REPORT

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FINAL RIS

Ballast water management

A regulation impact statement

Prepared for:

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FINAL RIS

Centre for International Economics
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Summary

Introduced marine pests can cause serious environmental and economic damage. In the Baltic Sea an invasion of comb jelly so affected the marine food chain of the region that it led to the collapse of most fishing industries there valued at an estimated $US 500 million a year.

Ballast water carried in ships is recognised as a major source for spreading of non-indigenous marine organisms around the world. Marine pests have already been introduced into Australian waters and spread to other locations through ballast water discharge.

The Natural Resource Management Ministerial Council (NRMMC) and Australian Transport Council (ATO) agreed to develop a National System for the Prevention and Management of Marine Pest Incursions that will include national arrangements for ballast water that provide consistency between requirements at state, Commonwealth and international levels. The Councils agreed to the key elements of the ballast water management requirements in November 2006. Arrangements are being put in place to implement the National System, including legislation to give effect to the ballast water management requirements.

- A state acting unilaterally is likely to be considerably less efficient at dealing with exotic marine threats than a nationally based authority.
- Having separate state or voluntary arrangements for domestic shipping may create inconsistencies, loopholes and confusion in creating effective safe-guards. Effective protection against incursions is likely to be compromised.
- Nationally based requirements can achieve economies of scale and scope and make domestic shipping requirements consistent with existing international requirements. Legislation may be required to establish the national requirements.

Avoiding overlapping and inconsistent regulation is a major reform priority identified by the Productivity Commission in its 2006 review titled *Rethinking Regulation*. Another priority identified by the Productivity Commission is for the 'Australian Government to expedite collaborative work with the states and territories to develop nationally consistent

legislation and management requirements for domestic ballast water that accord with Australian Government requirements for managing foreign ballast water.'

The International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004, has also been developed to provide consistency between national regulations for the control of marine pest risks through ballast water. Significant benefits are likely to be derived from ensuring that Australian regulations are in line with the Convention, including the ability of Australia to ratify the Convention, simplification of the regulations for the shipping industry and improved environmental protection as a result of the regulations of other countries.

A regulation impact statement is required

This document is a regulation impact statement (RIS). Its purpose is to examine the impact of implementing consistent national ballast water management requirements. The intention of the requirements is to facilitate Australian implementation of the International Convention for the Control and Management of Ships' Ballast Water and Sediments, to extend ballast water management requirements to domestically-sourced ballast water, and to provide consistency in ballast water management requirements. Benefits take the form of expected reductions in exotic marine incursions and the potential economic, environmental and amenity damage avoided. Costs take the form of potential delays in shipping times, higher ship capital and running costs, enforcement costs and flow-on costs to the rest of the economy.

Options for consideration

Until a permanent on-board ballast water treatment system can be adopted, the general mechanism underlying a proposed National System is a risk-based ballast water exchange requirement. This will exist in some form until 2016 and will require ships that take on ballast water from a high-risk Australian port to exchange ballast water at sea before discharging at another Australian port. The risks are assessed via a series of ballast water risk tables and algorithm.

There has been no consideration of ballast water exchange costs for ships entering Australia from international waters as these requirements are already in place under the existing international requirements.

From an economic perspective, the requirements clearly indicate that three broad options need to be considered for domestic ballast water exchange arrangements.

- Option 1: mandatory exchange whereby all ships would be required to exchange ballast water regardless of the risk or voyage length, as is required for international ships entering Australian ports.
- Option 2: risk-based exchange as proposed which would limit the number of ships needing to exchange ballast water.
- Option 3: no additional requirement to manage ballast water, which is the status quo option (that is, domestic management arrangements only for Victorian ports).

These options only apply to the measures involving ballast water exchange that are planned for phasing out between 2009 and 2016. Pending the Convention coming in to force, starting from 2009 ships will progressively be required to meet new ballast water discharge standards from the Convention that will require onboard treatment of ballast water for all ships coming to and travelling within Australia. This implies only two options after 2016, on-board treatment or no requirement.

Within the first two options there are sub-options relating to where ballast water exchange might take place: at 50 nautical miles, in special zones, at 12 miles, and 3 miles. The options and sub-options define a range of possibilities for evaluation as set out in table 1.

1 **Options**

Options & possibilities	*Temporary*	*Permanent*
Option 1	**Mandatory exchange**	**On-board treatment**
Possibility 1 (Sub-option 1.1)	50 miles/200 metres	On-board treatment
Possibility 2 (Sub-option 1.2)	Special zones	On-board treatment
Possibility 3 (Sub-option 1.3)	Beyond 12 miles	On-board treatment
Possibility 4 (Sub-option 1.4)	Beyond 3 miles	On-board treatment
Option 2	**Risk-based exchange**	**On-board treatment**
Possibility 1 (Sub-option 2.1)	50 miles/200 metres	On-board treatment
Possibility 2 (Sub-option 2.2)	Special zones	On-board treatment
Possibility 3 (Sub-option 2.3)	Beyond 12 miles	On-board treatment
Possibility 4 (Sub-option 2.4)	Beyond 3 miles	On-board treatment
Option 3	**Status quo**	**Status quo**
Other options	Not evaluated	Not evaluated.

Source: The CIE (2006).

Costs of the options

In the period from 2007 to 2008, the cost of the regulation will be the costs of exchanging high-risk ballast water at sea and these will vary according the management option implemented. During the transitional period between 2009 and 2015, the costs of the regulation will be a function of the proportion of ships still using the ballast water exchange procedures and the proportion of ships using on-board treatment. From 2016, the cost of regulation will be the cost of implementing the permanent on-board ballast treatment facilities on all ships. As such, it is crucial to understand and quantify these cost impacts through time.

Initial costs

The additional costs imposed on ships required to exchange high-risk ballast water on voyages will be a function of how far off the standard route the ship would have to deviate. Associated costs include fuel (pumping) and delay costs. To quantify these costs, we have constructed a model based on earlier work conducted by ABARE, BRS and CSIRO.

The direct costs to the domestic shipping industry are considerable for distant offshore ballast water exchange as shown in table 2. These costs will not be evenly distributed across states (table 2).

The extra cost to government of ballast water management consists of ballast water and logbook inspections and the maintenance of the risk assessment tool and ballast water management database. Ports will also be monitored for the presence of exotic pests as required. The government cost will be around $1.0 million per year for option 2, most of which will be due to the costs of surveying ports.

Increasing the cost of domestic shipping will have flow-on effects across the rest of the Australian economy as well. Using a highly detailed general equilibrium model of the Australian economy it is possible to trace through the economy-wide effects of such an increase (table 3). The total costs (direct and flow-on) are not evenly distributed by jurisdiction. Worst hit is Queensland in option 1 and Victoria and Queensland in option 2 depending on the sub-option.

2 The direct costs to the shipping sector differ by jurisdiction and option

	Sub-option 1	*Sub-option 2*[a]	*Sub-option 3*	*Sub-option 4*
	$m per year	$m per year	$m per year	$m per year
Option 1 – mandatory exchange				
New South Wales	10.1	7.1	4.2	2.8
Northern Territory	3.1	2.1	1.1	0.6
Queensland	13.4	13.0	12.6	12.4
South Australia	2.5	1.7	0.9	0.5
Tasmania	4.8	3.0	1.2	0.5
Victoria	10.6	7.0	3.4	1.9
Western Australia	1.4	1.0	0.6	0.4
Total	*45.9*	*34.9*	*24.0*	*19.1*
Option 2 – risk based exchange				
New South Wales	2.7	1.8	0.9	0.5
Northern Territory	0.0	0.0	0.0	0.0
Queensland	2.0	1.8	1.5	1.4
South Australia	2.0	1.4	0.7	0.4
Tasmania	2.1	1.3	0.6	0.2
Victoria	4.2	2.8	1.3	0.7
Western Australia	0.8	0.6	0.3	0.2
Total	*14.0*	*9.7*	*5.3*	*3.4*

[a] This has not been costed directly and is estimated as the mid-point interpellation between sub-options 1 and 3.

Source: The CIE (2006).

3 Total Australian costs from alternative management options

	Direct shipping cost	*Additional long-run flow-on economy costs*	*Enforcement costs*	*Total cost*
	$m per year	$m per year	$m per year	$m per year
Option 1				
Sub-option 1	45.9	26.6	0.2	72.7
Sub-option 2[a]	34.9	20.3	0.2	55.4
Sub-option 3	24.0	13.9	0.2	38.1
Sub-option 4	19.1	11.1	0.2	30.5
Option 2				
Sub-option 1	14.0	8.1	1.2	23.3
Sub-option 2[a]	9.7	5.6	1.2	16.5
Sub-option 3	5.3	3.1	1.2	9.7
Sub-option 4	3.4	2.0	1.2	6.7
Option 3				
	0.0	0.0	0.0	0.0

[a] This has not been costed directly and is estimated as the mid-point interpellation between options 1 and 3.

Source: The CIE (2006).

Permanent costs

On-board treatment would require ships (on both domestic and international voyages) to meet a discharge standard that prescribes the permitted marine pest content in ballast water for discharge. The standard will result in ships having to install equipment to treat ballast water either in the ballast tank or on the uptake or discharge of ballast water. Different treatment options are likely to have varying cost structures. Estimates available suggest that the capital cost could range from around $1 million to $5 million to install. However, as most ships will be required to install this equipment for international voyages, the extra capital costs for the National System will be those required by ships that undertake only domestic voyages. These are relatively few. However, variable costs per tonne of ballast water treated will apply to all domestic and international shipping. The feasible range of variable costs associated with on-board treatment systems is likely to be between 0.06 cents and 4.66 cents per tonne of ballast water treated. On an annual basis, onboard variable treatment costs for all domestic voyages will be around $542 000 per year.

Applying a discount factor of 7.5 per cent to the annual costs of both the initial and permanent costs, the accumulated costs to 2025 will range between $454.9 million and $155.2 million (tables 4 and 5).[1]

The legislation will also impose requirements on Australian-flagged ships relating to record keeping, survey of equipment and sediment disposal. Ships will incur costs relating to maintaining a Ballast Water Record Book on board the ship, development and maintenance of an approved Ballast Water Management Plan, regular survey and certification of ballast water equipment and disposal of sediments. These costs have been estimated at approximately $90 000 per year.

1 The discount rate of 7.5 per cent is the average of the minimum and maximum rates of 5 and 10 per cent respectively used in the sensitivity analysis. These bounds reflect the typical commercial borrowing rates.

4 **Costs through time for option 1**

	Sub-option 1	*Sub-option 2*	*Sub-option 3[a]*	*Sub-option 4*
	$m	$m	$m	$m
Cost component				
Exchange costs	209.7	159.7	109.7	87.5
Treatment costs	3.3	3.3	3.3	3.3
Capital costs	31.7	31.7	31.7	31.7
Depreciation costs	41.4	41.4	41.4	41.4
Inspection costs	2.8	2.8	2.8	2.8
Economy flow-on costs	165.9	136.9	107.9	95.0
Total	*454.9*	*375.9*	*296.8*	*261.7*

a This has not been costed directly and is estimated as the mid-point interpellation between sub-options 1 and 3.
Note: these calculations assume a discount rate of 7.5% per year.
Source: The CIE (2006).

5 **Costs through time for option 2**

	Sub-option 1	*Sub-option 2*	*Sub-option 3[a]*	*Sub-option 4*
	$m	$m	$m	$m
Cost component				
Exchange costs	63.9	44.1	24.4	15.7
Treatment costs	3.3	3.3	3.3	3.3
Capital costs	31.7	31.7	31.7	31.7
Depreciation costs	41.4	41.4	41.4	41.4
Inspection costs	9.6	9.6	9.6	9.6
Economy flow-on costs	81.4	69.9	58.5	53.4
Total	*231.3*	*200.1*	*168.9*	*155.2*

a This has not been costed directly and is estimated as the mid-point interpellation between sub-options 1 and 3.
Note: these calculations assume a discount rate of 7.5% per year.
Source: The CIE (2006).

Benefits of options

The annual output of the Australian fishing industry (including aquaculture) is around $2 billion a year. But only a small proportion of this is likely to be expected economic loss each year from the chance of an exotic marine pest incursion.

- Only around 30 per cent of output is value added.
- Only around 40 per cent of the entire Australian commercial fishery is potentially at risk because much is not immediate coastal fishery, and then of that only about 10 per cent of the immediate commercial coastal fishery might truly be at risk in any one year because any incursion would probably be species specific and therefore not affect all regions.

- The probability of an incursion that results in a high impact would be less than 10 per cent a year, based on historical patterns of invasion to Australia.

Taking account of these proportions the expected economic cost of incursions reduces down to $2.4 million a year. Documented costs of exotic marine pests to the fishing industry in Australia support this, suggesting costs of $1 million to $5 million might be expected annually from all sources. If ballast water accounts for around 30 per cent of incursions, then a benefit of the proposed national system would be 30 per cent of the total, say $0.3 million to $1.5 million a year.

The annual value of output of the tourism sector is put at around $37 billion. Were similar economic proportionality to exist in tourism as fishing, as it probably does, potential benefits might range from $5.5 million to $27 million annually.

Non-use values of the marine environment (relating to existence, bequest and option value) are not easy to quantify and partly it is covered by estimates for tourism. But based on various studies of non-use values of environmental resources the expected national value of preventing additional incursions might be argued to reach or exceed $10 million a year.

Estimates cannot be added but it is possible to make a plausible case that the expected benefits of preventing further incursions (and the costs of incursions) via ballast water could exceed $30 million a year were the proposed system expected to be 100 per cent effective. But complete effectiveness will not be achieved. On-board treatment of ballast water will be phased in after 2009 precisely because ballast water exchange at sea is not fully effective. If the proposed system is only likely to result in an 80 per cent reduction in risk of marine pest incursion, potential benefits would decline to $24 million.

The effectiveness of the proposed system will vary depending on where exchange takes place and will vary between deep and shallow water and between whether it occurs close to, or distant from, land. Based on some work undertaken by the BRS and other factors we assume that the relative effectiveness of each sub-option is as follows:

- 50 miles (sub-option 1) – 90 per cent;
- zones (sub-option 2) – 85 per cent;
- 12 miles (sub-option 3) – 82 per cent; and
- 3 miles (sub-option 4) – 57 per cent.

Effectiveness drops off rapidly at around 3 miles from shore. Moreover the margin of error close to shore is also reduced. Tides and waves play a more substantial role in moving water to shore. The standard in the Convention for onboard treatment is regarded as more effective than ballast water exchange at sea — 95 per cent (table 6).

Weighing up the benefits and costs of options

The costs of the proposed National System are more certain than the benefits, but whatever the benefits are they will be relatively similar between options. Mostly it will be the costs that vary. Assuming potential annual benefits of $30 million a year, the present value accumulated benefits and costs options to the year 2025 are set out in table 6. The benefit to cost ratio for each option is also presented.

Option 2, sub-option 3 (risk-based 12 miles) is the most economically viable. The benefit to cost ratio for this sub-option is 1.7:1 and the net accumulated present value benefit is estimated at $118 million. For this sub-option to break even –for the net present value benefits to equal costs — national annual benefits must equal or exceed $17.6 million a year, compared with the $30 million a year assumed — table 6. Based on uncertainties surrounding major economic variables there would appear to be only about a 13 per cent chance of this option not breaking even and an 87 per cent chance of it breaking even.

6 **Benefit-cost implications for each option**

	Potential annual benefit	*Initial effectiveness*	*Permanent effectiveness*	*Accumulated benefit NPV to 2025*	*Accumulated cost NPV to 2025*	*Accumulated net benefit*	*Benefit to cost ratio*	*Potential benefit/yr required to break even*
	$m	%	%	$m	$m	$m		$m
Option 1								
Sub-option 1	30	90	95	298	455	-157	0.7 : 1	45.8
Sub-option 2	30	85	95	291	376	-84	0.8 : 1	38.7
Sub-option 3	30	82	95	287	297	-10	1.0 : 1	31.0
Sub-option 4	30	57	95	253	262	-9	1.0 : 1	31.0
Option 2								
Sub-option 1	30	90	95	298	231	67	1.3 : 1	23.3
Sub-option 2	30	85	95	291	200	91	1.5 : 1	20.6
Sub-option 3	30	82	95	287	169	118	1.7 : 1	17.6
Sub-option 4	30	57	95	253	155	98	1.6 : 1	18.4
Option 3								
	0	0	0	0	0	0	0 : 0	n/a

Source: The CIE (2006).

The risk-based, 12 nautical miles sub-option appears to be the best option

Provided a case can be made that economic benefits of the proposed National System requirements for domestically-sourced ballast water are likely to far exceed $17.6 million a year, the risk-based 12 nautical mile sub-option is the option that provides most reassurance that benefits will exceed costs. Although the risk-based, 3 mile sub-option (sub-option 2.4) also looks relatively favourable, it provides considerably less effective protection from an exotic incursion. Moreover, the margin for error at 3 miles is much less than at 12 miles.

Sensitivity analysis

Considerable uncertainty surrounds the estimates of costs and benefits.

- Rather than an estimated annual benefit of $30 million a year, a range of between $10 million and $50 million a year may be a more plausible representation of what is known and not known.
- Among cost factors, the cost of delay and pumping, the costs of inspections and ballast water management plans, the number of required inspections, the capital costs of on-board treatments, depreciation rates and the number of ships could vary widely compared with those assumed.

These uncertainties raise questions about the robustness of the results.

Taking account of these uncertainties, results are most sensitive to estimates of the national benefits and assumptions about effectiveness of the system rather than cost factors. That said, for the risk-based 12 mile option there is:

- only an estimated 13 per cent chance that costs will exceed benefits - the accumulated net present value benefit is less than 0.0;
- an estimated 87 per cent chance that the benefits will exceed costs - the accumulated net present value benefit is greater than 0.0; and
- estimated 90 per cent chance that the accumulated net benefit will be between $-59.6 million and $289.1 million.

Most other options would require considerably higher annual benefits to breakeven. Option 1, sub-option 1 for instance would require annual benefits of around $45.8 million year, over 2.5 times those required for option 2, sub-option 3 to be viable — table 6.

1 Introduction

Introduced marine pests can cause serious environmental and economic impacts. Once established they can prey on and/or displace indigenous species. Directly and indirectly, invasive species can damage:

- commercial fisheries and aquaculture;
- the tourism industry;
- the amenity and non-use value of the marine environment relating to existence, bequest and option values;
- human health through diseases such as cholera;
- the commercial efficiency of ports through weed infestation; and
- infrastructure such as port facilities, navigation aids, water pipe systems and even hydroelectric plants.

Moreover, once established introduced species are typically difficult or expensive to eradicate. As an indication of the potential costs, in the Baltic Sea an invasion of comb jelly so affected the marine food chain of the region that it led to the collapse of most fishing industries there valued at an estimated $US 500 million a year (Low 2003).

Ballast water is a biosecurity risk

Ballast water carried in ships to maintain safety and stability at sea has now been recognised as a major source for the spreading of exotic marine pests around the world. Current national ballast water requirements aim to minimise the introduction of pests of concern into Australian territorial waters (12 nautical miles). The requirements, however, only cover the importation of ballast water from foreign ports. Ships already in Australia and moving Australian sourced ballast water to another domestic port are not yet covered by ballast water management requirements, except in Victoria. It has been estimated that 10 000 different species are being moved between various regions around the world in ballast water tanks each day (Low 2003). Marine pests have already been introduced into Australian waters and spread to other locations through ballast water discharge.

Recently an international convention was agreed that aims to reduce the risk of introducing marine pests through ballast water and provide consistent international ballast water management requirements for ships. The International Convention for the Control and Management of Ships' Ballast Water and Sediments was developed through the International Maritime Organization. The text of the Convention was agreed in February 2004 and Australia signed the Convention, subject to ratification in May 2005. The Convention will enter into force when it has been ratified by 30 countries representing 35 per cent of gross world tonnage (currently six countries representing less than 1 per cent of tonnage have ratified).

This RIS has been prepared in anticipation of regulatory change being required to implement the National System, which has been developed to comply with the standards set out in the International Convention. This RIS is intended to serve the dual role of assessing the regulatory requirements of the National System and facilitating the ratification of the Convention.

The Australian Government already has in place a ballast water management regime for arriving international ships, with ballast water exchange standards the same as those required under the Convention. This management regime is to be extended from 1 July 2008 under the National System to include ships carrying domestic ballast water, with the State and Northern Territory governments responsible for the operational and legislative elements of compliance. There will be additional requirements for all ships – both international and domestic — namely:

- survey and certification;
- the onboard possession and utilization of ballast water management plans and ballast water logs; and
- the management of residual sediment in ballast tanks.

This RIS also anticipates the impact of the Convention's future requirement that all ships – both domestic and international – move from deep sea exchange as a means of managing high risk ballast water, to the fitting and utilization of onboard ballast water treatment technology. This is expected to be phased in from 2009 with full compliance for existing and newly constructed ships due from 2016, assuming that the Convention enters into force during this time.

Incursions of exotic marine pests through ballast water discharge are an economic cost that one group in the economy (shipping) unintentionally impose on other industries, regions and individuals. In economic terms, ships potentially impose 'externalities' or 'spillovers' on others and they do not individually face direct market incentives to minimise or avoid the costs or risks created. In such situations typically markets are said to fail to allocate resources efficiently. An 'in-principle' case may be made for governments to intervene in markets to address such failure. Successfully addressing the failure may deliver a benefit to the economy. However, intervention also imposes costs of its own. To accept a case for intervention it must be shown empirically that the benefits of intervention exceed the costs.

Proposed intervention to address the risk

The Natural Resource Management Ministerial Council and Australian Transport Council have agreed to develop a National System for the Prevention and Management of Marine Pest Incursions. Jurisdictions formalised this agreement in an Intergovernmental Agreement on the development of a National System. The Councils agreed to the key elements of the ballast water management requirements in November 2006. The Australian Government and the governments of Victoria, Tasmania, South Australia, Queensland, Western Australia and the Northern Territory have signed the Agreement (Natural Resource Management Ministerial Council 2005).

The States and Northern Territory have agreed to ensure that arrangements consistent with those applying to international shipping are in place for ships that may discharge ballast water taken up in Australian waters. Jurisdictions have also agreed that measures implemented under the National System will be consistent with current or future international agreements.

The arrangements set out in the Ballast Water Convention rely on ballast water exchange similar to the current Australian requirements applying to international shipping. The existing Australian Requirements:

- prevent the discharge of high-risk ballast water inside Australian territorial seas (12 nautical mile limits generally apply);
- deem all water from ports (or coastal waters) outside Australia to be high-risk; and
- require that ships achieve a minimum 95 per cent volumetric exchange of their ballast water in deep water before discharging in Australian ports.

Further details of the international requirements are provided at:

http://www.daff.gov.au/corporate_docs/publications/html/quarantine/ballast_water/index.html

Under the Convention, the ballast water exchange requirements will phase out between 2009 and 2016. Starting after 2009 ships will be required to meet new performance standards for ballast water discharge that will require on-board treatment of ballast water. The Convention also requires that ships have a Ballast Water Management Plan, each ship be surveyed and issued with a certificate, sediments be managed appropriately, certain safety requirements be met and that each ship keep detailed records of ballast water management operations.

Had it not been agreed to develop a national system each jurisdiction would be likely to develop a separate system. A national system has the advantages of:

- having the backing of federal legislation where needed; and
- offering a single nationally consistent, coordinated and integrated system that is likely to offer ship owners and enforcement authorities economies of scale and scope in compliance.

The costs of separate systems can impose significant costs for national companies operating in what should be a national market (Productivity Commission 2006). Avoiding overlapping and inconsistent regulation is a major reform priority identified by the Productivity Commission in its 2006 review titled *Rethinking Regulation*. Another priority identified by the Productivity Commission is for the 'Australian Government to expedite collaborative work with the states and territories to develop nationally consistent legislation and management requirements for domestic ballast water that accord with Australian Government requirements for managing foreign ballast water.' (Productivity Commission 2006, page 81)

Shipping industry organisations and port authorities are particularly concerned that ships do not face a plethora of different arrangements as they move around Australia. They strongly support legislative arrangements that would secure the national consistency promised in the Intergovernmental Agreement.

Objectives of regulation

The three principal objectives of the proposed intervention are:

- to efficiently and effectively reduce the risk of the introduction and spread of exotic marine pests in Australian waters via ballast water;

- to make domestic requirements for the handling of ballast water similar to and consistent with international arrangements; and
- to avoid the development of separate, fragmented, disparate state-based systems.

Intent of ballast water regulations

Under the inter-governmental agreement (IGA), jurisdictions have agreed that:

- there is a need to develop, implement and maintain a National System to prevent and manage marine pest incursions;
- the National System would:
  - provide effective and cost efficient procedures in relation to prevention, emergency management and ongoing management and control of marine pest incursions, for the purpose of protecting Australia's marine environment and industries dependent on marine resources;
  - facilitate consistency in Australia's border and post border controls for marine pest management and their consistency with relevant international standards;
  - provide a consistent regulatory approach across Australia through legislation and/or nationally agreed standards, guidelines and protocols; and
  - provide cost effective compliance and enforcement arrangements for industry, government and the community;
- nationally consistent management arrangements for the regulation of ballast water are required;
- all inspection and other services related to ballast water management will be provided to an agreed national standard through the most cost effective and appropriate providers;
- measures implemented under the National System will be consistent with the provisions of any current or future international agreements relating to exotic marine species, subject to Australia's ratification or other form of endorsement of that agreement (noting the agreement, through the International Maritime Organization, of the International Convention for the Control and Management of Ships' Ballast Water and Sediments);
- a Single National Interface would be established to:

  - act as a single point of contact for ships and jurisdictions on ballast water management;
  - deliver functions, including provision of consistent, agreed advice on management requirements, management options or other relevant information for both internationally and domestically sourced ballast water;
  - take receipt of required risk management documentation; and
  - co-ordinate a national monitoring, inspection and verification regime;
- the Australian Government, states and Northern Territory will implement the legislation to ensure that there is a nationally consistent regime for the regulation of ballast water.

Other requirements of the convention and regulation

Record keeping

The current record keeping requirements for the Australian shipping are broadly consistent with the requirements of the International Convention, but are in a different format. The requirements of the Convention mandate that a ship has a separate record book for ballast water operations in a prescribed format. The proposed record keeping arrangements would not add a burden that is additional to what would be required by other Parties (countries) to the Convention.

Ballast Water Management Plan

Implementation of Ballast Water Management requirements consistent with the Convention would cause each Australian flagged ship to develop and implement a Ballast Water Management Plan and have it approved by the relevant government authority. The Ballast Water Management Plan is required to detail the shipboard procedures to be taken to implement the ballast water management requirements, including matters relating to safety, sediment management, ballast water operations, coordination procedures and crew responsibilities.

Survey and Certification

The Convention requires that ships of 400 gross tonnage and above to which the Convention applies are required to undergo a survey at regular intervals to confirm that the Ballast Water Management Plan and associated structure, equipment, systems, fitting, arrangements and material or processes comply with the Convention. The surveys vary through time, with more rigorous surveys required initially and following any major change through to more general condition inspections annually. A Certificate is issued to the ship by the relevant government authority following the successful completion of the survey.

Sediment management

The Convention contains a range of requirements to minimise the risk of marine pests being picked up and harboured in sediment. These include guidelines in relation to ship design and construction for the minimisation of sediment accumulation and easy access for removal and sampling. This provision of the Convention is recommendatory rather than mandatory, so there is little additional cost imposed by the regulations.

The Convention also requires that Parties to the Convention provide appropriate facilities for sediment reception at locations where the cleaning or repair of ballast tanks occurs. There are likely to be limited facilities in Australia where these procedures occur and the primary requirement for adequate biosecurity management is that the wastes do not find their way into the marine environment. This would generally involve provision of a bin or skip that sediment can be placed in before being disposed of in a landfill. There may be some reduction in the locations where ships can dispose of sediments (for example, through flushing ballast tanks), however, most sediment removal procedures are conducted during dry dock.

Safety

The Convention provides several exceptions for ships from the ballast water management requirements for reasons of ship safety in emergency situations, saving life at sea and accidental discharge resulting from damage to the ship. These exceptions would result in the discharge of unmanaged ballast water, but are likely to be relatively rare and would not reduce the benefits of regulation.

In addition, a ship conducting ballast water exchange is not required to meet the exchange standard if the master reasonably decides that such an exchange would threaten the safety or stability of the ship, its crew, or its passengers because of adverse weather, ship design or stress, equipment failure or any other extraordinary condition. The circumstances in which a ship would then be able to discharge this unmanaged ballast water in a port is still under consideration. Should the discharge be allowed, this would not have any cost implications for the ship. If, after the safety issue had been addressed, a ship was required to leave port again to exchange this ballast water prior to discharge then a significant cost would be incurred. However, safety incidents should be relatively rare, although the potential issues for shorter domestic voyages have not been well tested.

A regulation impact statement

To develop a national system that is enforceable by law will require use of federal and state based legislation. The Council of Australian Governments (COAG) endorses a set of 'Principles and Guidelines for National Setting and Regulatory Action by Ministerial Councils and Standard-Setting Bodies'. These principles require that a regulation impact statement (RIS) be undertaken whenever new legislation is proposed, or existing legislation significantly amended.

A RIS is also required in the process for consideration of Australia's ratification of the Ballast Water Convention.

Final RIS

This document is a final RIS. It examines the regulatory impact of implementing the ballast water management requirements proposed under the National System. It has been prepared following a two-phased public consultation process and in consideration of feedback provided on an earlier consultation RIS.

The consultation process

The first phase of consultation involved presentation of key findings to the National Introduced Marine Pests Coordination Group (NIMPCG) and a meeting with key industry representatives. In response to the first phase of the consultation process, written submissions were received from:

- Australian Quarantine and Inspection Service (AQIS)
- Australian Shipowners Association (ASA)
- The Association of Australian Ports and Marine Authorities Incorporated (AAPMA)
- Tasmanian Department of Primary Industries and Water
- Department of Transport and Regional Services (DOTARS)
- Western Australian Department of Fisheries

- NSW Departments of Primary Industries (DPI) and Environment and Conservation (DEC)
- Victorian Environment Protection Authority (EPA)
- Australian Maritime Safety Authority (AMSA)
- Queensland Environment Protection Agency (EPA)

A number of changes were made to the original document and a revised draft was released for public comment on 24 November 2006.

In response to the second phase of consultations, six written responses were received from:

- Pearl Producers Association
- AAPMA
- ASA
- National Bulk Commodities Group
- Victorian Government
- Australian Conservation Foundation.

As a result of the consultation process greater emphasis has been placed on:

- implementing the ratification of the Ballast Water Management Convention (BWM Convention);
- the benefits of a coordinated and consistent National System for the Prevention and Management of Marine Pest Incursions (National System);
- a number of cost and benefit estimates were recalculated; and
- the variation and uncertainty surrounding estimates and this was dealt with using sensitivity analysis.

Further details of the consultation process are outlined in appendix A and public submissions are available on www.thecie.com.au/ballastRIS.html

A RIS has seven key elements:

- the problem or issues which give rise to the need for action;
- the desired objective(s);
- the options that may constitute viable means for achieving the desired objective(s);
- an assessment of the impact (costs and benefits) on consumers, business, government and the community of each option;

- a consultation statement;
- a recommended option; and
- a strategy to implement and review the preferred option.

Although the proposed 'National System for the Prevention and Management of Marine Pest Incursions' is nationally based, it will be implemented through legislation at both Commonwealth and state levels as set out in the IGA. The jurisdictional impacts of the proposed system are therefore also of particular interest. Costs and benefits are assessed at the national as well as state level.

Benefits take the form of expected reductions in exotic marine incursions and the potential economic and amenity damage avoided. Costs take the form of potential delays in shipping times, higher ship running and capital costs, enforcement costs and flow-on costs to the rest of the economy.

The RIS assumes that the impact of the initial ballast water exchange requirements will primarily relate to extending the current requirements to the movement of ships between Australian ports. This is based on the assumption that relatively minor changes will be required to existing Australian ballast water exchange requirements for international ships to bring them into line with the National System.

As the international requirements change between 2009 and 2016, shifting from exchange to treatment, so will the proposed national system. The changes will cause the nature of costs to change substantially for both international and domestic shipping. Until the start of 2009, the costs will mostly relate to increased shipping time. After 2009 they will progressively relate to the increased capital costs of treatment equipment. Benefits will also change because onboard treatment is expected to be more effective than ballast water exchange. The RIS conducted here assesses costs and benefits in three main phases:

- in 2007 and 2008 — full ballast water exchange;
- between 2009 and 2016 - phase out of ballast water exchange and introduction of onboard treatment; and
- after 2016 - onboard treatment only.

The RIS also considers the impacts of the other requirements of the Convention that are different to current Australian requirements for international ships, including the Ballast Water Management Plan, survey and certification, sediment management and safety.

2 Problem and options

Victoria's Port Phillip Bay is testimony to the environmental impact that introduced marine pests can cause:

- an estimated 178 to 400 exotic species have been found (Hewitt et al 1999 and Low 2003);
- exotic species account for over 13 per cent of the recorded marine species (Hewitt et al 2004);
- exotic species occupy five of the top ten most abundant species in the bay (Currie and Parry 1999);
- one species alone, the Northern Pacific Seastar:
  - threatens to reduce fish stock numbers in Port Phillip Bay by 40 per cent over 3 years (Commonwealth of Australia 2004); and
  - threatens biodiversity.

The problem and its potential cost

An estimated 20 per cent of Port Phillip Bay's exotic marine species were introduced through ballast water discharge (Thresher et al 1999). More generally it is assumed that 30 per cent of invasive species arrive through ballast water discharge. Other pathways that introduce exotic species include biofouling and unsupervised disposal of aquarium water.

In an economic sense, the biosecurity problem posed by ballast water discharge has two dimensions:

- the extent and risk of the economic damage exotic marine pests could cause; and
- the case why government intervention may be required to reduce the risk.

Potential extent and risk of the biosecurity problem

With an estimated 33 000 large ships plying the world's oceans to trade between thousands of ports there is an estimated 10 billion tonnes of ballast water shipped around the world annually. And each day there may be up to 10 000 organisms travelling in ballast water, so that when ballast water is discharged there is a chance of another invasive species being established. An International Marine Organization (IMO) estimate is that one invasive species establishes somewhere new in the world every nine weeks (Low 2003).

No systematic quantification of the global costs caused by invasive species is available, but attempts to quantify some specific invasions suggest that the costs can be very high. Table 2.1 summarises the estimates from some studies. Raaymakers (2002) of the IMO has suggested that the costs globally could run into the tens of billions of dollars.

2.1 **Examples of incursions**

Species	***Location***	***Environmental impact***	***Cost to eradicate***	***Economic impact***		***Source***
				Potential	Actual estimated	
Northern Pacific seastar (*Asterias amurensis*)	Tasmania	Preys on shellfish 8m scallops lost			$10 m loss of culture method	Commonwealth of Australia (2004) p. 16 first para
Black-striped mussel (*Mytilopsis sallei*)	Darwin	Decimate aquaculture pearls	$2m	$350m pearl output if it invaded		DEH (2000)
Comb jelly (*Mnemiopsis leidyi*)	Black Sea	Change food chain, reduce fish stocks and anchovy fishery			$250m.yr loss of anchovy output	NIMPIS (2002)
Comb jelly (*Mnemiopsis leidyi*)	Baltic Sea	Dominates biomass crowds out and eats other species			$500m/yr loss of fishing industries	Low (2003)
Zebra mussel (*Dreissena polymorpha*)	Great Lakes North America	Clogs pipes, fouls fishing gear, boats, cooling systems, displaces other species			$1b over 11 years	Low (2003)
Cholera epidemic and planktonic algae (dinoflagellates)	Peru	Spread of cholera to millions of humans with 10 000 deaths and poisoned shellfish causing illness and dealth	$200m over 4 yrs to repair sewage and drinking systems in Latin America		$1b lost in seafood exports and tourism in Peru	Low (2003)

Source: Various.

Nature of the economic problem and the case for government intervention

Incursions of exotic marine pests through ballast water discharge are a form of unintended economic damage. No market mechanism currently exists to ensure that those causing incursions of exotic pests pay for the costs imposed on other industries and individuals. There is therefore no direct incentive to reduce or minimise such costs.

Externalities and spillovers

Incursions are not immediately detectable or easily traceable. They are most likely to be unintentional rather than deliberate and those causing the harm are likely to be unaware they have done so. Moreover, exotic marine pests are transmittable between regions. Costs can be innocently passed on to other regions. These features of the biosecurity risk imposed by exotic marine pests to other industries, regions and individuals are characteristic of factors defining economic 'externalities' or 'spillovers'. The presence of externalities suggests a potential for markets to fail to allocate resources efficiently because market incentives to minimise costs are absent. The presence of externalities may create a case for governments to intervene in markets to address such failure if it can be shown that with intervention the benefits will exceed the costs.

Alternatives to regulation

Sometimes voluntary or contractual arrangements rather than legislatively based arrangements may be sufficient to overcome market failures. It may for instance be possible for port authorities to contract with ship owners to meet particular environmental standards before entering their ports. However, it is not clear that port authorities have the same incentives to avoid exotic marine pests as the wider community does. The marine environment has a range of use and non-use values, not all of which a port authority might share.

- Moreover, a single port authority acting unilaterally may be considerably less efficient at dealing with exotic marine threats than a nationally based authority that can achieve economies of scale and scope. Legislation may be required to establish the national authority.
- Further, in the case of the proposed National System there are distinct economies of scale and scope of making domestic shipping requirements consistent with existing requirements for international ships. The international requirements have legislative backing.
  - Having a separate voluntary or contractual arrangement for domestic shipping may create inconsistencies, loopholes and confusion in creating effective safe-guards.
  - It may also create impediments to trade by favouring domestic shipping over international shipping. A voluntary domestic system may be inconsistent with Australia's international obligations under the GATT Technical Barriers to Trade Agreement (standards Code) and WTO Sanitary and Phytosanitary Code.

Options for consideration: the initial mechanism

Until the International Convention comes in to force and at least until the end of 2008, the initial mechanism will rely on ballast water exchange rather than treatment of ballast water. International requirements are that:

- whenever possible, exchange should take place at least 200 nautical miles from the nearest land and in water at least 200 metres in depth;
- where a ship is unable to conduct exchange as above, this should be as far from the nearest land as possible, and in all cases at least 50 nautical miles from the nearest land and in water at least 200 metres in depth;
- a ship shall not be required to deviate from its intended voyage or delay the voyage, to comply with the distance requirements above, or do so if it puts the ship and crew in danger;
- if the requirements above cannot be met, areas may be designated where ships can conduct ballast water exchange; and
- if ballast tanks cannot be completely emptied and refilled at sea due to the structural strength of the ship, it must be pumped through to achieve an exchange of water equal to three times the volume of each tank — a three-fold volume exchange is accepted as providing a 95 per cent exchange of water.

Option 1: mandatory exchange

Ballast water exchange could be made mandatory under the international mechanism subject to safety limitations. One option is that the National System also requires mandatory exchange under the conditions set out above. Under this option all ships would be required to exchange regardless of the risk or voyage length.

Option 2: risk-based exchange

However, risk varies widely between voyages depending on the source port. Voyages between two domestic ports that do not already have high-risk marine pests are likely to pose little or no risk. Using a risk-based system, potential exists to limit the number of voyages required to undertake exchange and so reduce the cost of the regulation. Indeed the proposed option is risk-based. It requires ships taking on ballast water from an Australian port to exchange ballast water in specific locations at sea before discharging at another Australian port where there is a risk of translocating a high risk pest to the receiving port. The international mechanism provides for the granting of exemptions from ballast water exchange requirements based on risk.

Exchange of ballast water will only need to occur if the proposed voyage is deemed to impose a risk. The risks are defined as those specified in the ballast water risk assessment tables. The database determines whether any particular proposed voyage involves a risk based on:

- the prevalence or absence of known problem species in the source port at any particular time of year;
- the prevalence or absence of known problem species in the proposed destination port or ports;
- the climatic and environmental conditions for establishment at the destination port or ports; and
- if exchanging ballast water is required, it will need to meet particular standards.

The distance from shore that ships are required to exchange ballast water will have considerable influence on voyage times and therefore voyage costs whether there is a mandatory or risk-based system. The international requirements clearly indicate that several possibilities could be considered until the end of 2016.

Some possibilities have been included that deviate from the approach proposed for the National System but have been included for the purposes of comparison. The analysis indicates these often involve greater cost and result in Australia not being able to ratify the Convention.

Possibility 1: 50 miles, 200 metres depth

The deeper the water and the further from Australian coastal waters that the ballast water exchange takes place, the lower the risk of translocation of exotic pests. At a depth of 200 metres or more ecosystems are regarded as sufficiently different from coastal ecosystems that exchange may be regarded as low risk and unlikely to contain organisms capable of establishing in coastal environments.

The International Convention requires that ships exchange ballast water beyond 200 nautical miles from the nearest land, in water at least 200 metres deep. If ships cannot meet this requirement the Convention requires ships to exchange at least 50 nautical miles from the nearest land in water at least 200 metres in depth. Under the Convention, ships are not required to deviate or delay to meet the depth and distance requirements.

The 200 mile and the 50 mile requirements would require many domestic voyages around Australia to go much farther out to sea than currently occurs. Because there is a choice, from an economic perspective the minimum requirement of 50 miles would define the option.

This possibility would achieve:

- the environmental objective of exchanging ballast water in sufficiently different marine ecosystems so as to minimise risk; and
- not require large increases in voyage times for those voyages taking place in deepwater anyway.

However, a major drawback of this possibility is that some voyages, such as those off Queensland ports close to the Great Barrier Reef and those across Bass Strait, would not meet the requirement. The water depth is less than 200 metres within 50 miles of land. To reach 200 metres depth could require considerable extra ship cruising times which could add considerably to costs for affected voyages.

Exchanging in designated zones

In sea areas where the distance from the nearest land is less than 50 nautical miles or the depth does not exceed 200 metres, the Convention provides port States with capacity to designate areas. Therefore a second possibility would be to define such zones and allow exchange to take place there. The risk of establishment of exotic species varies by factors other than water depth and there are areas in Australia where the water depth exceeds 200 metres within 50 miles of land. Three approaches to designating areas that are currently under consideration within Australian waters have been identified:

Possibility 2: special zones

There may be particular zones of ocean beyond the 12 nautical mile limit that offer low risk of exotic species establishment.

Possibility 3: beyond 12 miles

Given that a ship need not deviate from its intended voyage or delay the voyage, to comply with the other distance requirements, nor be required to risk ship and crew safety, high distance requirements may be difficult to enforce and may impose a significant cost on the ship. A second approach for a designated area would be to require exchange to take place beyond the 12 nautical mile limit. Whether this would satisfy requirements to protect the Great Barrier Reef remains an open question.

Possibility 4: exchanging outside the 3 nautical mile limit

Given that a ship need not deviate from its intended voyage or delay the voyage, to comply with the other distance requirements, nor be required to risk ship and crew safety, high distance requirements may be difficult to enforce. A third option for a designated area would be to require exchanging to take place beyond the 3 nautical mile limit. Whether this would satisfy requirements to protect the Great Barrier Reef remains an open question.

Option 3: no requirement

For the purposes of assessing costs and benefits for a regulation impact statement, it is also necessary to consider the 'maintain status quo' option, that is, no additional ballast water management requirements to be implemented. All costs and benefits can be defined relative to this and in effect, the 'maintain status quo' option becomes the baseline option.

Other 4: voluntary compliance

An option that does not involve the compliance burden of regulation would be to apply a voluntary regime, where ships are asked to complete a ballast water exchange where they can. Prior to implementing the mandatory requirements for international ballast water in 2001 a period of voluntary compliance was in place. During this period it was estimated that 75 per cent of ships complied with the requirements, although a specific assessment of the compliance rate was not undertaken.

It would be reasonable to expect that should a voluntary scheme be implemented for domestically-sourced ballast water that the compliance level would be similar. In some instances the compliance rate might be lower, such as voyages that are too short to complete exchange without a delay.

This option has some drawbacks in comparison with the regulatory mechanisms. In particular, Australia would not be able to ratify the International Convention. Voluntary compliance would also deliver lower levels of protection than that currently provided by the existing international requirements and those implemented for domestic voyages into Victoria. As a result this option has been ruled out.

Option 5: unilateral action by Australia

For the purposes of assessing costs and benefits for a regulation impact statement, it is necessary to consider the 'go it alone' option, whereby Australia has requirements that are different to other countries. This is a difficult option to consider as there is an infinite number of possibilities, however, some scenarios would be useful for this consideration.

One obvious scenario would be for Australia to impose stricter standards. A stricter exchange standard (for example, five time volumetric exchange) would generally increase the time taken to complete the exchange, thereby increasing costs through likely increases in the amount of delay for each ship. The exact cost would vary according to the amount of delay, but would cost more than implementing the Convention standards. This approach would add potentially significant costs to the models being proposed.

This option has not been considered further due to the likely substantially greater cost burdens and complexity they add in terms of ratification of the Convention. The Convention does enable Parties to implement more stringent measures, making it possible for Australia to implement some actions that are different to other countries and still ratify the Convention, the likely magnitude of the cost implications are such that this option has been discounted.

It may be possible to consider minor variations to the Convention requirements that could have a minimal cost impact for a level of environmental benefit. However, it is difficult to see how these would deliver much in the way of benefit for the obvious drawback of increased confusion created by Australia's different requirements.

Options for consideration: permanent mechanism

The proposed permanent mechanism relates to implementation of the ballast water treatment requirements set out in the International Convention. The permanent mechanism that will replace ballast water exchange at sea is target based. It specifies ballast water performance standards relating to:

- the maximum number and size of viable organisms for a specific volume of water; and
- the maximum number and size of three specific indicator microbes capable of affecting human health.

Ships built before 2009 must meet these standards by the start of 2014 in the case of ships with ballast capacity between 1500 and 5000 cubic metres and by the start of 2016 in the case of all other ships. Ships built in or after 2009 must meet the standard from the time they put to sea except for ships with more than 5000 cubic metres ballast water capacity which must meet it if built in or after 2012.

As yet, the technologies that will be used to meet the permanent standard have not been fully developed or tested. Several different technologies are under review, but all involve on-board treatment of ballast water designed to sterilise that water in some way. This is discussed further in chapter 3.

Unlike the initial mechanism which suggests several options may be considered, the permanent mechanism being performance based suggests only two main options:

- put in place some sort of on-board treatment device to meet the target; or
- have no requirement.

This implies that starting in 2009 options 1 to 4 would begin incorporating the permanent mechanism as described above. Option 5 would require no on-board treatment.

The only alternative would be for Australia to implement a different treatment standard. A stricter treatment standard would force each ship trading in Australia to fit different treatment machinery. As a result all of the capital cost of the treatment would therefore be caused by the Australian regulations, making this option prohibitively expensive as the capital expenditure would be up to $5 million per ship, plus any associated development costs.

The option of a less stringent standard than the international benchmark has also been rejected. This may provide some cost savings, however, with most ships operating in Australia having to fit the treatment systems anyway because they trade with other Parties to the Convention the likely benefits are very small. The costs are potentially substantial as a result of reduced environmental protection and possible increased cost of fitting different equipment. Under this option Australia would not be able to ratify the Convention and would be inconsistent with the requirements in other parts of the world.

3 Benefits and costs

In analysing the impacts from regulating ballast water, consideration must be given to the costs and benefits of the alternative options. The options for both temporary (exchange) and permanent (treatment) requirements that have been evaluated are set out in chart 3.1. There are three main options during the temporary phase: mandatory ballast water exchange; risk-based ballast water exchange and maintain the status quo. Within each of the first two options there are four possibilities about where the exchange could take place. These form sub-options. Once the permanent phase is reached, there are only two main options: either onboard treatment or maintain the status quo.

3.1 **Options**

Options & possibilities	*Temporary*	*Permanent*
Option 1	**Mandatory exchange**	**On-board treatment**
Possibility 1 (Sub-option 1.1)	50 miles/200 metres	On-board treatment
Possibility 2 (Sub-option 1.2)	Special zones	On-board treatment
Possibility 3 (Sub-option 1.3)	Beyond 12 miles	On-board treatment
Possibility 4 (Sub-option 1.4)	Beyond 3 miles	On-board treatment
Option 2	**Risk-based exchange**	**On-board treatment**
Possibility 1 (Sub-option 2.1)	50 miles/200 metres	On-board treatment
Possibility 2 (Sub-option 2.2)	Special zones	On-board treatment
Possibility 3 (Sub-option 2.3)	Beyond 12 miles	On-board treatment
Possibility 4 (Sub-option 2.4)	Beyond 3 miles	On-board treatment
Option 3	**Status quo**	**Status quo**
Other options	Not evaluated	Not evaluated.

Source: The CIE (2006).

The specific costs of each option relate to:

- direct costs to the shipping industry from implementing the requirements;
- government-incurred costs relating to controls, including inspection, administration, training and communications/awareness costs; and

- flow on economic costs to the Australian economy.

The benefits of managing ballast water relate to the reduced probability of foreign pest incursions, and a resulting reduction in the expected damages.

Direct ballast water management costs

Requiring ships to exchange ballast water on voyages rather than in port will impose additional costs on ship operators. The exact cost impact per voyage is a function of:

- whether or not exchange is mandatory or risk-based;
- whether or not the voyage is considered high risk if a risk-based system is in place;
  - Is the ballast water on board high risk according to the ballast water risk assessment tables?
  - Does the ship take on port water for use as ballast?
- the distance of the voyage and the time taken to complete the voyage;
- how far off the standard route the ship would have to deviate to be in a designated area for ballast water exchange:
  - 50 NM offshore in water at least 200m in depth (sub-options 1.1 and 1.2);
  - 12 NM offshore in designated zones (sub-option 1.2 and 2.2);
  - 12 NM offshore in coastal water (sub-option 1.3 and 2.3); or
  - 3 NM offshore in coastal water (sub-option 1.4 and 2.4);
- the additional time required to reach the exchange zone;
- the amount of time required to pump the ballast water subject to on-board pumping capabilities, either:
  - flow-through ballast water tanks; or
  - empty-fill ballast water tanks;
- the direct energy and labour costs and indirect maintenance costs of running the ballast water pumps; and
- the additional time required to move from the exchange zone to the destination port.[2]

[2] Because ballast water exchange may compromise safety, it could be argued that there is also a cost associated with reduced safety. To the extent that there is, this will be built into insurance costs. International charter rates are used here and as ballast water exchange is already required with

For ships that are required to exchange ballast water, the costs can be broken into two components:

- the additional fuel, energy and labour requirements and machine maintenance costs associated with running ballast water pumps, the *pumping costs*; and
- the deviation and delay costs associated with having to sail to a designated exchange area or having to slow down ship speed while pumping is conducted, the *delay cost*.

To quantify these costs, we have constructed a model based on earlier work conducted by ABARE, BRS and CSIRO. The model is an activity based financial model of Australian shipping that brings together in an economically consistent way the interaction of all variables and assumptions, and reports results on a state by state basis. The model provides the capacity to ask a lot of 'what if' questions about a number of important economic parameters affecting how ballast water exchange may affect the cost of Australian shipping.

Where there are costs, the impact will fall heavily on shorter journeys where the time required for a complete exchange exceeds the time available to exchange ballast water. In these situations, the ship's relative journey time will be significantly extended to allow for a complete exchange to take place. Delays impose opportunity costs as ships will be able to move less cargo per year compared with a situation where the delays did not occur.

As identified above, there are a number of cost components that need to be considered in calculating the direct cost impact upon domestically-plying ships. These include:

- the frequency and distribution of ship movements;
- identifying whether or not particular voyages are high risk;
- calculating the cost of having to pump ballast water; and
- calculating the delay time and cost associated with having to exchange ballast.

Australian domestic ship movements

Australian shipping movement data has been obtained from the Lloyd's Maritime Intelligence Unit, covering the period 1998 to 2002. The data set has over 42 000 individual entries, specifying the departure and arrival

international shipping, we assume increased insurance charges are already built in. This increase in unlikely to be large because insurance is only a small proportion of operating costs (8%).

port, the ship name and ID, the dead weight tonnage and the departure and arrival dates. Covering a five-year period, the data set provides a realistic picture of the domestic shipping sector.

According to the data set, each year there are approximately 7 500 coastal ship movements between Australian ports. One quarter of these journeys are between Victoria and Tasmania, and reflect Tasmania's heavy reliance on sea for the transportation of goods and people (table 3.2).

3.2 **Australian domestic ship movements by origin and destination (per cent of all journeys)**

	Arrival state							
	New South Wales	Northern Territory	Queensland	South Australia	Tasmania	Victoria	Western Australia	**Total**
Departure state								
New South Wales	4.0	0.0	2.5	0.8	2.2	11.3	0.2	**21.1**
Northern Territory	0.2	3.1	1.6	0.0	0.1	0.0	0.5	**5.5**
Queensland	7.6	1.5	6.0	0.2	0.3	1.5	0.1	**17.2**
South Australia	1.2	0.0	0.3	0.5	0.5	2.2	0.4	**4.9**
Tasmania	1.6	0.0	0.2	0.5	0.8	12.4	0.1	**15.5**
Victoria	6.4	0.0	1.1	4.5	12.4	2.2	0.6	**27.2**
Western Australia	1.6	0.4	0.2	1.4	0.1	2.3	2.4	**8.5**
Total	**22.6**	**5.1**	**11.9**	**7.9**	**16.4**	**31.9**	**4.2**	**100.0**

Source: Lloyds (2003).

Twenty-three per cent of voyages are high risk

Although the final list of species that will be monitored using the risk-based approach is still under consideration, the CSIRO Marine Research Unit has developed risk tables for eight main foreign marine pests that are currently established at a number of Australian ports:

- *Asterias amurensis;*
- *Carcinus maenas;*
- *Crassostrea gigas;*
- *Gymnodinium catenatum;*
- *Varicorbula gibba;*
- *Musculista senhousia;*
- *Sabella spallanzanii;* and
- *Undaria pinnatifida.*

The risk tables are based on 35 port surveys undertaken between 1995 and 2002, and classify a journey as high risk if one of more of the eight species is present in the departure port and not present in the arrival port. To ensure these tables are kept up to date, an ongoing monitoring program will need to be implemented, with each location surveyed at least once every two years. The risk tables allow for seasonal variations in the spawning pattern of each species as well as whether or not species would survive in the arrival port. Journeys are either classified as high or low risk, and for high-risk journeys, ballast water exchange is mandatory in the absence of on-board treatment facilities.

High-risk voyages requiring exchanging ballast water can be identified using ballast water risk assessment tables. However, not all high-risk journeys identified using the risk assessment tables are high-risk journeys. That is, a journey is only a high-risk journey if ballast water is taken on-board at the departure port due to the ship being unloaded and ballast-water being discharged at the arrival port when the ship is loaded. Based on consultations with industry and DAFF, it has been assumed that 50 per cent of all identified high-risk voyages would be taking on ballast water (for example when discharging cargo) in port and therefore require exchanging ballast water at sea.

Combining the Lloyd's data set with the risk tables, 23 per cent of all journeys would be required to exchange ballast water (table 3.3).

3.3 **High risk ship movements by origin and destination (per cent of all journeys)**

	Arrival state							
	New South Wales	Northern Territory	Queensland	South Australia	Tasmania	Victoria	Western Australia	**Total**
Departure state								
New South Wales	0.0	0.0	0.7	0.3	0.1	3.3	0.1	*4.5*
Northern Territory	0.0	0.0	0.3		0.0			*0.4*
Queensland	0.1	0.4	0.3			0.0		*0.8*
South Australia	0.6		0.1	0.2	0.2	0.5	0.1	*1.7*
Tasmania	0.8		0.1	0.2	0.3	2.6	0.0	*4.1*
Victoria	3.2		0.5	2.3	2.7	0.2	0.3	*9.3*
Western Australia	0.6	0.1	0.1	0.1	0.1	0.1	0.9	*1.9*
Total	*5.3*	*0.5*	*2.2*	*3.1*	*3.5*	*6.7*	*1.3*	*22.6*

Note: Where cells are empty, there are no high-risk voyages.

Source: Lloyds (2003).

Journeys from Victoria and Tasmania account for just under 60 per cent of all high risk ship movements combined. This does not include a number of roll-on/roll-off ferries moving between Victoria and Tasmania. These ships only use fresh water for ballasting so these journeys are not considered a high-risk.[3]

The pump costs of ballast water exchange

Under either option 1 or 2, where required, the pumping cost per voyage would be equal regardless of the option.

Using the Lloyd's data set, ship ballast water capacity has been estimated as 30 per cent of each ship's dead weight tonnage (DWT).

Each ship in the Lloyd's data set has been classified into one of three categories according to its DWT:

- 'small' if the DWT is less than 10 000 tonnes;
- 'medium' if the DWT is 10 000 tonnes or greater and less than 50 000 tonnes; and
- 'large' if the DWT is 50 000 tonnes or greater.

Based on consultations with industry and work undertaken by ABARE (2003) and BRS (2005), different sized ships are considered to have different operating structures (table 3.4).

3.4 **Cost and operating structures by ship size**

	Pumping capacity (average)	*Pumping cost*	*Cruising speed*	*Charter costs*
	Tonnes per hour	$ per tonne pumped	Knots	$ per day
Ship size				
Small	800	$0.05	14	50 000
Medium	2 300	$0.05	14	50 000
Large	3 100	$0.05	14	50 000

Source: ABARE (2003), BRS (2005), industry consultations (2006).

The exact amount of ballast water exchanged on voyages is a function of the existing ballast exchange technology on board each ship.

- Ships using the 'empty and fill' ballast exchange technique only have to pump the volume of their ballast water. This technique is based on

3 The ships Tasmanian Achiever and Victorian Reliance are not included in the fresh water only ships. Additionally, ANL Bass Trader is included in the fresh water ships. This is based on consultations with industry. When the National System is implemented ships using freshwater as ballast will need to seek an exemption based on the risk tables.

completely emptying tanks on the ship, one or two at a time, and then re-filling them with water sourced from either beyond 50 nautical miles or within a designated area.

- Ships not able to use the empty and fill techniques will have to pump through at least three times the volume of the ballast tanks to ensure a 95 per cent exchange of water in the ballast tanks. Ships using this approach will have to pump water into each tank with the excess flowing out the top of the tank through air valves and access holes.

The empty and fill technique can only be used in calm weather and may not be able to be used for some ships for construction or stress reasons. So while a ship may be capable of the technique, the actual proportion using it will be less than the maximum. Based on consultations with industry and in-line with previous work, we have assumed that where ballast exchange is required, 50 per cent of ships will use the empty and fill process and the remaining will use the flow through technique. Therefore the average amount of ballast pumped per voyage will be twice the ballast capacity of the ships having to pump.

For option 1 — mandatory exchange — average pumping costs per voyage is $688 per voyage (table 3.5). It is important to note that this cost is not dependent upon the distance from shore a ship is required to be before being able to discharge ballast. Similarly, for option 2 — risk based exchange — average pumping costs per voyage affected is $735 (table 3.5). The average exchange cost for mandatory exchange is less than risk based exchange as it includes a number of smaller low-risk ships, which lowers the overall average.

3.5 Average pumping cost per high-risk voyage

	Arrival state							
	New South Wales	Northern Territory	Queensland	South Australia	Tasmania	Victoria	Western Australia	**Overall average**
Option 1 – mandatory exchange								
New South Wales	763	1 078	764	1 088	662	877	2 038	**840**
Northern Territory	1 432	73	1 091	889	1 257	37	538	**477**
Queensland	739	1 127	632	994	594	761	1 474	**743**
South Australia	956		856	1 144	730	916	1 097	**940**
Tasmania	749		525	814	720	272	495	**366**
Victoria	725	1 452	791	912	289	728	1 157	**570**
Western Australia	2 169	474	1 036	1 004	578	813	1 068	**1 160**
Overall average	**859**	**430**	**746**	**957**	**385**	**625**	**1 070**	**688**
Option 2 – risk based exchange								
New South Wales	898	1 401	750	1 111	755	876	2 089	**885**
Northern Territory	979	1 058	95		1 380			**299**
Queensland	783	89	573			624		**357**
South Australia	956		856	1 197	724	966	1 195	**967**
Tasmania	749		525	811	774	350	465	**495**
Victoria	725		790	912	403	1 010	1 091	**698**
Western Australia	1 200	395	1 061	1 531	594	1 034	1 113	**1 112**
Overall average	**809**	**198**	**644**	**965**	**483**	**687**	**1 154**	**735**

Note: Where cells are empty, there are no high-risk voyages

Source: The CIE (2006).

The delay costs of ballast water exchange

The delay costs associated with ballast water exchange will vary according to the journey and the management plan implemented.

The further off-course a ship has to go to reach an approved exchange zone, the higher the overall delay cost. There are two components to the delay cost:

- moving off-course will add to the overall cruising time as the ship will have to travel further overall; and
- the further off-course a ship has to go to reach an exchange zone, the lower the time available to exchange once in the zone. This assumes that ships cruise towards the exchange zone at a 45-degree angle, allowing for shipmasters to continue cruising in the general direction of the destination port.

Together, the additional time required to reach the exchange zone and any possible delays associated with remaining in the exchange zone while pumping impose an opportunity cost on ship owners.

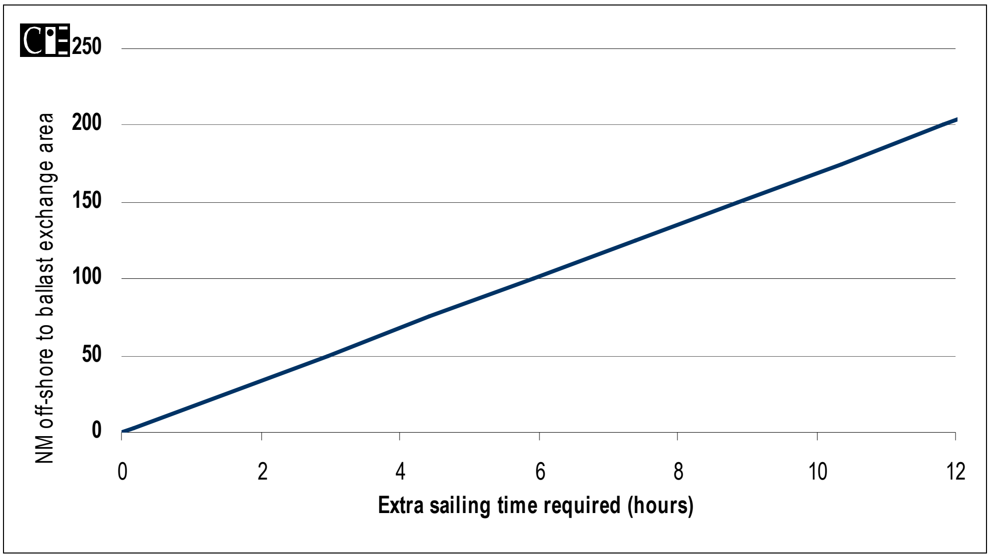
Assuming an average cruising speed of 14 knots, each high-risk voyage would require additional time just to get to and from the exchange zone:

- 3.0 hours to exchange at 50 nautical miles (sub-option 1 for both options 1 and 2);
- 0.7 hours to exchange at 12 nautical miles (sub-option 3 for both options 1 and 2); and
- 0.2 hours to exchange at 3 nautical miles (sub-option 4 for both options 1 and 2) (see chart 3.6).

Until the designated coastal exchange zones have been identified (sub-options 1.2 and 2.2) it is not possible to identify the additional cruising time required. However, it is likely the value would be between 0.7 hours (sub-options 1.3 and 2.3 — 12 miles) and 3.0 hours (sub-option 1.1 and 2.1 — 50 miles).

Option 3, the maintain status quo case would not impose any additional cruising hours.

3.6 **Extra cruising time required for each exchange zone**



Source: The CIE (2006).

The baseline time required to undertake each journey was calculated using pilot-point to pilot-point trade route distances. These pilot-points detail the actual distance in nautical miles between each port to port pairing (BTRE 2006).

Different journeys are likely to be affected to differing extents by each ballast water management sub-option (1 to 4). For example, ship movements between Sydney or Melbourne and Fremantle will not have to deviate as much as ship movements between Melbourne and Devonport in order to reach an exchange zone 50NM offshore. To a large extent these delay times will be unique to state by state pairings.

Of the four sub-options that impose mandatory ballast management, sub-option 1 (50 miles) imposes the most significant time delay requirements to reach a ballast water exchange zone. Sub-option 4 (3 miles) is the least burdensome. Sub-options 2 (zones) and 3 (12 miles) fit within the upper and lower bounds of these two options. Using the calculations from chart 3.6, we have calculated a range of times (in hours) that would be added to each journey for options 1, 3 and 4 (table 3.7).

3.7 **Extra cruising time required to reach ballast water exchange zones for alternative options**

	Arrival state						
Departure state	New South Wales	Northern Territory	Queensland	South Australia	Tasmania	Victoria	Western Australia
Sub-option 1 – 50 NM							
New South Wales	3.0	0.0	3.0	3.0	3.0	3.0	0.0
Northern Territory	0.0	3.0	0.0	0.0	0.0	0.0	1.5
Queensland	3.0	0.0	11.8	0.0	3.0	3.0	0.0
South Australia	3.0	0.0	0.0	3.0	1.5	3.0	3.0
Tasmania	3.0	0.0	3.0	1.5	3.0	3.0	0.0
Victoria	3.0	0.0	3.0	3.0	3.0	3.0	0.0
Western Australia	0.0	1.5	0.0	3.0	0.0	0.0	3.0
Sub-option 3 – 12 NM							
New South Wales	0.7	0.0	0.7	0.7	0.7	0.7	0.0
Northern Territory	0.0	0.7	0.0	0.0	0.0	0.0	0.4
Queensland	0.7	0.0	11.8	0.0	0.7	0.7	0.0
South Australia	0.7	0.0	0.0	0.7	0.4	0.7	0.7
Tasmania	0.7	0.0	0.7	0.4	0.7	0.7	0.0
Victoria	0.7	0.0	0.7	0.7	0.7	0.7	0.0
Western Australia	0.0	0.4	0.0	0.7	0.0	0.0	0.7
Sub-option 4 – 3 NM							
New South Wales	0.2	0.0	0.2	0.2	0.2	0.2	0.0
Northern Territory	0.0	0.2	0.0	0.0	0.0	0.0	0.1
Queensland	0.2	0.0	11.8	0.0	0.2	0.2	0.0
South Australia	0.2	0.0	0.0	0.2	0.1	0.2	0.2
Tasmania	0.2	0.0	0.2	0.1	0.2	0.2	0.0
Victoria	0.2	0.0	0.2	0.2	0.2	0.2	0.0
Western Australia	0.0	0.1	0.0	0.2	0.0	0.0	0.2

Source: The CIE (2006).

Under all sub-options, discharge would not be allowed inside the Great Barrier Reef. We have therefore assumed that 12 hours would be required for Queensland to Queensland voyages to reach an exchange zone.

The window of opportunity in which exchanging of water can be undertaken was calculated by subtracting the additional cruising time required from the baseline cruising time of each voyage. The further off-course the ship has to go to reach the exchange zone, the lower the amount of time available to exchange ballast water.[4]

Once in the exchange zone, ships will exchange until sufficient water is exchanged to meet the standard. Ships will be delayed by the amount of time to exchange ballast water. This is on top of the additional cruising time required to reach the exchange zone.

The baseline time to undertake each journey was calculated by dividing the voyage distance by the average speed of the ship. This approach is considered more robust that estimating the distance using Cartesian straight-line estimates.

The further out to sea ballasting is required, the higher the costs

Using the above data, assumptions and the activity-based financial model, the costs to the Australian shipping industry of implementing a mandatory or risk-based ballast water exchange system were calculated.

Annually, the direct cost to the domestically-plying ships increases the further offshore ballast water exchange is required. These increase further if mandatory exchange (option 1) is implemented:

- option 1 — mandatory exchange:
  - sub-option 1.1 (50 miles) would cost $45.9 million per year — 94 per cent of this is attributable to the delay cost;
  - sub-option 1.3 (12 miles) would cost $24.0 million per year — 88 per cent of this is attributable to the delay cost; and
  - sub-option 1.4 (3 miles) would cost $19.1 million per year — 85 per cent of this is attributable to the delay cost;
- option 2 – risk based exchange:

[4] Having to exchange ballast water and potentially slow down while at sea may impact upon a ship's ability to meet a planned tide to enter a port. That is, mandating the exchange of ballast water, either for all ships or just those deemed high-risk, may impose a flexibility constraint. To the extent that there is a flexibility constraint, additionally time would be required. Any additional time required is captured in the use of the daily charter rates used.

- sub-option 2.1 (50 miles) would cost $14.0 million per year — 90 per cent of this is attributable to the delay cost;
- sub-option 2.3 (12 miles) would cost $5.3 million per year — 74 per cent of this is attributable to the delay cost; and
- sub-option 2.4 (3 miles) would cost $3.4 million per year — 60 per cent of this is attributable to the delay cost.

Sub-option 2 (zones) of options 1 and 2, is likely to cost between the cost of sub-option 1 and sub-option 3. It cannot be explicitly costed until the designated zones are identified and the additional cruising times required to reach each zone is determined. The midpoint of sub-option 2 is $34.9 million and $9.7 million for options 1 and 2 respectively.

On a per voyage basis, the costs can be considerable depending upon the particular journey and option implemented (tables 3.8 and 3.9).

3.8 **Option 1 – average marginal cost per voyage**

	Arrival state							
Departure state	New South Wales	Northern Territory	Queensland	South Australia	Tasmania	Victoria	Western Australia	*Overall average*
Sub-option 1 – 50 NM								
New South Wales	30 756	1 078	6 928	7 251	6 825	7 042	2 038	*11 448*
Northern Territory	1 432	22 951	1 091	889	1 257	37	3 620	*13 641*
Queensland	6 905	1 127	48 500	994	6 758	6 925	1 474	*20 846*
South Australia	7 120		856	22 074	3 812	7 092	7 261	*7 866*
Tasmania	6 913		6 689	3 896	6 886	7 369	495	*7 155*
Victoria	6 890	1 452	6 955	7 076	7 356	25 280	1 157	*8 504*
Western Australia	2 169	3 556	1 036	7 168	578	813	12 225	*5 470*
Overall average	*10 757*	*14 631*	*26 975*	*7 652*	*7 064*	*7 975*	*8 219*	*11 041*
Sub-option 3 – 12 NM								
New South Wales	14 973	1 078	2 244	2 567	2 141	2 356	2 038	*4 715*
Northern Territory	1 432	7 460	1 091	889	1 257	37	1 277	*4 703*
Queensland	2 218	1 127	48 500	994	2 073	2 241	1 474	*18 296*
South Australia	2 436		856	9 868	1 469	2 396	2 577	*2 945*
Tasmania	2 228		2 004	1 553	2 200	1 759	495	*1 823*
Victoria	2 204	1 452	2 270	2 392	1 775	10 468	1 157	*2 690*
Western Australia	2 169	1 214	1 036	2 483	578	813	4 475	*2 398*
Overall average	*4 477*	*4 994*	*25 479*	*2 779*	*1 829*	*2 571*	*3 191*	*5 775*
Sub-option 4 – 3 NM								
New South Wales	11 454	1 078	1 134	1 457	1 031	1 247	2 038	*3 162*
Northern Territory	1 432	3 791	1 091	889	1 257	37	722	*2 586*
Queensland	1 109	1 127	48 500	994	963	1 131	1 474	*17 692*
South Australia	1 326		856	7 249	915	1 286	1 467	*1 806*
Tasmania	1 119		895	999	1 090	642	495	*729*
Victoria	1 095	1 452	1 161	1 282	661	7 345	1 157	*1 438*
Western Australia	2 169	659	1 036	1 374	578	813	2 929	*1 751*
Overall average	*3 029*	*2 712*	*25 124*	*1 640*	*746*	*1 400*	*2 161*	*4 605*

Note: Where cells are empty, there are no voyages.
Source: The CIE (2006).

3.9 **Option 2 – average marginal cost per high-risk voyage**

	Arrival state							
Departure state	New South Wales	Northern Territory	Queensland	South Australia	Tasmania	Victoria	Western Australia	*Overall average*
Sub-option 1 – 50 NM								
New South Wales	9 998	1 401	6 914	7 275	6 919	7 040	2 089	*6 946*
Northern Territory	979	8 840	95		1 380			*604*
Queensland	6 947	89	48 357			6 788		*20 500*
South Australia	7 120		856	20 627	3 806	7 159	7 359	*7 939*
Tasmania	6 913		6 689	3 893	6 939	7 471	465	*7 050*
Victoria	6 890		6 954	7 076	7 602	20 921	1 091	*7 349*
Western Australia	1 200	3 477	1 061	7 695	594	1 034	10 341	*5 785*
Overall average	*6 264*	*1 010*	*11 148*	*7 782*	*7 136*	*7 602*	*7 573*	*7 447*
Sub-option 3 – 12 NM								
New South Wales	2 377	1 401	2 230	2 590	2 234	2 355	2 089	*2 339*
Northern Territory	979	3 213	95		1 380			*383*
Queensland	2 262	89	48 357			2 104		*19 984*
South Australia	2 436		856	8 889	1 463	2 446	2 675	*3 012*
Tasmania	2 228		2 004	1 551	2 254	1 841	465	*1 930*
Victoria	2 204		2 269	2 392	1 895	8 234	1 091	*2 289*
Western Australia	1 200	1 135	1 061	3 010	594	1 034	3 297	*2 220*
Overall average	*2 117*	*403*	*8 277*	*2 802*	*1 895*	*2 352*	*2 675*	*2 843*
Sub-option 4 – 3 NM								
New South Wales	1 268	1 401	1 120	1 481	1 124	1 246	2 089	*1 249*
Northern Territory	979	1 880	95		1 380			*331*
Queensland	1 153	89	48 357			994		*19 862*
South Australia	1 326		856	6 400	909	1 336	1 565	*1 882*
Tasmania	1 119		895	996	1 144	720	465	*852*
Victoria	1 095		1 160	1 282	775	6 021	1 091	*1 180*
Western Australia	1 200	580	1 061	1 901	594	1 034	1 990	*1 537*
Overall average	*1 136*	*259*	*7 598*	*1 642*	*835*	*1 219*	*1 749*	*1 831*

Note: Where cells are empty, there are no high-risk voyages.

Source: The CIE (2006).

The direct cost increase of the regulation will increase the cost of shipping to the point of destination - the arrival state of each high-risk journey. On this basis, the direct cost increase will be distributed across states as set out in table 3.10.

Option 3, maintain status quo will not impose any direct shipping costs.

3.10 **The direct costs to the shipping sector differ by jurisdiction and option**

	Sub-option 1	*Sub-option 2* [a]	*Sub-option 3*	*Sub-option 4*
	$m per year	$m per year	$m per year	$m per year
Option 1 – mandatory exchange				
New South Wales	10.1	7.1	4.2	2.8
Northern Territory	3.1	2.1	1.1	0.6
Queensland	13.4	13.0	12.6	12.4
South Australia	2.5	1.7	0.9	0.5
Tasmania	4.8	3.0	1.2	0.5
Victoria	10.6	7.0	3.4	1.9
Western Australia	1.4	1.0	0.6	0.4
Total	*45.9*	*34.9*	*24.0*	*19.1*
Option 2 – risk based exchange				
New South Wales	2.7	1.8	0.9	0.5
Northern Territory	0.0	0.0	0.0	0.0
Queensland	2.0	1.8	1.5	1.4
South Australia	2.0	1.4	0.7	0.4
Tasmania	2.1	1.3	0.6	0.2
Victoria	4.2	2.8	1.3	0.7
Western Australia	0.8	0.6	0.3	0.2
Total	*14.0*	*9.7*	*5.3*	*3.4*

[a] This has not been costed directly and is estimated as the mid-point interpellation between sub-options 1 and 3.

Source: The CIE (2006).

Previous cost calculations

There are three key studies that have previously been undertaken into estimating the cost impact on Australian shipping of ballast water exchange for domestic voyages:

- Blias, A. and Delforce, R. (2003), *Ballast Water Management: a Comparison of Alternative Approaches*, Australian Bureau of Agricultural and Resource Economics, Canberra;
- O'Keeffe, M. (2005), *Cost Analysis Tool for the Management of Invasive Marine Pest Species*, Bureau of Rural Sciences, Canberra; and
- Bax, N., et al (2006), *Evaluation of National Control Plan management options for the North Pacific Sea-star Asterias amurensis*, CSIRO, Hobart.

The ABARE and the BRS reports focused on the Australia wide impact of ballast water exchange (option 2, sub-option 3), and slight variations around this. The CSIRO report analysed the impact of ballast water management on southeast Australian shipping (Tasmania, Victoria and parts of New South Wales and South Australia).

ABARE found that the cost to industry of ballast water exchange (equivalent to option 2, sub-option 3) was $357 million over 20 years. On a per voyage basis, the cost was estimated at $1 417. This cost estimate is lower to the CIE finding of $1 849 per voyage.

BRS considered the marginal cost of managing domestic shipping for a variety of target species. The cost of managing all species by using ballast water exchange (equivalent to option 2, sub-option 3) was estimated at $7.0 million per year. This is approximately double the cost determined the by the CIE calculations.

CSIRO found that a risk-based approach to managing a single foreign species was $4 million per year for ballast water exchange (equivalent to option 2, sub-option 3). The savings from using a risk-based approach rapidly diminish as the number of species managed increases. Were exchange required on all journeys, regardless of risk, the cost to shipping in the southeast of Australia would exceed $130 million a year. The CSIRO ballast water exchange costs are approximately 40 per cent higher than the CIE calculations. However, were all of Australia modelled using the CSIRO technique, the cost would likely increase.

The ABARE and the BRS reports did not consider alternative ballast water exchange options. The CSIRO report did analyse alternative management options, including exchange at 200NM and at 12 nautical miles.

The CIE's work builds on and adds to the previous three studies. Including Australia wide impacts (ABARE and BRS study) and alternative ballast water exchange management options (CSIRO study), the CIE models has gone further by allowing for the impact of each option to be analysed on a jurisdictional basis.

Government and industry enforcement costs

The cost to government of ballast water management consists of ballast water and logbook inspections and the maintenance of the ballast water risk assessment tables, including inspecting ports for resident pests as required. It should be noted that while for the purposes of the RIS these costs are termed government enforcement costs the proposal under the National System is that the majority of these costs would be recovered from industry.

As a general rule, the cost impost caused by regulation creates incentives for some businesses not to comply with the requirement. For many firms, the cost of being caught because of non-compliance is enough to ensure compliance. However for some firms, where the costs can not always be passed on, the incentive for non-compliance will be stronger.

The stronger the incentives not to comply, the greater will be the need for surveillance and enforcement. However, in calculating the cost to shipping, we have assumed 100 per cent compliance because costs are relatively low and the shipping industry has expressed considerable support for regulation.

The government cost will be the same for options 1 and 2. Option 3, maintain the status quo, would not impose any additional cost on government, as it is the existing arrangement.

There will be no additional costs for ballast water exchange verification of arriving international ships as this already takes place. The cost of domestic inspections has been estimated at $360 000 per year, using existing service providers as a guide and assuming a rate of 20 per cent of inspections (that is, 2 inspections per year for frequently visiting ships and 20 per cent of ships that visit less than 5 times a year). This figure does not take into consideration travel to remote unmanned ports and inspections conducted outside normal working hours that would attract penalty rates.

In addition to the costs of monitoring ships for compliance, under option 2 ports will have to be continually sampled and monitored in order to maintain the validity of the ballast water risk assessment tables. Based on consultations with DAFF and CSIRO, port surveys would need to be undertaken at least once every two years. Any longer and the information would be considered out of date. It should be noted that under mandatory exchange (option 1) the update of the ballast water risk assessment tables is unnecessary, as exchange has to happen regardless.

Currently, 35 ports have been surveyed for the risk assessment tables. Assuming that a survey is undertaken once every two years and the same 35 ports are survey, the total survey cost to government will be $1.3 million per year. However, were only 18 ports surveyed, costs will be $675 000 per year. The target cost in developing the monitoring program under the National System was $50 000, however, this figure has not been extensively tested. Conservatively, we assume a cost of a survey is $75 000 (DAFF 2006). For option 2, we have used the mid-point between the two values, calculating the total cost to government as $993 750 per year. Thus, the total government cost for option 2 is approximately $1.2 million.

The legislation will also impose requirements on Australian-flagged ships relating to each ships ballast water management arrangements. Ships will incur additional costs relating to maintaining a Ballast Water Record Book on board the ship, including:

- development and maintenance of an approved Ballast Water Management Plan; and
- regular survey and certification of ballast water equipment.

Based on consultations with industry, we have assumed that the development and maintenance of a Management Plan will initially cost $5 000, and would need to be updated once every five years.

Additional surveying and certification of equipment will likely be conducted in line with general maintenance and structural integrity surveys conducted every two to four years (depending on ship type). Based on discussions with industry, a survey of equipment is likely to cost between $2 000 and $3 000. We have used the mid-point of these two numbers and allowed for $2 500 per survey.

For the approximately 50 ships that make up Australia's shipping fleet, the additional management plan and surveying costs will come to slightly more than $90 000 on an annual basis. It should be noted that the regular survey and certification cost component would only apply from 2009 onwards as the on-board treatment systems are installed and operated.

Economy wide cost impacts

Increasing the cost of domestic shipping will have flow-on affects across the rest of the Australian economy as well. Higher shipping costs will have direct effects on output, imports and exports of the sector as well as flow-on effects to all goods transported by sea. Using ORANI, a highly detailed general equilibrium model of the Australian economy, it is possible to trace through the economy-wide effects of such an increase.

Results of modelling indicate that a cost increase on the domestic shipping sector would cause extra flow-on costs equal to a decrease in real output within the economy of between $2.0 million and $26.6 million per year depending on the management option implemented (table 3.11). The value of domestic shipping, rail and road transportation would fall, while the value of domestic air transportation would increase. The total costs (direct and flow-on) are not evenly distributed by jurisdiction (chart 3.12 and 3.13). Queensland would bear the greatest financial burden under all versions of option 1, while under option 2, it would be Victoria for sub-options 1 and 2 and Queensland for sub-options 3 and 4.

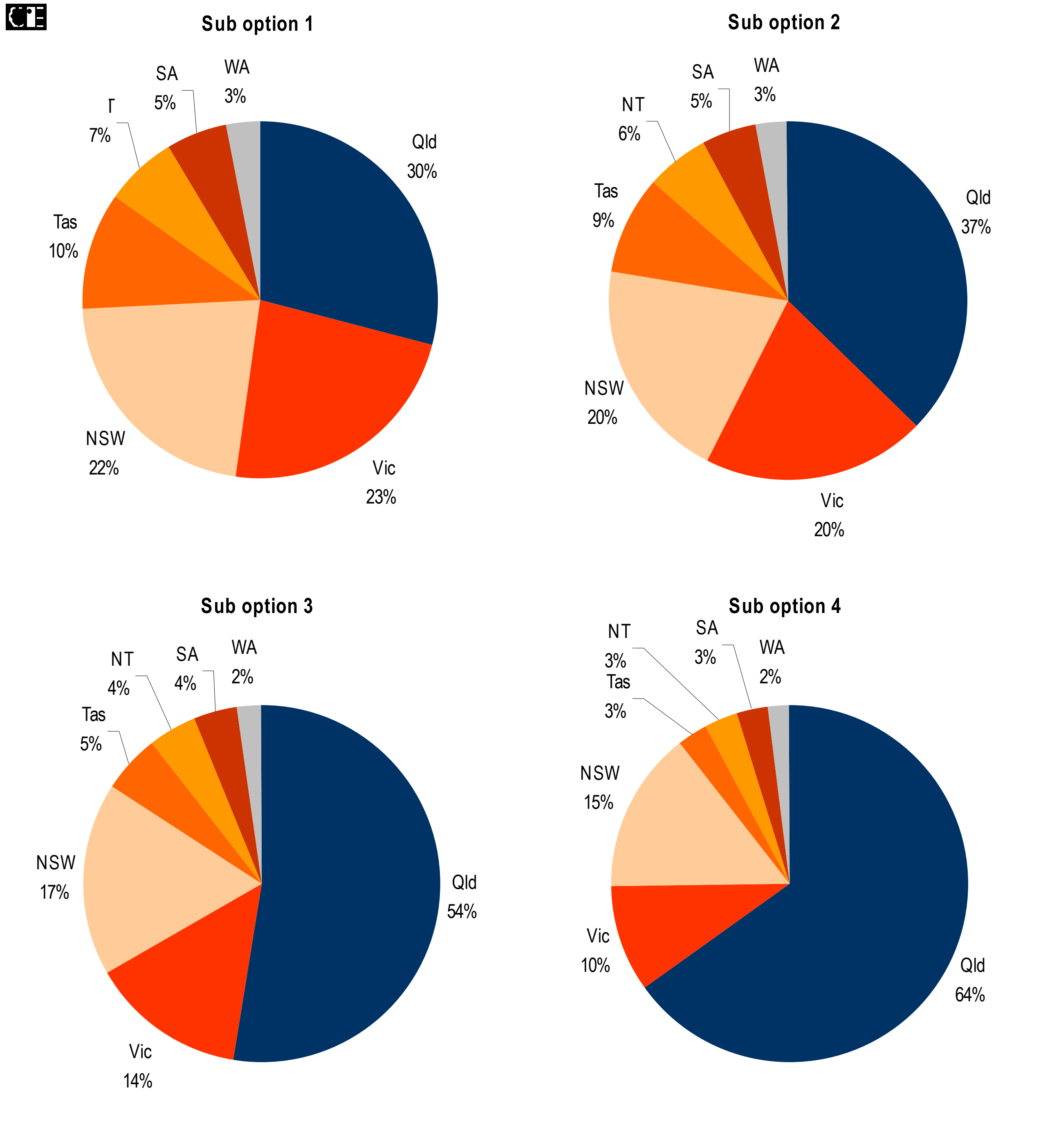
3.11 **Total Australian costs from alternative management options**

	Direct shipping cost	*Additional long-run flow-on economy costs*	*Enforcement costs*	*Total cost*
	$m per year	$m per year	$m per year	$m per year
Option 1				
Sub-option 1	45.9	26.6	0.2	72.7
Sub-option 2[a]	34.9	20.3	0.2	55.4
Sub-option 3	24.0	13.9	0.2	38.1
Sub-option 4	19.1	11.1	0.2	30.5
Option 2				
Sub-option 1	14.0	8.1	1.2	23.3
Sub-option 2[a]	9.7	5.6	1.2	16.5
Sub-option 3	5.3	3.1	1.2	9.7
Sub-option 4	3.4	2.0	1.2	6.7
Option 3				
	0	0	0	0

a This has not been costed directly and is estimated as the mid-point interpellation between sub-options 1 and 3.

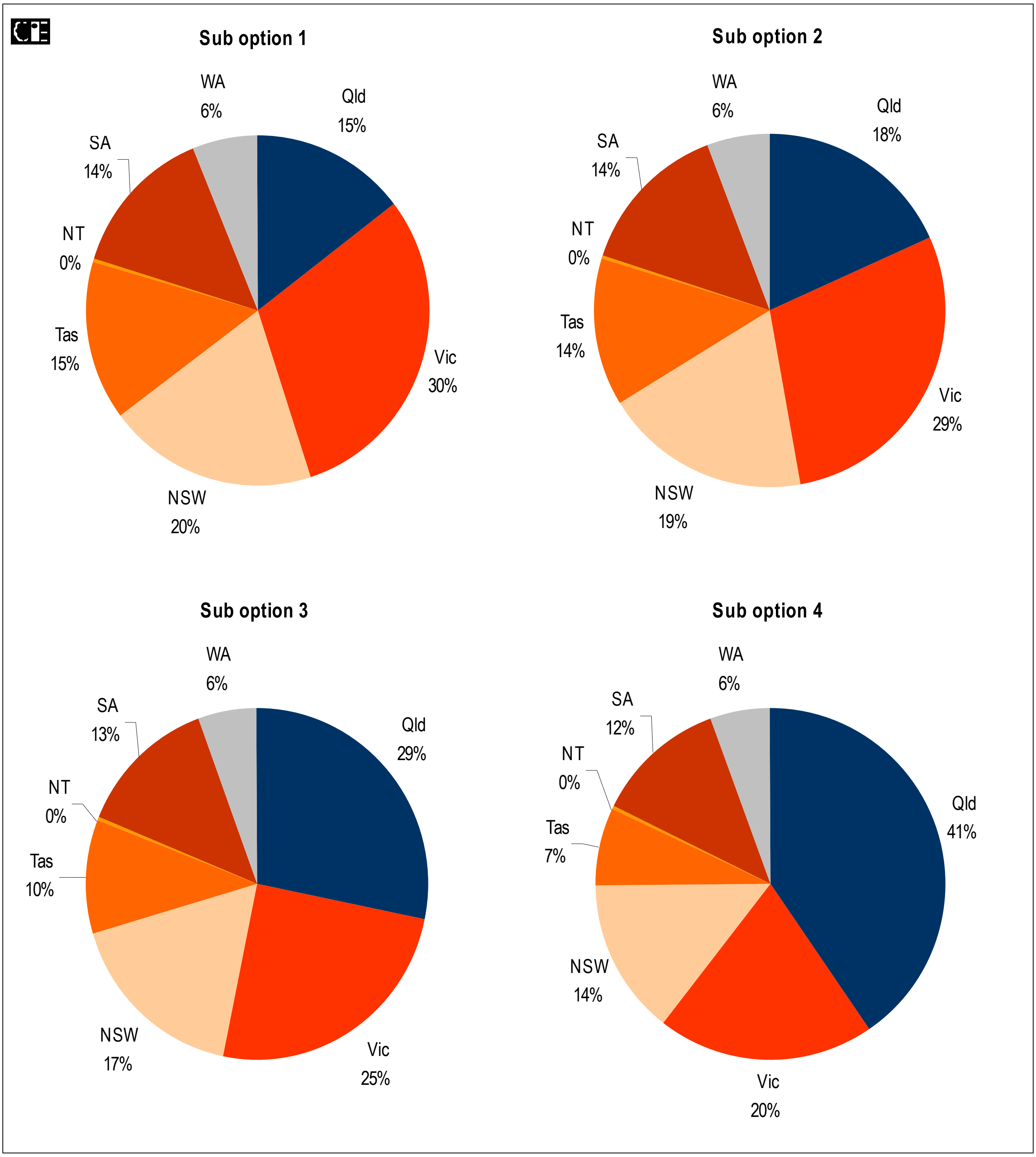
Source: The CIE (2006).

3.12 **The burden of costs vary by jurisdiction (option 1)**



Note: Sub-option 2 has not been costed directly and is estimated as the mid-point interpellation between sub-options 1 and 3.
Source: The CIE (2006).

3.13 **The burden of costs vary by jurisdiction (option 2)**



Note: Option 2 has not been costed directly and is estimated as the mid-point interpellation between sub-options 1 and 3.

Source: The CIE (2006).

Ballast exchange is only a temporary solution

From 2009 onwards, new ships built, followed by existing ships will progressively (based on ballast water capacity) be required to have on-board ballast water treatment systems in place. And from 2016, all ships will be required to have on-board treatment facilities. Thus, from 2016 the regulation cost is likely to be consistent regardless of the management sub-option implemented prior to 2016.

On board treatment would require ships to install equipment that would treat ballast water either in the ballast tank or on the uptake or discharge of ballast water. Different treatment options are likely to have varying marginal cost structures. However, currently no treatment systems have been approved as meeting the Ballast Water Performance Standard in the Convention. Thus it is difficult to know exactly the running cost of alternative options. Studies have reported that these costs range between 0.06 cents per tonne of ballast water treated through to $13.80 per tonne of ballast water treated (table 3.14).

3.14 **Marginal cost of on-board treatment options**

Treatment option per tonne of ballast water	***Lower bound***	***Mean value***	***Upper bound***
	Cents per tonne treated	Cents per tonne treated	Cents per tonne treated
Treatment option			
Heating/flushing	2.53	3.60	4.66
Filtration	0.30	0.60	0.90
Hydrocyclones	0.20	0.43	0.65
Ultraviolet irradiation	0.06	0.07	0.07
Combined filtration/ultraviolet	0.30	0.64	0.97
Combined hydrocyclones/ultraviolet	0.20	0.47	0.73
Chemical treatment	24.00	702.00	1 380.00
Range of cost estimate			
Range	0.06	101.11	1 380.00
Range (not including chemical treatment)	0.06	0.96	4.66

Source: Rigby (2001), p.79, MEPC (2006).

To be approved under the Ballast Water Performance Standard, on-board treatment systems must meet certain effectiveness rates. As only approved systems will be installed in ships, it is unlikely that ship owners and operators would opt for systems that may cost up to $13.80 to treat each tonne of ballast water when alternative and far cheaper options may exist. Thus, the feasible range of costs associated with on-board treatment systems is likely to range between 0.06 cents and 4.66 cents per tonne of ballast water treated, with a mean cost of 0.96 cents per tonne. While these costs are still preliminary estimates, they are consistent with cost estimates examined by the Marine Environment Protection Committee (55th session), October 2006.

Unlike ballast exchange management options, on-board treatment options would apply to all ballast water discharges, unless an exception applies or an exemption is granted. It is expected the only a limited number of exemptions would be requested. Mandating one of the four management options, 22.6 per cent of all voyages will be required to exchange ballast water, with some ships using the empty and fill technique and others the flow through technique (see table 3.3). With on-board treatment, all ballast water discharged will be treated.

Applying the marginal costs in table 3.14 to 50 per cent of all 7 500 domestic voyages, on an annual basis, onboard treatment costs will be $542 000 per year, or approximately $140 per affected voyage. This includes the cost imposed on domestic based and foreign ships.

It is difficult to estimate the cost impost of the Convention to international journeys, though the cost is likely to be low. This is due to a large number of Australia's trading partners likely being signatories to the Convention. Thus, regardless of Australia's decision to implement the international Convention, the vast majority of ships moving between Australian and international ports would be required to install and maintain on-board ballast treatment facilities.

Similarly it is difficult to estimate the impact that a transition from ballast water exchange to onboard treatment will have on arriving international vessels. With the estimated marginal cost of onboard treatment varying widely from 6 cents per tonne for ultraviolet irradiation to $13.80 per tonne for chemical treatment (table 3.14), the type of treatment system adopted plus the volume of ballast water to be treated will determine what the costs will be. At the high end there will likely be a cost increase in the transition from exchange to onboard treatment, however, with exchange of ballast water being an existing function of arriving international vessels, and using the calculated average pumping cost of $688 for ballast water exchange (table 3.5) with the average onboard treatment cost of $140 per affected voyage, there is also potential for a considerable reduction in the existing cost impact for arriving international vessels.

From the start of 2009 and up until 2016 (seven years) we have assumed that an equal number of ships will have onboard treatment systems installed each year so that by the start of 2016 all ships operating on Australian coastal shipping routes will be using onboard treatment systems. It has been assumed that the risk-based approach will not be used frequently from 2016 onwards, so port monitoring will not be undertaken for ballast water management purposes.

With no systems currently accredited, and with none currently being mass-produced, there is limited information on the likely capital cost of installing onboard treatment systems. Based on consultations with industry, these may cost between $1 million and up to $5 million each. Conservatively we have taken the mid-point of these estimates and assumed that the cost to each ship would be $3 million.

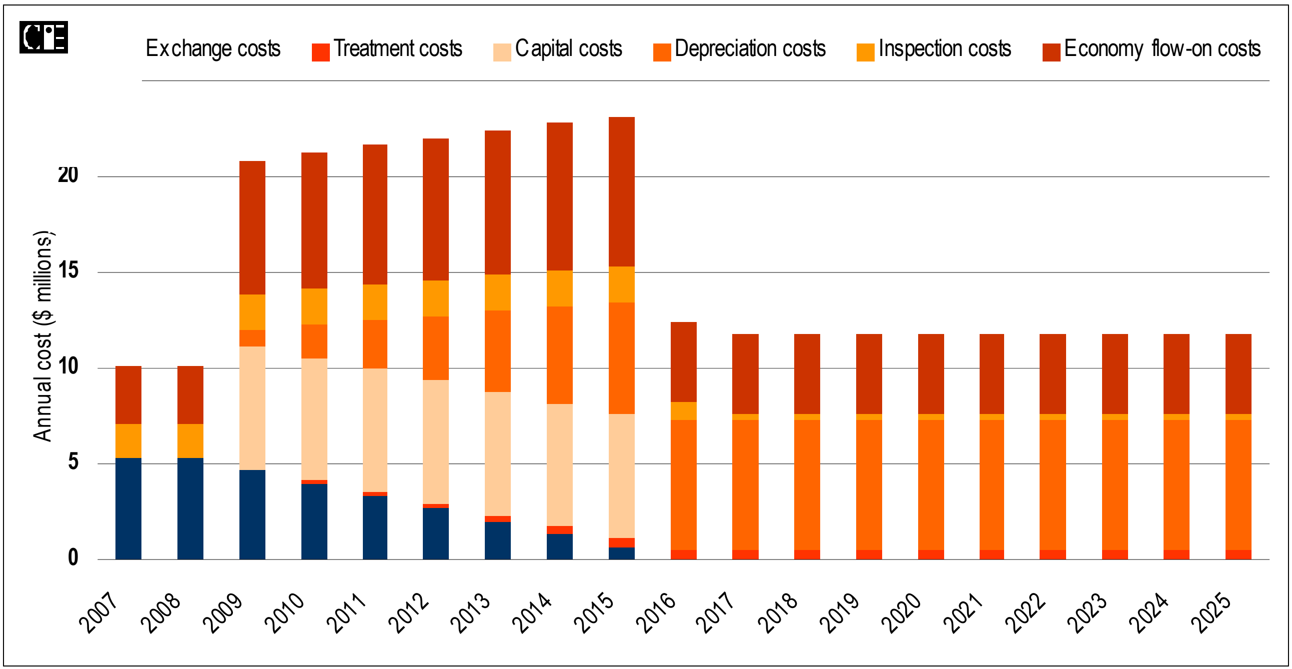
Importantly, any ship that ventures into a foreign port where that country has signed and ratified the International Convention, or otherwise has ballast water treatment requirements that at least meet the Ballast Water Performance Standard, would be required to have the on-board treatment system in place. Therefore, in calculating the cost to industry of the regulation, only the capital cost to those ships that are unlikely to ever venture overseas need be included. From consultation with industry, perhaps 10, and up to 20 Australian based ships are unlikely to venture outside Australian waters. Conservatively, we have used the lower value and assumed 10 ships would not leave Australian waters. For these ships, the installation and capital (including depreciation) cost is included in the cost calculations.

Furthermore, there is the possibility that Australian based ships would *only* trade internationally with countries that are not party to the Convention. The number of ships that fall within the category is unknown but likely to be very small. Conservatively we have assumed five ships fit into this class. For these five ships, the cost of installation and capital (including depreciation) is also included in the cost calculations.

In the period from 2007 to 2009, the cost of the regulation will be the exchange costs calculated above, and vary according to the management option implemented. During the transitional period between 2009 and 2016, the costs of the regulation will be a function of the proportion of ships still using the ballast exchange procedures and the proportion of ships using on-board treatment. From 2016, the cost of regulation will be the cost of implementing the permanent on-board ballast treatment facilities. As such, it is crucial to understand and quantify these cost impacts through time.

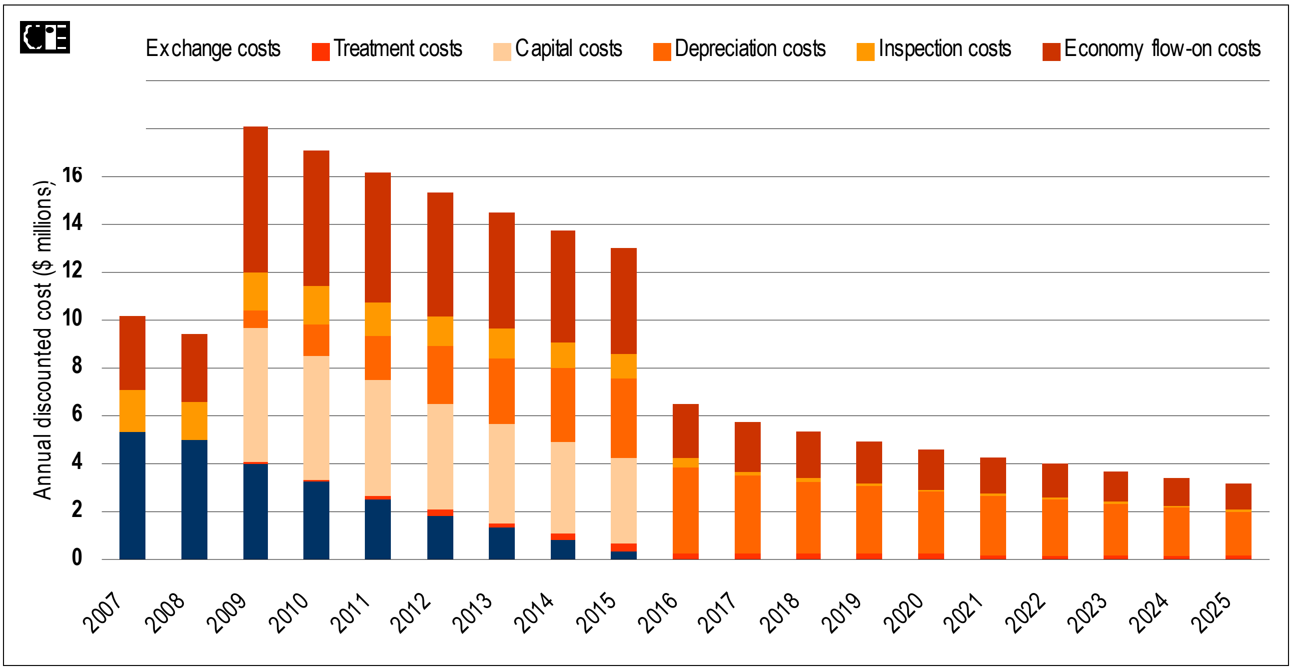
For example, were option 2, sub-option 4 implemented, the cost for the first two years (2007 and 2008) will be $6.7 million per year. Following this there will be a transitional arrangement in which both exchange and on-board treatment are used, and finally from 2016 onwards on-board treatment is used (chart 3.15). Applying a discount factor of 7.5 per cent to the annual costs, the accumulated costs to 2025 will be $155.2 million (chart 3.16).

3.15 **Ballast exchange and treatments costs – 2007 to 2025 (option 2, sub-option 4)**



Source: The CIE (2006).

3.16 **Discounted ballast exchange and treatment costs – 2007 to 2025**



Source: The CIE (2006).

This is the cheapest sub-option overall, with the most expensive, option 1, sub-option 1, costing $454.9 million up to 2025 (table 3.17 and 3.18).

3.17 **Costs through time for option 1**

	Sub-option 1	*Sub-option 2* [a]	*Sub-option 3*	*Sub-option 4*
	$m	$m	$m	$m
Cost component				
Exchange costs	209.7	159.7	109.7	87.5
Treatment costs	3.3	3.3	3.3	3.3
Capital costs	31.7	31.7	31.7	31.7
Depreciation costs	41.4	41.4	41.4	41.4
Inspection and monitoring costs	2.8	2.8	2.8	2.8
Economy flow-on costs	165.9	136.9	107.9	95.0
Total	*454.9*	*375.9*	*296.8*	*261.7*

[a] This has not been estimated and is a mid-point interpellation between sub-options 1 and 3.
Note: these calculations assume a discount rate of 7.5% per year.
Source: The CIE (2006).

3.18 **Costs through time for option 2**

	Sub-option 1	*Sub-option 2* [a]	*Sub-option 3*	*Sub-option 4*
	$m	$m	$m	$m
Cost component				
Exchange costs	63.9	44.1	24.4	15.7
Treatment costs	3.3	3.3	3.3	3.3
Capital costs	31.7	31.7	31.7	31.7
Depreciation costs	41.4	41.4	41.4	41.4
Inspection costs	9.6	9.6	9.6	9.6
Economy flow-on costs	81.4	69.9	58.5	53.4
Total	*231.3*	*200.1*	*168.9*	*155.2*

[a] This has not been estimated and is a mid-point interpellation between sub-options 1 and 3.
Note: these calculations assume a discount rate of 7.5% per year.
Source: The CIE (2006).

Benefits of options

The benefits will depend on:

- how highly marine resources are valued which in turn will depend on:
  - the value added by industries reliant upon the resource;
  - the flow-on effects of those industries;
  - the amenity and recreational value provided;
  - the non-use values that the resource provides in its current form relating to its existence, bequest and option values;

- the likely extent or proportion of the marine resource that might be damaged and how long the damage will last;
- the economic discount rate;
- the probability of an incursion; and
- the likelihood, effectiveness and costliness of eradication, control or clean-ups.

All these parameters are difficult to estimate, but for illustrative purposes it is possible to narrow down what the values may be.

Benefits to the fishing industry

The annual output of the Australian fishing industry (including aquaculture) is around $2 billion a year. Probably around 30 per cent of this is value added, the rest pays for purchased inputs such as fuel, boats, nets, packaging and marketing. So the value added might be $600 million. Deep-sea fisheries are probably not at threat, so under a worse case scenario only some proportion of Australian fisheries may be impacted. Commercially, the immediate coastal fisheries are of most value to aquaculture. Were we to assume that:

- around 40 per cent of the entire Australian commercial fishery is potentially at risk, the fishing industry value added at risk would be $240 million ($600 million x 40 per cent);
- if an incursion occurred it would affect 10 per cent of the immediate commercial coastal fishery, then only $24 million of value added might truly be at risk in any one year ($240 million x 10 per cent) - were an incursion to occur it would probably be species specific and affect one or two regions rather than all; and
- the probability of an incursion in any year at say 10 per cent, which is high, the expected cost each year might be around $2.4 million ($24 million x 10 per cent).

Given the costs of incursions assessed in Australia so far, see table 2.1, a ball park figure of $2.4 million a year may not be unrealistic. But given the uncertainties surrounding such estimates, a range of $1 million to $5 million might be a better expression of the expected annual costs of an incursion from all sources. The higher end estimates would also take account of flow-on effects. However, given ballast water accounts for around 30 per cent of incursions, a benefit of the proposed national system would be only 30 per cent of the expected cost. This would put the range of benefits at $0.3 million to $1.5 million a year.

Benefits to tourism and amenity

The potential benefit to another important industry partly reliant on the marine environment is tourism. The value of the direct output of this sector is around $37 billion (based on ABS 2002), 18 times that of fishing. Were similar economic proportionality to exist in tourism as fishing, potential benefits might range from $5.5 million to $27 million annually. In tourism value added is higher than in fishing due to its higher labour intensity, but its reliance on any particular part of the marine environment is probably less. The higher end estimates would take account of flow-on effects.

Some recreational or amenity value of the resource will not be captured directly by the tourism industry, providing further grounds to support estimates at the higher end of the range given above.

Benefits to retain existence, bequest and option values: non-use values

Non-use values of the marine environment are not easy to quantify. They relate to:

- the value the community obtains from just knowing the resource exists in a healthy state and can be passed on to future generations; and
- the value that might derive from the resource in the future from maintaining its biodiversity today for instance.

These non-use values may be put at risk by an incursion of an exotic marine pest. Some studies suggest that non-use values can be high (Non-market Economic Values & the South-East marine Region, National Oceans Office, www.oceans.gov.au/uses_economics/).

- Hundloe, Vanclay and Carter (1987) estimate that willingness to pay to ensure the Great Barrier Reef is maintained in its current state was A$45 million per year in 1987 dollar terms or $95 million in 2006 equivalent dollar terms (about $19 per Australian household), with biodiversity valued at $32 million alone in 2006 dollars.
- Bennett et al (1996) found that where both recreation and conservation values are important, the willingness of individuals to pay for the conservation benefits may be three times their willingness to pay for direct recreational use of the area.

These estimates help to establish that substantial values can be attached to non-use values of a resource such as the marine environment. What proportion of this value might be lost due to an exotic pest incursion from ballast water and the probability of such an event, remain as questions. But what is clear is that what is at risk in any year is a small proportion of the total non-use value (some proportion of the $95 million quoted above for instance). Were it five percent, this might suggest Australian households would be willing to pay $5 million a year to protect the reef from exotic incursions. Were Australian households to value all other marine resources similarly, this might suggest Australian households could be willing to pay $10 million a year to protect the reef from exotic incursions.

Australia-wide benefits

The benefits above cannot be easily added, partly due to the fact that some benefits tend to overlap. But the illustrative numbers above combined with the estimates presented in table 2.1 make a plausible case that the expected benefits of preventing further incursions via ballast water could be more than $30 million a year.

- Fisheries say $2.5million.
- Tourism and amenity say $27 million.
- Non-use values say $10 million.
- Total, say $40 million.
- Allowing for the possibilities that probabilities of incursions for the eight species of concern are overstated, say $30 million.

Although benefits may potentially be high, the benefits estimated assume that all future incursions can be prevented. This assumes that the proposed National System between 2007 and 2016 will be completely effective. This is not so.

- Complete compliance cannot be guaranteed.
- The risk assessment tool covers only eight known species and is not fool proof.
- Only a 95 per cent exchange of water is guaranteed.
- Marine organisms can survive in sediments in the bottom of tanks and in the biofilm that forms on the walls of ballast tanks (Low 2003).
- Reballasting can resupply dying organisms with nutrients and oxygen to promote their survival (Low 2003).
- Marine organisms from deep water can survive in coastal waters (Low 2003).

That on-board treatments will be phased in after 2009 is recognition that the proposed ballast exchange based national system and the current international system are not effective enough. If the effectiveness of the proposed system is only around 80 per cent, potential benefits would be reduced. Instead of being more than $30 million a year they would be more than $24 million.

The effectiveness of the proposed system may vary depending on where exchange takes place and this may vary between deep and shallow water and between whether it occurs close to, or distant from, land. Some work undertaken by the BRS (2007) that compared the risk of incursion from discharge of unmanaged ballast water in port with discharge in places a certain distance from land. In this work discharge in port of unmanaged ballast water posed the highest risk of incursion and was therefore said to be 100 per cent, noting that this does not mean a 100 per cent chance of an incursion.

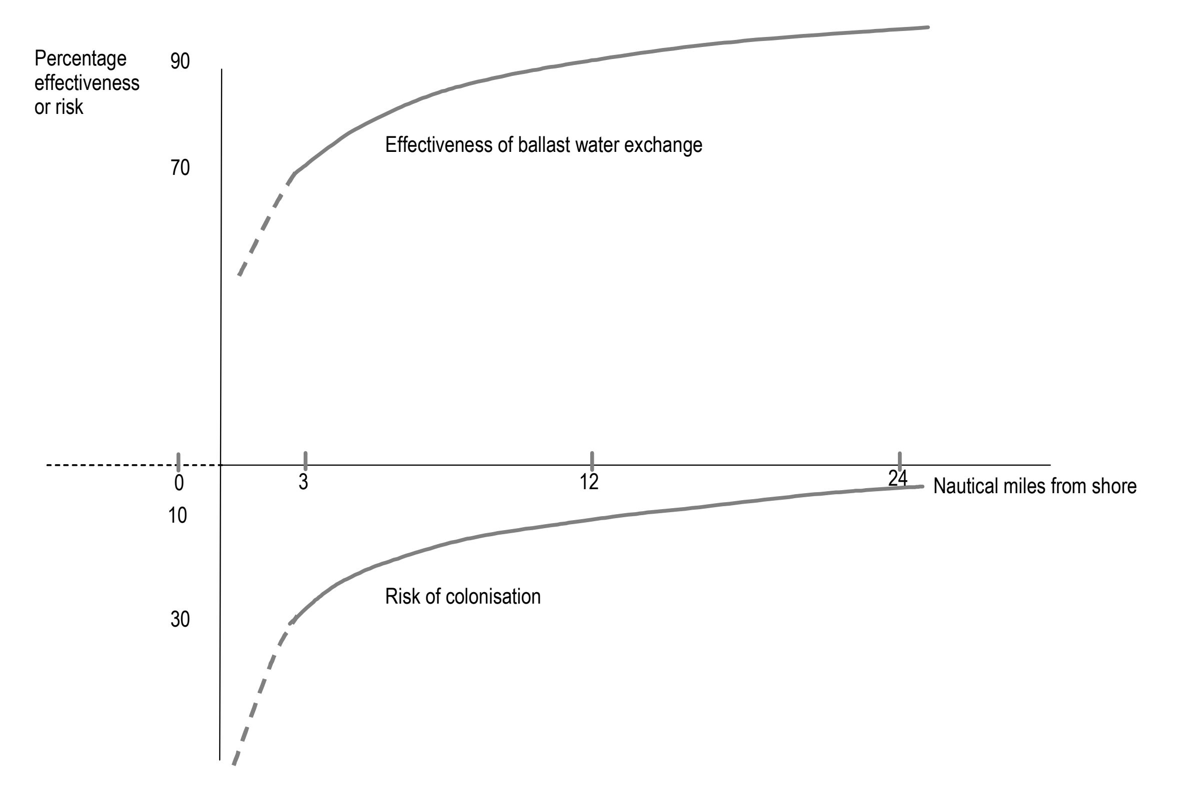
The BRS work suggests that the risk of an incursion around the Australian coast line is considerably higher at 3 miles than at 12 or beyond. There is about a 33 per cent chance that ballast water exchange at 3 miles could lead to colonisation (compared to a discharge in port) if marine pests are present in ballast water compared with a about an 8 per cent chance at 12 miles and a 2 per cent chance at 24 miles. These figures represent averages for journeys between Brisbane and Sydney, Sydney and Melbourne and Fremantle and the East Coast. These results would suggest ballast water exchange is 67 per cent (100-33) effective at 3 miles and 92 per cent effective at 12 miles (chart 3.19), compared with discharge of unmanaged ballast water in port.

However, distance from land is only one of the factors compromising effectiveness of ballast exchange. The other factors listed above will also compromise effectiveness, but these are likely to be similar for each option. Were we to allow an additional 10 per cent risk to attach to these other factors, this might suggest that the relative effectiveness of each sub-option might be something like the following:

- 50 miles (sub-option 1) – 90 per cent;
- zones (sub-option 2) – 85 per cent;
- 12 miles (sub-option 3) – 82 per cent; and
- 3 miles (sub-option 4) – 57 per cent.

Presumably on-board treatment is regarded as more effective than ballast water exchange at sea, perhaps 95 per cent.

3.19 **Relationship between effectiveness of ballast water exchange and distance from shore**



Source: Adapted from BRS (2007).

4 Best option and strategy

The annual economic benefit of the proposed National System is the reduction in probability of an incursion in that year. That benefit is received each year provided the system remains functional and provided the costs of the system are met in each year. Hypothetically, if the National System ceased for a year, the benefit deriving from the reduced probability of incursion would also cease. In an economic sense, the benefit is received in the year the cost is incurred. The benefit does not extend beyond one year, so annual benefits and costs can be compared to assess the various options.

Benefits and costs of options

The costs of the proposed National System vary more between options than benefits do.

- Costs vary substantially depending on:
  - the extra distance and delays that might be caused by the water-depth and distance-to-sea requirements for ballast water exchange; and
  - type of on-board treatment that might be used.
- Benefits may vary by the relative effectiveness of the water-depth and distance-to-land requirements too, but the differences in benefits are unlikely to be as large between options and sub-options.

Table 4.1 indicates the benefits and costs of the eight sub-options assessed in chapter 3 assuming:

- that the potential benefit might be around $30 million a year as discussed in chapter 3; and
- the effectiveness of each option ranges between 57 and 90 per cent depending on the distance from land where ballast exchange occurs.

4.1 **Benefit-cost implications of measures if potential benefits are $30m/yr**

	Costs	Assumed potential benefit	Effectiveness	Effective benefit	Net benefit	Benefit cost ratio
	$m per year	$m per year	%	$m per year	$m per year	
Option 1						
Sub-option 1	72.7	30.0	90	27.0	-45.7	0.4 : 1
Sub-option 2[a]	55.4	30.0	85	25.5	-29.9	0.5 : 1
Sub-option 3	38.1	30.0	82	24.6	-13.5	0.6 : 1
Sub-option 4	30.5	30.0	57	17.1	-13.4	0.6 : 1
Option 2						
Sub-option 1	23.3	30.0	90	27.0	3.7	1.2 : 1
Sub-option 2[a]	16.5	30.0	85	25.5	9.0	1.5 : 1
Sub-option 3	9.7	30.0	82	24.6	14.9	2.5 : 1
Sub-option 4	6.7	30.0	57	17.1	10.4	2.6 : 1
Option 3						
	0	0	0	0	0	0 : 0

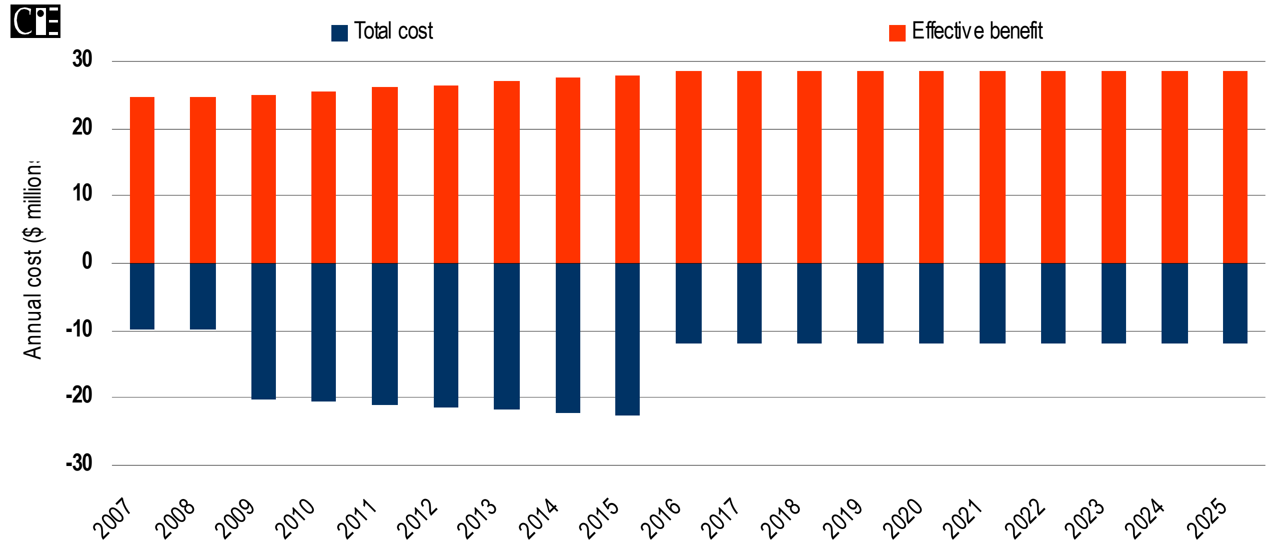
[a] This has not been estimated and is a mid-point interpellation between sub-options 1 and 3.

Source: The CIE (2006).

If potential annual benefits are assumed to be $30 million a year, all sub-options within option 2 are viable, but sub-options 3 (12 miles) and 4 (3 miles) are clearly the most desirable with benefit to cost ratios of 2.5:1 and 2.6:1. Benefits are similar for sub-options 1, 2 and 3, but considerably less for sub-option 4 due to the lesser effectiveness. The highest net benefits come from sub-option 3 (12 miles). It provides an estimated annual net benefit of $14.9 million compared with $10.4 million for sub-option 4 and $9.0 million for sub-option 2.

The undiscounted costs and benefits for sub-option 3 are set out in chart 4.2. After 2009, benefits can be seen to rise because of the assumed increased effectiveness of on-board treatment relative to ballast water exchange at sea. It is assumed to be 95 per cent effective compared with only 82 per cent for the initial measures under option 2, sub-option 3. However, after 2009, costs can also be seen to rise due to the capital costs of on-board treatment equipment. From 2016 onwards this cost falls once all ships are equipped and only maintenance and replacement costs are required.

4.2 **Year on year benefits and costs (undiscounted) of option 2, sub-option 3 (12 miles)**



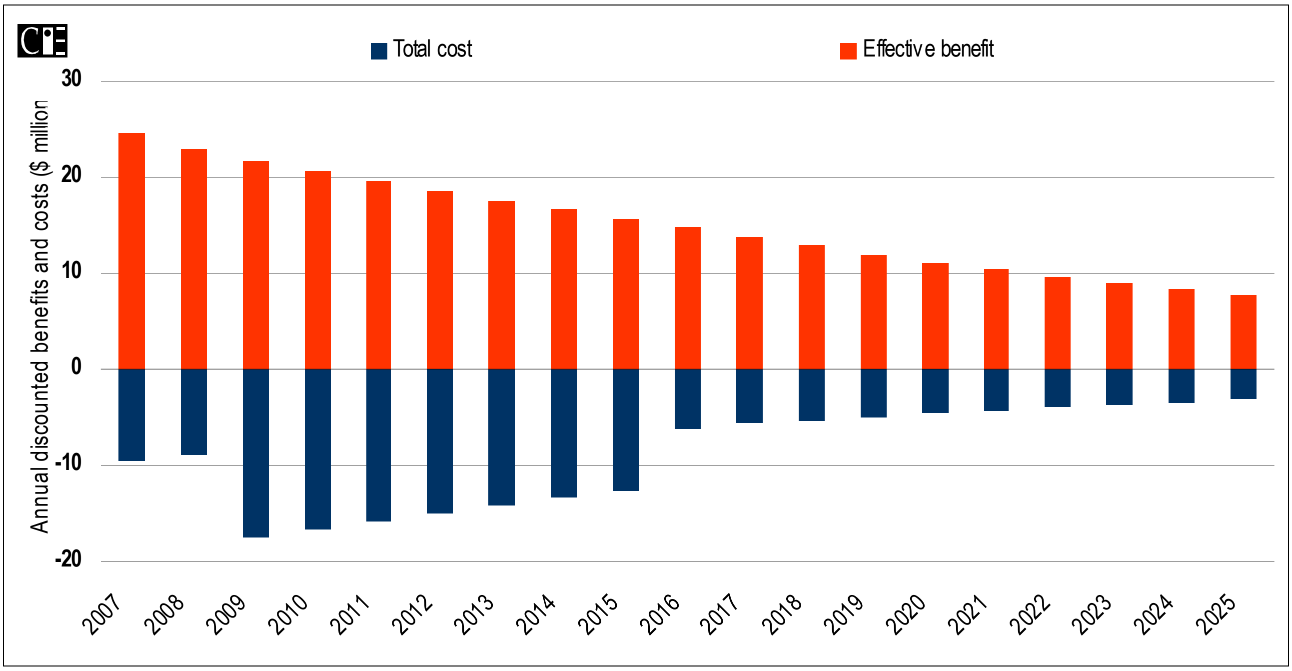
Source: The CIE (2006).

Benefits and costs must be discounted through time to be properly compared

Because costs and benefits are incurred unevenly through time, to compare them accurately it is necessary to calculate the net present value of each annual cost and benefit. This is done by discounting future values to present values using the economic discount rate (the opportunity cost of capital). Chart 4.3 shows the effects of discounting the streams of costs and benefits in chart 4.2 assuming a discount rate of 7.5 per cent.

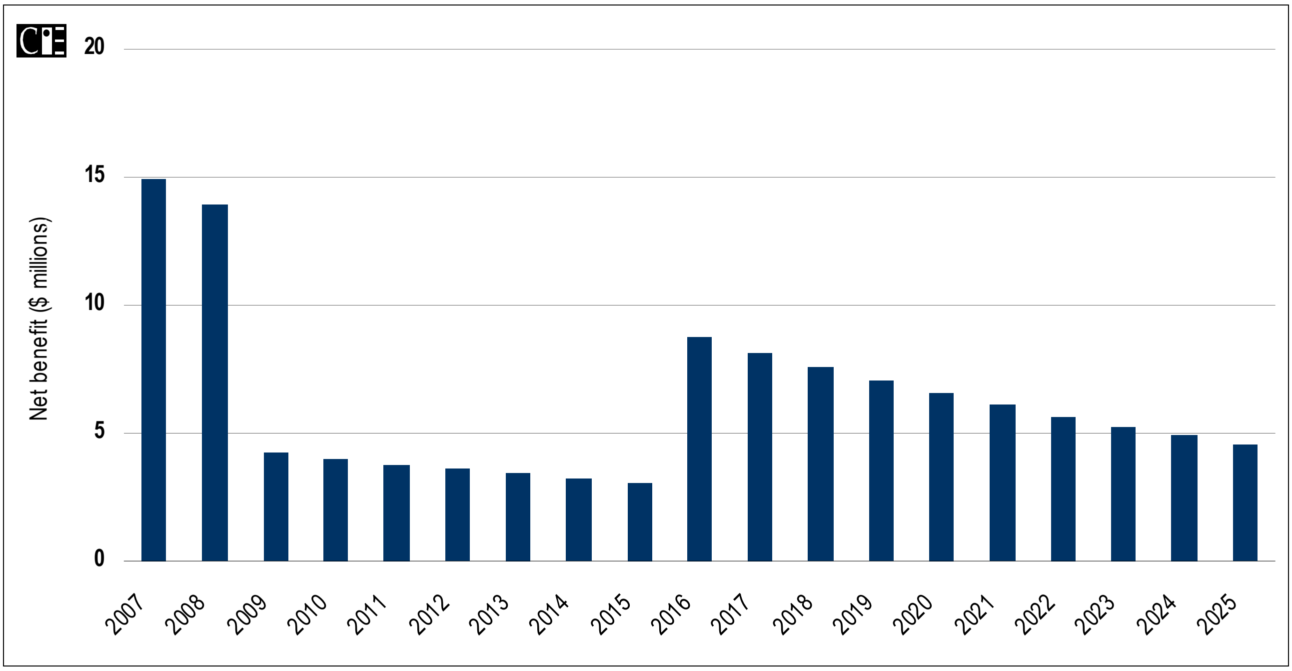
The sum of discounted (present day) costs over the 18 years to 2025 is estimated at $169 million compared with the sum of discounted benefits of $287 million, giving a benefit to cost ratio of 1.7:1. The net benefits (benefits minus costs) each year are set out in chart 4.4 and how the net benefits accumulate through time are set out in chart 4.5. By 2025 estimated net benefits (in net present value terms) are $118 million ($287 million minus $169 million).

4.3 **Year on year benefits and costs (discounted): initial and permanent measures**



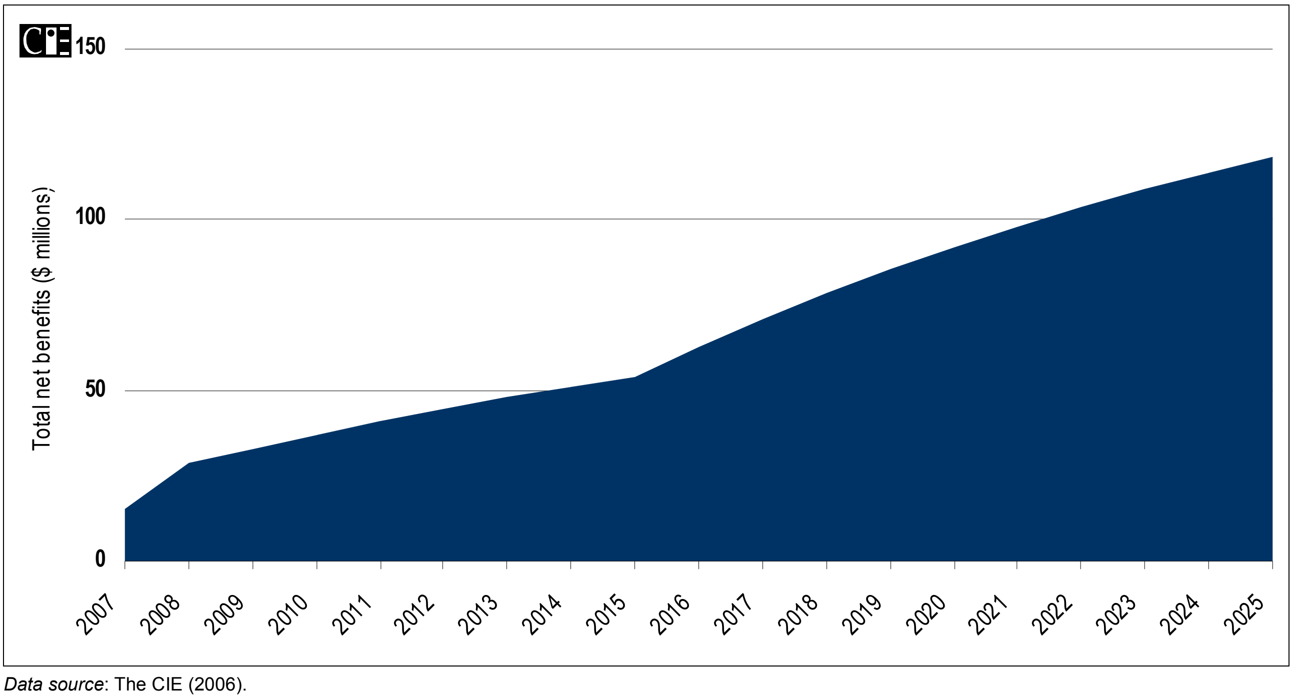
Source: The CIE (2006).

4.4 **Discounted net benefits (benefits minus costs of chart 4.3)**



Data source: The CIE (2006).

4.5 **Cumulative discounted net benefits**



Data source: The CIE (2006).

Option 2, sub-option 3 remains viable with on-board treatment but falls

Taking account of on-board treatment, benefit to cost ratios change substantially compared with those for the initial measures. Option 2, sub-option 4 loses some but not all of its advantage over others - table 4.6. The benefit to cost ratio for option 2, sub-option 4 falls from 2.6:1 for the initial ballast water exchange system to 1.6:1 with the on-board treatment because the on-board treatment is expensive relative to the extra benefit it delivers. The extra benefit derives from lifting the effectiveness of the National System from 57 per cent to 95 per cent. Although some cost saving are made in not delaying shipping times, the extra capital costs of on-board treatment outweigh these savings. The rate of increase in costs is greater than the rate of increase in benefits with on-board treatment.

4.6 **Benefit-cost implications for each option**

	Potential annual benefit	*Initial effectiveness*	*Permanent effectiveness*	*Accumulated benefit NPV to 2025*	*Accumulated cost NPV to 2025*	*Accumulated net benefit*	*Benefit to cost ratio*	*Potential benefit/yr required to break even*
	$m	%	%	$m	$m	$m		$m
Option 1								
Sub-option 1	30	90	95	298	455	-157	0.7 : 1	45.8
Sub-option 2	30	85	95	291	376	-84	0.8 : 1	38.7
Sub-option 3	30	82	95	287	297	-10	1.0 : 1	31.0
Sub-option 4	30	57	95	253	262	-9	1.0 : 1	31.0
Option 2								
Sub-option 1	30	90	95	298	231	67	1.3 : 1	23.3
Sub-option 2	30	85	95	291	200	91	1.5 : 1	20.6
Sub-option 3	30	82	95	287	169	118	1.7 : 1	17.6
Sub-option 4	30	57	95	253	155	98	1.6 : 1	18.4
Option 3								
	0	0	0	0	0	0	0	n/a

Source: The CIE (2006).

Sensitivity of benefits and costs

Although estimates of costs and benefits were provided in chapter 3, and despite improving these estimates as a result of the consultation process, considerable uncertainty still surrounds the estimates. To assess the robustness of the findings, systematic sensitivity testing was conducted.

- Rather than an estimated annual benefit of $30 million a year, a range of between $10 million and $50 million a year may be a more plausible representation of what is known and not known.
  - At an assumed 10 per cent a year the probability of an incursion may be overstated - it is feasible that this could be considerably less, say 3 per cent or even less.
  - The effectiveness of the National System preventing an incursion may be overstated.
  - The non-use values the community place on avoiding an incursion may be either under or overstated, given the difficulty in capturing these values in economic terms it is more likely that these values have been understated.
- Among cost factors, the cost of delay and pumping, the costs of inspections and ballast water management plans, the capital costs of

on-board treatments, depreciation rates and the number of ships are all uncertain[5] but with plausible ranges being:

- cost of delay/pumping - $1.4 million to 4.2 million per year;
- capital costs of on-board treatment - $1 million to $5 million per ship;
- running costs of treatment system - $0.05 million to $1.1 million per year; and
- depreciation rate - 10 per cent to 20 per cent.

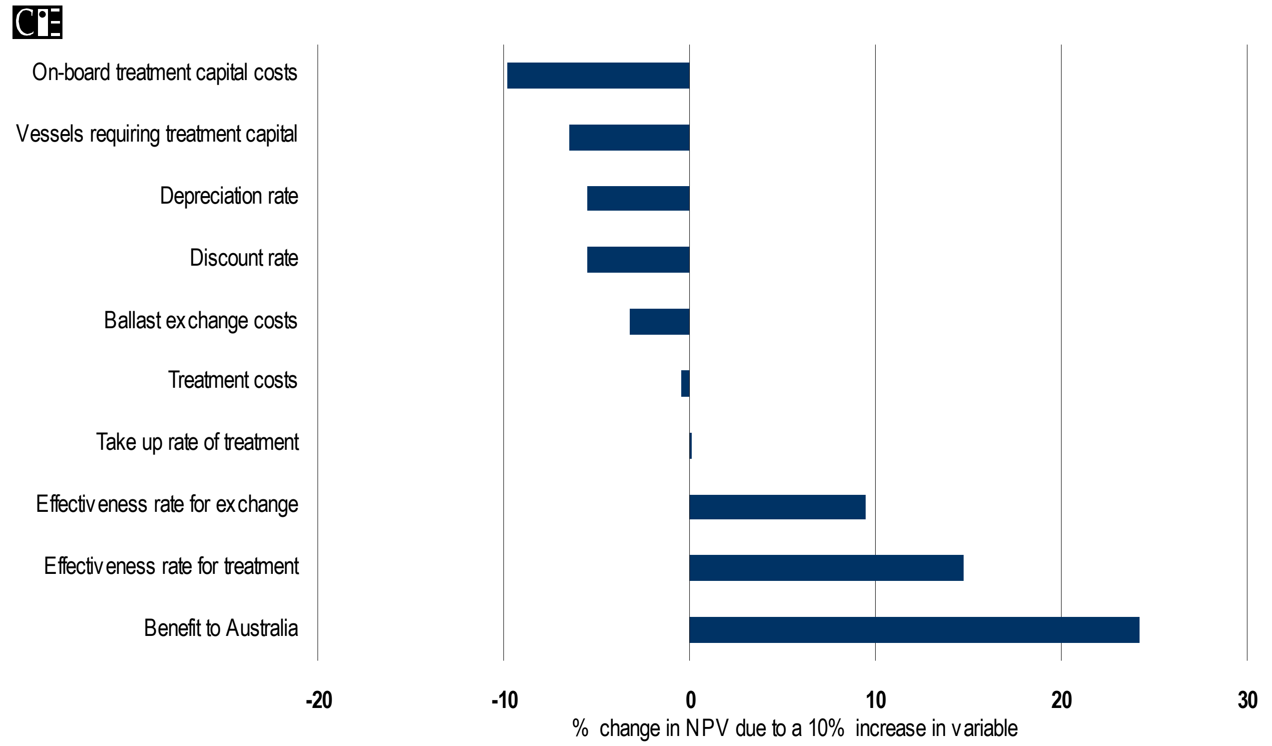
- The economic discount rate is another uncertainty and could have a plausible range of 5 to 10 per cent.

Results are most sensitive to estimates of benefits

Taking account of these uncertainties and using a program called *@Risk*, it is possible to assess how sensitive the economic results are. Chart 4.7 shows how much the accumulated net present value would change for a 10 per cent increase in each major variable used in the calculation. The results are clearly most sensitive to estimates of the national benefits and assumptions about effectiveness of the system.

[5] The calculation of costs is further complicated by the fact that Victoria already operates a system for managing domestic ballast water and the large mining companies already voluntarily have systems to manage their domestic ballast water. Therefore, by one interpretation, the extra costs imposed by mandatory ballast water management may be overestimated here, but so too will be the extra benefits, so the benefit–cost ratio is likely to remain largely unchanged.

4.7 **Sensitivity analysis**



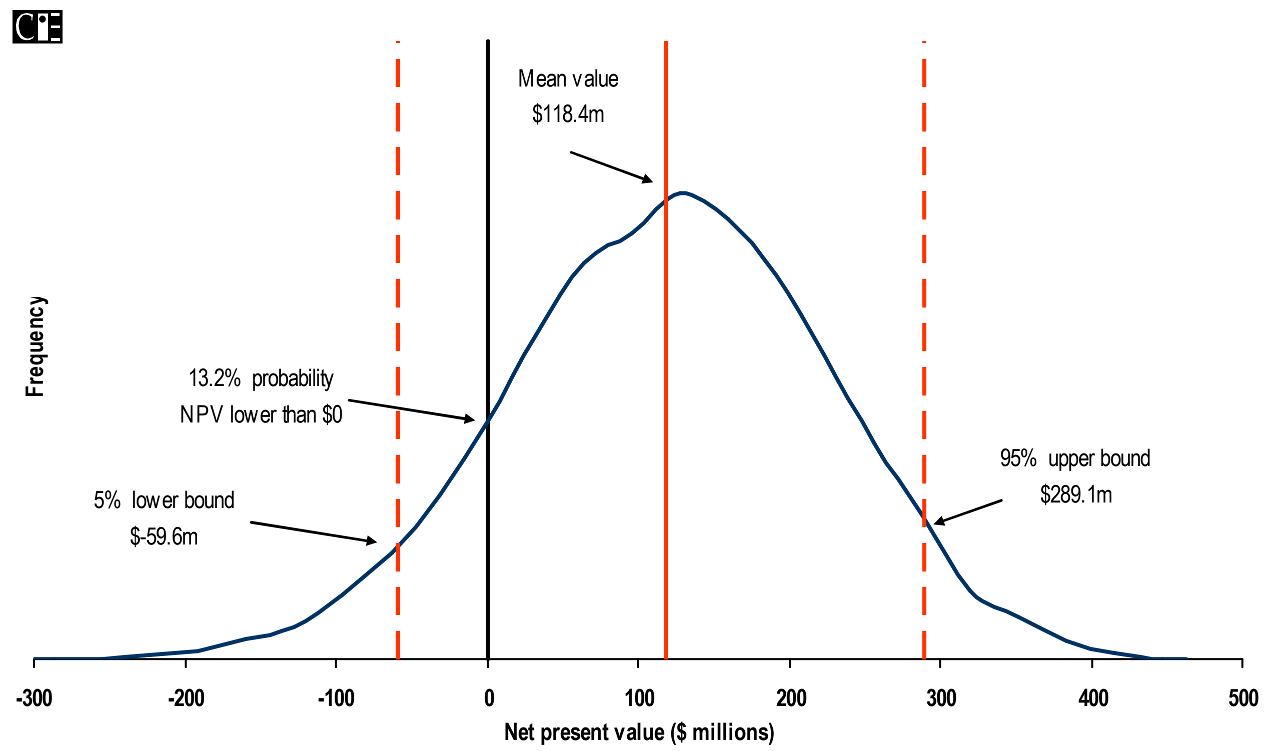
Source: The CIE (2006).

Benefits need to exceed $13 million a year for option 2, sub-option 3 to breakeven

For option 2, sub-option 3 (risk-based 12 miles) to breakeven - for the net present value benefits to equal costs - national annual benefits must equal or exceed $17.6 million a year (table 4.6). This is at the lower end of the plausible range - $10 million to $50 million a year. Assuming that all major variables are approximately normally distributed over the plausible ranges stated above (which is reasonable), the probability of not breaking even appears to be a fairly low. Chart 4.8 shows the expected range and distribution of accumulated net present value benefits of sub-option 3 taking account of the uncertainty of all major benefit and cost variables.

Most other options would require considerably higher annual benefits to breakeven. Option 1, sub-option 1 for instance would require annual benefits of around $45.8 million year, over 2.5 times those required for option 2, sub-option 3 to be viable — table 4.6.

4.8 **Probable distribution and range of net benefits**



Source: The CIE (2006).

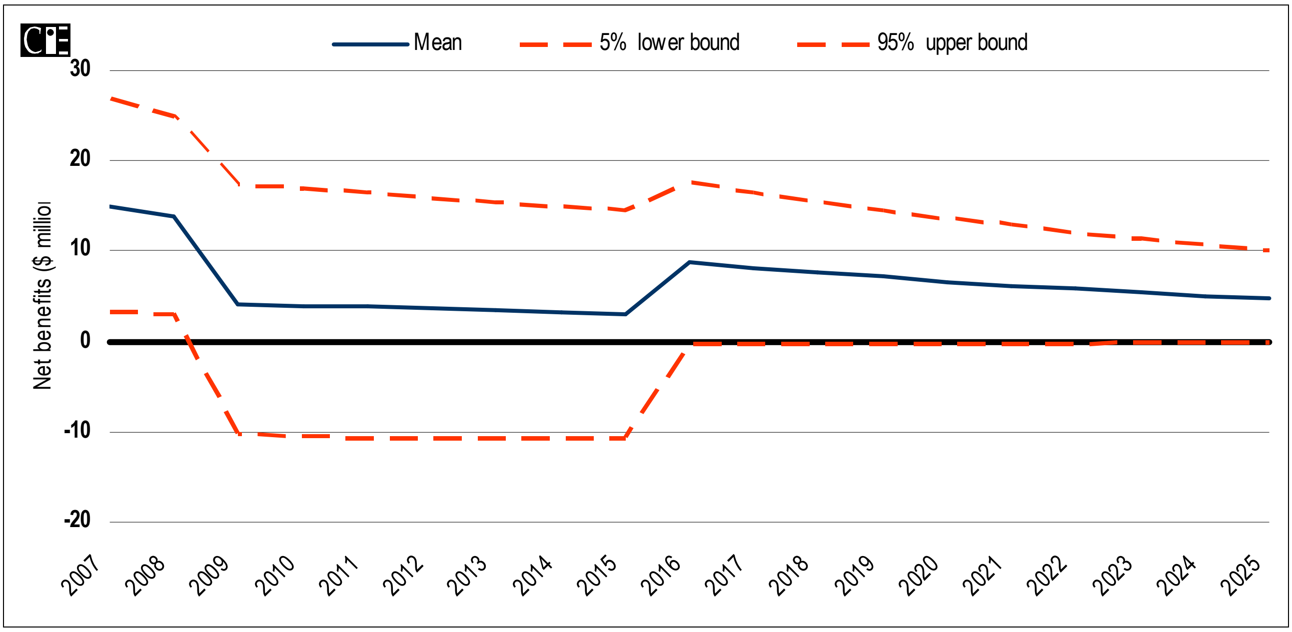
Chart 4.8 shows there is an:

- estimated 13 per cent chance that costs will exceed benefits - the accumulated net present value benefit is less than 0.0;
- estimated 87 per cent chance that the benefits will exceed costs - the accumulated net present value benefit is greater than 0.0;
- estimated 50 per cent chance of the accumulated net benefit being between negative $302 million and positive $118 million;
- estimated 50 per cent chance of the accumulated net benefit being between $118 million and $463 million; and
- estimated 90 per cent chance that the accumulated net benefit will be between $-60 million and $289 million.

High costs of on-board treatment and low national benefits are the main risk

Chart 4.9 shows the plausible upper and lower range of annual net benefits between 2007 and 2025 for option 2, sub-option 3. There is a ninety per cent chance of net annual benefits lying within this range, a 5.0 per cent chance of them being below the range and a 5.0 per cent chance of being above. The results show that there is some chance that the net benefits of the proposed system will be negative between 2010 and 2016 when the capital costs of on-board treatment equipment is being absorbed. Benefits in other years will be insufficient to offset these costs in 4.0 per cent of many (25 000) plausible scenarios assessed.

4.9 **Plausible upper and lower net benefit ranges**



Source: The CIE (2006).

The Enforcement Costs do not include specific costs on the Australian Ballast Water Unit (ABWU) in DAFF. The ABWU costs include staffing and support costs. The final staffing level and support costs for this unit are not yet finalised, but may cost approximately $0.5 million initially (up to 2009) and $0.6 million from 2009 onwards. Discounted through time at 7.5 per cent up to 2025, this would add $4.3 million to the Enforcement Costs. For option 2, sub-option 3, this would increase overall costs from $168.9 million to $173.2 million, an increase of 2.6 per cent. Importantly, at these higher costs, the benefit cost ratio for option 2, sub option 3 up to 2025 remains the same at 1.7:1. The overall net benefit of this option would be $114 million.

It is important to note, that while the specific ABWU costs have not been included in the analysis directly, the ABWU costs are just one of a number of overall costs and benefits that are uncertain. The results of the sensitivity testing in chapter 4 indicate that option 2, sub-option 3 remains viable over a broad range of cost and benefit options.

The cost of domestic inspections has been estimated at $360 000 per year, using existing service providers' costs and assuming an inspection rate of 20 per cent. There remains a level of uncertainty surrounding these costs. Some stakeholders have suggested this cost may be up to three times higher at $1.2 million per year. Similarly, if the rate of inspection was increased to say 30 per cent then inspection costs would increase to approximately $550 000 per year. However, it should be noted that an increase in the inspection costs due to an increase in the inspection rate or time required to conduct an individual inspection, would lead to a corresponding increase in the effectiveness rate of ballast water management. This in turn which would lead to an increase in the associated benefits associated with ballast water management. The final impact of these scenarios on net benefits is uncertain. In any case, the figures and variations are sufficiently low as to not alter the cost-benefit result.

Results are not highly sensitive to estimates of costs

During the consultation process, the Victorian Government observed that onboard inspection costs could be significantly higher than those stated in the RIS (see appendix A). However, even if such costs were doubled or tripled to $720,000 or $1,080,000, they would still have only a minimal impact on the resultant cost-benefit ratio. Moreover, the Victorian Government submission suggested that in their experience in the management of domestic ballast water the costs attributed to ship delay to complete exchange used in the RIS are overstated (appendix A). If so, this may strengthen, but not alter the conclusion above.

Sub-option 3 (12 nautical miles) appears to be the best option

Provided a case can be made that economic benefits of the proposed National System for domestic shipping are likely to far exceed $17.6 million a year, option 3 is the option that provides most reassurance that benefits will exceed costs. Sub-option 4 appears to provide a similar benefit to cost ratio, but net benefits are lower. Moreover, at 3 miles, although costs are lower, so is the effectiveness of ballast water exchange. At around 3 miles from shore, the effectiveness of ballast water exchange appears to drop off rapidly and the risk of colonisation rises steeply as indicated in chart 3.19.

As a result the margin for error at 3 miles is considerably narrower than at 12 miles. On this basis, the 3 mile sub-option would appear more risky.

Many stakeholders argued that estimated benefits were understated (see appendix A). If so, this may strengthen, but not alter, the conclusion above.

The Victorian Government and the Australian Conservation Foundation (ACF) both state that the value of benefits has been undervalued through the absence of consideration for the value of recreational fishing. (Additional 'non-extractive' values such as scientific research, education and conservation are also put forward by the ACF). Increasing the benefit value by including an estimated value of recreational fishing adversely affected by marine pests would again strengthen, but would not change, the conclusion above.

Cost recovery process

The recovery of costs incurred by government in implementing the National System has been considered as part of the overall Australian Ballast Water Management Arrangements. Jurisdictions have agreed that the preferred option is for the majority of prevention costs to be recovered from the shipping industry via a uniform quarterly levy to be applied to all ships. Alternative means including fee per ship visit (with and without cap), fees based on inspections conducted, and an annual fee applied to all ships (Cost Recovery Impact Statement, NIMPCG April 2006) were also examined. The quarterly levy is supported by industry and is the preferred option due to its potential for reduced administration costs and the ability to implement via existing recovery arrangements.

Recommendation

The Natural Resource Management Ministerial Council and the Australian Transport Council should base its national management system on option 2, sub-option 3 (12 nautical miles ballast water exchange and on-board treatment after 2009) **only if,** in its judgement, it can mount a case that the potential annual benefits are likely to exceed $17.6 million by a considerable margin. Otherwise the Councils should accept option 5 and not implement a national management system.

If an argument can be made that potential annual benefits are likely to exceed $17.6 million a year the advantages of option 2, sub-option 3 over others is that it is:

- relatively low cost;
- likely to be nearly as effective as other more expensive options;
- likely to be considerably more effective and lower risk than the 3 mile option;
- more certain of providing a positive net benefit relative to most other options; and
- likely to have a higher level of compliance due to the relatively small incentives to avoid it compared to higher cost options.

Implementation and review

The date of implementation is currently set at 1 July 2007 for commencement of the voluntary phase with the mandatory phase to commence from 1 July 2008. This latter date would be subject to relevant legislation being implemented in all jurisdictions.

Preceding any implementation would be the communication of requirements to relevant stakeholders including the shipping industry. A draft framework for communicating the new ballast water management system is currently nearing completion. This framework sets out a timetable for communication to the various audiences and recommends specific tools and materials to effect the rollout.

Regardless of what the actual implementation dates are for voluntary and mandatory phases, an evaluation and review proposal has already been prepared. The Evaluation and Review Strategy of the National System for the Prevention and Management of Marine Pest Incursions, Version 1 (FARI, 2005) has been approved by the relevant Ministerial Councils and includes four key evaluation and review goals:

1. Implementation of the National System is monitored and where necessary remedial action taken to improve implementation.
2. Progress towards the desired outcomes of the National System is regularly reviewed and where necessary improvements made.
3. External factors influencing the National System are evaluated and where necessary the National System is updated.
4. The E&R strategy is regularly updated as new knowledge about the National System is developed.

Assessment will be carried out through the monitoring of suitable indicators identified for missions, goals and actions. Seventy six indicators have been prepared and are expected to be finalised in the near future.

A 13-year reporting schedule sets out the timetable for assessment. Reporting products include a three-yearly summary report and a three-yearly full report of outcomes and implementation of the National System.

A Consultation summary[6]

In December 2005 DAFF initiated discussions with the Office of Regulation Review (ORR) regarding the probability of legislative amendments being required by the Australian Government to serve the dual purpose of ratifying the International Convention for the Control and Management of Ship's Ballast Water and Sediments – adopted by Australia in February 2004 and signed in May 2005 – and establishing a National System for the Prevention and Management of Marine Pest Incursions.

Background

Advice received from the ORR was that a Regulation Impact Statement was required to discuss the cumulative cost burden on businesses such as ship owners and operators, exporters and importers, while taking into account any proposed changes that would likely be phased in over time. With the final decision makers on the Convention and National System being Ministerial Councils, the format of the RIS is to be prepared using the Council of Australian Governments (COAG) RIS model.

On 15 August 2006 the draft Ballast Water Management – Regulation Impact Statement was granted 'Consultation' status by the ORR and on that day it was presented by the authors, Centre for International Economics (CIE), to the National Introduced Marine Pests Coordination Group (NIMPCG) at the NIMPCG 20 meeting held in Melbourne.

Initial feedback from a number of NIMPCG stakeholders was that there may be merit in considering key (i.e. NIMPCG) stakeholders' comments prior to the Consultation RIS being released for general public comment. Consequently a two-phase consultation was agreed.

6 Both the Department of Agriculture Forestry and Fisheries (DAFF — Invasive Marine Species Program, Australian Biosecurity Taskforce) and the CIE conducted the consultation process. This summary has been prepared by DAFF.

Written responses to the initial draft of the Consultation RIS were received from:

- Australian Quarantine and Inspection Service (AQIS)
- Australian Shipowners Association (ASA)
- The Association of Australian Ports and Marine Authorities Incorporated (AAPMA)
- Tasmanian Department of Primary Industries and Water
- Department of Transport and Regional Services (DOTARS)
- Western Australian Department of Fisheries
- NSW Departments of Primary Industries (DPI) and Environment and Conservation (DEC)
- Victorian Environment Protection Authority (EPA)
- Australian Maritime Safety Authority (AMSA)
- Queensland Environment Protection Agency (EPA)

Following consideration of these submissions a meeting was held in Sydney on 28 September 2006 to further discuss issues with key industry representatives and Australian Government agencies.

A number of changes were made to the original document and a revised draft was resubmitted to the ORR on 20 November 2006 for their information. That version of the Consultation RIS was released for public comment on 24 November 2006 with comments requested by 22 December 2006.

Six written responses were received including two late submissions. The written responses were from the below sources. The Pearl Producers Association response that was received via email and effectively resolved via subsequent telephone and email communications – further detail in the below Comments section.

- Pearl Producers Association
- AAPMA
- ASA
- National Bulk Commodities Group
- Victorian Government
- Australian Conservation Foundation.

Comments

DAFF expresses its gratitude to all contributors for their time and input into this RIS.

The extensive consultation phase and range of comment received have contributed to a detailed and robust document. This final RIS contains further amendments as a result of the second phase of consultation.

Amendments made as a result of the first round of consultation include a greater emphasis implementing the ratification of the Ballast Water Management Convention (BWM Convention) (see Summary and Introduction), and highlighting the benefits of a coordinated and consistent National System for the Prevention and Management of Marine Pest Incursions (see 'Proposed intervention to address the risk' chapter 1). A number of cost estimations were also recalculated as a result of feedback received from stakeholders.

The majority of comments raised in the second consultation phase relate to estimations for the various costs and benefits. The existence of variation and uncertainty in estimations provided in the RIS is acknowledged. Several areas of the impacts were difficult to estimate, particularly given the difficulty in attributing value to environmental benefits as well as the diverse nature of operating costs for ships. The difficulty in assessing these values and the impact of this on the final cost-benefit assessment are addressed in the Sensitivity Analysis section.

In many cases respondents agreed that the estimated benefits were understated, or related to costs that have little overall impact on total cost. The conclusion of the RIS is that legislative action is warranted, therefore increasing the estimated benefit will strengthen, but not alter, this conclusion.

One example of a possible underestimation in cost is the Victorian Government's observation that onboard inspection costs could be significantly higher than those stated in the RIS. Contributing factors to higher costs include inspections being conducted out of normal working hours, and travel time, including travel to remote ports. If these factors were to result in the doubling or even tripling of the estimated domestic inspection costs contained in the RIS, the subsequent amounts of $720,000 or $1,080,000 respectively can be considered in context via the Year on year benefits and costs graph (see chart 4.2). Clearly even the higher amount of $1,080,000 would still have only a minimal impact on the resultant cost:benefit ratio.

The Victorian Government submission suggested that their experience in the requirements for the management of domestic ballast water indicated that the costs attributed to ship delay to complete exchange, and the proportion of ships using flow through exchange, are overstated. Changing both of these factors as suggested by Victoria would reduce the cost to industry and increase the benefit to cost ratio, which would strengthen but not change the conclusion.

Similarly the Victorian Government and the Australian Conservation Foundation (ACF) both state that the value of benefits has been undervalued through the absence of consideration for the value of recreational fishing. (Additional 'non-extractive' values such as scientific research, education and conservation are also put forward by the ACF). Increasing the benefit value by including an estimated value of recreational fishing adversely affected by marine pests would again strengthen the case for legislation, but would not change the conclusion reached by the RIS.

Comments received from the Dry Bulk Commodities Group largely centred on their lack of access to the risk assessment tables for calculating voyage costs and therefore their inability to provide further comment on the projected costs to domestic shipping. The risk tables had been made available to the NIMPCG at the NIMPCG 20 meeting held in Melbourne on 15-16 August 2006 where they were also endorsed. A presentation on the same day drew members' attention to an Internet-based prototype of the IT system that delivered online risk assessments utilising the approved risk tables.

The Dry Bulk Commodities Group have since been approached directly by DAFF and been provided with access to that Internet-based risk-assessment tool. Subsequent feedback received has been positive due to assessments of key routes returning a low-risk assessment and therefore incurring minimal management costs for members' vessels.

The Pearl Producers Association expressed concern that the new exchange requirements for domestic shipping may impact on pearl farms particularly in the north west of Australia. These concerns were largely allayed after considering the number of voyages that would likely be impacted and the fact that pearl farms are not located close to the deeper shipping lanes where any exchange would be likely to occur.

Comments were raised on the lack of detail on the structure (model) of legislation that will support the National System. The RIS has been prepared using the latest known information while recognising that the States and NT are still considering which model will best deliver the shared responsibility and national consistency that has been agreed to by all jurisdictions.

Some comments received have sought to revisit decisions that have already been made, for example, the ACF's request for the National System to adopt the Victorian model of prior-reporting for all vessels. While the RIS considers variable factors wherever possible, it has also been developed in consideration of progress made to date on key issues. In the case of prior-reporting for the National System, this has been previously examined at length and unanimous agreement by all jurisdictions and peak industry groups has been reached for a no prior-reporting system. The shipping industry has agreed to fund the prevention areas of such a management regime.

After the second round of consultation, industry stakeholders are in general support of the preferred option 2, sub-option 3, with a strong desire for regulation, in whatever form it takes, to be nationally consistent.

It is worth bearing in mind also that ballast water exchange has a limited life and that the future of ballast water management is in the field of onboard treatment technology. This RIS provides a detailed analysis of the cost implications of both systems including the transitional period of 2009 to 2016. In doing so the RIS should serve well in its stated roles for the Australian Government whilst also providing a valuable tool for those jurisdictions that will be undertaking a further RIS in accordance with their respective State/Territory requirements.

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