In some states, fisheries patrol stations are regionalised thus limiting translocation distances because patrol areas are smaller. For example, in Queensland there are 19 coastal patrol stations distributed throughout the state. However, in Western Australia, three vessels patrol the entire coastline so each vessel must travel further from its home base, permitting longer-range translocations.

As the S*outhern Supporter* is used for several functions other than fisheries patrol work (eg lighthouse maintenance and research) it can be operating for up to 75% of the year in a wide variety of localities. It is designed for offshore work and undertakes many long-distance voyages. It also regularly travels to environmentally sensitive areas such as Heard Island and the Great Barrier Reef (R Burgess *pers. comm.*2003). It therefore has the potential to effect long-range translocations to areas of high conservation significance.

Examples

There are no specific examples demonstrating the spread of marine pests by this vector.

Risk assessment

Results

Entrainment	Translocation	Overall Rank
20	**3**	**17**

The *Southern Supporter* was not included in the risk assessment for this sector as it has its own rather unique characteristics that would skew many of the risk factors (eg Range). The overall risk for fisheries patrol boats was low (17) as was the entrainment rank (20). This is because the majority of fisheries patrol boats are trailered and are also well maintained and kept clean. Translocation risk was ranked very high (3) because these vessels are utilised often and they voyage extensively through marine waters visiting both recreational and commercial fishing grounds.

Gaps and Uncertainties

Each state operates its own fisheries enforcement agency (and in some cases, responsibility is spread across several agencies) therefore consolidated information about the sector as a whole was not readily obtainable. Confidentiality considerations also contributed to a lack of complete knowledge about the movements and behaviour of this sector, and hence uncertainty in assessing risk.

Management Approaches

Existing

There are no formal regulations or guidelines relating to marine pests management in this sector, however, awareness levels are high because fisheries agencies are often involved in emergency response, and have led to voluntary arrangements such as routine vessel cleaning practices.

Proposed

This sector has been deemed relatively low risk. It is therefore suggested that they continue to uphold their good vessel cleaning practices and be encouraged to regularly inspect submerged or damp crevices and gear, including seawater systems, bilges and anchor wells and remove any attached or concealed organisms and dispose of them onshore. Furthermore, fisheries officers could serve a useful role in educating boat owners as they are out on the water a great deal and are in regular contact with recreational and commercial fishers. It is therefore recommended that marine pest identification be formally incorporated into existing training courses undertaken by fisheries officers, building on their high level of awareness.

12. Harbour Services Craft

Description of sector

There are three main types of craft that assist with commercial shipping operations in ports and harbours: pilot boats, tugs[7] and lines boats. Pilot boats are single-purpose vessels used for transporting pilots to and from ships to guide them into and out of port. They are typically about 15 m long, but may be up to about 20 m in length. With few exceptions, all ships over a certain length (eg Port of Hobart = 35 m) are required to engage a pilot. Pilot boats are therefore in constant use, ferrying pilots out to incoming vessels and retrieving them from departing vessels. The Port of Fremantle estimates that its three pilot boats effect about 4000 pilot transfers a year (Fremantle Ports 2003). In some of the smaller ports, eg Stanley in northern Tasmania, there is no pilot launch so other appropriate boats are chartered to transport pilots. A range of providers offers pilotage services, including private companies and government agencies. There are no consolidated records of the number of pilot boats in Australia. The Australian Marine Pilots Association (AMPA), however, estimates that there are about 80 pilot boats in operation around the country.

Tugs are typically multi-purpose vessels about 25 m, but up to 40 m, in length and having powerful engines (see photo above). They are used for manoeuvring large vessels in port, including freeing vessels that have become grounded, moving large non self-propelled objects such as cranes and for salvage operations. In 2001 - 02, of the approximately 25 000 ship calls to Australian ports (AAPMA 2002), about 75% (18 750) required towage services. Harbour towage services are provided at 51 Australian ports; tugs are based at 45 of these (Figure 10) (Productivity Commission 2002). There is considerable variety across these ports in terms of their requirements for tugs to assist vessels, usually as a consequence of the type of approach to the port (ie whether or not there is a channel), prevailing weather conditions (strong winds can make manoeuvring a large vessel difficult without tugs), tides, water depth, etc. Some large vessels may require up to four tugs for manoeuvring, while others may not require any. Many tugs are fitted out as emergency response craft to respond to fires, pollution spills or vessels running aground.

[7] (Ocean-going tugs, which move mobile drilling rigs, are covered in the section on Offshore Support Vessels (Part I: Section 14).

Lines boats are small craft, about 12 – 15 m in length, whose function is to carry mooring lines from ships to the wharves to which they are to be tied up. Most of the large ports seem to have lines boats, though they are usually operated by private enterprises, rather than by the port authorities themselves. There are some exceptions to this rule, such as the Port of Bunbury. Adsteam is the largest harbour services company in Australia and provides services such as tugs and lines boats in 30 ports. The number of lines boats is difficult to gauge, as they tend to be small, insignificant craft and are therefore not often explicitly quantified. Their function may also be undertaken by other vessels or by general purpose craft, not explicitly defined as lines boats. Research on ports around Australia would suggest that the smaller ports might have one or two lines boats and the large ports three or four. This suggests a total population of about 80.

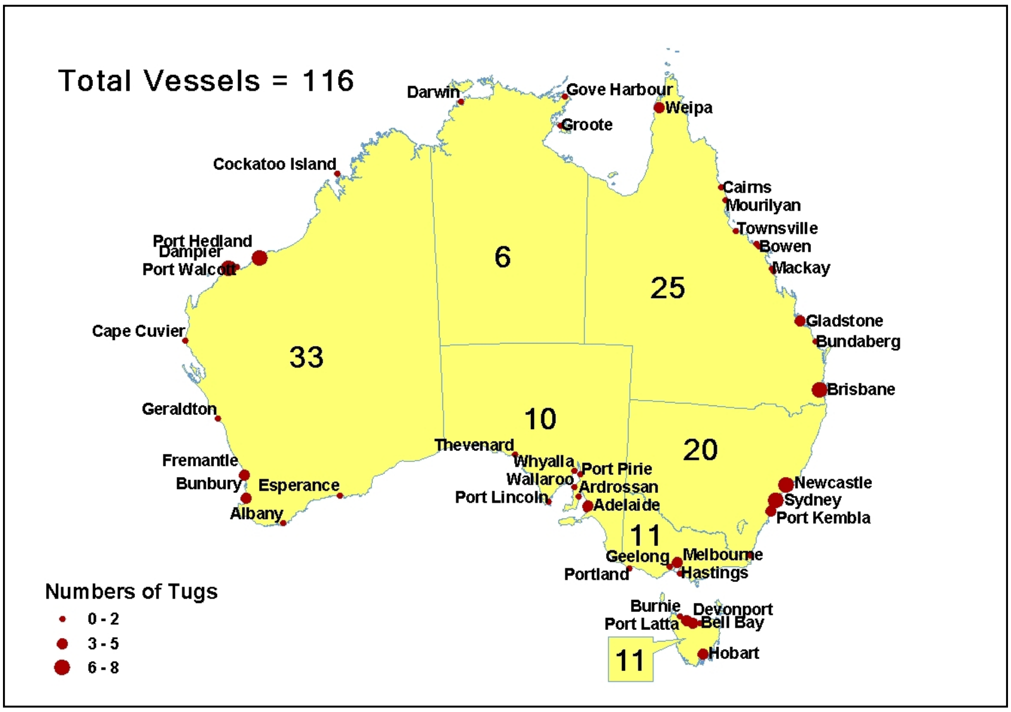


Figure 10: Distribution of tugs at Australian ports. (Data sources: Geoscience Australia; Productivity Commission).

Issues associated with sector

Entrainment

Harbour services craft, by definition, spend the majority of their time in and around commercial trading ports, coming into close contact with both foreign and domestic shipping, particularly, but not exclusively, merchant vessels (eg tugs and lines boats are often passed large diameter ropes from the vessels they manoeuvre). This offers opportunities for entrainment of IMP through biofouling or infection from other vessels.

Translocation

All three types of vessel tend to operate around their home ports. In some cases, a port authority has responsibility for a number of ports and/or localities and harbour services craft will be shared between these locations. For example, the Port of Hobart pilots provide pilotage services for Hobart itself, the D'Entrecasteaux Channel, Port Arthur and Spring Bay. This provides an opportunity for pests to be translocated from port to port or spread through their local area. IMP may also be transmitted from harbour services craft to cruise ships or trading vessels and so spread to another port on that vessel's itinerary.

Examples

There are no specific examples demonstrating the spread of marine pests by this vector.

Risk assessment

Results

Entrainment	Translocation	Overall Rank
3	**14**	**5**

Harbour services craft were ranked high risk overall (5) with entrainment risk ranked very high (3). This was primarily due to the large amounts of time vessels spend in ports, both operating and stationary, and the close contact they have with international merchant ships. This sector was ranked in the middle for translocation risk (14), as the vessels are in frequent use but do not travel over long distances.

Gaps and Uncertainties

This sector is heterogeneous because it includes three different types of vessel undertaking different activities. As a result, it was at times difficult to apply a whole-of-sector approach when assessing risk, particularly for translocation factors.

Management Approaches

Existing

The Australian Marine Pilots Association (AMPA) is aware of the potential for translocation of marine pests in ballast water (AMPA 2003) and the Association of Australian Ports and Marine Authorities (AAPMA) is also aware of the problems IMP pose. The front page of the AAPMA website has a prominent link to a series of pages developed by the IMO's GLOBALLAST Programme. A number of companies with an interest in port operations, such as Adsteam, the owner of the largest fleet of tugs in Australia, are members of the Australian Shipowners Association (ASA). ASA lists "Marine Pests – Ballast Water and Biofouling" among the key environmental issues for its members and discusses some international and national approaches to dealing with IMP.

Proposed

As this sector has been ranked as high risk, guidelines regarding antifouling frequency and inspection of vessels moving between ports, developed in association with AAPMA, AMPA and ASA, may be warranted. ASA is already involved in stakeholder consultations for the National System, and who should therefore provide a first point of contact, at least for the operators of tugs and possibly lines boats. AMPA would the point of contact for the operators of pilot boats. In addition, an educational/information brochure to alert skippers and crew to the risks of entrainment and translocation of IMP is recommended.

13. Mobile Drilling Rigs

Description of sector

The offshore petroleum industry employs large, semi-submerged and jack-up mobile drilling rigs to carry out exploratory drilling for offshore oil and gas reserves located beneath the seabed (see photo on right). These rigs are owned by multinational oil companies such as Diamond Offshore Drilling, for example, which has its headquarters in Houston, Texas and whose rigs have fulfilled contracts in six continents (Diamond Offshore Drilling 2003). This company owns three of the rigs that have operated in Australian waters recently. Mobile drilling rigs arrive in Australian waters from locations in South East Asia to operate in the major offshore oilfields on the North West Shelf (WA) and in Bass Strait. They occasionally show up in the gulfs of South Australia or the south coast of Western Australia, however (Figure 11).

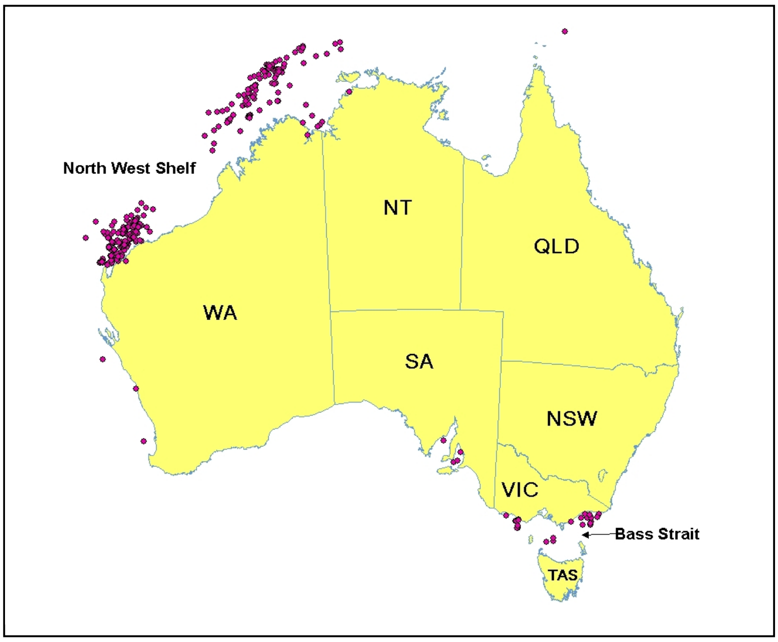


Figure 11: Position reports for all mobile drilling rigs in Australia between 1997 and 2002. (Data source: Notices to Mariners 1997 – 2002).

Over the period 1997 - 2002 between 9 and 15 rigs were active in Australia each year. The majority of these rigs appeared only once in our waters (Figure 12) but there are a few that have been back every year (eg ‘Ensco 56’ and ‘Sedco 702’) and these ones also tend to move most frequently between locations.

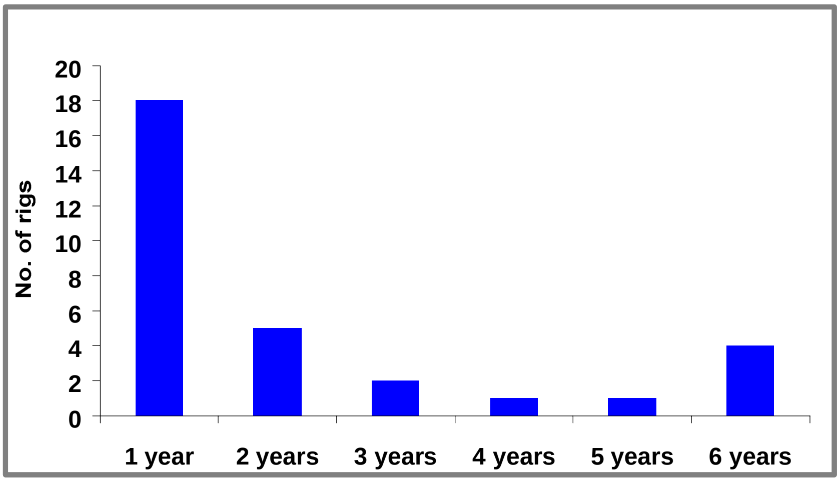


Figure 12: Frequency of operation of mobile drilling rigs in Australian waters. (Data source: Notices to Mariners 1997 – 2002).

Mobile drilling rigs, as their name implies, move back and forth between sites where they have been contracted to carry out drilling operations. They are towed between well locations by Anchor Handling Tug Supply vessels (AHTS) (see Part I: Section 14), at speeds of around two knots. When contracts in Australia conclude, they depart for countries such as New Zealand or Singapore. An example of the pattern of movement of an individual rig in 2002 is shown in Figure 13.

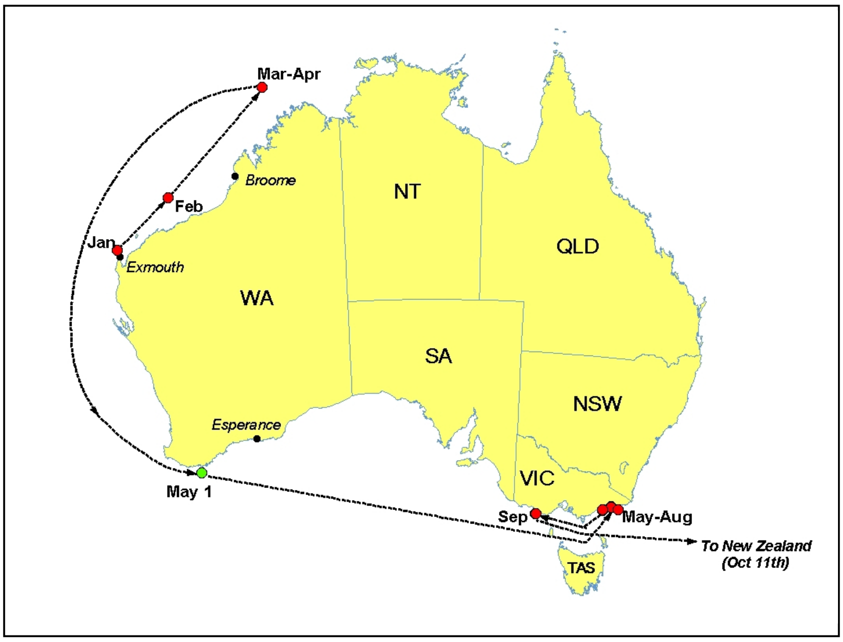


Figure 13: Movements of oil rig 'Ocean Bounty' in 2002. (Data source: Notices to Mariners 1997 – 2002).

Issues associated with sector

Entrainment

There are a number of conflicting factors to be considered in assessing the entrainment potential of mobile drilling rigs. They are very large, semi-submerged structures (eg hull dimensions of Ocean Bounty = 112 m x 81 m x 39 m or ~ 350 000 cubic meters), thus offering a large surface area for fouling and a multiplicity of low-flow, fluid-filled spaces in which larger or more mobile pests could remain lodged during transit between locations. Development of fouling communities on offshore oil platforms can be very extensive (Minerals Management Service 2003).

Mobile drilling rigs are also moored to the seabed by a minimum of eight anchors, each at the end of thousands of metres of chain (J Homsey *pers. comm*. 2003), providing adequate submerged substrate for pest organisms to colonise. However, they are generally not found in port environments, where a marine pest might be picked up, except infrequently. They may potentially, however, entrain pests from offshore support vessels, particularly AHTS, with which they are in regular contact and which often operate out of major trading ports such as Dampier (see Part I: Section 14).

Translocation

Mobile drilling rigs are very wide-ranging and undertake both short and long voyages between drilling locations. They provide ideal pest translocation conditions because of their slow towing speeds (typically around 2 knots). They could therefore be responsible for transferring pest species over long distances very rapidly. They may also transfer marine pests to the offshore support vessels that service them – particularly the tugs involved in anchor handling that tow them between locations and, in turn, enter ports.

Examples

There are no specific examples demonstrating the spread of marine pests by this vector.

Risk assessment

Results

Entrainment	Translocation	Overall Rank
4	**16**	**6**

Mobile drilling rigs were ranked as high risk overall (6). Entrainment risk was ranked very high (4), indicating that it was the major factor contributing to overall risk. This was largely due to the fact that they are in constant contact with the seabed, as well as the substantial quantities of suitable habitat oil rigs offer for attachment and refuge of marine pests. Translocation risk was ranked as medium (16) due to the small number of rigs in Australia (see Appendix 1) and the fact that, while on occasion they undertake very long voyages, most movements are short-range.

Gaps and Uncertainties

Mobile drilling rigs have somewhat unique characteristics as they are items of infrastructure rather than vessels *per se* and this presented difficulties in fitting them in with the definitions of translocation factors. Very little is understood about how often and under what circumstances they visit ports, where and when maintenance work is carried out, how frequently they are stacked ashore etc. This information was difficult to obtain, as mobile drilling rigs are invariably owned and operated by multinational companies based overseas.

Management Approaches

Existing

Diamond Offshore Drilling has an environmental policy that commits to “protecting the environment” but deals largely with pollution and waste management and makes no mention of marine pests.

Proposed

This sector has been somewhat overlooked so far and needs to be formally assessed for its quarantine risk. There is currently a proposal by DAFF and AQIS to set up a working group to investigate the activities of the sector, in particular, maintenance schedules, port visits and the risks of cross-infection between mobile drilling rigs and offshore support vessels. In the interim, promoting and encouraging the voluntary adoption of best management practice, developed in consultation with relevant industry bodies such as APPEA, is recommended for this sector.

14. Offshore Support Vessels

Description of sector

Up until the mid-1950s, vessels such as converted fishing vessels or tugs transported people and supplies to offshore drilling units. As oil rigs increased in size and began to operate in deeper waters, special purpose support vessels emerged. Now, offshore support vessels (OSVs) are large and highly specialised craft. They assist in the construction and maintenance of oil and gas drilling and production facilities and they transport food, stores, personnel and equipment to oil platforms, mobile drilling rigs and seismic survey ships. More than 3 250 vessels ranging in length between 60 and 80 m operate in the industry worldwide and the fleet is classified into 19 discrete types. There are two types of vessel that dominate, with Platform Supply Vessels (PSVs) and Anchor Handling Tug Supply Vessels (AHTS) constituting 54% of the total offshore fleet (Swire Pacific Offshore 2003).

PSVs are specifically designed for the transport of materials to and from offshore installations, mainly to supply fields in production. This involves the transport of individual items, usually in containers on deck, and a variety of liquid products such as methanol, pre-blended drill fluids, brine, water and oil in tanks below the deck. Dry bulk cargo such as cement, barite and bentonite are also transported in tanks. Many of the larger PSVs are occasionally used to transport pipes for pipe-laying activities. AHTS perform the same functions as PSVs but are equipped with more powerful engines and a deck-mounted winch, giving them the added capability to perform general towing duties, buoy-setting and anchor-handling work. They are used primarily to tow, position and support mobile drilling rigs (see Part I: Section 13). AHTS are also equipped for fire fighting, rescue operations and oil recovery.

Over the past year, there have been about 30 offshore support vessels operating in Australian waters (S Pullen *pers. comm.* 2003). Three multinational companies own most of these vessels meaning they often fly a foreign flag. The vessels are based and operate out of the port closest to the project they are supporting. As shown in Figure 14, vessels are predominantly based in Dampier and Darwin. Barry Beach is however the major base port for the Bass Strait oil and gas fields. Some OSVs have been operating out of these ports for up to 10 years while others only remain in the country for 30 days.

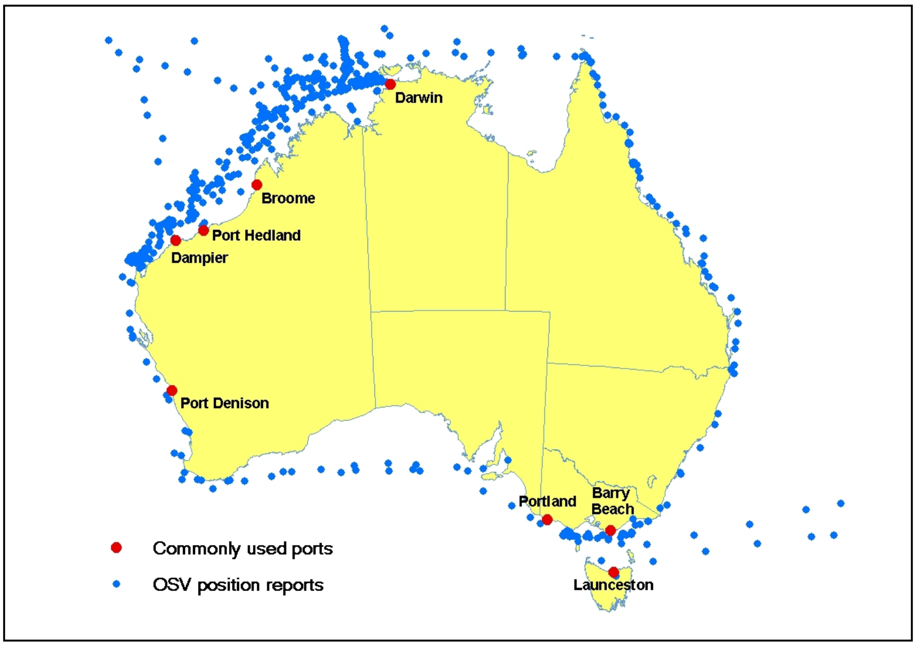


Figure 14: Position reports for OSVs in Australian waters in 2001. The data represents approximately 30 vessels, some of which are international visitors and some are based in Australia. Locations of commonly used ports are also represented. (Data source: AMSA 2003).

Issues associated with sector

Entrainment

Offshore support vessels operate 24 hours a day, moving around between platforms or voyaging to and from port loading and unloading cargo. It has been estimated that support vessels operated by Farstad Shipping spend approximately 10% of their time in port (J Homsey *pers. comm.* 2003), thus minimising the potential for entraining a pest in port through biofouling. For the majority of the time, OSV are on the move in open water, where the potential for entraining a marine pest is low. When offshore support vessels do return to their base port to pick up supplies and re-fuel, they typically leave again within 24 hours.

Offshore support vessels do, however, operate for much of their time in close proximity to structures that are considered essentially to be artificial reefs (Aebel et al. 1997). There is therefore the potential for an offshore support vessel to be infected with IMP that are attached to or associated with mobile drilling rig (see Part I: Section 13). These risks may be higher for OSV undertaking anchor-handling activities (AHTS) if IMP are entangled around anchor chains and warps.

As shown in the photo above, support vessels are designed with low gunwales and sterns. This allows water to splash onto the deck more easily. Coupled with the large amounts of equipment on deck, offshore support vessels may provide wet refugia for marine pests. OSVs carry ballast water for trimming purposes and, at present, there are no requirements for vessels to manage ballast water on domestic voyages (unless entering Western Port).

Translocation

OSVs can potentially translocate IMP from a port to an installation or between installations. They have high port fidelity and are therefore less likely to transport pests from port to port. If a marine pest were entrained in port, it would need to survive the trip offshore. These vessels travel at speeds of around 10 knots, which is relatively slow, so it is likely that marine pests would remain lodged on the vessel at this speed. As installations provide ideal habitat for settlement and attachment, a support vessel could also transfer an IMP from rig to rig or from a rig back to base port. If the latter occurs and a population of the pest species becomes established in the port, other vessels that use that port such as fishing boats and merchant ships may subsequently become infected.

Examples

There are no specific examples demonstrating the spread of marine pests by this vector.

Risk assessment

Results

Entrainment	Translocation	Overall Rank
7	**2**	**3**

Offshore support vessels were ranked very high risk overall (3) as a result of scoring high on both entrainment (7) and translocation (2) factors. They are constantly mobile, travel over relatively long distances and often operate out of major commercial trading ports that are used by both domestic and international merchant ships. They are also relatively large vessels and offer a number of refugia to marine pests.

Gaps and Uncertainties

Comprehensive information on the operations of offshore support vessels was received from Farstad Shipping; however, it is not known how accurately this can be extrapolated to the sector as a whole. In addition, little is known about the management of ballast water that is used by these vessels for trimming purposes.

Management Approaches

Existing

Offshore support vessels must be surveyed twice in a five-year cycle for hull maintenance (and annual renewal for other parts). At the end of the cycle, they must be sent to dry dock and antifouled. As it is important for these vessels to remain fuel efficient, operators typically send their vessels to dry dock more regularly (eg 30-month intervals). In the interim, antifouling paint minimises the accumulation of biofouling. Under the IMO's International Safety Management (ISM) Code 2002, companies are required to develop, implement and maintain a Safety Management System (SMS), which includes the following requirements:

- a safety and environmental protection policy
- instructions and procedures to ensure safe operation of ships and **protection of the environment** in compliance with relevant international and flag-State legislation.

As the onus is on the company that owns the vessel to develop its own policies, it is therefore the company's decision whether measures to minimise the translocation of marine pests are included under the umbrella of "environmental protection". This could differ substantially between companies depending on their level of awareness. They must, however, ensure that their policies meet Australia's requirements for managing marine pests. Ships' officers (Captain and mates) are aware of these requirements because they are covered during the mandatory training they undertake as part of their professional certification. This training, however, has a focus on marine pest translocations on an international, rather than domestic, basis.

Proposed

The Australian Government could require that companies include marine pest management in their SMS Environmental Policies. Currently, they tend to be aimed at environmental pollution (eg Swire Pacific Offshore). Alternatively, Australia could develop a specific policy towards this sector, as it is not adequately dealt with under the proposed arrangements for commercial shipping under the National System. These arrangements are intended only to cover port-to-port voyages and do not include movements between ports and offshore rigs/installations. Such a policy could involve developing voluntary guidelines for maintaining particular standards of vessel cleanliness and education about domestic translocation issues. It may be necessary for this sector to work in conjunction with the petroleum industry, which own and maintain drilling rigs and production platforms.

15. Recreational vessels

Description of sector

This is a very large and diverse sector, comprising almost a million vessels (Figure 15) ranging from small wooden, plastic and fibreglass boats that are rowed or paddled (canoes, kayaks, dinghies) through open aluminium vessels powered by outboard motors ('tinnies') to large, offshore cruising yachts and luxury motor sailers. Three-quarters of these vessels (686 259) are based on the eastern seaboard in the states of Queensland, New South Wales and Victoria (Figure 15) and a large proportion of them are used for recreational fishing. In recent surveys (Queensland Transport 2002, MAST 2002) 85% and 79% respectively of all respondents identified recreational fishing as their main reason for boating. Summer, particularly on weekends and during school holidays, is the most popular recreational boating time (eg McGlennon & Kinloch 1997, MAST 2002) but there is significant activity all year round, particularly in northern Australia.

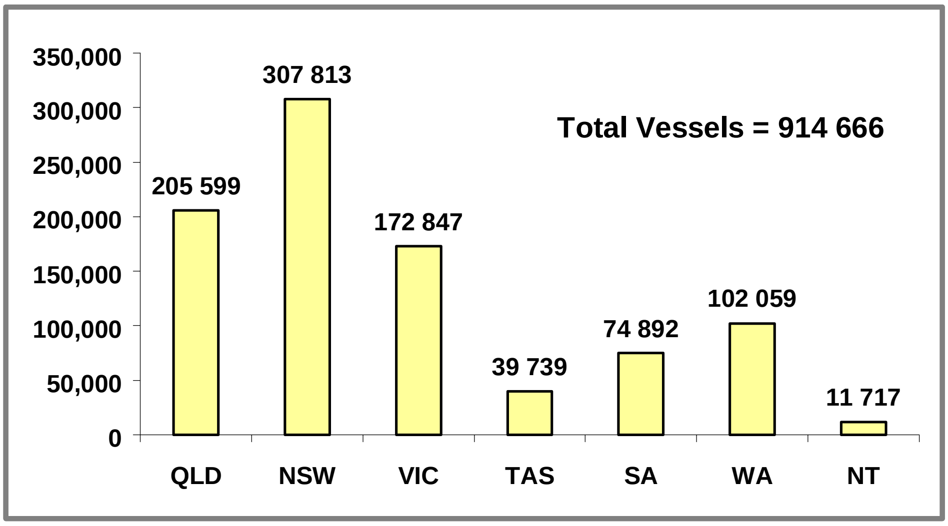


Figure 15: Number of recreational vessels per state/territory. Figures represent all sub-sectors discussed in the report. (Data source: Henry and Lyle 2003).

Translocation and entrainment risks vary substantially across the recreational sector, but generally increase with the size of the vessel, as larger vessels travel longer distances (increased range) to a greater array of destinations (higher degree of promiscuity) and provide both more surface area for attachment and a wider variety of refugia for concealment. Larger vessels are generally also kept in the water rather than stored on the hard. If vessels anchor, or are involved in recreational fishing, additional entrainment opportunities exist. Because of the diversity of vessel types in this sector, it has been divided into five sub-sectors for the purposes of discussion and assessment of risk.

15.1 Yachts

Description of sub-sector

A yacht is generally defined as a vessel with a fixed keel whose primary method of propulsion is sail. Yachts are usually also greater than 6 m in length; sailboats smaller than this tend to fall into the category of trailer sailers (see section 15.3 below). Yachts form a relatively small recreational sub-sector, comprising around 6% of all recreational vessels (MAST 2002, Queensland Transport 2002), but they are particularly prevalent in some states, like Tasmania and Queensland.

Yachts are predominantly used for leisure purposes, although some also compete in races or regattas. There are about 30 “blue water” races each year, of which the Sydney to Hobart is the best known. Generally, however, yachts cruise leisurely around the coastline at a safe distance offshore, visiting a number of destinations such as bays, harbours and islands where they remain for a few hours, days or weeks at a time. During these sojourns, they will drop anchor in a sheltered bay or harbour, tie up to a quay or pontoon, raft alongside other vessels in a marina or pick up a mooring. Yachts are generally privately owned but there is a thriving “bareboat” yacht charter industry operating in places such as the Whitsunday Islands (Qld), which provide ideal cruising grounds for novice sailors.

Issues associated with sub-sector

Entrainment

Largely because of their fixed keels, yachts are kept permanently in the water, either at anchor, on a mooring or berthed in a marina, except for occasional haul-outs for repainting or antifouling, which is often done over the winter or ‘off’ season. Yachts therefore are in constant contact with the water, often connected to the seabed via an anchor or mooring line or else rafted up alongside many other vessels in a marina, allowing fouling to accumulate on their hulls, rudders, mooring lines, anchor chains and in seawater pipes. Many yachts remain stationary in these environments for long periods between voyages. Furthermore, domestic yachts will also sometimes enter a port, or a marina situated within the environs of a port, making them susceptible to infection by IMP brought in by international trading vessels.

Yachts generally cruise and anchor in productive, inshore waters such as bays, estuaries and inlets, where marine organisms, including pests, are more densely distributed. Because they are relatively small craft with low gunwales, the topsides of yachts are often wet and this feature, combined with the plethora of cavities and deck gear associated with their design act to provide a variety of damp refugia for where pests may become trapped, eg anchor-wells, ropes, netting. Finally, some yachts are constructed of wood, so they may harbour pests in bilge water or the hull may be penetrated by wood-boring organisms.

Racing yachts, especially those in the 'Maxi' class, are, by contrast, kept clean of biofouling in order to maximise hydrodynamic efficiency. However, recent International Sailing Federation rulings now allow some race classes to carry up to eight tonnes (t) of ballast water. The Sailors with Disabilities round-Australia record attempt vessel, for example, carried 1.3 t of ballast water (Sailors with disABILITIES 2003). Nonetheless, these volumes are small in comparison with merchant ships, which carry in the order of tens to hundreds of thousands of tonnes.

Translocation

Yachts typically undertake long, slow voyages (cruises) comprised of several 'legs', interspersed with sojourns in anchorages or marinas. They are capable of covering considerable distances on a single cruise and may visit many varied and far-flung locations, including places not generally visited by other craft. They will also typically visit areas with significant environmental and visual amenity values such as coral reefs and pristine bays. Because of their nomadic habits, and their propensity to undertake long-range voyages, yachts have the potential to inoculate numerous locations on a single cruise and may translocate IMP interstate as well as intrastate. They may infect marinas, ports, slipways, moorings and anchorages (see Part II). However, a sizeable number of yachts are used almost exclusively for short day sails around their local bay and return directly to their point of origin.

Being predominantly sail-powered, yachts are limited to some extent by wind and sea conditions and will avoid exposed coastlines and a lee shore. They therefore tend not to be found in areas like the west coast of Tasmania, for example. Indeed, on the whole, “yachties” prefer parts of the coastline that are dotted with bays and islands, both for aesthetic reasons and for the safety that is provided by the availability of anchorages suitable in all weathers. Thus there are dense concentrations of yachts in the Whitsunday Islands (Qld) and on the south-east coast of Tasmania, for example. Most sailors also prefer to sail in clement weather – so summer is the preferred season for yachting. For the same reason, yachts are more prevalent in the warm tropics than in southern temperate climes – with the possible exception of Tasmania. There is therefore a greater risk of yachts spreading pests in warm, sheltered waters and around bays, islands and reefs.

Examples

- Anchors from cruising yachts have been linked to the spread of *Caulerpa taxifolia* around the Mediterranean (Meinesz et al. 2001). Yacht anchors have carried *C. taxifolia* from anchorage to anchorage and from harbour to harbour, sometimes over great distances (Yip 2001).
- The black striped mussel was almost certainly introduced to Darwin Harbour on the hull of an international cruising yacht (although this is a primary invasion) (Ferguson 2000).

Risk assessment

Results

Entrainment	Translocation	Overall Rank
14	**6**	**9**

Yachts were ranked as medium risk overall (9). Entrainment risk was ranked as moderate (14) whereas translocation risk was ranked relatively high (6) due to the large number of yachts (see Appendix 1) and their tendency to undertake long-range cruises. They are also fairly promiscuous, travelling between marinas, ports and anchorages.

Gaps and Uncertainties

It was difficult to generalise about this sub-sector, as vessels are in private ownership and voyage lengths and durations are likely to be highly variable, depending on the individual yacht owner and the size of the vessel. As with all recreational craft, no formal or aggregated records are kept of yacht movements or maintenance practices.

15.2 Motor Cruisers

Description of sub-sector

Motor cruisers are large, luxury recreational craft, typically constructed of fibreglass, with swept-back aerodynamic shapes and powerful engines - often inboard or twin outboard motors. They are commonly seen in places such as the inner reaches of Sydney harbour, along the Brisbane River and in the canals of the Gold Coast. This type of vessel is also used in places like Queensland for deep-sea game fishing for marlin and tuna. Their heavy fuel consumption generally restricts their movements to local areas.

Issues associated with sub-sector

Entrainment

Many motor cruisers are employed very infrequently, generally on summer weekends and holidays, and remain stationary for much of the rest of the year, allowing biofouling to steadily accumulate on submerged parts of the vessel. Moreover, huge numbers of motor cruisers reside in marinas, where water flow is restricted and vessels are concentrated, presenting the opportunity for cross-infection and heavy biofouling build-up (see Part II: Section 7). However, as they are expensive craft to purchase, their topsides are generally well maintained and their owners can afford to slip and antifoul them regularly. Larger motor cruisers with inboard engines can entrain pests in seawater plumbing systems. Those used for recreational or game fishing may entrain pests in fishing tackle, burley buckets, etc.

Translocation

Motor cruisers generally move only within a localised area and return to their home port – usually a marina or private jetty. They are capable of travelling to most inshore locations, however, and could therefore potentially spread pests to multiple habitats within a limited local area.

Risk assessment

Results

Entrainment	Translocation	Overall Rank
14	**21**	**16**

Motor cruisers were ranked as medium risk overall (16). They were assessed as offering moderate potential for entrainment of marine pests (14), as they commonly spend large amounts of time in marinas, but seem to be generally well maintained. They were ranked low risk for translocation (21) as they are used relatively infrequently, do not journey far and typically return to their point of departure.

Gaps and Uncertainties

Very little information was available about the activities of this sub-sector as a whole and the authors had limited personal experience to draw on either. Given that there are tens of thousands of these craft (see Appendix 1) it is anticipated that their activities are quite variable and individualistic and it was therefore difficult to generalise about their voyage patterns and maintenance practices.

15.3 Trailer Sailers

Description of sub-sector

Trailer sailers are small sailboats, generally less than seven metres long and very often of fibreglass construction. They are fitted with retractable keels or “centreboards” and are kept as their name implies on trailers, in sheds, boatyards and yacht clubs and are launched for day sails at a local boat ramp. They comprise a very small sub-sector of recreational vessels (~ 1% (MAST 2002)).

Issues associated with sub-sector

Entrainment

Trailer sailers are not prone to biofouling as they are stored out of the water and are generally only taken out for day sails. Most would not have an inboard motor or head, and therefore no seawater plumbing systems. They may, however, anchor in bays and estuaries, or be used as a platform for fishing and could therefore entrain marine organisms on anchors, ropes and fishing gear or in anchor wells or buckets. It should be noted, however, that marine pests generally have limited viability once out of the water; therefore if vessels are used infrequently it is unlikely that marine pests will survive.

Translocation

Trailer sailers, by definition, almost certainly return to their point of origin ie the boat ramp where the trailer is parked, and trips are confined to a limited local area. They do not generally embark on long, meandering voyages. On the whole, they are used fairly infrequently, and predominantly during the warmer summer months.

Risk assessment

Results

Entrainment	Translocation	Overall Rank
22	**15**	**22**

Trailer sailers were ranked second from the bottom (22) both for entrainment and in terms of overall risk. This is because they are small, smooth-hulled vessels that are stored out of the water and have minimal contact with the seabed. They also rarely, if ever, enter ports. They scored higher for translocation risk (15), mainly because of the high volume of the sub-sector (see Appendix 1).

Gaps and Uncertainties

Not much is known about the overall behaviour of this sector apart from some generalities, but there may be significant individual differences. As with other recreational vessels that are in private ownership, no consolidated records are kept on vessel activities and there was no source of aggregated data or information on voyage patterns.

15.4 Small powered craft (Cabin cruisers and tinnies)

Description of sub-sector

Of the almost 1 million recreational vessels in Australia (Figure 15), the vast majority (> 80%) are small, powered craft, less than 10 metres in length that are kept on trailers and launched at boat ramps (NRIFS 2003, MAST 2002, Queensland Transport 2002). This category encompasses cabin cruisers, typically constructed of fibreglass, and 'tinnies' (open aluminium boats) powered by outboard engines. They are ubiquitous in inshore marine environments, particularly bays, estuaries, inlets and gulfs and their activity is especially prodigious during summer school holidays and on fine weekends.

Issues associated with sub-sector

Entrainment

These craft are strongly associated with recreational or subsistence fishing. The National Recreational and Indigenous Fishing Survey (Henry & Lyle 2003) estimated that between 50% (Vic.) and 73% (NT) of small powered craft are used for this purpose and, in a recent survey in Tasmania, (MAST 2002) 79% of respondents identified recreational fishing as their main reason for boating. Fishing usually occurs in productive, sheltered, inshore waters where IMP typically occur and involves the deployment of fishing gear that may harvest or entangle an IMP. Additional opportunities are offered by burley buckets, which were identified by Hayes (2002) as being likely entrainment habitat. Conversely, these vessels are stored out of the water and washed down with freshwater after use to prevent corrosion. They will also usually dry out between voyages, gear will be rinsed and burley buckets emptied, so the chances of a marine pest surviving are very low.

Translocation

Cabin cruisers and tinnies travel to numerous inshore locations in large numbers. However, they travel over a fairly restricted distance as they are limited by fuel consumption and, due to their small size, do not travel far offshore. As a rule of thumb, the maximum distance covered during voyages is around 5 nm. Because the vessels are trailered, this sub-sector also displays high port fidelity, almost invariably returning to their point of origin, ie the same boat ramp or beach-launching site they departed from. There is the possibility however, if a vessel is frequently used, that marine pests could be translocated from one stretch of coastline to another by road if the vessel is retrieved at one boat ramp and launched for its next trip at a different one, within a space of a few hours or days. A Marine and Safety Tasmania (MAST) survey found that 47% of boat owners use more than 1 - 3 boat ramps (MAST 2002).

Risk assessment

Results

Entrainment	Translocation	Overall Rank
19	**8**	**21**

Cabin cruisers and tinnies were ranked very low risk overall (21). They were ranked low for entrainment risk (19), as they are typically small, trailered, planing hull vessels that do not enter ports and offer few permanent refugia for pests. They were ranked fairly high for translocation (8) however, as they are an extremely large sub-sector (see Appendix 1) and vessels are used quite frequently. They do not undertake long journeys however, and typically return to their point of departure.

Gaps and Uncertainties

As with other recreational vessels that are in private ownership, no consolidated records are kept on vessel movements. This is a very large sub-sector, however, comprising hundreds of thousands of vessels (see Appendix 1); there is therefore likely to be significant variation in activity patterns and practices across the sub-sector.

15.5 Personal Water Craft (PWC)

Description of sub-sector

This is a relatively minute sub-sector (eg 1.72% of all recreational vessels in Tasmania (MAST 2002), 2.3% in Queensland (Queensland Transport 2002)) comprised of vessels such as jet skis, windsurfers and canoes that generally have the capacity to carry only a single person, or at most two people. Like other recreational craft, they are used predominantly on weekends and during summer and are generally launched from the beach or shoreline for trips lasting a few hours at most and encompassing a bay or short stretch of coastline.

Issues associated with sub-sector

Entrainment

These are small, smooth-surfaced craft that are removed from the water after use and stored on dry land. They therefore do not accumulate biofouling or remain wet. Being small, PWC are easily inspected and cleaned; they also don’t tend to harbour a lot of wet gear or equipment such as ropes, nor do they offer many nooks and crannies for pest concealment.

Translocation

PWC are limited to making short journeys, restricted to a local area and returning to their point of departure. They do not range far out to sea or stop at other locations. Canoes and kayaks are the occasional exception to this, although sea kayaking is relatively rare. They tend to limit their activities to smooth waters within the confines of a few popular and easily accessible bays, estuaries and inlets.

Risk assessment

Results

Entrainment	Translocation	Overall Rank
23	**18**	**23**

PWC were ranked last among all the sectors (23) both for entrainment and in terms of overall risk. This is because they are very small craft that provide few refugia, rarely use nodes and are removed from the water after use. They were also ranked low for translocation (18), despite being a large sub-sector (see Appendix 1) as they make relatively infrequent voyages to a limited number of locations and typically in close proximity to their point of departure.

Gaps and Uncertainties

As with other recreational vessels that are in private ownership, there was no source of aggregated data or information on this sub-sector as no consolidated records are kept on vessel movements or activity patterns.

Management Approaches

Existing

The Victorian Department of Sustainability and Environment (DSE) has produced a set of guidelines outlining proper cleaning and maintenance procedures for recreational vessels in order to help prevent the spread of marine pests (DSE 2002). These guidelines outline where, when and how the boat should be cleaned and, based upon the work of Hayes (2002), identifies areas on the vessel where pests are most likely to occur and recommends them for special care and attention. These guidelines are clearly intended to educate boat owners and foster wider community awareness.

The Boating Industry Association (BIA) is the peak recreational boating body representing about 90% of this sector. BIA is a national organisation with ‘chapters’ in each state except Tasmania. It has developed a Code of Practice establishing standards of conduct for all BIA members as well as guidelines for boat owners that encourage them to be environmentally responsible. Part seven of the BIA CoP relates to the responsibilities of consumers and boat owners and contains a subsection dealing with the environment (Section 7.2, p.20), which does not make explicit reference to marine pests but does refer to preventing the contamination of waterways and discouraging in-water hull cleaning or other practices that are likely to “remove…deleterious material into the marine environment”.

Proposed

Voluntary reporting of voyage plans could be encouraged for yachts and motor cruisers that are kept in marinas or boat harbours, in order to track vessels in the event of a pest outbreak. Education and awareness campaigns, similar to the Coasts and Clean Seas ‘Stormwater Awareness Campaign’ could be coordinated through peak bodies such as BIA and Yachting Australia (formerly the Australian Yachting Federation) and could potentially tap into existing community extension services such as the Fishcare volunteer program. The Australian Boating College conducts a number of licensing and seamanship courses in Queensland, New South Wales, Victoria and South Australia and could be persuaded to include marine pest awareness in their training materials. Furthermore, all states (except NT) require powered recreational vessels to be registered, therefore a brochure or other educational information could be included with the vessel licence. Current best practice initiatives, such as the *ANZECC Code of Practice for Antifouling and In-Water Hull Cleaning and Maintenance* (ANZECC 2000) and MAA *Clean Marinas; Australia* CoP (see Part II: Section 7) should be promoted to the recreational boating public, who should be encouraged to follow their recommendations regarding vessel cleaning and maintenance practices.

16. Research Vessels

Description of sector

This is a diverse sector, which includes large vessels such as *Aurora Australis*, the research and re-supply vessel chartered by the Antarctic Division and *Southern Surveyor*, the research vessel operated by CSIRO as a national facility, mid-sized vessels such as *Bluefin*, the vessel operated by the Australian Maritime College, and the many small launches, tinnies, Zodiacs and cabin cruisers operated by Universities and state research agencies around the country to undertake research on marine ecology, fisheries, oceanography, geology etc. (see photo above). Most of the larger vessels involved in research are chartered and some of these are sourced from overseas. *L'Atalante*, for example, is a French vessel that has been chartered by Geoscience Australia for swath-mapping cruises in the South-East Marine Region. *Astrolabe* is a French vessel operated by the French Polar Research Institute for re-supplying their base at Dumont D'Urville in Antarctica. This vessel spends much of the year in Hobart docks. It is impossible to determine the precise number of smaller vessels in use by all of the many and varied research facilities around the country. However, it is estimated to be in the order of 50 – 100.

Issues associated with sector

Entrainment

The activities of this sector involve close interaction with the marine environment (both water column and seabed), very often in shallow inshore habitats, where pests predominantly occur. Instruments and sampling equipment (nets, sediment grabs etc.) are deployed to measure water properties or retrieve samples of water, sediment or biota. Sampling equipment may inadvertently harvest marine pests directly or may be immersed for long periods and become fouled. However it is common practice for scientific gear to be cleaned and rinsed at the end of a voyage and between sample sites.

Larger research vessels not only dock in commercial trading ports (eg Hobart) where, due to government funding constraints, they may remain immobile for lengthy periods, but may also carry ballast water. They therefore have a fairly high potential to entrain marine pests as biofouling or in ballast tanks. They also often have purpose-built wet wells to hold live marine organisms for transport back to a laboratory. Depending on where this seawater is sourced from, it may contain IMP larvae or spores or potentially small pelagic marine pests. The majority of the smaller vessels are trailered, however, and would invariably be subject to a thorough wash down with freshwater upon retrieval and in most cases would dry out between research trips.

Translocation

Smaller research vessels tend to have high home port fidelity and most voyages are of relatively short duration (ie day or half-day trips) and distance, typically within a 30 nm radius of base. The exceptions to this are the long, often multi-disciplinary cruises (typically 2 - 3 weeks duration) undertaken by the larger vessels, which can traverse hundreds or thousands of kilometres of ocean, including areas not regularly visited by other vessels. During these extended cruises a research vessel may call briefly into another port. There is therefore the possibility of larger vessels translocating IMP both between ports as well as from ports to offshore waters or islands rarely visited by other craft. Moreover, in most cases, research voyages involve sampling at several locations, creating the potential for IMP to be translocated between sample sites.

Examples

There are no specific examples demonstrating the spread of marine pests by this vector.

Risk assessment

Results

Entrainment	Translocation	Overall Rank
12	**16**	**14**

The *Aurora Australis* was not included in the risk assessment as it is different to the majority of research vessels and likely to skew some of the risk factors. The overall risk for research vessels was assessed as moderate (14) as was entrainment risk (12). This is because the majority of research vessels are trailered and not very large and both gear and vessels are cleaned and rinsed with freshwater after use. Translocation risk was ranked low (16) because there are relatively few vessels in the sector (see Appendix 1) and they are used relatively infrequently. These craft also tend to be involved in day trips and return to their point of departure.

Gaps and Uncertainties

There was no single source of information on vessel numbers and movements for research vessels, making it difficult to assess translocation factors. This sector is also characterised by a dichotomy between small, trailered vessels used in inshore bays and estuaries and large displacement vessels used for extensive cruises through offshore waters and to multiple sites.

Management Approaches

Existing

There are no coordinated, national arrangements in place for this sector with respect to managing the spread of marine pests, but some sub-sectors (eg government fisheries research agencies) are very much aware of the issue as they have a responsibility to deal with IMP incursions.

Proposed

This sector is comprised of research and educational institutions with a professional interest in the marine environment. They should therefore be amenable to targeted education on the issue as well as to a range of either voluntary or mandatory initiatives to control the spread of IMP including inspection regimes and adherence to gear and vessel cleaning guidelines. The development of these could be coordinated through university and government research bodies. It would be useful for marine science agencies that conduct field research to be trained to identify marine pests of concern.

17. Sail Training Vessels

Description of sector

Sail training vessels are medium to large, typically square-rigged ships (see photo on right), owned and operated by non-profit organisations or charitable trusts in order to "provide opportunities for sail training and adventure at sea under sail" (AUSTA 2003). Sail training vessels are mostly run by volunteers and their trainees (deck crew) are usually young people who pay a fee to participate in a particular voyage. However, they are in some cases also available for charter for corporate events and two of these vessels operate as businesses offering cruises at full fares so they may not strictly be sail training vessels, though they operate the same type of vessel.

Sail training vessels undergo voyages of highly variable length, from an evening sail around the bay to very lengthy cruises. For example the *Leeuwin* is currently on a voyage from Fremantle to Darwin. With the exception of the Northern Territory, there are one or more resident sail training vessels based in each state (Table 8). In addition to these resident vessels, each year a number of sail training vessels visit Australia, either as part of their voyage plan or as part of a Tall Ships Race. In 1998, for example, 100 sail training vessels took part in a race from Sydney to Hobart.

STATE	NO. VESSELS	NAME(S) OF VESSEL(S)
Tasmania	1	Lady Nelson
Victoria	1	Enterprize
South Australia	2	One and All, Falie
Western Australia	2	Leeuwin II, Duyfken
Northern Territory	0	- - -
Queensland	2	South Passage, Rainbow Gypsy, Solway Lass
New South Wales	4	James Craig, Svanen, Windeward Bound, The Bounty Endeavour (replica),
Australian Government	2	Young Endeavour (Sydney), Salthorse (RAN only, based in Jervis Bay, NSW)
TOTAL	**14**	

Table 8: Numbers and names of sail training vessels by state. (Source: AUSTA).

Issues associated with sector

Entrainment

Sail training vessels are relatively large, are kept permanently in the water and are generally based in ports, offering biofouling opportunities on their hulls and other submerged surfaces. Being sail powered, these vessels travel very slowly so that if an organism attaches itself to the hull it is unlikely to be dislodged. Most sail training vessels are made of wood and offer lots of wet refugia such as bilges anchor wells and scuppers. These ships often make regular anchorage stops in order to allow their crew to relax, which will offer opportunities of entrainment on anchors and warps. These vessels also tend to be gregarious and are often to be seen at festivals such as the Australian Wooden Boat Festival in Hobart or the Sydney Wooden Boat Festival. This provides an opportunity for cross-infection from other vessels.

Translocation

These vessels tend to undertake two types of voyage: short day or evening sails, returning to their point of origin and, extended long-distance cruises likely to involve frequent stops at anchorage and calls to other ports. The *Lady Nelson* for example, sails all round the coast of Tasmania and occasionally crosses Bass Strait, such as during the re-enactment of the discovery of Port Phillip and Western Port in 2001. IMP may therefore be translocated between ports and anchorages and multiple inoculations are possible.

Examples

There are no specific examples demonstrating the spread of marine pests by this vector.

Risk assessment

Results

Entrainment	Translocation	Overall Rank
10	**12**	**9**

Sail training vessels were ranked moderately high risk for both entrainment (10) and translocation (12). This is because they have little interaction with the seabed, apart from anchoring, but, being large, wooden sailing vessels, do provide a number of refugia for marine pests and can spend lengthy periods of time in port and cruising inshore waters. Whilst there are few of these vessels (see Appendix 1) they are relatively wide-ranging and promiscuous. On balance therefore, this sector was ranked intermediate risk overall (9).

Gaps and Uncertainties

The movements of sail training vessels are fairly well documented on operators' websites, providing access to a fairly comprehensive knowledge base that could be used in assessing this sector for secondary invasion risks.

Management Approaches

Existing

The Tasmanian Sail Training Association (the operators of the *Lady Nelson*) report that they are aware of the risks of translocating IMP and, while they do not have a formal policy on reducing risks, take "every reasonable step" to minimise them, such as washing down anchor chains and drying warps. They also slip, inspect and antifoul the vessel every year. It is not known if these practices are replicated throughout the sector.

Proposed

These vessels are owned and run by their own associations, or, in the case of the *Young Endeavour*, by the RAN. The Australian Sailing Training Association (AUSTA) acts as a quasi-peak body for these associations; it sends out newsletters and organises a seminar every two years for owner/operators. It would therefore be appropriate to approach AUSTA (http://www.sailtrainingaustralia.com/contactAUSTA.htm) with a view to developing an education campaign directed at the associations/organisations who run the vessels as well as to assist the permanent officers and crew of sail training vessels to instruct their clientele in procedures to minimise the risk of entrainment and translocation.

18. Seismic Survey Ships

Description of sector

Seismic survey ships are large, purpose-built vessels designed to carry out exploratory surveys of the seabed to search for potential new oil and gas reserves. They are equipped with a multiple array of cables fitted with air guns and hydrophones that are towed behind the vessel (see photo above). The airguns emit pulses of low frequency sound waves that pass through the water column, penetrate the seabed, are reflected off subsurface geological layers and travel back to the hydrophones. The cables range from 150 – 6 000 m long (Figure 16). Most offshore seismic surveys in Australia are conducted in south-eastern Australia or on the North West Shelf (WA), where significant petroleum deposits are located. Other surveys have been conducted in the Perth Basin, Timor Sea and Offshore Kimberley (Figure 17). Most surveys take place several kilometres offshore in waters greater than 50 m deep.

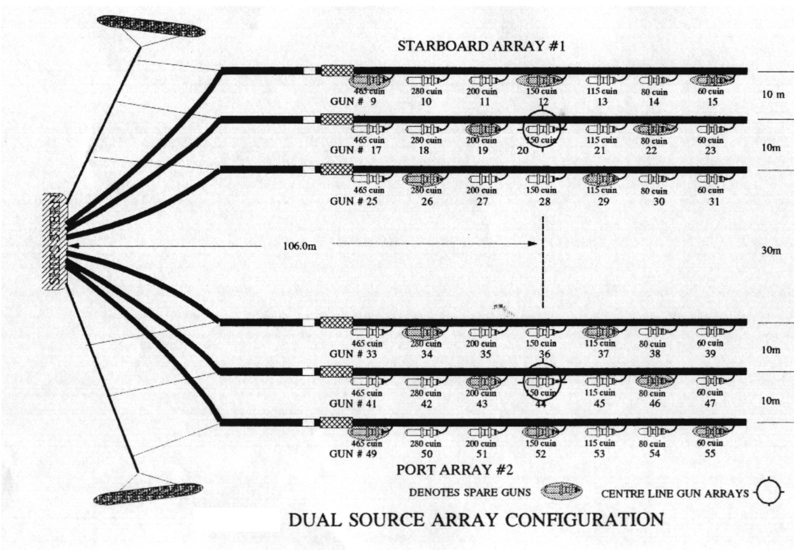


Figure 16: Plan of air gun array towed by a 3D seismic survey ship. (Source: Geoscience Australia.)

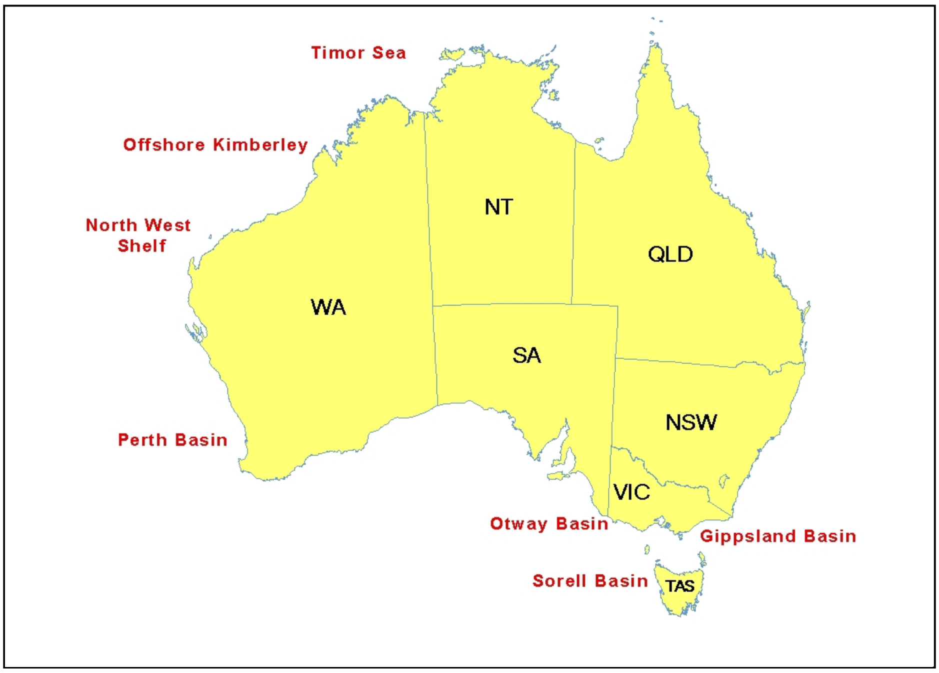


Figure 17: Areas where offshore seismic surveys have taken place in Australia.

As an example of the scale of seismic survey ship activity, in the period 1985 – 1995, there were a total of 85 seismic surveys (68 x 2D; 17 x 3D) in south-east Australia, covering a total of almost 130 000 km of track line. This equates to an average of six 2D (range 1 – 15) and two 3D (range 0 - 4) surveys per year in this region (Figure 18). Exploration activity is seasonal in certain areas (eg in the Otway Basin to avoid interactions with whales during periods of migration through the area); however, seismic vessels generally experience steady, year-round activity by relocating to new exploration areas.

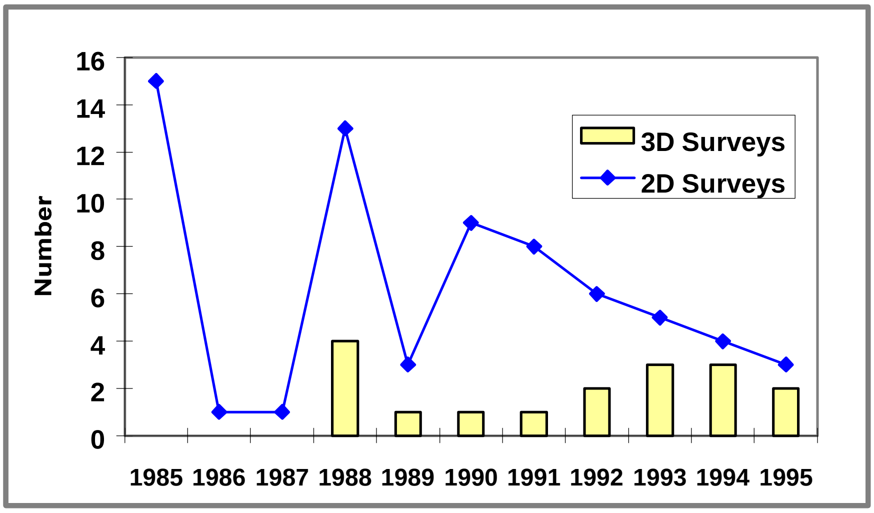


Figure 18: Numbers of seismic surveys conducted in south-eastern Australia from 1985 - 1995. (Data sources: Geoscience Australia; Australian Seismic Brokers).

Issues associated with sector

Entrainment

When seismic survey ships visit port, they may entrain marine pests as fouling organisms on the hull or in sea chests and seawater intake pipes or via the exchange of ballast water. Due to expense, however, seismic ships avoid ports whenever possible and utilise offshore support vessels (see Part I: Section 14) and helicopters for crew changes, provisioning and refuelling. The only time seismic vessels may need to come into port, where they are most likely to entrain IMP, is when they first arrive in Australia, in order to undertake Customs and Immigration checks. Even this will be avoided if possible, as such activity is "idle" time and these formalities can be completed offshore. When port visits are necessary, they are of short duration, being usually only long enough to re-fuel (typically less than 24 hours). Furthermore, seismic survey ships are inspected and cleaned regularly and antifouled typically every three years, or when the vessel is no longer hydrodynamically efficient and hull inspections are often conducted by divers when the vessel is anchored offshore, as it is less expensive than sending the vessel to dry dock (L Wigle *pers. comm.* 2003). The likelihood of pest entrainment in port through biofouling or ballast water exchange is therefore low.

Seismic survey ships tow long arrays of cables, airguns and hydrophones at slow speeds over wide stretches of ocean, so there is the potential for pelagic organisms or life stages to become entrained on cables or in wet spaces in the airguns or hydrophones. This risk is minimised through a routine cleaning regime that is carried out each time the cables are brought onboard the vessel to ensure that the expensive and highly technical gear functions effectively and continuously (L Wigle *pers. comm*. 2003).

Translocation

Seismic survey ships are expensive to construct and maintain and therefore need to remain active to prevent loss of revenue from lying idle. Consequently, they are constantly on the move, actively acquiring seismic data and typically remain at sea for several weeks or months at a time. For example, in 2000 - 2001 the MV *Geco Beta* conducted a survey for 13 months. When not actually acquiring data, a seismic vessel will either be in transit from one survey area to another or calling into port. Seismic ships therefore spend long periods offshore and cover substantial distances during the course of a survey. Historically, there have been several surveys in Bass Strait and, whilst the risk is probably low, there is the possibility of a pest that is picked up either in a port such as Melbourne or out at sea, being transported to new locations in the shallow continental shelf waters of the Strait, where a pest population could become established. Some IMP species are already established in Bass Strait, for example the New Zealand Screwshell (Bax et al. 2003). Large parts of the coastline of Western Australia are also at risk of colonisation (see Figure 17).

Examples

There are no specific examples demonstrating the spread of marine pests by this vector.

Risk assessment

Results

Entrainment	Translocation	Overall Rank
12	**22**	**18**

Seismic survey ships were ranked low risk overall (18). Entrainment risk was ranked moderately high (12) because they carry ballast water and trail equipment through the sea that may entangle pests, but they also spend lengthy periods of time in offshore waters, whilst port visits are short and infrequent. The sector was ranked low (22) for translocation risk because there are very few seismic vessels operating in Australian waters each year (see Appendix 1) and they are restricted in terms of the areas in which they operate.

Gaps and Uncertainties

The fact that these vessels are not based in Australia but are owned by various multinational petroleum companies made it difficult to obtain comprehensive, detailed information on the specific operations of the sector.

Management Approaches

Existing

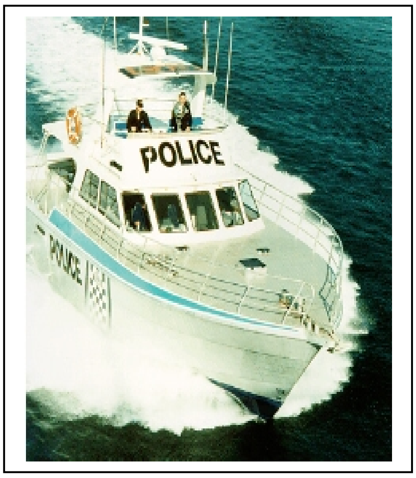
Seismic survey ships operating in Australian waters must comply with Australian governance arrangements. Vessel masters are therefore required to consult the BWDSS or manage their ballast water before entering Western Port. Currently, they are not required to manage their domestic ballast water for other ports. However, this will be addressed during development of the National System.

General deck crew are not typically aware of marine pests and the sector does not have any guidelines specifically relating to practices for minimising the spread of marine pests (L Wigle *pers. comm.* 2003). However, the ships' officers undertake mandatory training as part of their professional certification that includes marine pest issues, ie ballast water management, antifouling protocols etc. This training has a focus on international, rather than domestic, marine pest translocation issues.

Proposed

As seismic survey ships are deemed low risk it is proposed that the Australian government focus their resources on other sectors. Nevertheless, an education kit about domestic IMP translocation issues could be distributed through APPEA. In any case, these vessels will come under the umbrella of Coastal Shipping, which will be the first sector to be addressed for ballast water management, and eventually for biofouling, as part of the National System.

19. Water Police



Description of sector

The Water Police operate in different capacities in each state but their core work is essentially the same. They patrol coastal waters monitoring general crime (eg drink-driving, drug-trafficking), coordinate search and rescue operations (often including dive operations) and check marine safety equipment on pleasure craft. Most state water police departments enforce fisheries legislation, regulations and management plans as a secondary function, however, Tasmania and the Northern Territory have incorporated this into their primary duties.

The Western Australian Water Police are based in Perth and their patrol is stretched to cover the entire Western Australian coastline. In contrast, Queensland and New South Wales Water Police operate out of a number of regional bases. As shown in Table 9, there are many more water police vessels in the eastern states. The majority of water police vessels range from 4 - 7 m in length and are kept on trailers but there is usually at least one larger vessel in each state (14 - 23 m) that is kept in the water (see photo above).

STATE	NO. OF VESSELS
Queensland	30
New South Wales	35
Victoria	14
Tasmania	32
South Australia	3
Western Australia	4
Northern Territory	6

Table 9: Number of water police vessels per state. (Data sources: State Water Police departments).

Issues associated with sector

Entrainment

Most work carried out by the Water Police is undertaken in coastal waters where IMP are distributed in greatest abundance. The larger water police vessels are more likely to entrain a marine pest, as they are stored in the water and gather fouling when stationary. However, fouling organisms may be dislodged, as water police vessels have planing hulls and often travel at speeds of 25 - 40 knots.

It is important for the Water Police to keep their vessels in good working condition so that they will perform well at a moment's notice. Accordingly, larger vessels are typically slipped at a boatyard every 6 - 12 months (depending on the state/region) and the smaller boats are washed down with freshwater when they are retrieved from the water each day. This cleaning practice is not specifically aimed at minimising the entrainment of marine pests, but serves to reduce slime build-up and the likelihood of biofouling nonetheless.

Translocation

Water police vessels typically operate only within their own state waters, so most translocations would be intrastate. In Tasmania, however, vessels travel between islands in Bass Strait and sometimes reach the mainland coast of Victoria. Water police vessels tend to cover a wide range of coastal areas and they visit many other nodes such as marinas, fishing harbours, boat ramps and anchorages before returning to base, so it is possible for them to effect node to node translocations.

Examples

There are no specific examples demonstrating the spread of marine pests by this vector.

Risk assessment

Results

Entrainment	Translocation	Overall Rank
17	**4**	**15**

Water police vessels were ranked low for entrainment risk (17) as most of these vessels are trailered and well maintained. Translocation risk was ranked high (4) however, as they are used frequently and in many locations. Overall risk was ranked 15.

Gaps and Uncertainties

This is not a consolidated sector; each state maintains its own water police and some states have regional branches. This made it difficult to obtain information for the sector as a whole.

Management Approaches

Existing

The Water Police sector appears to have a moderate awareness of marine pest issues. They occasionally encounter them while conducting diving investigations and they are sometimes involved in projects to eradicate them. In the Northern Territory the Marine and Fisheries Enforcement Unit (Water Police) were involved in responding to the Black Striped Mussel outbreak. They continue to be involved in the ongoing management of marine pests through cleaning and inspections of international and other high-risk vessels entering Darwin marinas.

This sector does not comply with any Code of Conduct that directly relates to marine pests but many regional branches have an internal policy to slip vessels regularly (eg every 6 months). In many cases, maintenance of water police vessels is outsourced to private boatyards, in which case the onus is on the boatyard owner to manage waste. This is not true in all states however. The Tasmanian Water Police, for example, have their own maintenance officer who conducts most cleaning and maintenance work. The Water Police in the Cairns region, having been alerted by the Asian Green Mussel incursion, inspect the hulls of their vessels when they are being slipped in the boatyard and make inquiries when they identify a suspected pest.

Proposed

As the Water Police operate extensively in coastal waters, it would be useful to educate officers through their formal training courses so that they are aware of the threats posed by marine pests and are better equipped to recognise an outbreak of a marine pest when on patrol. For example, they could be trained to recognise both existing and potential marine pests in their local area and alerted to the types of vessels that are likely to carry them. This could be particularly important for water police officers that conduct diving investigations, as they are more likely to notice an incursion or species' range expansion. In addition, the Water Police have a high level of interaction with vessel owners and could therefore be utilised as a conduit for information to other sectors. For example, they deal with recreational boaters, yachties, Customs officers and commercial fishers. When enforcing and educating vessel owners about marine safety they could also educate them about marine pests and the importance of cleaning vessels and fishing gear regularly.

Summary of vector risk assessment results

SECTOR	Entrainment Rank	Translocation Rank	OVERALL RANK
Commercial fishing vessels	6	1	1
Dredges	1	18	2
Offshore support vessels	7	2	3
Barges and Lighters	2	10	4
Harbour services craft	3	14	5
Mobile drilling rigs	4	16	6
Ferries and water taxis	9	9	7
Defence vessels	16	5	8
Yachts	14	6	9
Sail training vessels	10	12	9
Charter boats	11	13	11
Cable ships	5	22	12
Cruise Ships	8	20	13
Research vessels	12	16	14
Water Police	17	4	15
Motor cruisers	14	21	16
Fisheries patrol boats	20	3	17
Seismic survey ships	12	22	18
Customs launches	18	10	19
Coastguard patrol boats	21	7	20
Small powered craft	19	8	21
Trailer sailers	22	15	22
Personal water craft (PWC)	23	18	23

Part II: NODES

1. Anchorages

Description of sector

There are many localities around the coast, generally bays sheltered by headlands from the prevailing winds, that are popular anchorages for recreational craft (see photo above). They may be good fishing sites, refuges from bad weather or simply peaceful and attractive places to pass the night. Some may be used as permanent moorings by local craft but also be used by visiting boats as a temporary stopover. Many of these localities are well known and are marked on navigation charts as “Recommended anchorage” such as Waterloo Bay on the eastern side of Wilson’s Promontory in Victoria. Absence of protected anchorages is one reason why few small vessels venture round the west coast of Tasmania, for example

Issues associated with sector

Anchorages are used predominantly by recreational vessels, in particular yachts and motor cruisers, but they may also be visited by fishing vessels, charter boats, water police, fisheries patrol and coastguard vessels. Some of these vessel categories have been assessed as high risk for the entrainment of marine pests through hull or gear fouling (see Appendix 2). In addition, anchors and their chains or warps may entrain organisms or release organisms entrained at previous sites. Sometimes the crew of a vessel will take the opportunity to scrub the hull, and particularly the waterline, of a vessel to remove biofouling whilst it is resting at anchor.

No records are kept on patterns of use of anchorages but there is likely to be anecdotal information available from sectors such as water police, volunteer coastguard, marine and safety agencies, waterways authorities and fisheries enforcement officers. There are many guides available on the locations and characteristics of anchorages. For example, Smith (1997) lists more than 156 anchorages around Tasmania and its surrounding islands.
The more popular the anchorage, the greater the potential for pest organisms to be translocated to or from the site.

Management Approaches

As anchorages are used predominantly by the recreational vessel sector, codes of conduct developed by the Boating Industry Association would be the most appropriate channel for informing boat owners about the marine pest problem and influencing their practices. It might also be possible for local community groups or dive clubs to survey popular anchorages periodically, although quality control and assurance would be an issue with this

.

2. Boat Ramps

Description of sector

Boat ramps are inclined concrete or wooden ramps leading down to the sea, constructed for the purposes of launching and retrieving trailered boats (see photo above). State and local governments build and maintain these ramps as a service to the general public. They are used mostly by small to medium-sized recreational craft such as tinnies, cabin cruisers and trailer sailers. Commercial fishermen also use some boat ramps. In some states, especially South Australia, Western Australia and the Northern Territory, boats may also be launched along certain sections of beach to which motor vehicles have access.

Table 10 lists the number of boat ramps in each state. The number is not fixed as governments build new ramps regularly and occasionally ramps are destroyed or become unsafe.

STATE	NO. OF RAMPS	YEAR COUNTED	DATA SOURCE
Queensland	281	1997 - 98	Office of Economic & Statistical Research
New South Wales	557	2002	NSW Waterways Authority
Victoria	389	2001	Department of Infrastructure
Tasmania	113	2002	MAST
South Australia	143	2001	Transport SA
Western Australia	131	2003	Dept of Planning & Infrastructure
Northern Territory	16 (Darwin area)	2003	DBIRD
TOTAL	**1630**		

Table 10: Boat ramps in Australia.

Issues associated with sector

Boat ramps are areas where people clean and wash down their vessels after a fishing or boating trip. During this process, marine pests may be discarded or washed into the marine environment around the ramp and subsequently colonise the area and infest other vectors.

Many boat ramps attract very high levels of usage and can become congested with vessels at weekends, particularly during summer. MAST survey data (MAST 2002) shows that 77% of all boat owners in Tasmania use boat ramps as boating access sites. People returning from fishing trips may also gut their catch at boat ramps; indeed many boat ramps have tables installed for the purpose. If fish heads and offal are then thrown back into the sea, they may produce a locally enriched subtidal environment that could promote the survival of marine pests.

Management approaches

Prominent signage could be installed at boat ramps encouraging environmentally responsible vessel cleaning practices that include dislodging and disposing of marine plants and animals and leftover burley or bait in appropriate waste receptacles, draining water from vessels and buckets on hardstand areas away from the water's edge and washing down and drying vessels, boating equipment and fishing gear. This could be coordinated through state and local governments.

3. Defence Force Bases

Description of sector

There are 12 ADF maritime bases around the coast of Australia that are regularly used by ADF vessels. Eleven of these bases are RAN facilities, of which four are major fleet bases (Darwin, Cairns, Garden Island (Sydney) (see photo above) and HMAS Stirling (Fremantle)) and one is the Army Maritime School and Landing Craft Base at Ross Island Barracks, Townsville. The RAN bases fulfil a variety of functions including fleet bases, training bases and bases for specialist operations such as mine warfare. In addition, there are two facilities for ammunition storage; the interim facility at Point Wilson and the new facility at Eden, currently under construction. There are also four major civilian facilities where the fleet is constructed and maintained, these are the Australian Submarine Corporation facility in Adelaide, Forgacs dockyard in Newcastle and Tenix Defence's facilities at Williamstown (Vic.) and Henderson (WA). Figure 19 shows the location, function and number of vessels at each of these bases.

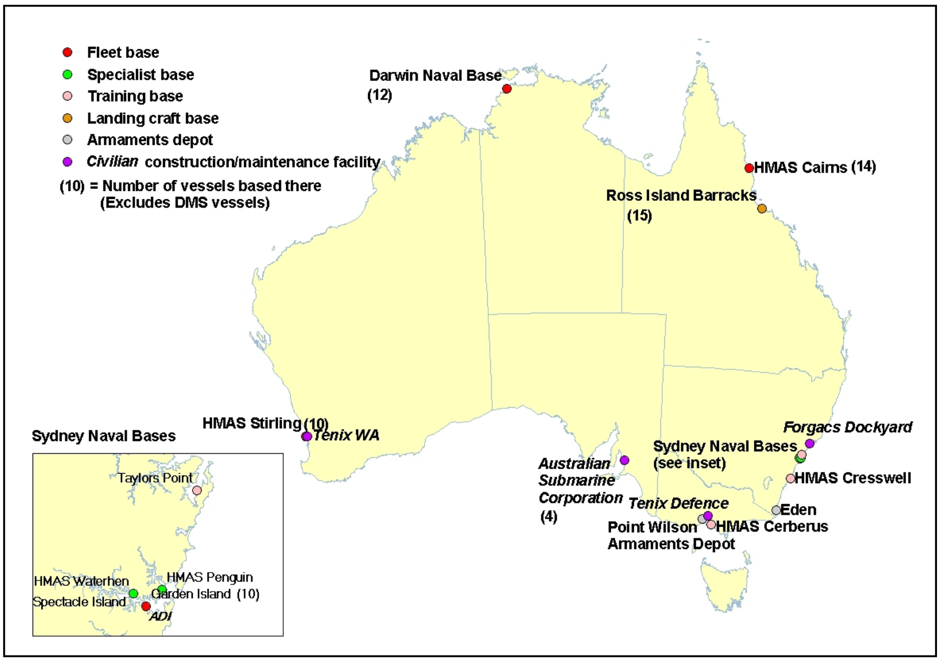


Figure 19: Distribution of Australian Defence Force maritime bases. (Data source: Department of Defence).

Some of these bases carry out more than one function, for example, Garden Island in Sydney is both a fleet base and a dockyard and HMAS Stirling is also a submarine base. Naval vessels may also use civilian shipyards for graving (scraping and re-painting of the hull) or refit. Recent contractors include Forgacs (Newcastle and Brisbane) and Tenix Defence (Williamstown and Perth).

The RAN also has an extensive network of Naval Cadet training schools, usually designated Training Ship. There are 86 Training Ships across the country, with a headquarters in each state. Most are in coastal locations though there are some inland such as in Canberra and Albury. None appears to own a ship, as such, though most seem to have a variety of small craft including sailing dinghies and inflatable rubber boats.

Issues associated with sector

With the possible exception of HMAS Stirling in Western Australia, all naval facilities are in sufficiently close proximity to civilian port facilities, including wharves, slipways and dry docks to allow the migration of organisms from civilian to military facility and vice-versa through natural dispersal.

Management approaches

As with many other sectors, it is recommended that IMP issues could be made part of RAN and Army maritime training. Appropriate courses, directed at all levels but perhaps especially at those officers and ratings who handle vessels and associated gear, could include some training on the identification of IMP and development of best practice to avoid entrainment and translocation.

4. Derelict & Abandoned Craft

Description of sector

A small percentage of vessels, very often recreational craft, become derelict or abandoned for one reason or another (see photo above). Reasons vary from simple neglect or financial hardship to storm or collision damage or some combination of all three. Derelict and abandoned vessels are often found in the backwaters or round the peripheries of ports, marinas, bays, lagoons and estuaries and may remain in this state for many months or years, particularly if vessel ownership is difficult to ascertain. Commercial vessels rarely end up derelict or abandoned (unless they are shipwrecked) because of their value, if only to salvage companies.

Issues associated with sector

Derelict and abandoned boats, whilst not strictly speaking a node, are an excellent example of a reservoir, not only because they are likely to remain undisturbed for long periods, but also because they are generally situated in places frequented by other vessels and offer vacant habitat to a range of invasive organisms. There is also the risk that these organisms will be translocated elsewhere if the vessel is moved.

Management approaches

The issue of derelict and abandoned vessels will need to be tackled by multiple sectors and agencies. It is probable that port and harbour authorities would become concerned and involved if an abandoned vessel is causing a navigational hazard to shipping. Likewise, marina operators would no doubt wish to (although it is not known if they do) remove vessels that have become unsightly or are occupying valuable berth space. Where a vessel has been abandoned in a public waterway, the responsible agency would no doubt be the state government department responsible for marine safety or environmental issues (eg MAST, Marine and Safety Victoria, NSW Waterways Authority or NSW Marine Parks). Each of these sectors will need to be advised about best management practice for dealing with these craft so as to minimise the risk of spreading marine pests from a potentially infected hull.

5. Dry Docks

Description of sector

Dry docks are semi-enclosed docks fitted with gates that can be shut once a vessel has entered, allowing the dock to be pumped dry of seawater (see photo on right). This enables maintenance teams to gain complete access to the vessel's hull for repairs, painting and antifouling. Dry docks are used for ships that are too big to be brought up on shore using a slipway or ships hoist. There are nine known dry docks in Australia (Table 11), with at least one in each state.

STATE	NO.	LOCATION	OPERATOR
Queensland	2	Cairns Brisbane	NQEA Australia Forgacs
New South Wales	2	Newcastle[1] Sydney (Garden Island)	Forgacs Australian Defence Industries Ltd
Victoria	1	Williamstown	Tenix Defence
South Australia	1	Adelaide	Australian Submarine Corporation
Tasmania	1	Hobart	INCAT
Western Australia	1	Fremantle	ADI/Tenix Defence
Northern Territory	1	Darwin	Sadgroves
TOTAL	**9**		

Table 11: Dry docks in Australia. (Data sources: Operators' websites).

[1] Forgacs Newcastle operates a 15,000 tonne floating dock, which is similar to a dry dock, but afloat.

Issues associated with sector

The risks presented by dry docks are similar to those of slipways (see Part II: Section 5) in terms of the management of fouling removed from ships' hulls and sea chests. Unlike slipways, however, the risk of fouling being returned to the marine environment is theoretically much lower as it can all be cleaned up before the gates are re-opened. This is standard practice at the Australian Defence Industries Ltd (ADI) dry dock in Sydney, for example, where all fouling that is scraped off the hull is swept up from the floor of the dry dock and collected in bags for later disposal at a landfill site. Fouling that is removed from a vessel using a high-pressure hose is flushed into the sewer system for disposal. It is not known to what extent these practices are emulated elsewhere.

Management approaches

Dry docks fall under the banner of "other boat repair and maintenance facilities" referred to in the *ANZECC Code of Practice for Antifouling and In-water Hull Cleaning and Maintenance* (ANZECC 2000), which has been adopted by all Australian states and territories, so presumably they abide by the recommended practices. Given the small and specialized nature of this sector, dry docks ought to be fairly easy to target and regulate. The staff that conduct vessel cleaning at dry docks could be familiarised with marine pest issues and trained to recognise priority pest species if they encounter one. They should also be encouraged to observe the recommendations of existing codes of conduct for boat maintenance facilities, if not already doing so. This includes appropriate waste disposal practices either via the sewerage system or through collecting the scraped fouling in bags. All dry docks should install an effluent treatment plant so that biofouling can be treated before entering the sewerage system. The ADI dry dock in Sydney currently has plans for such a facility.

6. Fishing Harbours

Description of sector

There are hundreds of major and minor fishing harbours dotted around Australia's coastline, some of which are contained within the environs of major commercial trading ports. Fishing harbours are the base for the Australian Government-managed fishing fleet as well as some larger, state-licensed vessels. Most state vessels, however, are not located in man-made harbours, but operate from bays (where vessels are moored or kept at anchor), boat ramps, beach access sites or jetties.

STATE	NO. HOME PORTS
Queensland	11
New South Wales	26
Victoria	17
Tasmania	23
South Australia	18
Western Australia	5
Northern Territory	1
TOTAL	**101**

Table 12: Number of Australian Government fishery home ports per state. (Data source: AFMA).

Australian Government-managed fishing vessels are based at around 100 "home ports", nearly 95% of which are located in the eastern and southern states (Table 12). The major home ports, where the largest fleets are located, are:

- Lakes Entrance (58)[8]
- Port Lincoln (51)
- Fremantle (48)
- Mooloolaba (40)

[8] Figures in brackets indicate the number of Australian Government-managed vessels based at the port.

followed by:

- Eden (28)
- Hobart (28)
- Ulladulla (23)
- Cairns (20)
- Portland (20)
- Sydney (19).

State fishing vessels, as mentioned previously, are based at a large number of locations. Some of these are ports or harbours, but many others are boat ramps, creeks and bays located in metropolitan and country towns. Figures suggest there are about 400 such locations around Australia (Table 13).

STATE	NO. FISHING PORTS
Queensland	23 plus all boat ramps
New South Wales	45
Victoria	130
Tasmania	55
South Australia	75
Western Australia	47
Northern Territory	3
TOTAL	**380 +**

Table 13: Number of state fishing harbours per state. (Data sources: DBIRD, MAFRI, MAST, NSW Fisheries, PIRSA, QDPI and WADF).

Issues associated with sector

In fishing ports and harbours, vessels are concentrated, and often even moored alongside one another. In addition, some fishing harbours are within the boundaries of major ports where other vessels, including international boats, merchant ships and ferries may be encountered. This provides a high-risk environment for cross-infection between vectors. Fishing boats generally tie up to different wharves than merchant ships however, and are sometimes even in separate basins. In other cases, the distance between the two can be quite small, for example in Hobart, where fishing wharves are not only directly adjacent to some cargo wharves but also are adjacent to a marina. There is also a high degree of connectivity between fishing ports, with a certain percentage of vessels basing themselves at alternative ports at different times of the year or landing their catches at non-home ports.

Typical activities that occur in fishing harbours are the mending of nets and the cleaning, maintenance and stowing of gear, during which there is a risk of organisms entrained in fishing gear or boat equipment being discarded in the harbour environment. Vessel hulls, and particularly the waterline, may be scraped whilst a boat is at anchor or on a mooring, thereby potentially infecting the local marine environment.

Management approaches

To be effective, management needs to address general sanitation measures such as post-border controls on international vessels (merchant ships and cruising yachts) to keep ports and harbours clean, removing derelict and abandoned craft which can act as pest reservoirs (see Part II: Section 4) etc. As fishermen spend a great deal of time in ports, they may be a good first line of defence in terms of early detection of IMP incursions. Awareness of the issue could be raised and fishermen trained to recognise an infestation. Major fishing ports/harbours could also be included in port survey and monitoring activities currently underway for major commercial trading ports.

7. Marinas

Description of sector

Marinas consist of a collection of concrete and wooden pilings and floating pontoons to which recreational craft, especially yachts and motor cruisers, tie up (see photo above). They are invariably situated in sheltered bays or harbours, often with additional protection provided by a man-made breakwater. Marinas may be operated on a commercial basis, but many are also associated with a yacht club. Most yacht clubs and marinas also operate a slipway, where their members or clientele can scrape and antifoul their boats. Marinas may be used for permanent storage of some vessels or as a temporary stopover during a cruise by others.

There are approximately 550 coastal marinas in Australia, with the majority being in Queensland, New South Wales and Tasmania and a minority in the Northern Territory (G Jones *pers. comm.*2003). Table 14 presents an approximate breakdown of marina numbers by state.

STATE	APPROXIMATE NO. COASTAL MARINAS
Queensland	160
New South Wales	160
Victoria	35
Tasmania	90
South Australia	35
Western Australia	55
Northern Territory	15
TOTAL	**550**

Table 14: Approximate number of coastal marinas per state. (Data courtesy of Glen Jones, President, Marinas Association of Australia.)

Issues associated with sector

Marinas aggregate recreational vessels, often in huge numbers, and provide an unregulated interface between international and domestic craft. A marina is often the first port of call for an international cruising yacht arriving directly from overseas and offers an environment in which it comes into immediate proximity to domestic recreational craft, without having to undergo any mandatory reporting or inspection procedures. This was the case with the Black Striped Mussel incursion in Darwin in 1999. Marina traffic is also largely unregulated. There is very little monitoring of incoming or outgoing vessel movements; however, it has been estimated that tens of thousands of boats travel between Australia's marinas each year (Floerl 2001).

Most marinas house vessels for long periods of time, during which biofouling accumulates on hulls and other immersed surfaces. According to Floerl (2001), 20 - 45% of vessels in marinas carry some fouling. Not only may vessels remain immobile in their marina berths for extended periods, but protected marinas are also renowned for encouraging high rates of biofouling (almost 20 times faster than other coastal locations) due to their reduced water circulation (Floerl 2001). Apart from the vessels themselves, marinas provide many other surfaces for pests to become established on, such as the pontoons that vessels tie up to.

Management Approaches

Measures directed towards managing the environmental issues associated with marinas, and other boat repair and maintenance facilities, have come from both government and industry sectors. A range of state and local government authorities are involved in administering a number of legislative requirements relating to marinas, in particular, pollution control acts. In addition, two sets of EPA guidelines exist, one for Victoria (EPA 1998), the other for New South Wales (EPA 1998, EPA 1999), for environmentally responsible practices at marinas. "Exotic species" are listed as a pollutant type in the Victorian EPA report (p.6), and it is recommended that "all cleaning should be performed in a way to ensure no marine organisms....fall into marina waters." (p.9). There is no mention of marine pests in the list of key environmental issues for marinas, boatsheds and slipways in the NSW EPA document however.

At the same time, the Marina Association of Australia (MAA) is developing a national Code of Practice that establishes standards of conduct for marina, boatyard and slipway operations, including guidelines for acting in an environmentally responsible manner so as to minimise on- and near-shore impacts (MAA 2003). This is commonly referred to as the "Clean Marinas; Australia" plan and it includes reference to "performing boat maintenance and repairs in such a way that debris and waste is…collected and disposed of in an environmentally responsible manner." It recommends "preventing or discouraging in-water hull cleaning and maintenance…that is likely to remove antifouling [paint] or any other deleterious material into the marine environment" as well as "incorporating traps, bunds and other controls to prevent pollutants coming from slipways or hardstand areas from reaching the waterways." (MAA 2003).

As a result of these efforts, gradual, incremental adoption of environmental best practice relating to waste management is occurring in this sector. However, it is happening in a piecemeal fashion with no national coordination and there are financial constraints to its complete adoption. There are also no mandatory standards that these facilities are obliged to comply with and no recognition of the risks posed by the accumulation of biofouling that occurs whilst boats remain *in situ.* These fouling communities may include marine pests that can be translocated to new sites during subsequent vessel voyages.

As marinas are places where the potential for entrainment of marine pests is high, government agencies should work with the MAA to extend current initiatives relating to hull cleaning to other aspects of marine pests management. Education should be an element of this. Many marinas distribute newsletters to boat owners and post notices in their reception area, thus providing potential fora for raising awareness among marina clients. Mandatory reporting requirements for vessels arriving from overseas (eg international cruising yachts) and inspections of vessels that are deemed high risk are also recommended. It may also be useful to carry out regular surveys of high-risk marinas as is currently being done for ports.

8. Moorings and buoys

Description of sector

Moorings are fixed anchors and chains attached permanently to the seabed (often by means of a large cement block) and usually marked with a buoy, for vessels to tie up to. They may be either publicly or privately-owned, the former being supplied by port and harbour authorities for the temporary use of any vessel or available for lease from waterways or marine and safety agencies (eg MAST) and the latter being the property of a particular vessel owner. Buoys are anchored floats (see photo above) marking navigational hazards and shipping channels. Buoys are also used by boat clubs as racecourse markers and by marine farmers to mark the boundaries of mariculture leases. The total number of moorings and buoys in the Australian marine environment is unknown (and probably unknowable) but, according to MAST data, there are approximately 3250 moorings in Tasmania and they are used by around 5% of boat owners in that state to store their craft.

Issues associated with sector

Moorings and buoys provide marine pests with submerged and semi-submerged surfaces to which they may attach themselves. In many cases, these structures remain undisturbed for long periods before they are lifted up for maintenance or re-positioning. All craft that pass near or handle them, but in particular workboats used by port authorities and other agencies, may be at risk of infection from a fouled mooring or buoy. Buoys, in particular, can also become vectors if they break adrift and float off downwind or down current carrying their load of fouling with them.

Management approaches

There are many agencies, organisations and private individuals that use moorings and buoys, making it a difficult sector to manage. While there appears to be no evidence that buoys or moorings have been implicated in a marine pest incursion it is suggested that inspection and maintenance protocols or guidelines be considered, particularly in the event of a marine pest outbreak or if the structure is to be relocated.

9. Pontoons

Description of sector

Pontoons are floating wooden structures that form bridges, walkways and platforms. There is a diverse range of sizes and uses for these structures, but their predominant function is as items of infrastructure for vessels to tie up to. For example, there are approximately 20 pontoons moored on the Great Barrier Reef as support structures for tourism operations (Kapitzke et al. 2002). An unusual use of a pontoon is as a floating bar on Sydney Harbour (see photo above). The “fish” punts in Hobart docks, which are used for retailing fish, are a similar type of craft.

Pontoons may occasionally move (or be moved), in which case they have the potential to be a translocation vector. On the whole though, pontoons remain immobile for long periods, often serving as jetties or marina walkways. However, this sector is somewhat obscure and further research is needed to determine the numbers and types of these structures, the extent to which they may become reservoirs for pest organisms and the circumstances under which they may be relocated.

Issues associated with sector

Pontoons are relatively large items of infrastructure, immersed permanently in the water and therefore liable to collect fouling, which could harbour marine pests. Pontoons are quite likely to remain *in situ* for long periods of time and be carrying significant amounts of fouling, possibly including motile organisms embedded in the attached fouling community. Furthermore, they are often situated in or near marinas or ports where fouling rates and the likelihood of the presence of a marine pest are both high. Pontoons may therefore be infected by IMP either directly (through physical contact with an infected vessel) or indirectly (through the accumulation of biofouling) and have the potential to act as pest reservoirs. They may subsequently transfer pests to other vessels that tie up to the pontoon.

While pontoons are generally stationary objects, they may be moved from time to time for maintenance or other operational reasons. For instance, they are moved from Queensland ports to sites on the GBR (P Tomkins *pers. comm.* 2003), in which case they may act as translocation vectors. This presents a serious biosecurity threat if the pontoons are infected with IMP and moved to a World Heritage site or marine park.

Management Approaches

There do not appear to be any existing management arrangements for this sector. For example, there are currently no guidelines for the management of pontoons on the GBR (P Tomkins *pers. comm.* 2003). GBRMPA issues permits to individuals or companies (eg tourism operators) but are not involved in maintenance arrangements, although they do encourage owners not to clean pontoons on site. For this reason, they are generally moved to ports to be cleaned or refitted. This takes place only occasionally, usually when the pontoon is being sold. Pontoons may sit in port for extended periods before being taken out to the reef again. Regulations regarding the maintenance and inspection of pontoons could be made a mandatory condition of the issue of a permit. The Tourism Advisory Committee could be engaged to foster best practice in the tourism industry and educate the owners/operators of pontoons about the risks of IMP translocation.

10. Slipways

Description of sector

Slipways are concrete ramps leading into the sea, fitted with steel rails and a mobile cradle and designed for launching or retrieving large, fixed-keel vessels such as commercial fishing boats (see photo above), yachts, motor cruisers and smaller trading vessels. During the retrieval process, the cradle is rolled down the rails and submerged under a floating vessel. The vessel is secured onto the cradle with girdles and winched ashore in order to effect repairs or carry out maintenance, such as the removal of biofouling (which reduces the vessels' hydrodynamic efficiency) and the application of antifouling paint. This work may be conducted on the slipway itself or on an adjacent hardstand area, with the boat supported by wooden poles and chocks. Some slipways offer additional haul-out facilities such as cranes and forklifts. Slipways generally have the capacity to haul out vessels weighing from tens to thousands of tonnes; vessels larger than this typically use dry docks (see Part II: Section 5).

It is difficult to obtain information on slipways in Australia as a whole as there is no peak organisation such as an industry body that represents the sector. Moreover, ownership of and responsibility for slipways is divided between port authorities, state government departments, local councils, community associations (eg yacht clubs), members of the general public and the private sector. However, a comprehensive survey of the boat repair and maintenance industry has recently been completed and documented in Tasmania (DPIWE 2002) so this data will be presented as an example of the scale and nature of activities in the sector. In Tasmania there are at least 216 slipways, the majority of which (150 or 70%) are small, privately-owned, single slips used for small craft such as dinghies, less than 5 m in length. Twenty-five percent (53) are commercial or large private facilities and the remaining 5% (13) are boat club slipways available mainly to club members. The Tasmanian Department of Primary Industries, Water and Environment (DPIWE) report estimates that more than 4 000 boats are slipped annually in Tasmania.

Issues associated with sector

Biofouling removed from the hulls of vessels cleaned at slipways, may be either deliberately or inadvertently returned to the marine environment, allowing a pest population to become established in the slipway environs. This reservoir of pests may subsequently infect other vessels. Slipways are often sited in estuaries, ports or marinas where many vessels transit through the area while boats are being hauled out and cleaned. A mixture of vessel types congregates at slipways, including commercial fishing vessels, other small industrial craft and yachts, and these arrive from a variety of locations. For example a small pilot study of slipways in the Derwent estuary (K Peake *pers. comm.* 2003) showed that, whilst the majority of vessels slipped in the Derwent came from the local region, a small percentage came from further afield, including as far away as the north coast of Tasmania.

The DPIWE survey (DPIWE 2002) identified the following issues associated with slipway operations in Tasmania that are relevant to the spread of marine pests. These issues would be common to slipways elsewhere in Australia also.

- Half or more of all commercial and boat club slipways have more than one slip.
- 30% of commercial slipways slip more than 50 boats a year and 64% of boat clubs slip between 100 and 1 000 boats a year.
- Most facilities undertake all work on the actual slipway (this is true for nearly 90% of the commercial slipways), which often extends below the high tide mark.
- Few measures are in place to capture or trap waste material from hull cleaning. For example, only three facilities in Tasmania have bunded their slipways and graded the surface to a pit or sump that captures all wastes.
- There are few, if any, dedicated staff at slipways to monitor or manage on-site activities and, at 70% of facilities, boat owners are solely responsible for disposal of waste.
- There is a low level of awareness of and compliance with appropriate waste management practices. To some degree this results from lack of "technological sophistication" and financial constraints on implementing best management practices.

Management approaches

Slipways are generally regulated by legislation and licensing requirements, either through the state EPA or local government council, except in Victoria and the Northern Territory, although there is considerable interstate variation in activity types and capacity thresholds that are applicable to regulation (DPIWE 2002). Following on from their review of the sector, DPIWE has recently developed *Draft Environmental Management Guidelines for Operational Best Practice at Slipways and other Boat Repair and Maintenance Facilities* (DPIWE 2003). These contain a section (p.15) on "Removal of hull foulants and marine biota" that aims to encourage the implementation of measures to contain all wastewater and biological material removed from vessels. In South Australia, the EPA's code of practice for stormwater pollution prevention contains a section on Marinas, Ports and Slipways (p.22) that recognises the need to dispose of ballast water or sludge in sea chests via the sewer system, to carry out maintenance work above the high water mark and to dispose of slipway wastes in a collection pit or approved landfill.

State Governments and industry associations are also now encouraging all facilities and boat owners to adopt the *ANZECC Code of Practice for Antifouling and In-water Hull Cleaning and Maintenance* (ANZECC 2000). This document outlines desirable requirements for the construction of new facilities as well as measures that can be adopted by existing ones to minimise slipway wastes and run-off of any kind from returning directly to the sea. It contains major references to marine pests and explicitly refers to the disposal of "live organisms from another country or a distant part of Australia" and "marine biota removed from antifouled hulls" and recommends this material be collected and deposited in landfill sites. The Code of Practice also prohibits the cleaning of hull apertures such as sea chests (which are known to provide high entrainment potential) without a permit application that must detail how marine debris will be contained and disposed of. The ANZECC Code of Practice is, however, applicable only to all commercial vessels in Australia. Initiatives that deal with recreational vessels include the guidelines and codes of conduct developed by the NSW EPA, the BIA and the MAA discussed previously in Part II: Section 7, which apply not only to marinas but to all boat repair and maintenance facilities.

Vector:Node Connectivity Table

Nodes are an integral part of the secondary invasion process. Nodes are sites where vectors become infected by pests and vector traffic between nodes is the primary mechanism by which marine pests are translocated to new sites. The table below presents a preliminary attempt to classify, in qualitative terms (Low, Medium, High), the extent to which each vessel sector uses each type of node.

Node / Vector	Anchorages	Boat ramps	Defence bases	Derelict craft	Dry docks	Fishing harbours	Marinas	Moorings	Pontoons	Slipways
Barges & Lighters	L	L	M	L	L	L	L	H	L	H
Cable ships	L	L	L	L	L	L	L	L	L	L
Charter boats	H	M	L	L	L	M	H	H	H	H
Coastguard patrol boats	M	H	L	L	L	M	M	L	M	M
Commercial fishing boats	M	M	L	L	L	H	L	H	L	H
Cruise ships	M	L	L	L	M	L	L	L	L	L
Customs launches	M	L	M	M	L	L	L	M	L	H
Defence vessels	L	L	H	M	H	L	L	M	L	M
Dredges	L	L	L	L	L	L	L	L	L	H
Ferries & Water taxis	L	L	L	L	M	L	L	L	M	H
Fisheries patrol boats	M	M	L	L	L	M	M	M	M	M
Harbour services craft	L	L	L	M	M	L	L	M	L	H

Mobile drilling rigs	L	L	L	L	L	L	L	L	L	L
Motor cruisers	H	M	L	L	L	L	H	H	H	H
Offshore support vessels	L	L	L	L	M	L	L	L	L	M
Personal water craft	M	M	L	L	L	L	L	L	L	L
Research vessels	L	H	L	L	L	M	L	L	L	M
Sail training vessels	H	L	L	L	L	L	L	L	M	H
Seismic survey ships	L	L	L	L	M	L	L	L	L	L
Small powered craft	L	H	L	L	L	L	L	L	L	L
Trailer sailers	M	H	L	L	L	L	L	L	L	L
Water Police	M	M	L	M	L	M	M	M	M	M
Yachts	H	L	L	L	L	M	H	H	M	H

Conclusions

This report identified 19 sectors, (one of which, recreational vessels, was divided into 5 sub-sectors) of non-merchant vessels operating in the Australian marine environment. The combined fleet of all these sectors amounts to almost a million vessels, each of which is, to varying degrees, capable of translocating an introduced marine pest from place to place and therefore acting as a vector for the domestic spread of marine pests. Most of these vessels are based permanently in Australia, but some are international visitors and several carry ballast water for trim or stability purposes.

The potential for each sector/sub-sector to translocate marine pests was systematically assessed on the basis of the operational characteristics of the sector, and the sectors were ranked in order of secondary invasion risk. **It was concluded that commercial fishing vessels, dredges, offshore (petroleum) support vessels and barges pose the highest risk of facilitating secondary invasions, followed by harbour services craft and mobile drilling rigs.** All of these sectors scored particularly high for entrainment potential. Fishing boats emerge as the highest risk, because they are extremely active on the water and deploy gear that is designed to capture marine organisms. This is consistent with an earlier assessment conducted at an expert workshop on the spread of *Asterias amurensis*, which ranked commercial fishing as one of the two primary vectors, amongst a group of 19, for spreading adult seastars in southern Australian waters (DSE 2002). It was recognised there, as here, however, that the threat is not consistently high for all fisheries and fishing techniques. Further, more detailed work is required to identify the high-risk sub-sectors.

The sectors assessed as low risk incorporate all of the smaller, trailered, recreational vessels, as well as vessels belonging to coastguard organisations and the Australian Customs Service. These sectors were all considered unlikely to entrain a marine pest. The remaining sectors could be considered as intermediate risk. This group includes the larger recreational and tourism vessels (yachts, motor cruisers, charter boats, ferries, sail training vessels and cruise ships), international visitors such as cable ships, enforcement vessels (water police, fisheries patrol, Defence) and research vessels.

The risk assessment is preliminary and the assignment of scores was carried out by the project team. An equal, linear and additive relationship between factors and risk was assumed, but this is unlikely to be true. Further research is required in order to understand the full suite of factors contributing to risk, the relationships between factors and actual risk and the relative importance of each factor. It is also suggested that a future improvement to the risk assessment would involve assembling a team of experts from each sector and using their expertise to assign scores as well as to examine some sectors at a more detailed, sub-sectoral level. This is especially recommended for commercial fishing vessels and the Defence sector.

The report also identified ten types of maritime feature that are termed nodes to indicate the fact that they are places or features in the network of routes vessels travel along at which they cross paths with other vessels, either from the same or another sector. Nodes are sites at which marine pests are most likely to be picked up or deposited, because vessels remain stationary at nodes and because nodes are the sites of primary invasions. A risk assessment of nodes was not carried out, but three types emerged from the review (Table 15): (1) nodes where pest organisms may be dislodged from vessels and colonise the environs of the node; (2) nodes where vessels aggregate and where cross-infection between vessels is possible; and (3) nodes that, in addition to the former functions, also have the potential to become vectors if they are moved either deliberately or accidentally, by a storm for example.

IMP dislodgement nodes	Vessel congregation nodes	Nodes as vectors
Dry docks	Fishing harbours	Moorings & buoys
Slipways	Marinas	Abandoned & derelict craft
Boat ramps	Pontoons	Pontoons
	Anchorages	
	Boat ramps	
	Defence force bases	
	Moorings & Buoys	

Table 15: Classification of nodes.

Most of the sectors examined in the review are so far largely unregulated in terms of secondary invasions, although some vectors will come under the Coastal Shipping component of the National System. Existing management arrangements within and across sectors are currently patchy and uncoordinated and there is limited understanding of the issues by stakeholders. Notable exceptions are agencies such as the Water Police and fisheries patrol, which have been alerted by recent invasions such as Black Striped Mussel. Some industry bodies and community organisations are aware of the problem, however, and have implemented voluntary responses such as environmental guidelines for boat repair and maintenance facilities and recommended practices for small vessel cleaning. It is recommended therefore that these current, fragmentary initiatives be consolidated. For example, where existing Codes of

Practice or EPA guidelines exist for a particular state, sub-sector or activity type, these should be used as the basis for development of a set of national best management practice guidelines for the sector as a whole. It is recommended that this process involve consultation and collaboration with industry and stakeholder groups such as AMPA, Yachting Australia, BIA, etc. Agencies and organisations such as the coastguard, Water Police, fisheries patrol, and Customs can be approached directly as they have formal organisational structures and a clear hierarchy of responsibility and, in most cases, an environmental officer who could be used as a point of contact for consultation.

A general need has been identified for education and awareness-raising across all sectors, but in particular for those rated as high risk. This may be achieved in a number of ways, according to the sector, but suggestions include:

- exploiting vessel registration processes to distribute an information and awareness kit (brochures, identification guides etc.) and draw attention to existing guidelines and Codes of Conduct
- incorporating education about marine pests into existing formal training courses undertaken to obtain professional qualifications or run by organisations such as the coastguard in order to equip volunteers for their role
- utilising peak representative bodies and professional associations to coordinate educational campaigns.

As nodes are critical elements of the translocation process, efforts to improve the sanitation of nodes by inspecting and cleaning both vessels and fixed infrastructure in a manner that reduces the likelihood of IMP being established in the node environment are recommended. Such measures include the installation of effective waste management and treatment facilities at dry docks and slipways (including those run by yacht clubs and marinas), discouraging the scraping of hulls in places where vessels are moored or lie at anchor, particularly if these sites are located within the boundaries of a marine park, and inspection and treatment of derelict and abandoned boats, pontoons, moorings and buoys before they are transferred to a new location.

In terms of management actions, it is recommended that top priority be afforded to the high-risk vessel sectors and that consideration be given to managing all aspects of the invasion cycle (ie vectors and nodes) in an integrated manner.

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APPENDIX 1: Volume of each sector

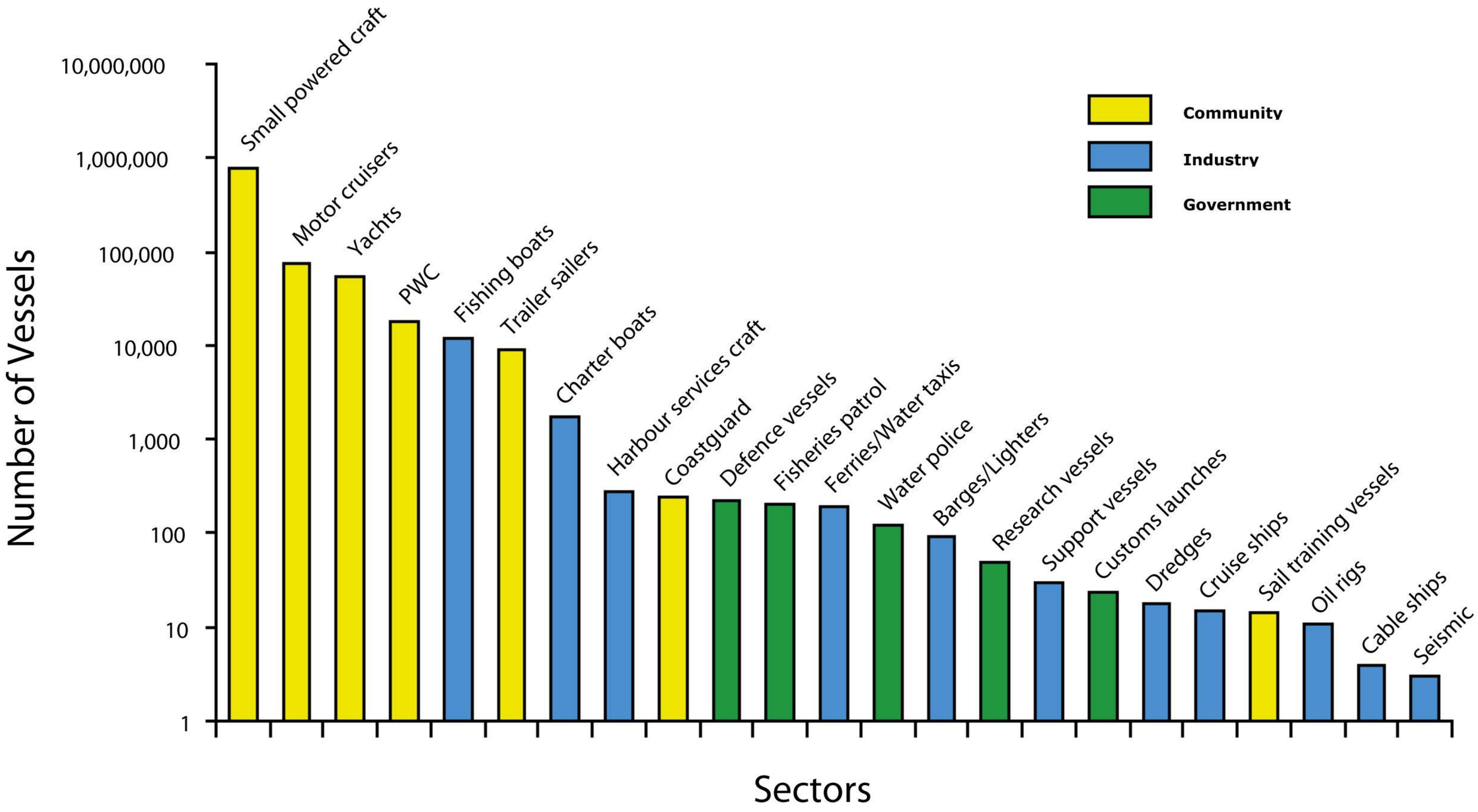

Figure 20: The number of vessels in each sector, displayed on a logarithmic scale. Each sector is displayed in the colour corresponding to the domain it belongs to, ie industry, government or community.

APPENDIX 2: Table of scores for all factors used in risk assessment

Sector	ENTRAINMENT							TRANSLOCATION					RISK RANKING
	Vessel Size	Contact with sea or seabed	Maintenance regime	Refugia	Relative time inshore	Node time	Total Score	Frequency	Range	Volume	Promiscuity	Total Score	
Barges & Lighters	15	18	21	14	14	20	**102**	17	11	10	11	**49**	**4**
Cable ships	21	21	14	20	8	10	**94**	2	18	2	3	**25**	**12**
Charter boats	8	16	13	10	13	17	**77**	13	9	17	6	**45**	**11**
Coastguard patrol boats	4	4	4	3	17	8	**40**	15	8	15	16	**54**	**20**
Commercial fishing boats	11	20	20	22	9	11	**93**	20	15	19	23	**77**	**1**
Cruise ships	23	8	14	18	5	12	**80**	6	21	5	5	**37**	**13**
Customs launches	16	3	7	9	6	7	**48**	7	23	7	12	**49**	**19**
Defence vessels	14	15	7	11	7	15	**69**	14	15	14	16	**59**	**8**
Dredges	18	23	22	21	21	21	**126**	15	13	6	4	**38**	**2**
Ferries & Water taxis	13	2	18	8	16	22	**79**	23	6	12	9	**50**	**7**

Fisheries patrol boats	5	4	4	6	14	8	**41**	18	10	13	21	**62**	**17**
Harbour services craft	12	7	19	15	21	23	**97**	22	5	16	1	**44**	**5**
Mobile drilling rigs	22	22	23	23	1	4	**95**	4	19	3	13	**39**	**6**
Motor cruisers	5	10	9	7	21	19	**71**	3	4	22	6	**35**	**16**
Offshore support vessels	20	17	14	15	4	13	**83**	21	20	8	20	**69**	**3**
PWC	1	1	1	1	23	1	**28**	11	1	20	6	**38**	**23**
Research vessels	10	19	12	17	11	5	**74**	9	12	9	9	**39**	**14**
Sail training vessels	17	13	11	13	10	14	**78**	11	17	4	16	**48**	**9**
Seismic survey ships	19	14	14	19	2	6	**74**	1	22	1	1	**25**	**18**
Small powered craft	3	11	2	5	19	2	**42**	10	2	23	16	**51**	**21**
Trailer sailers	2	9	2	2	19	2	**36**	8	3	18	13	**42**	**22**
Water Police	5	4	4	4	18	16	**51**	19	8	11	22	**60**	**15**
Yachts	8	12	10	12	12	17	**71**	5	14	21	15	**55**	**9**

APPENDIX 3: Image Sources

Barge: Perkins Shipping. http://www.perkins.com.au

Cable ship: Cable & Wireless. http://www.cwhistory.com/history/html/Cableships.html

Charter boat: Rupert Summerson

Coastguard patrol boat: http://www.coastguard.com.au/main.htm

Commercial fishing boat: Rupert Summerson

Cruise ship: http://www.simplonpc.co.uk/

Customs launch: http://www.customs.gov.au/site/index.cfm?nav_id=670&area_id=5

Defence vessel: Defence Image Gallery. http://www.defence.gov.au/gallery/index.html

Dredge: Albert Caton

Ferry: Tourism Tasmania. http://www.tourismtasmania.com.au/

Fisheries patrol boat: http://www.westernbb.com.au/military_kir.asp#

Harbour Services Craft: http://www.freport.wa.gov.au/Educaton/gallery.asp?k=&pic=301

Mobile drilling rig: http://www.diamondoffshore.com/fleet/bounty.htm

Offshore Supply vessel: http://www.swire.com.sg/

Pontoon: http://www.cocklebaywharf.com/pontoon.html

Recreational vessel: Albert Caton

Research vessel: Albert Caton

Sail training vessel: http://www.tased.edu.au/tasonline/ladynel/corframe.htm

Seismic survey ship: http://www.veritasdgc.com/bins/content_page.asp?cid=4-20-21

Water Police: http://www.sapolice.sa.gov.au/operations/watpol.htm

Anchorage: Rupert Summerson

Boat ramp: Albert Caton

Buoy: Buoyage Systems Australia Pty Ltd. http://www.buoys.com.au/zonebuoys.html

Defence base: Alexander Seewald. http://www.ai.univie.ac.at/~alexsee/

Derelict yacht: NOAA. http://response.restoration.noaa.gov/dac/vessels/

Dry dock: Defence Image Gallery. http://www.defence.gov.au/gallery/index.html

Fishing port: Rupert Summerson

Marina: Rupert Summerson

Slipway: Rupert Summerson

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Data sources

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