Evaluation of the Hastings National Demonstration Project

Prepared for

Prepared for: Environment Protection Authority Victoria as project managers for the Victorian Government Consortium of the Department of Natural Resources and Environment, Department of Infrastructure and EPA and project partners Australian Quarantine and Inspection Service and CSIRO – Centre for Research on Introduced Marine Pests

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Overview

The Hastings National Demonstration Project

Australia is a maritime nation and relies heavily on shipping. Ballast water, because of the marine pests it may carry, poses a risk to the Australian economy and environment. Ballast water may be of international or domestic origin, posing challenges for its effective management given historical separation of responsibilities between the Commonwealth and state governments.

In July 2001, the Commonwealth government introduced mandatory ballast water management requirements for all international voyages. No management of ballast water from domestic sources is currently required. However, the length of domestic voyages within Australia can vary from less than 100 nautical miles to the same order of distance as international movements and pose equivalent risks of introducing marine pests.

The Hastings National Demonstration Project (HNDP) was conceived to trial the operational and management arrangements of an integrated ballast water management model to assess its suitability for Australia wide implementation. The Port of Hastings was chosen due to the variety and the number of traceable shipping movements and the ability to regulate both domestic and internationally sourced ballast water with existing state and Commonwealth legislation. The project commenced on 1 July 2001 and ended on 31 December 2002.

The ballast water requirements used in the trial were supported by dual regulation (through existing Commonwealth and State legislation) and delivered through separate administrative arrangements (separate Commonwealth/State forms, monitoring etc). This report evaluates the model used in the trial and examines its ability for extension to Australia-wide implementation. It should be noted that the Hastings Project did not trial possible alternative options to the model used in the trial, including the option of the use of multiple regulation, with a single administrative interface for industry, delivered through nationally consistent template legislation. It was beyond the scope of this evaluation to examine the constitutional or legislative issues surrounding various options, which will be important in the overall decisions on implementing the proposed National System.

The HNDP is managed by the Environment Protection Authority (EPA) Victoria. The project partners are a Victorian Government Consortium (comprising EPA, Department of Natural Resources and Environment and Department of Infrastructure), Australian Quarantine and Inspection Service (AQIS) and the CSIRO Centre for Research on Introduced Marine Pests. The Project Steering Committee and Technical Advisory Committee comprises the project partners and the Association of Australian Port and Marine Authorities, Australian Shipowners Association, Agriculture Fisheries and Forestry - Australia, Environment Australia, Australian Marine Conservation Society and the Hastings port manager TollWesternPort.

The Trial

During the first 12 months of the trial period, a total of 66 vessels passed through the Port of Hastings, making a total of 183 calls in the port. The following table summarises the vessel calls:

	Discharging/not discharging ballast	Number of calls	Number of vessels
International voyages	Discharging	15	15
	Not discharging	8	7
Domestic voyages	Discharging	40	24
	Not discharging	120	23
Total number calls/vessels		183	
Average calls per week		3.5	

The majority of the callers were tankers, gas and oil, on domestic voyages (39%), and the regular supply of steel slab from Port Kembla (39%) by a single dedicated vessel *(Iron Monarch*). A large percentage of calls were repeat calls by the same vessels, only a relatively small percentage (22%) being one off calls by itinerant vessels. The majority of these were overseas tankers or vessels calling to load steel products for BHP Steel. Appendix 5 of this report provides a more detailed view of ship visits.

The dominance of vessels calling as part of a domestic or coastal schedule adds to the rationale for the choice of Hastings for the ballast water management project. Of the fifty five calls where vessels advised their intention to discharge ballast, forty were reporting carrying ballast sourced from within Australia. One vessel on an international leg (from NZ) was also found to be carrying ballast sourced in Australia during a previous voyage. The sources of the ballast water varied widely, including Port Botany and Port Kembla, NSW; Brisbane, Queensland; Fremantle and Kwinana, WA; Port Stanvac and Bonython, SA; Bell Bay in Tasmania and Geelong and Melbourne in Victoria.

Evaluation of the Project

The project evaluation addressed two major issues: physical implementation and environmental effectiveness. More specifically, the evaluation assesses how the objectives of the HNDP have been met.

Physical Implementation

The HNDP implemented the management model shown below and used both state and Commonwealth legislation to provide the necessary regulatory arrangements.

BALLAST WATER MANAGEMENT MODEL

Vessel			Regulator			Vessel		Regulator	
Assess risk	Manage ballast. Record manamgement practices	Report to regulator	Receive application for ballast water discharge	Process application. Assess risk	Advise permission to discharge	Receive advice re permission to discharge	Be available for inspection	Perform verification inspection	Enforce if required

Some operational elements of the model were inevitably duplicated as a consequence of having dual regulatory and administrative arrangements in the trial ballast water management model and this resulted in a somewhat cumbersome arrangement. Increased administrative cost to the regulators and vessels could be incurred if the dual regulatory and administrative arrangements as trialed in the Hastings Project were to be carried forward into an integrated national ballast water management model.

To ensure that the integrated ballast water management model operated effectively, close communication between both agencies was required and this has been sustained throughout the Hastings Project. This was delivered by varying and formalising procedures in the early stages of the project to ensure that communication issues did not effect vessel operations or increase environmental risk.

The application of the integrated ballast water management model for the eighteen month period was effective in testing the following:

- receipt of ballast water from both domestic and international origins
- large quantities of ballast water relative to voyage duration
- ballast water intended for discharge assessed to be high and low risk
- receipt of vessels trading internationally, coastally (international ship on second or subsequent port of call) and domestically
- various voyage durations
- a range of options used by vessels to manage their ballast water; including exchange, retention (including tank to tank transfers) and avoidance of taking up high risk ballast in previous ports of call
- routine port visits by one of the most demanding classes of vessels with regard to ballast usage (tankers)
- a variety of frequent and routine vessel calls as well as ‘one off’ vessel calls
- demanding (100%) compliance inspection regime
- application of the Ballast Water Decision Support System (DSS) to movement of ballast water within Australia
- the outsourced delivery of compliance inspections for domestic ballast water;
- typical meteorological conditions
- routine operation of the port.

Given the range of circumstances tested and experience gained, the physical concept of an integrated ballast water management system has been proved. While it has been shown possible to obtain satisfactory implementation of the integrated system using dual regulators and administrators as trialled in the Hastings Project, this is far from ideal in terms of its replication across eight Australian jurisdictions. Further, it was also identified that the administrative arrangements for the integrated ballast water management system would benefit from a Quality Management System, with policy and procedures documented, and the administrators accredited, under an externally recognised QA system, such as ISO 9000.

Environmental Effectiveness

The project used the Ballast Water Decision Support System (DSS) as the risk assessment tool for ballast water intended for discharge into the Port of Hastings. This ensured a consistent approach to that adopted for the assessment of international ballast water.

The use of the DSS for the eighteen month period enabled the following:

- incorporation into the risk assessment of new data on the status of marine pests in the Port of Hastings and other Australian ports
- inclusion of data for selected target species into Part B (probability that the target species will be taken up by the vessel) of the risk assessment
- inclusion of data for selected target species into Part C (probability that the target species will survive the journey) of the risk assessment.

Given the range of circumstances tested and experience gained, the concept of application of the DSS to international and domestic ballast water movements is supported. Specifically, the availability of data on the infection status of Australian ports showed that in some instances ballast water treatment was unnecessary en route to Port of Hastings.

In evaluating the proof of the concept that the DSS can be applied to both international and domestic ballast water movements, the following issues were identified and these will require attention irrespective of arrangements made to implement an integrated ballast water management system:

- A Quality Management System, such as ISO 9000 is also required to provide system transparency. The issues that need to be addressed include: software design, the integrity of input data, algorithms used to calculate risk, criteria for determining the level of risk that is acceptable.
- The determination of the Type II error rate within the DSS, an investigation currently underway, will be an important step towards reducing uncertainties in the risk assessment.
- Given the probabilistic nature and the average rate of introductions to Australia, an assessment of the environmental effectiveness of ballast water management requires determination over the long term.

The way forward

The performance of the Hastings Project clearly indicates support for the benefits and the possibility of developing a national integrated ballast water system. Further analysis would be needed to identify the most effective and viable options for administering such a system. Progress towards this end has been made during the evaluation period. A high level officials working group has recently been formed to address the issues involved in implementing a National System. It is understood that, while the HNDP evaluation was limited to management of ballast water and more particularly the performance of the Hastings Project against its project objectives, the scope of the high level working group's considerations have extended well beyond this. It is considering options for either a single regulatory approach or one based on model template State/Territory legislation that will provide the required level of consistency identified as important in this review. Such an approach would need to be delivered through a single interface to ensure a single point of contact for industry.

Recommendations related to each of the Hastings project objectives

The project brief identified that an overarching objective of the trial was to:

> *...provide a nationally applicable model that integrates the management of internationally and domestically sourced ballast water*

In overall terms, the findings of the evaluation are that:

- The evaluation of the HNDP indicates no impediment to the establishment of an integrated ballast water management model across all Australian ports and suggests that there are good reasons for doing this as soon as possible.
- An integrated national ballast water management model would benefit from being administered by a single national body or regulatory system to help ensure cost effectiveness, and provide a single interface with industry, , consistent implementation across eight jurisdictions and the basis of the application of an auditable quality management system for the ballast water management model and associated risk assessments. However, the Hastings Project did not trial an option for integrating administrative functions across jurisdictions.
- Given that the only resource required at an individual port is that needed to undertake shipboard verification inspections, advantage should be taken of the various service delivery options available across Australia including out-sourcing to authorised personnel.

Specific changes or improvements that would facilitate the model being adopted for a national integrated ballast water management system are discussed below.

Further objectives were defined as:

…an effective administration framework

The conclusion reached by this evaluation is that an integrated system of ballast water management for both international and domestic sourced ballast water is essential. The dividing lines are too blurred, and the potential for gaps, inconsistencies and incompatibilities may result in exposure that is too great to allow a series of separate state based administrative programs for domestic ballast to be sustainable. The results from this trial suggest a preference for a regime based on a single regulatory or administrative body with responsibility nation wide. However, the Hastings Project did not trial options for integrating administrative and regulatory functions, such as nationally uniform template legislation across all jurisdictions (including the Commonwealth, all States and NT).

A single regulatory system or an integrated administrative approach is needed to provide consistency and clarity – it would provide less risk in the overlap of administrative roles; less confusion regarding which paperwork applies and when; and consequent reduction in duplication and resultant administrative cost to regulators and the industry.

In seeking an effective administration framework, the evaluation identified specific issues of communication and response that should be addressed to facilitate the national acceptability of the ballast water management model trialled. These may be summarised as:

- A fail-safe approval notification system should be implemented so that ballast water is not permitted to be discharged until approval has been granted by the relevant authority.
- The dwell time between lodging data and receiving an assessment is critical if vessels are to access the decision support system directly.
- A channel should be established for ships or their agents to feed back suggestions on workability and possible improvements to both data capture and physical implementation.
- Communication channels should be clear and unambiguous, preferably covered by written procedures with third party audit capability.
- Advice from one agency to another of high risk vessels will be valuable, and a formal channel for timely communication is recommended.

…minimise the risk to the environment

It is considered essential for any nationally adopted integrated ballast water management model that a common and consistent risk assessment system and model is applied, both for international and domestic ballast, and between ports and across jurisdictions.

In refining the ballast water management model for future use or for national application, the following recommendations are made in relation to the decision support system:

- The transparency of the decision making process in relation to settings in the DSS is clearly critical.* A fully documented system capable of third party audit is recommended.

- Timeliness of changes to the DSS model has been an issue*. The quality system recommended above should incorporate a set of target timings, and an audit trail to ensure reasonable compliance.

(*It is noted that these issues may be considered in the Post Implementation Review being carried out by AQIS.)

Given that currently the only means of treating ballast is to exchange it at sea, in terms of the physical processes, the current procedures may incur a risk of the volume of ballast exchanged being less than reported. It is recommended that more research should be encouraged by trials and sampling to ensure that:

(a) the current protocols are environmentally effective

(b) the pumping of suggested volumes does actually take place, given the shortcomings of the only verification (Newcastle method).

…appropriate options for vessels to manage the risk posed by their ballast water

Safety and operational issues dictate that ocean exchange of ballast water is not the preferred option in the longer term, but there will clearly be a long lead time before either ship design or other treatment methods will remove the risk elements to the vessel. It is recommended that

- Government at both Commonwealth and State/Territory level should be actively encouraging the development of alternative technologies, to be investigated both by research bodies and industry.
- Industry should be encouraged through education and awareness programs to view developing technology as eventually constraining costs, as well as providing triple bottom line benefits.

In concluding this evaluation, the following is distilled from, and informed by, the many comments obtained during the consultative process.

Society has to make decisions about the balance between acceptable risk and the growth of the domestic economic fabric. The ballast water management model trialled in the **Hastings National Demonstration Project** is a major step towards managing the risk of marine pest invasion to the Australian marine environment, vis-a-vis the commercial and social benefits that the environment provides.

<u>It is very important that the momentum developed through this project be maintained.</u>

1. INTRODUCTION

1.1 Background

The Hastings National Demonstration Project (HNDP) was conceived to trial and form the basis for the operational and management aspects of an integrated (both international and domestic ballast) risk-based ballast water management system prior to Australia wide application. The management system is designed to be effective in terms of both vessel operations and protection of the environment.

The Hastings Project builds on the AQIS mandatory national ballast water management arrangements for all international vessels and a previous trial to develop and implement procedures for coastal ballast water known as the Three Port Trial. The Three Ports Trial involved ships travelling between the ports of Melbourne, Adelaide and Devonport (PPK, 1999).

1.2 Objective of this evaluation

The aim of the Evaluation Project is to assess how the objectives of the HNDP have been met. This report presents the evaluation of the HNDP and is prepared for the information of the stakeholders. It does not therefore attempt to describe the project itself or the background to its inception or implementation, except where those factors impact directly on the criteria defined in the Project Brief.

The criteria by which the HNDP is to be evaluated are contained in the Aims of the HNDP as set out on Page 2 of the Specification[1] (Project Brief).

1.3 Evaluation of the Hastings National Demonstration Project

The overall structure of the evaluation report comprises several discreet parts, namely:

- an introduction (**Section 1**)
- the effectiveness of the Hastings project's administration framework (**Sections 2**)
- the degree to which the Hastings project minimises the risk to the environment (**Sections 3**)
- options for vessels to manage the risk posed by their ballast water (**Section 4**)
- issues associated the performance of the Hastings Project as a basis for a nationally applicable ballast water management model (**Section 5**)
- matters recommended for further consideration (**Section 6**).

The *Appendices* contain detailed information developed during the evaluation, providing background to views and conclusions reached.

[1] Request for Tender (RFT) issued by EPA Victoria, 18 May 2002: Part B Specification

This evaluation follows the overall structure of the Specification, picking up each of the Hastings Project aims. Each of the aims is broken down into sets of criteria, and the structure of this part of the report follows that basic format, except that the overarching issues contemplated in 2 (i) are covered in Part 5 of the report, following on from the detailed issues discussed in Parts 2 to 4.

The Aims as described are to provide:

(i) a nationally applicable model that integrates the management of internationally and domestically sourced ballast water

(ii) an effective administration framework

(iii) minimisation of risk to the environment

(iv) appropriate options for vessels to manage the risk posed by their ballast water.

Of these, the latter three have been described as proving the concept, whilst (i) refers to the question of transferability, based on the issues arising in (ii), (iii) and (iv).

The report therefore deals with aims (ii) to (iv) first in **Sections 2 to 4** of the Report, and extrapolates the information to provide an overview of the ballast water management model and its transferability in terms of (i) in the Specification in **Section 5**.

As an underlying theme of this evaluation, the success of the Hastings project is established against all of the criteria on the basis of the review criteria set out in Task A of the specification. The criteria are defined as:

- *to establish how well the objectives have been met*
- *to identify deficiencies/gaps in the current arrangements and provide explanations as to the existence of these, including issues of practicality, administrative and political and legal constraints where applicable*
- *to recommend any remedial action to address deficiencies.*

1.4 Information: acquisition and sources

The information was gathered for this evaluation from a desk review of various documents and from stakeholder consultation. Both in the scientific aspects of the decision support system, and in the day to day implementation of the trial, personal experience of the consultants has played a large part in understanding the issues involved. Considerable information was accessed from professional sources and the public domain. This was augmented by informal discussion with industry contacts, particularly in the area of ship operations and cost assessment.

1.4.1 Stakeholder consultation program

Inception meeting

As set out in the proposal, the number of stakeholders and their different perspectives made a joint meeting at the inception of the project valuable.

Key stakeholder interviews

Stakeholders were consulted where appropriate on a one-on-one basis, although joint meetings were held where a commonality of purpose made this effective. Meetings covered the initial discussions to assess expectations of the HNDP ballast water management model, its management and implementation and the scientific and operational issues underlying it. The meetings were also an opportunity for the stakeholders to indicate their expectations of the evaluation process and their views on the suitability of the ballast water management model for national adoption. Key issues have been drawn from this consultation and, where these issues are considered substantive in light of the project brief, they are discussed in the body of the report.

Other meetings/consultation

In addition to the listed stakeholders, discussion was held with various industry contacts to assist with an understanding of the issues confronting the system at an operational level. This process included on-site work, including visits to the Port of Hastings to discuss operational issues and to visit ships, on one occasion in conjunction with a verification inspection being conducted by AQIS.

1.4.2 Relevant reports

A range of reports was accessed in forming a view of the ballast water management model and its management characteristics. Many of these were made available but many others were accessed through web-sites. Although it could not be said that all literature on the subject was accessed, the range of reports helped in an understanding of a problem that has many aspects, with a range of sometimes conflicting views associated with them.

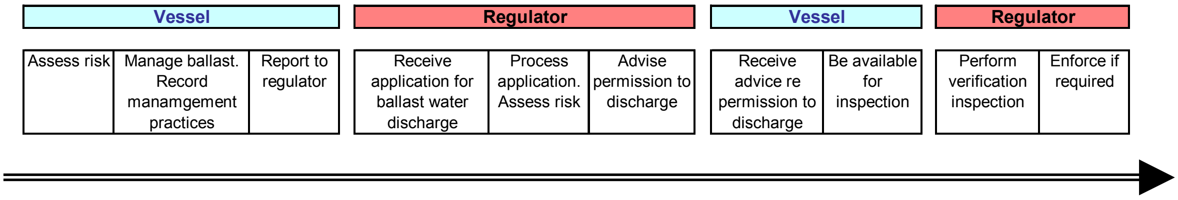
Reports and other literature accessed are included under the list of references in Appendix 1.

1.5 Proof of concept

The main thrust of this evaluation is to prove the effectiveness of the implementation of the HNDP ballast water management model at Hastings, with the added tasks of assessing its environmental effectiveness and its transferability to other Australian ports.

The HNDP implemented the management model is shown in figure 1.

FIGURE 1 - BALLAST WATER MANAGEMENT MODEL[2]



The Hastings Project utilised existing Commonwealth and State legislation to deliver international and domestic ballast water management requirements through separate administrative arrangements (separate forms, contacts, monitoring etc.).

It should be noted that the Hastings Project did not trial possible alternative options to the model used in the trial, including the option of a single regulatory authority or the use of multiple regulation (delivered through nationally consistent template legislation) with a single administrative interface for industry. It was beyond the scope of this evaluation to examine the constitutional or legislative issues surrounding various options for a national ballast water management model, which will be important in the overall decisions on implementing the proposed National System for the prevention and management of marine pest incursions.

The concept has been in operation for the full duration of the HNDP. During this period, there have been various issues arise with particular ship calls, but these can be generally attributed to problems of implementation and administration. Experiences with the HNDP have highlighted several areas in which the administration of the ballast water management should be varied, but in general terms the operational and management aspects have operated in a way which has proved that the concept developed for international ballast is sound, and has been proven in general terms for the management of domestic ballast.

In terms of the physical operation of the ballast water management model, **Appendix 3** includes notes on operational aspects arising from a review of the model as it was applied during the trial period. These relate to desk review of EPA paperwork, visits to Hastings and two ships, one of which was a joint visit with AQIS performing a verification inspection, discussion with agents, ships' staff, port operators (Toll), and with AQIS.

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[2] Based on 'Ballast Water Management and Reporting Procedures' - E'PA Victoria

2. HNDP ADMINISTRATIVE FRAMEWORK

The Specification paragraph 2 (ii) defines the criteria for *'An effective administration framework'*. This section explores the administrative aspects of the management model in light of these criteria.

2.1 Roles and responsibilities

2.1.1 Overview

EPA

The project was managed by EPA Victoria on behalf of a consortium of Victorian agencies, in collaboration with project partners, with an agreement with AQIS to provide the decision support system (DSS) and to carry out verification of data provided by ships.

EPA Victoria provides the overall supervision of the model, overseeing documentation, monitoring compliance with ballast water management requirements, liaising with AQIS for verification inspections and auditing information on the management of ballast, exchange of locations etc.

EPA Victoria takes responsibility for compliance enforcement for domestic ballast water and AQIS for international ballast water.

Documentation was developed specifically for the Hastings project.

The port

In the case of the Hastings trial, the port of Hastings (operated under a management contract by Toll) played a role. The Harbour Master, employed by Toll and licensed in respect of his Harbour Master role by the Marine Board of Victoria (now Marine Safety Victoria), took an active hand in ensuring dissemination of information, and ensuring that vessels and/or their agents were aware of their obligations and completed necessary documentation.

The vessel

From a vessel perspective, the master is responsible for the management of the vessel and compliance with regulations and will interface with the regulatory authority through the required documentation, and may access the DSS for an assessment.

AFFA - including AQIS and BRS

As stated earlier, AQIS performed verification inspections on behalf of EPA and made the DSS available to perform risk assessments on domestic ballast water at the Port of Hastings.

Within the DSS, the roles of administering the system appear clear, with a specific individual assigned the role of administrator of the system. The roles in respect of policy issues seem less clear cut. The DSS administrator makes changes to thresholds etc. The decisions for these changes are made by AFFA as the entity responsible for policy issues, with AQIS handling the operational role. Ostensibly, the decisions are made with reference to other stakeholders, with advice on scientific aspects from BRS, also part of AFFA. These are policy issues, relatively small changes which can have overarching results in terms of percentage of high/low risk assessment and therefore on the balance between environmental effectiveness and industry impact.

The process by which these changes are implemented is identified by many stakeholders as a critical issue. This process certainly had some effect on the project itself, as commented on later in this report. This issue is particularly critical for the ongoing acceptability of the ballast water management model to industry and to government as regulator acting on behalf of the community.

Other agencies

In addition to the EPA and AQIS (AFFA/BRS), other agencies have had a role in the development of the trial ballast water management model, but no day-to-day involvement. These include the Victorian Department of Natural Resources and Environment (DNRE), the Commonwealth Scientific and Industrial Research Organisation Centre for Research on Introduced Marine Pests (CSIRO/CRIMP), the Victorian Department of Infrastructure (DOI), Environment Australia (EA) and the Australian Marine Conservation Society (AMCS). Industry has been represented by Australian Shipowners Association on behalf of ship owners, and Australian Association of Ports and Marine Authorities (AAPMA) on behalf of port operators.

2.1.2 Assessment of performance

Objective: The specification (2 (ii)) identifies that an effective administration framework must … *'have allocated, articulated and implemented the roles and responsibilities of individuals and organisations including ports, Government regulators, ship's agents and vessel Masters.'*

The Hastings trial has been successfully communicated in general terms, but this has been at some considerable effort by various parties, including the port. There may be areas in which communication of obligations could be improved. Since Hastings is only one port, there is going to be the difficulty that requirements are not common to all Australian ports, and tend to overlay the requirements to interface with AQIS for internationally sourced ballast. The adoption of a national ballast water management model may assist this as the requirements would become Australia wide. Once ports and agents and repeat callers become used to the system, awareness will automatically increase.

2.1.3 Deficiencies and recommended remedies

The following are identified as key issues:

- Communication of roles and responsibilities has worked in the case of the Hastings trial as a result of intensive effort by various parties. A more formal approach to promulgating obligations would be recommended when expanding the ballast water management model to other ports. To ensure consistency of implementation all roles required should be clearly defined.

- Responsibility for policy changes to the DSS requires better definition, and procedures should be developed to allow transparency and proper audit (see later comments on quality management).

2.2 Effectiveness of communication

2.2.1 Overview

Communication takes place on many levels in the process of complying with the requirements, including establishing and implementing the effects of a risk assessment. For the purposes of this section, data input can be considered on two levels:*

- Data on specific ballast conditions fed into the DSS by Internet connection or INMARSAT-C, either by the ship, or by its agent after receiving information by fax or telex. Access requires a username and password for the Internet interface, but not for access by email or Inmarsat-C.
- Communication of risk assessment data and resultant management options.

(*Note: Data population of the DSS from survey and feedback loops within the DSS is dealt with under section 3.2 which discusses the effectiveness of the DSS as a tool.)

Data collection from ships as they access the DSS is critical to the smooth implementation of the system. Although this has not been substantiated by individuals concerned, there is anecdotal evidence that ships' masters have been frustrated by the length of time taken for the DSS to respond, not only in assessing data and issuing a unique Risk Assessment Number (RAN), but also in accepting data input. The process will often be taking place over an expensive satellite connection and the ship's master will soon lose patience if the system frequently rejects data due to minor discrepancies in presentation. The result is cost – both in dollar terms and in terms of the credibility of the ballast water management system. It is noted that this issue is being dealt with under the AQIS Post Implementation Review. It may be related more to the error requirement of the decision support system for precise formatting than in any delay in response. It is also suggested that the incidence of this type of problem is reducing, probably as a result of ships' staff becoming more familiar with the system.

The ballast water management model applied by EPA in Hastings did not communicate a specific approval to carry out discharge, the assumption being that no advice is implied approval. This is clearly not 'fail safe' and should be reviewed in any development of the ballast water management model for national application. In fact, during the trial period there was an inconsistency between the EPA and AQIS approach to feedback to vessels. The approach used by AQIS of formal advice permitting discharge is preferred.

Formal communications and reporting

Formal communications and reporting have been promulgated through AQIS documents as the domestic trial has been integrated with the international system introduced on a mandatory basis on 1 July 2001. This appears to have been effective although it has required some education and re-education by EPA staff. Discussion with senior staff on one vessel trading internationally indicated no difficulty with the process, and an acceptance of the reporting and compliance requirements, which are now becoming commonplace world wide.

Formal reporting in relation to the operation of the DSS appears however to have been less than satisfactory, particularly in relation to transparency of decision making for policy changes, and in speed of response to specific requests for amendments to the DSS. Discussion with AFFA/AQIS about those processes did not give the impression of clearly defined and documented procedures, and this was subsequently confirmed. Although there are documented procedures for the actual work of adjusting settings in the DSS, it is understood that no documentation exists for the process by which decisions are made. This is understandable given the relatively short time since inception of the DSS.

A quality system to provide the level of transparency and third party audit capability would be highly desirable if the agencies concerned are to develop confidence in the system's environmental effectiveness, and instil that confidence in their own stakeholders, the community. It is also considered that such a quality system would allow AFFA/AQIS to better demonstrate its own capabilities to the community and the maritime industry, which both bear the brunt of preventive and remedial costs if the ballast water management system fails.

2.2.2 Deficiencies and recommended remedies

Objective: The specification (2 (ii))identifies that an effective administration framework must … '*establish effective communication links to ensure that data is collected and processed efficiently*'.

The decision support system model being currently employed falls down in two areas, namely:

- in the complexity and lack of flexibility in input format for the DSS risk assessment
- in the lack of a specific, failsafe, approval notification system.

The following are recommended for remedying these deficiencies:

- In refining the ballast water management model for future use or for national application, data input formats for the DSS should be reviewed to allow quick input. There is also delay in response to request for changes in DSS settings which should be investigated.*
- A fail-safe approval notification system should be implemented so that ballast water is not permitted to be discharged until approval has been granted by the relevant authority.

It is noted that some legislative change may be needed to give effect to this.

(*Note: Comments from steering committee members note that these issues are being considered under the AQIS Post Implementation Review.)

2.3 Feedback

2.3.1 Overview

Feedback within the ballast water management model takes place at various levels:

a) at an operational level, feeding back results of risk assessments and instructions to ships, and for ships/agents to make suggestions on improving the quality of information capture

b) at an administrative level, feeding back data on vessels and assessments between agencies

c) at a scientific level, feeding back data on pests, survey results etc. to the decision support system (dealt with under Section 3.2)

d) at a policy level, feeding back scientific and operational data to allow informed and reasoned input into policy decisions processes, and the promulgation of those processes.

Operational feedback

The system for accessing the DSS and obtaining a risk assessment is relatively straight forward and, according to industry comment, appears to have generally worked well apart from some minor deficiencies noted below. The only caveat to this, mentioned in 2.2 above, is in the format for transmitting data to the DSS and obtaining the RAN, and the dwell time between lodging data and receiving an assessment. This is an administrative matter related to the current DSS structure and is explored in 3.2 below.

An issue that will need attention as the system develops concerns feedback loops when problems occur. For the Hastings trial, the close attention available from EPA when issues develop has solved problems early. With greater number of vessels in other ports, the ability to access decisions promptly will be essential and should be clearly defined in procedures developed for an integrated national ballast water management system. The issues envisaged here are where doubt develops over the risk assessment itself, or where vessel specific information on the data base or obtained through links with other agencies suggests a high risk of non compliance or evasion.

A further level on which it is recommended that there be a formal feedback channel is for the ship or its agents to feed back suggestions on workability and possible improvements to both data capture and physical implementation.

Administrative

On an administrative level, an audit of inter agency communications between EPA and AQIS suggests some lack of adherence to communication channels. There have been occasions where verification inspections have been jeopardised by communication problems. Once again, the issues arising have been resolved in the trial situation as there has been the time and resource to do this, and changes to procedure have been implemented. In a nationally applicable ballast water management model, particularly if more than one agency is involved, it will be necessary to ensure that these communication channels are clearly documented and compliance can be audited (see later comments on quality systems).

Whilst not resulting in any major problem during the trial and therefore not seen as a deficiency, these reinforce the need for failsafe communication. In the cases reported, no major exposure resulted, but a similar number of problems translated into a national management system would represent a major risk.

Transfer of information from one agency to another about high risk vessels, is known to have been an issue under discussion. It is also considered to be important. This feedback loop will assist in establishing high risk situations in advance, and planning resource to best address them.

Both the above issues underline the potential advantages of a single body managing the integrated ballast water management model.

Policy

Feeding back scientific and operational data to allow informed and reasoned input into policy decisions processes, and the promulgation of those processes, is clearly central to the workability of the system. Currently, decisions are made on policy issues such as threshold setting within the DSS by AFFA with scientific input and interpretation from BRS.

The major issue raised by stakeholders was transparency of the process. While AFFA/AQIS are confident that the scientific issues to making policy changes within the DSS are discussed with other stakeholders, this confidence was not shared by all stakeholders. It is clear that to provide a system that will address those issues, a proper quality management system needs to be applied that will (a) prescribe and audit documented procedures; and (b) provide for rigorous internal or, preferably, external audit of implementation.

The timeliness of changes to the DSS model is also an issue. As an illustration, a situation arose (the C*orbula gibba* issue at the Port of Hastings) where EPA Victoria requested the DSS be amended in light of new information. This was eventually done, but after several months. The decision process was not clear, and the outcome was not entirely satisfactory.

2.3.2 Deficiencies and recommended remedies

Objective: The specification (2 (ii)) identifies that an effective administration framework must … '*provide efficient accurate feedback to all participants* '.

The measure of efficient and accurate feedback is in the satisfaction level of participants – the stakeholders. In overall terms, there were some substantive deficiencies noted by stakeholders, particularly in the policy area. These concerns were borne out in the evaluation. These issues are therefore seen as critical, not so much in the ability of the trial ballast water management model to be adopted nationally, but in the future effectiveness of an integrated model for ballast water management based on the DSS as a risk assessment tool.

The following were the issues arising, and recommendations for remedial measures.

- The dwell time between lodging data and receiving an assessment is critical if vessels are to access the decision support system directly.
- Channels should be established for ships or their agents to feed back suggestions on workability and possible improvements to both data capture and physical implementation.
- Communication channels should be clear and unambiguous, preferably covered by written procedures with third party audit capability.
- Advice from one agency to another of high risk vessels will be valuable, and a formal channel for timely communication is recommended.
- The transparency of the decision making process in relation to settings in the DSS is clearly critical. A fully documented system capable of third party audit is recommended.
- Timeliness of changes to the DSS model has been an issue. The quality system recommended above should incorporate a set of target timings, and audit trail to ensure reasonable compliance.

Whilst not a deficiency during the trial period, clearly defined channels for agents/vessels to access decisions promptly when issues arise should be included in documented procedures.

2.4 Awareness and education

2.4.1 Overview

Awareness of the Hastings project has been high in the industry locally, and ballast water management issues are generally well understood by most ship operators and their agents as ballast water management activity levels increase world wide. The HNDP steering and technical advisory committees include AAPMA and ASA representing ports and Australian ship owners respectively.

AQIS has run a program of education for the international ballast water management program, and EPA Victoria has been able to use this as a platform to include educational material regarding the HNDP.

The specific requirements and obligations of the system for ship operators are covered in the AQIS publications[3] and the domestic ballast issues have been integrated into these, although with modified paperwork requirements. Promulgation of day–to–day requirements has been effective.

In terms of overall awareness, the issues of domestic ballast water appear not to have been fully understood. An example was a vessel that, after an Australian coastal rotation, sailed to NZ and then returned to Hastings, thus carrying domestic ballast still representing high risk if discharged in Hastings. AQIS, in line with their operational procedures, had not received the "Uptake / Discharge" log prior to boarding, and the EPA was not aware it was carrying "domestic" ballast water, with intent to discharge in Westernport. Therefore, as a further consequence, no Westernport ballast water reporting form was completed. The vessel was in port for several days, and the appropriate form was eventually completed.

As it turned out there was no environmental threat as ballast water was exchanged on passage as a charterer's requirement. The EPA sent out a reminder to the agent that international vessels can carry domestic ballast, and therefore both AQIS and EPA forms must be completed and submitted to both authorities.

This example underlines the potential dangers of having two (or more) regulators/administrators involved as trialled in the Hastings Project. It also indicates the level of duplication and adds further to the case for a single body managing or overseeing an integrated system.

The problems may have been teething problems in the HNDP, but extending the current ballast water management model elsewhere or adopting it nationally will require an intensive education program, particularly in relation to agents, a vital link to ensure that arriving vessels understand their obligations.

2.4.2 Deficiencies and recommendations

Objective: The specification (2 (ii))identifies that an effective administration framework must … '*have implemented effective maritime awareness and education programs* '.

[3] AQIS (2001), a folder on Australian Ballast Water management requirements

Given the specialised nature of the Hastings project, awareness was found to be high among agents handling frequent calls at the port but understandably less so in general. The example quoted previously where a Melbourne based agent was allegedly not aware of the HNDP requirements illustrates this. This is not seen as an impediment to national adoption of an integrated ballast water management model as the more universal approach will ensure higher awareness. However, once again this supports an integrated national ballast water management model, administered by a single body ~~or single interface~~ with consistent procedures across all ports.

Awareness among industry leaders (Australian ship and port owners) was high. However, the most challenging sector for education and awareness is likely to be one off calls to Australia by vessels including coastal legs and potentially, multi port discharge/load, as part of an international movement. Ensuring that operators of ships making one-off calls in Australia– that may include domestic legs – are aware of restrictions on discharge of ballast, may best be made through such channels as the Sailing Directions and Radio signals put out by the British Admiralty. Although Australia puts out its own charts, it still employs the virtually universally used British Admiralty system for informing seafarers of local port and coastal conditions. This channel may have been explored but, if not, it is recommended that this be considered.

3. ENVIRONMENTAL RISK MINIMISATION

The Specification paragraph 2 (iii) defines the criteria for a system that will '*minimise the risk to the environment.'* This section explores the conduct of the HNDP in light of these criteria.

3.1 Risk based approach

3.1.1 Overview

Australia has been highly proactive in identifying the need to control the introduction of marine pests and in approaches to managing the issue. This is seen partly as a response to our general geographic isolation, to high levels of endemism among Australian flora and fauna (particularly in temperate regions) and practical experience with the effects of previous introductions – both aquatic and terrestrial. Moreover, the eradication of pests, once they become established in the marine environment, can be highly problematic, hence the "prevention" of introductions may be more achievable and far less expensive than the "cure" of eradication. An example of the approaches associated with risk minimisation and treatment following introduction is provided by the National Control Plan for the Northern Pacific Seastar (*Asterias amurensis*)(ANON 1999).

Risk assessment is a procedure for identifying the risk to a location, species, population or community of certain specified actions (e.g. Lipton *et al.* 1993, Hill *et al.* 2000). It involves identifying the sources of risk and predicting consequences for selected receptors, hence it is a formalised structure for making predictions and understanding uncertainty at different levels of detail (Sarewitz *et al.* 2000). In human risk assessment the risk is considered in terms of humans (at the individual or community level) while ecological risk assessment is considered in terms of aspects of the environment. It is important to distinguish between "hazard", which may be seen as the potential for some unacceptable event to occur, from "risk", which is the likelihood, or probability that it will occur, and the magnitude of any consequences. In the context of ballast water, the obvious hazard is that there may be pest species introduced into areas, whereas the risk is the probability that such introductions (often also termed "inoculations") will occur and have significant consequences. Whilst the magnitude of the consequences of various levels of risk is also important, in the case of ballast water a conservative approach is taken consistent with the principles of Ecologically Sustainable Development (ESD) and it is assumed that any inoculation could have significant consequences.

Both human and ecological risk assessments are often used to evaluate the likelihood of disease or contamination and often involve the evaluation of food webs, potential for bioaccumulation of contaminants and the toxicity of contaminants. CSIRO-CRIMP has prepared technical reports on the risk-based rationale (e.g. Hayes 1998, Hayes and Hewitt 1998, which is revised but is still in draft form as Hayes and Hewitt 2000; Hayes 1999) and these should be examined for more detailed discussion of risk assessments.

The development of a risk based approach to management of ballast water reflects concerns regarding the consequences of introducing pests. It also acknowledges that, theoretically, a proportion of vessels will have little chance of carrying pests within their ballast water, and hence management of ballast water should not be made too onerous for such vessels.

In considering a risk based approach to ballast water management there are four possible scenarios that need to be considered, as outlined in Table 3.1.

Table 3.1 Relationship between predicted and true condition of pests within ballast water (modified from Fairweather 1991 and Stewart 2000). Here, "viable" means that a pest species that could have been present in the uptake port and drawn into the ballast tank(s), survived the journey to the discharge port and is capable of surviving 24 hours in the discharge port.

		Predicted Condition of Ballast Water *(e.g. by DSS)	
		Viable pests likely to be present	No viable pests likely
True condition of ballast water tank(s)*	Viable pest(s) present	1. Correct Prediction (true positive)	3. Incorrect Prediction (false negative) = **Type II Error**
	No viable pests present	2. Incorrect Prediction (false positive) = **Type I Error**	4. Correct Prediction (true negative)

* This is for water within the ballast tank prior to discharge.

These scenarios are based on what viable target pests are actually present in a ballast tank of concern, and what we predict is present, using a system such as the DSS. Of the four outcomes, we can be correct in two ways or incorrect in two ways, described as follows:

1. That the ballast in one or more of the ballast tanks of a vessel that intends to discharge in an Australian port is known to contain viable pests designated as target species and that the predictive mechanism also indicates that viable pests are present. Appropriate management here would lead to an automatic decision for treatment, which currently entails discharge at sea.
2. That the predictive mechanism indicates that target species are likely to be present. However, we know that there are no viable pests present. Based on the prediction, management would decide that ballast water treatment should be initiated and no water discharged into the port of interest. This scenario is known as a Type I error and its consequence is a high cost to the vessel (due to treatment of ballast) but a low cost to the environment of the receiving port. In experimental terms, this approach is equivalent to rejecting a null hypothesis when it is true. In management terms, this type of approach can be considered consistent with the Precautionary Principle (ie. where lack of scientific certainty should not be used to postpone measures to avoid environmental damage), as it allows management options to be initiated even in the absence of scientific certainty.

3. That the predictive mechanism indicates that target species are unlikely to be present. However, we know that there are pests present. This is experimentally equivalent to accepting a null hypothesis when it is false. Based on the prediction, management would decide that ballast water could be discharged into the port of interest. This scenario is known as a Type II error and its consequence is no additional cost to the vessel but potentially a very high cost to the environment of the receiving port, if pests become established.
4. That the ballast in one or more of the ballast tanks of a vessel that intends to discharge in an Australian port is known to contain no target species and that the predictive mechanism also indicates that no viable pests are present. Appropriate management here would allow the vessel to discharge ballast water into the port.

It should be recognised from the above discussion that, whilst the "low", "high" and "very high" descriptors could give the impression of ranking, there are very large gaps between these categories and it is not currently possible to quantify these gaps.

Given the high volume and frequency of shipping to and from Australian ports and current technology, we currently cannot know whether ballast water contains target species on any but a very small proportion of vessel movements. Furthermore, the DSS does not address other species that may become pest species under suitable physico-chemical and biological conditions.

One of the advantages put forward for using a target species approach is that the high profile, high impact, invasive species tend to attract scientific attention and therefore investigation. As a result information on the biology and ecology of the target pest species is available. There are, however, still limits in the amount of information particularly with respect to component C of the model which relates to survival of the species within the ballast tank. Hence, there is a need to rely on predictive models with an acceptable level of risk. The DSS ensures that a structure is in place such that the model could be further refined as new information on the species is obtained. Furthermore, the net effect of the way the model has been constructed is to adopt a precautionary approach which allows less chance of a Type II error.

Currently CSIRO-CRIMP is assessing mechanisms for determining Type II error rates using genetic markers which will allow detailed assessments for a proportion of vessels (Hewitt and Patil 2002). Logically, this could also enable an assessment of Type I error rates however that is not within the scope of the current project.

In an international context, the issue of whether a vessel takes on ballast within an Australian port is not relevant under the current system, other than as a concern for foreign ports that the vessel may discharge into (which is a significant responsibility in relation to Australia's international obligations). However, in the national context, this issue becomes of great significance and is the key rationale for the HNDP. This is even more significant because target pest species occur at several ports in close proximity to the Port of Hastings (e.g. Port Phillip Bay – Hewitt *et al*., 1999).

3.1.2 Assessment of performance

Objective: The objective as set out in the Specification was that the risk must be minimised by *'adopting a risk-based target species approach.'*

There are two broad ways in which assessment of performance of a risk based approach can be undertaken:

Direct Assessment

The ultimate assessment of performance might be that:

1. No target species are introduced into any Australian ports where they were not present before the ballast water management system was initiated.
2. If the use of target species is an appropriate filter for non-target species, then it should also be a requirement that no species that was not present in Australian ports prior to the initiation of the ballast water management system should become a pest species within Australian ports after the system is initiated.

There are at least two reasons why this assessment of performance is virtually impossible to achieve. First, it requires that there are very comprehensive port surveys providing a highly confident baseline of information on species and population size. In essence, there should be a risk assessment of the veracity of the port surveys. Second, there are other vectors by which target species may enter ports including:

- the hulls of commercial and recreational vessels
- pockets of sediment or sessile organisms transferred in anchor wells, dredges/hoppers or fishing equipment
- transfer of aquaculture species (e.g. Pacific oysters in New South Wales via the Sydney rock oyster industry)
- expansion of distribution by non-human factors from nearby ports where species have become established
- potential advection on to the coast of biota from offshore waters where ballast water has been exchanged.

At this stage, it is not known if there have been any new, successful introductions of the target species into Australian ports via ballast water discharge while the ballast water management model has been in operation. Therefore, there is no way to assess its performance in terms of direct assessment, although methods of indirect assessment are being developed by CSIRO-CRIMP (Hewitt and Patil, 2002).

Indirect Assessment

If, as suggested above, direct assessment is unrealistic at this time, an alternative approach is in terms of the objective of minimising risk. Here, if the introduction of a target species did occur, it would need to be demonstrated that the risk of that introduction was very low (i.e. there was a very low Type II error rate, but that it just happened to become established).

For example, the species may have been in a bioregion where it was not reported to occur; or it was within the ballast water over a period of time longer than it was considered to be capable of surviving, etc. However, this information implies that details of the vector (i.e. the specific vessel involved, timing, etc) were known, which is unlikely to be the case.

3.1.3 Issues

There are three broad sets of issues associated with using a risk based approach: availability of information used in risk assessment models, pathways and assumptions made and ways in which models can be refined to improve their predictive ability (and hence structure research programs and management approaches).

A common criticism of risk assessment is that it can be based on very limited information about the occurrence of species, their physiological and toxicological tolerances and how they respond to stressors in a complex biophysical environment. Clearly, these sorts of comments can be applied to the DSS, both at an international and domestic level; although it is argued that the availability of information makes the DSS relatively more effective at the domestic level. These issues are discussed further in Sections 3.2 and 5.8.

3.2 DSS: Effectiveness as a tool

3.2.1 Overview

The risk based approach as applied in the Ballast Water Decision Support System provides an assessment of the likelihood that pests will be taken up in a quantum of ballast water, survive the journey and become established in the discharge port. Barry and Bugg (2002) provide a detailed review of the DSS and that report should be referred to for further information. In this report, we provide an overview of the DSS in terms of the model used, the target species selected, surveys of Australian ports for the presence of introduced species and the data inputs required to run the DSS model.

The Risk Assessment Model

The risk assessment model was developed by CSIRO-CRIMP on behalf of AQIS to assist in meeting the objectives of the national Ballast Water Management Strategy, established by AQIS in 1995 (Hayes and Hewitt 1998, Hayes 2000, Barry and Bugg 2002). The risk of introducing a species into an Australian port is defined as

$$\mathrm{R}i = \mathrm{P(A)} \times \mathrm{P(B)} \times \mathrm{P(C)} \times \mathrm{P(D)},$$

where:

- R*i* is the risk of introduction into an Australian port
- P(A) is the probability that a target species is present within the port of uptake
- P(B) is the probability that a target species is taken on board a vessel within a quantum of ballast water
- P(C) is the probability that the species will survive the journey within the ballast water and
- P(D) is the probability that the species is discharged and survives in the recipient port for 24 hours.

R*i* ranges from 0 (where there is no risk of introduction) to 1 (which implies that a species is certain to be introduced). The threshold set for triggering ballast water management is R*i* = 0.1 (Barry and Bugg 2002). An interpretation of the R*i* threshold was provided by AFFA as follows: "in a month of discharge, only 10% of days are within the environmental tolerance of the species. The implication of this is that 90% of days are outside the tolerance of the species and the species has therefore negligible probability of establishing". This is discussed further in Section 4.

Hayes and Hewitt (2000) and Hayes and McEnnulty (2002) provide detailed reviews of aspects of each of the risk components. P(A) relies on information available from uptake ports, which is often scant, but is gradually being addressed via international initiatives. In the domestic situation, there is potential for far more comprehensive information to be gathered.

P(B) can have a number of sub-components, including the depth of the port and likelihood of disturbing the seabed, the presence of larvae or other propagules in the water column at the time of uptake and even the recent history of other shipping movements, which can cause suspension of sediments and biota (Hayes and Hewitt 2000). P(C) is one component where, theoretically, a much greater degree of certainty can be attained based on an understanding of larval durations. It is also possible to test directly the water in ballast tanks to determine the presence of target species (Hewitt and Patil 2002) and there is already a growing body of information to assist in determining P(C) (Hewitt *et al.* 2001, Hobday *et al.* 2002). It should be noted, however, that there is limited scope for risk reduction of the component for species that have a very long larval period or a resting stage, such as the dinoflagellates.

P(D) relies on information about the presence of target species within potential discharge ports and on the tolerances to environmental conditions of the target species that may be released in to the discharge ports. Acquisition of more detailed information on tolerances will assist in refining this component of the DSS. Recently, Hayes and McEnnulty have suggested that an approach based on "whole life-cycle" information may be a more useful approach (see Section 5.7).

Target Species

Whilst there have been many alien aquatic organisms introduced into Australia (Furlani 1996, Hewitt and Martin 2001), the DSS is based on using a list of 12 target species (Table 3.2) whose status arises from their ability to affect habitats and/or other flora and fauna already present (e.g. giant fan worm), their potential to affect commercial and recreational resources (e.g. Pacific oyster), or their potential to affect human health (e.g. toxic dinoflagellates). The DSS target species were originally identified by the Australian Ballast Water Management Advisory Council (ABWMAC). According to Barry and Bugg (2002), all these pests have successfully invaded at some location in Australia. This makes development of a national system far more important as well as urgent, if domestic spread of pest species via ballast water is to be mitigated.

In addition, another 8 species have been identified as cause for concern by the Australian Introduced Marine Pest Advisory Committee (AIMPAC), but these have not yet been included in the DSS (Table 3.2). Summaries of biological and distributional information on these species are available via the CSIRO-CRIMP webpage. A further 32 species are also being evaluated by CSIRO-CRIMP (Barry and Bugg 2002). The addition of any new target species would have important implications for the DSS as any single species could trigger a high risk assessment.

Under the risk assessment model, if port survey data that a target species occurs in the port of uptake, P(A)=1 for that species. If the port hasn't been surveyed, the system resorts to the bioregion data. If the species is known in the bioregion, the system calculates whether the species can survive in the bioregion (in this case P(A) = survivability in the bioregion). If no survivability data are available, P(A) = 1. If the species is not in the bioregion, the system will also check tolerance/survivability in the bioregion. If there is no data to calculate this, P(A) = 0.05.

For domestic voyages, however, all Australian ports have presence/absence status for each species, thus the system won't resort to bioregion data (as long as a port is entered as the uptake location). This is due to the policy decision that ports that have not been surveyed would have all species recorded as present for uptake (not discharge).

Table 3.2 List of species target species identified by ABWMAC (currently in the DSS) and by AIMPAC (not currently in the DSS)

List	Species Name	Common name
ABWMAC	*Sabella spallanzanii*	Mediterranean fanworm
	Carcinus maenas	European shore crab
	Asterias amurensis	Northern pacific seastar
	Corbula gibba	Asian bivalve
	Crassostrea gigas	Pacific oyster
	Musculista senhousia	Asian date mussel
	Mytilopsis sallei	Black-striped mussel
	Undaria pinnatifida	Japanese seaweed
	Alexandrium catenella	Dinoflagellate
	Alexandrium minutum	Dinoflagellate
	Alexandrium tamarense	Dinoflagellate
	Gymnodinium catenatum	Dinoflagellate
AIMPAC	*Eriocheir sinensis*	Chinese mitten crab
	Hemigrapsis sanguinues	Asian crab
	Caulerpa taxifolia	Seaweed (aquarium hybrid)

Mnemiopsis leidyi	Comb jellyfish
Potamocorbula amurensis	Asian bivalve
Dreissena bugensis	Quagga mussel
Philline aurioformis	New Zealand sea slug
Sargassum muticum	Japanese seaweed

It has been acknowledged that there is a lack of information on the environmental requirements of the target species (Hewitt and Martin 2001, Barry and Bugg 2002). Consistent with the bioregional approach, the temperature and salinity tolerances of the target species have been determined or inferred from their distributions (Hewitt *et al.* 2001, Barry and Bugg 2002). These tolerances have been considered in the decision support system model (see below) when assessing a quantum of ballast water. The tolerances used in the model are shown in Table 3.3 and they indicate that most species would survive in most Australian ports.

Table 3.3 Tolerances of ABWMAC target species to salinity and temperature, as applied in the DSS model* (source: Barry and Bugg 2002)

Species	Salinity range (parts per thousand)	Temperature range (C)
Sabella spallanzanii	15 – 40	0 - 30
Carcinus maenas	0 - 54	-2.8 – 35
Asterias amurensis	15 - 45	0 – 35
Corbula gibba	0 - 40	-2.8 – 30
Crassostrea gigas	3 - 56	-2.8 – 35
Musculista senhousia	10 - 40	-2.8 – 35
Mytilopsis sallei	0 - 50	0 – 45
Undaria pinnatifida	0 - 40	-2.8 – 31
Alexandrium catenella	5 - 50	0 -38
Alexandrium minutum	3 - 40	0 – 36
Alexandrium tamarense	5 - 45	0 – 26
Gymnodinium catenatum	0 - 50	0 – 35

(*Note: While it is understood that the DSS is currently based on the tolerance levels identified in Table 3.3, there is more up-to-date information in Hayes & McEnnulty (2002) that is under review by members of the project steering committee and technical committee.)

Port Surveys

The data obtained in port surveys are clearly an essential part of an effective risk assessment process. The acquisition of that data requires a significant investment and the issue of balancing the cost of the process against the environmental and commercial benefits of an effective risk assessment program is discussed elsewhere in this report.

Given that this investment is justified, and the importance of knowing whether target species occur in a port of discharge, it is essential that surveys of ports be appropriately designed and implemented. CSIRO-CRIMP has developed a protocol for port surveys for introduced species (Hewitt and Martin 2001). A list of known surveys is given in Table 3.4. This list shows that there are relatively few Australian ports that have been surveyed and that most of the selected ports were surveyed in the mid to late 1990s. The exceptions are Hastings and Twofold Bay/Eden, which have been surveyed three and two times, respectively. It is important to recognise that this table does not include any port surveys that have been completed recently or that are underway.

Under the protocol for undertaking port surveys several types of habitat are sampled, including the water column (for plankton), hard substrata (including jetty piles, buoys, breakwaters and reef) and soft substrata (see Hewitt and Martin 2001). Standard sampling techniques are used, including netting, trapping, visual observations, scrapings from hard surfaces and sediment cores or grabs.

Table 3.4 Port surveys for introduced species

(Sources of information: CSIRO-CRIMP WebPages, NRE WebPages, Dr Chad Hewitt and the Library Database of The Ecology Lab)

State or Territory	Port	Survey Year	State or Territory	Port	Survey Year
Vic.	Hastings	1996, 2000, 2001	Qld., cont.	Abbot Pt	1998
	Pt Phillip Bay	1995-6		Port Curtis	1999
	Melbourne	1999 - 2000		Mourilyan	1998
	Geelong	1998		Mackay	1997
	Portland	1995		Hay Point	1997
Tas.	Devonport	1995		Lucinda	1999
	Launceston	2000		Brisbane	2000
	Hobart	2001		Gove	2001
	Lady Barren, Flinders Is.	1997	NT	Darwin	1998/9
NSW	Twofold Bay	1987, 1996	WA	Port Hedland	1998
	Port Kembla	2000		Geraldton	2001
	Botany Bay	1999		Fremantle	1999
	Port Jackson	2001		Bunbury	1996
	Newcastle	1998		Albany	1996
Qld	Weipa	2000		Esperance	2002
	Karumba	2000	SA	Port Lincoln	1997
	Cairns	2001		Adelaide	2000
	Townsville	2001			

An important issue regarding the port surveys for pest species is how often surveys should be done. Hewitt and Martin (2001) considered this issue in two ways – monitoring a port and re-surveying a port. According to these authors, the specific need for monitoring should be determined on the basis of:

- finding a targeted pest species in the port of interest at low densities or in a limited distribution
- identifying cysts of toxic dinoflagellates in the sediments
- where the original survey does not detect a target pest species which is common in an adjacent or frequent trading domestic port (an example would be the presence of fan worms in Port Phillip Bay which do not occur in Westernport).

The design and intensity of monitoring should be based on the species issues/species involved. In the case of cysts of toxic dinoflagellates, for example, there may be a need to sample the plankton on a fortnightly basis to determine whether the species enters the water column (and hence has the potential to cause a bloom) (Hewitt and Martin (2001). For other species there may be a need to sample very small areas to quantify distribution within a port; or for species common in nearby ports, the use of settlement plates may be the most cost effective approach.

Resurveying of ports applies where there are not currently major concerns, but there is a need to ascertain whether target species are establishing in the port. According to Hewitt and Martin (2001), the frequency of re-surveying should be based on a balance between survey costs and the likelihood of detecting a new species versus the likelihood that a harmful species will have established and spread. Interestingly, Hayes and Hewitt (2000) recommend that port infection models be developed that acknowledge the probability of Type II error and allow the probability of infection to vary as a function of the time elapsed since the last survey. This approach may provide an incentive to have surveys done at regular and frequent intervals.

In the absence of specific information, the current recommendation is that ports be re-surveyed every 3 to 5 years. This provides a mechanism to refine estimates of invasion rates and recommended resurvey frequency (Hewitt and Martin 2001). It does run the risk, however, that species introduced soon after a survey may not be detected for several years, by which time populations may have become established. It is understood that the issue of repeat surveys was recently considered by the National Introduced Marine Pests Co-ordination Group and that they will be providing a context for determining the purpose, timing and taxonomic coverage of surveys in Australia.

In addition to actually doing the surveys of Australian ports, it is important that the findings of these surveys be incorporated into the DSS as soon as practicable, as this will affect both the risk threshold and P(A) component (i.e. likelihood of occurrence within a port). An analysis of hypothetical trip scenarios presented in Appendix 4 suggests that it may take 2 years or more for the data from a port survey to be incorporated into the DSS.

Application of the DSS Model

The decision support system model is maintained by AQIS and accessed by vessel owners or operators through the Internet (www.aqis.gov.au/shipping) or via email satellite connection. Access via internet requires a username and password obtained from AQIS, but this is not required for access by email or INMARSAT-C. Specific details about lodgement of information on ballast water are available in AQIS (2001), a folder on Australian Ballast Water management requirements.

Lodgement of details regarding ballast water involves standard information such as vessel name, call sign, etc. More detailed information is then required for each tank containing ballast water, the source of this ballast, whether a sea suction strainer was used on the pumps and the date of uptake. Next, details are required for all discharges likely to occur in Australian ports. These include location and date of discharge, which tanks are to be discharged and whether full or partial discharge is to take place. The completed information package is emailed to the DSS, where the decision support system model is run on that information, risk is assessed and the finding emailed back to the vessel. No explanation of the assessed risk is provided, simply a statement of whether risk is high or low and whether ballast water management (i.e. offshore exchange) is required.

In running the model, the DSS takes into account any information available on the target species within the context of each component of the decision support system model (i.e. A, B, C & D). This information takes into account any seasonal details of spawning or presence in the water column, use of strainers on uptake pumps, duration of survival in relation to the duration of the voyage, likely survival in the port of discharge and whether any of the target species are known to occur in the discharge port. Where information on species' biology and distribution is lacking, the model defaults to a conservative decision with respect to the environment. It is important to recognise that the risk threshold needs to be exceeded for only one species for there to be an overall assessment of high risk. Thus, if one target species is already present in a discharge port, risk would still be assessed as high if other target species, which could occur in the ballast water, have not been recorded in the discharge port.

3.2.2 Assessment of performance

Objective: The objective as set out in the Specification was that the risk must be minimised by *'assessing the effectiveness of the Ballast Water Decision Support System (DSS) as a risk assessment tool to minimise the risk (of target species introductions) to the environment'*.

This assessment is carried out on two levels – environmental effectiveness and the quality management issues arising.

3.2.3 Quality management

The evaluation has identified the need for quality management at two levels in the ballast water management model used during the Hastings project. The first, dealt with in this section, is the need for a quality system in the administration of the DSS. The second dealt with elsewhere in the report, is related to communications and implementation of the ballast water management model.

As noted in various places above, there is clearly a need for a better documented and auditable system for making 'policy changes' within the decision support system. Currently, the DSS is administered by AQIS and the HNDP has relied on it as the primary risk assessment tool. Several stakeholders have raised the issue of transparency in the processes leading up to changes in the settings within the DSS. The DSS is the most appropriate tool available for the dual role of international and domestic ballast management, and is particularly valuable to the domestic task given the high percentage of short voyage times. Whilst ocean exchange may not pose major difficulties on a longer voyage, the need for diversion on a shorter voyage is more likely to cause delay and is a much larger component of overall voyage time and increased cost. However, to ensure its effectiveness and acceptability, there is a need for quality systems to underpin it and ensure full confidence in its capabilities.

There are various quality systems that would provide the necessary framework for the establishment of a management system that will allow for the development of operating procedures and internal and external audit procedures to ensure consistent implementation. The two series of systems under the International Standards Organisation, ISO 9000 and ISO 14000, would both be appropriate, although the ISO 14000 series provides more for the broader environmental initiatives of an organisation. Specialist advice should be sought on the comparative advantages of available systems. However, the following may provide some guidance.

Under ISO 14000, there are 21 specific requirements for areas of management control, grouped under Policy, Planning, Implementation and Operation, Checking and Corrective Action and Management Review. Some 'guidance on use' is provided in an Annex to the document. This is considered to place a lesser emphasis on issues such as Operational Control, Emergency Planning and Monitoring and Measurement, where it could have given comprehensive guidance on the relevant points to recognise, and the systems and procedures required in an organisation. In these three areas it gives no guidance.

The issues that have arisen during the evaluation of the HNDP are more those of management of procedures and providing transparency and track-back (audit path) for those procedures. It is therefore considered that an ISO 9000 series system (ISO 9002) may well be the more appropriate mechanism, allowing the organisation that has control of the decision support system to demonstrate transparency in its management processes. The 9000 series also places high priority on customer satisfaction and feedback, which is considered to be an important element when the decision support system is likely to be managed and operated by one organisation for the benefit of others.

Enquiries of AFFA/AQIS suggested that although there are documented procedures covering the actual change mechanisms, there is as yet no documented procedure setting out the steps to reaching a decision on 'policy' type changes – e.g. thresholds. It should be noted that AQIS indicated that there is the intention to document these procedures.

The recommendation for this would be two-fold, namely:

- The drafting and agreement of documented management procedures in line with ISO 9000 (or alternative).
- The seeking of accreditation under an internationally accepted QA system for the organisation tasked with administering the decision support system.

The need is seen for quality systems to monitor and provide audit ability in two other areas, namely:

- The decision support system, which requires up dating with information on domestic and international port surveys and research on biological invasions, the biology and ecology of pest species, etc; and reviews after each new port survey.
- The DSS model which requires that mechanisms be available for regular updates. There should be regular reviews (e.g. 6 to 12 months) to ensure literature is reviewed and incorporated.

3.2.4 Environmental effectiveness

The overall environmental effectiveness of the DSS has been assessed in detail by the Bureau of Rural Sciences, BRS (Barry and Bugg 2002). The risk of Type II errors associated with the DSS is currently being assessed by CSIRO-CRIMP (Hewitt and Patil 2002). The information presented in this section is drawn largely from these reports and from discussions held with private, State and Commonwealth stakeholders during the course of this consultancy.

The BRS report was commissioned by Agriculture, Fisheries and Forestry – Australia (AFFA) to investigate the most cost effective way of updating the data in the DSS, but it focused only on international shipping movements (Barry and Bugg 2002). The main device used in the report was to predict future behaviour of the DSS by considering its effect on a representative sample of vessels. This was done by using data extracted from the 2000 Vessel Monitoring System (VMS), maintained by AQIS, and which provides information on ballast histories of international vessels entering Australian ports. The database contained 6,424 visits where the vessel had declared an intention to discharge ballast water. It should be noted that vessels typically contain several ballast tanks, with potential for different uptake, discharge and management for different tanks on the same vessel. Hence, analysis of the data was applied to a quantum of ballast water, not simply a vessel.

The broad conclusion regarding the effectiveness of the DSS is that the risk assessment model is a powerful tool for assisting in decisions about ballast water management, but it is hampered by a lack of good data. Hence it relies very heavily on the default conditions (particularly bioregions, temperature and salinity tolerances and trip survival). Whilst originally set up to enable incorporation of new information as it becomes available, realistically it will be years before sufficient new information is gathered (particularly from overseas) to significantly enhance the decision support system model. This conclusion was reached by Barry and Bugg (2002) who considered that the potential to collect such information is low in the short to medium term (say, 10 years). They did note, however, that the potential for collecting data for domestic ports (and pests already present) should be greater.

This study concurs with this evaluation, but notes that it will require considerable and ongoing commitment to ensure that all ports are surveyed to a consistent standard, both initially and at regular intervals thereafter. In helping to maintain this commitment, it should be noted that the port surveys can make a valuable contribution to understanding aquatic biodiversity of Australian estuaries, not just the occurrence of introduced species. It should also be recognised that port surveys contribute only one component of the DSS and that risk reductions may be achieved, possibly for less cost, by investing in other components of the system.

The key issues regarding environmental effectiveness are summarised below.

Quality control (QC) mechanisms within the DSS

There are a number of Quality Control issues associated with the DSS and these are discussed below.

Decision-making steps of the risk assessment process

Ninety-three percent of vessels assessed in the BRS report would have been declared at high risk when the DSS was initiated – this heavily favoured the environment over the vessel operators (Barry and Bugg 2002). The 93% figure is based on an analysis undertaken using voyage data extracted from the AQIS Vessel Monitoring System (VMS) for the year 2000. Updating the DSS with additional data collected after implementation of the DSS has reduced the proportion of high risk vessels only by about 3%. However, the DSS may be non-conservative in some situations:

- Where a port that is adjacent to a port that contains a pest it would be declared low risk if the ports were separated by a bioregion boundary (relates to Risk Component A).
- In the case where a marine pest species is already present in the port of intended discharge and not being controlled or eradicated, ballast water management requirements are not placed on that vessel based on that particular species. Under the World Trade Organisation (WTO), requirements must not be applied if a pest species is already present at the import location and it is not being actively controlled or eradicated. In these cases the risk is thus assessed as low for that species.
- Where there are specific microhabitats in a port that could affect the assessment of Component A (presence) or of Component D (survival))(c.f. the concept of "environmental subunits" in Hayes and Hewitt 2000). A good example of this is in Botany Bay, NSW, where an oil refinery discharges warm cooling water adjacent to the berthing area. Temperatures around the cooling outlet are significantly greater than the ambient water and habitats include soft sediments and solid structures associated with the cooling outlet pipe. In this case, the environment around the outlet may provide a refuge for warm water pests.
- Trip survival (Risk Component C). Originally, the decision support system model set P(C) = 1 as a highly conservative measure, reflecting a lack of knowledge regarding survival. The model has since been refined marginally to accommodate maximum survival periods of 26 days for European shore crab, Asian bivalve, Pacific oyster, Asian date mussel, black-striped mussel and Mediterranean fan worm (Barry and Bugg 2002).

Use of default values in the risk assessment model, including defaults to higher level data

The default values are intended to allow the model to be run, whilst providing an environment-conservative assessment. These default values are consistent with the types of approaches used in ecological risk assessment. It is import to recognise that there is a general acknowledgment that the use of defaults is less than perfect and this topic is a primary focus of review of the DSS (Barry and Bugg 2002). The default values occur predominantly in three areas:

- Use of bioregional data where no port-specific data are available. This approach tends to be highly conservative, but may have non-conservative elements, as discussed above.

- Use of salinity and temperature tolerance data where no species-specific data are available on environmental requirements. This approach is also very conservative (Table 3.3), suggesting that all the target species in the DSS would be able to survive in most Australian ports. This area of the risk assessment model is reviewed on an ongoing basis by CSIRO CRIMP and AQIS. Hayes and McEnnulty (2002) provide extensive discussion of tolerances for target and AIMPAC species at different life history stages, although the values cited in Table 3.3 (above) are still in current usage.
- Use of data for related species where no species-specific data is available on likelihood of survival in ballast tanks.

Assumptions

The assumptions in the decision support system model have been discussed above and tend to make the DSS more conservative in favour of the environment. This approach is consistent with the principles of ESD, particularly the Precautionary Principle, where lack of scientific certainty should not be used to postpone measures to avoid environmental damage. Possible exceptions to this include:

- The DSS utilises port surveys, which should be up-to-date and comprehensive. Whilst considerable effort has been made to design appropriate port surveys with suitable QA procedures (Hewitt and Martin 2001), there are issues related to season of sampling, conditions at the time of sampling (e.g. high turbidity will affect visual observations), targeting of sites and proper species identifications. Many Australian ports have not yet been surveyed, which is important both from an international and domestic perspective. Knowledge of the presence of target pests in Australian ports also provides some indication of how introductions are being managed and helps refine our understanding of the rates of introductions (Hewitt and Martin 2001). Whilst in theory the port surveys are a key mechanism in ensuring the effectiveness of the DSS, in practice there needs to be more work done in this area. An "investment" in survey data can reduce costs in the following ways:
  - If target species are detected at a port from the port surveys, there will be less cost to the shipping industry in terms of managing ballast water that could otherwise be discharged into that port.
  - If target species are detected at a port, then we will be a better able to fulfil international obligations regarding transfer to overseas ports; in the domestic environment it will assist in determining risk of transfer to other Australian ports. (Ultimately, this would help to reduce the costs of managing introduced species at these other ports)

  (Note: the question of the return on investment in data acquisition is discussed in section 5.6 of this report.)
- Where port surveys locate a target species within a port, the DSS sets a "threshold" for the risk assessment at 1.0, the highest number possible. Hence discharge is assessed as low risk. Applying this assumption risks multiple inoculations of a target species, which could enhance its establishment or even spread to other domestic ports (e.g. by introducing the species at more favourable times, or by introducing greater genetic vigour). In practice, however, the DSS is applied for all the target species, so even if one is removed from the list, there is a chance that a high risk will be assigned on the basis of the other target species in the decision support system model.

- Whilst the utility of target species is beyond the scope of this study, it is noted that the selection of target species was raised as a concern by Barry and Bugg (2002) and by many of the stakeholders during the consultation process for this study. Particular issues that need to be considered here are the availability of information on potential pest species and the cost of acquiring data to fill any gaps.
- The ballast water management model simply recognises that exchange of ballast water at sea is the current best available technology. This issue is discussed in Section 4, but it is important to recognise here that:
  - pest species may be acquired within ballast water if exchange is adjacent to a foreign coast where propagules may have been advected to offshore waters; or
  - pest species may be introduced if ballast water is exchanged adjacent to the Australian coast, where propagules may be advected on to the shore (e.g. by coastal eddies).

These matters are considered in detail by Hobday *et al.* (2002) and are discussed further in Section 4.5, below.

The level of risk thresholds

Issues related to Type II errors are currently being investigated by CSIRO-CRIMP (Hewitt and Patil 2002), with the aim of developing screening techniques to refine determination of the presence of target pest species.

The quality of input data.

This issue is dealt with in detail by Barry and Bugg (2002) and discussed in numerous other sections of this report. The quality of data varies from good to very poor across the modules/species/bioregions and ports. Improvement to the quality of the data and refinement of the DSS to accommodate the new information are desirable in order to increase the functionality of the risk assessment tool.

Deficiencies or gaps in the process, Implications and remediation

A number of gaps have been identified in the DSS process, as discussed throughout this section. Many of these have been considered by Barry and Bugg (2002) and mechanisms are being sought to rectify them. Importantly, while the decision support system model itself is potentially very powerful, until more detailed information on the target species is obtained, it will continue to be conservative, based on the default values.

The major deficiencies may be summarised as follow:

- *Data assisting with the calculation of risk components* Further information is required to populate the model with up-to-date information. Data collection is however costly, therefore further consideration is required on the most cost effective focus which could be on the presence of target pest species in international and domestic ports and/or on uptake and survival in ballast tanks. A lack of up-to-date quality information will progressively weaken the effectiveness of the risk assessment tool and require continued assumptions about the presence and survival of target pests.

- *Issues related to Type II errors* The potential impact of uncontrolled Type II error rates is a risk of introductions. Work is currently being done in this (Hewitt and Patil 2002) area and this should continue.

3.3 Compliance monitoring

3.3.1 Overview

Compliance, enforcement and remedial action

Compliance can be monitored and enforced in various ways. The process can be considered at several levels:

- Initial 'barrier control' measures (eg. QPAR and/or domestic ballast water reporting procedures/documentation
- Monitoring input into the risk assessment system (DSS)
- Verification inspections
- Remedial action
- Building data on specific ships/masters for future reference and inter-agency liaison
- Negotiation of compliance agreements.

Initial measures

Currently the AQIS system of monitoring commences with the lodging of the 'QPAR' notification that AQIS requires to be lodged from 12 to 48 hours before arrival from an international voyage. For the Hastings project, a further set of documents, the Western Port Ballast Reporting Form (WPBWRF) and ballast logs are submitted. This system has worked effectively in the HNDP. Although some domestic voyages may be very short – for instance, a few hours between say Port Phillip Bay and Hastings - the 12 to 48 hours currently in place should not be a major issue as, even with a short voyage, it would be known in the vast majority of cases that this is to take place and ballast details can be provided on the basis of what ballast is planned to be taken or discharged. As long as the actual tanks used comply with the data issued in the risk assessment, this could be completed sometime before actual departure from the previous port.

Monitoring of data input is a matter of accessing the Risk Assessment Number supplied by the vessel in its documentation to ensure that risk assessments have been correctly acted upon.

Verification inspections

Verification inspections during the trial were carried out by AQIS officers under an agreement between AQIS and EPA Victoria. This has worked to a reasonable level, although in the early stages of the trial, communication lines were stretched at times. The need for inter-agency liaison, distances involved in attending vessels in Hastings and after-hours/weekend scheduling of inspections have led to some problems where inspections were not carried out, or were delayed to the point where remedial action may not have been effective in preventing discharge had high risk ballast water been on board. These were more in the nature of teething problems occurring early in the trial period and were resolved. The procedures developed will provide the basis for an integrated national system coping with greater volume and multiple ports.

A general observation is that the verification inspections themselves, where there is no pressing need to act as a result of imminent potential discharge of at-risk ballast water, should be scheduled to fit with the urgent operational and cargo related matters that the ship's staff must deal with, particularly within two hours after arrival. This is not seen as a deficiency of the trial, but a potential point where conflict in delivery could undermine the assistance and cooperation so important for the effective operation of the system. Without in any way down-grading the importance of the inspection, flexibility should be exercised where practicable, particularly if ballast does not have to be worked immediately, although this will vary with circumstances.

Ballast water treatment: Ocean exchange effectiveness

Currently, pending technological advances, ocean exchange is the only method of treating ballast water. The methodology employed is arguable in two respects:

- the effectiveness of the physical exchange process
- the effectiveness of the location for exchange.

Neither of these is an issue in terms of the national adoption of the current trial or a deficiency in the HNDP, but the issues are considered sufficiently important to be serious in terms of the environmental effectiveness of the existing systems.

Also an issue is the effectiveness of the ship's staff in estimating what volume of water has actually been pumped. A ballast pump when newly installed is rated in terms of its capacity in tonnes per hour. To achieve the three times tank volume requirements appears a simple task of dividing the tonnes required to be moved by the rate. However, the pump will lose its efficiency with time, and such factors as back-pressure can result in further losses. AQIS view is that pumps will seldom achieve their nominal rating, and they rely on the experience of the ship's staff in assessing a realistic out-put. Thus it is considered that there is some risk of the volume being less than recorded in the ballast log kept by the vessel.

AQIS has previously applied a test known as the Newcastle Verification, which comprises reconciling energy use with the claimed pump usage. This is only going to be effective in confirming, or otherwise, the pumping times claimed. It will not assist with the areas of doubt mentioned above. It is also understood that the use of this method has declined, although AQIS indicates that it continues. It is understood that it used now when there is reason to doubt the validity of information given by a vessel. Since it requires reconciliation of claimed pumping times with generator loadings and wattage consumption, it is time consuming and clearly requires a reasonable level of understanding of the issues and interpretation of the ship's records.

The other issue is the location in which ballast exchange takes place. Effectively, recorded ocean exchange is sufficient to establish a low risk assessment. However, as discussed elsewhere in this report, the location may be such that risk may still exist or, in fact, may be greater. Recent work done (CSIRO/CRIMP) to establish safe zones for discharge and uptake of ballast will in due course assist but may be of only marginal benefit for domestic ballast, with the many short and coastal voyages (Hobday *et al.* 2002).

Remedial action

If verification demonstrates deficiencies or non-compliance, there are currently only two available remedial actions. These are prevention of discharge or ocean exchange.

Environmental legislation can be applicable (eg. the ability to act against persons in possession of pest species or material) but, under current state/territory legislation, defining at-risk ballast as a pollutant may not be legally sustainable. Clear legislation is required to set specific and unambiguous standards and to ensure that the powers of the regulator are specifically defined in relation to ballast water management. Whilst the evaluation did not find a deficiency during the trial period, this is considered a key issue for the future of the ballast water management system. In a maritime business environment undergoing change and legal challenge as to liabilities, it is identified as a key issue that all involved in compliance monitoring and enforcement are aware of the risk of assuming liability, even if inadvertently as a result of misinterpretation or over-zealousness at a local level.

Clearly the ultimate threat is prosecution. However, although some environmental legislation is very clear about possession or control of species, in other cases there is some difficulty in defining ballast water or a species as a 'pollutant'. Also, to be able to prove an invasion and tie it back to a vessel in a time scale that would allow successful prosecution is unlikely, although current development of gene probe techniques should in due course allow reliable real time identification of the presence of marine pest samples. However, in general terms any proceeding would be costly and fraught with difficulty, and would be unlikely to be undertaken unless the circumstances were extreme.

AQIS has a policy whereby it relies on education to bring non-compliance to the attention of ships' staff, and to outline the downside of future transgressions. This may be effective if the vessel and its staff return to Australian ports, but in many cases vessels chartered on the spot market for general bulk cargoes are very likely to be one off calls. It is therefore recommended that measures be taken to ensure that the non-compliance is brought to the attention of the vessels owners, rather than relying on educating a master who may cover up the issue and not return to Australia.

Another question that arises is the need for the regulating authority to be present in the port to carry out verification inspections and enforcement. It is likely that the system once implemented would elect to carry out verifications on a random basis. It is unlikely that endeavouring to cover every call would be cost effective. Since physical enforcement is difficult – a determined ship's officer would usually be able to discharge ballast unseen – the need to have someone physically in the port is not critical. However, it would be seen as valuable in encouraging compliance to have someone available to carry out ship visits if necessary.

3.3.2 Deficiencies and recommended remedial action

Objective: The objective as set out in the Specification was that the risk must be minimised by '*undertaking compliance monitoring of vessels*'.

During the Hastings trial, this objective has been met satisfactorily, although there have been a few instances where verification inspections have been impacted by communication problems dealt with elsewhere. These are not seen as substantive deficiencies as there is no evidence that these have caused significant environmental exposure and records show that no high risk ballast was discharged. However, as covered elsewhere in this report, communication procedures would need to be clearly documented and auditable in the higher volume, multi port situation of an integrated national ballast water management system.

4. BALLAST WATER MANAGEMENT OPTIONS

The Specification para 2 (iv) defines the criteria for *'Appropriate options for vessels to manage the risk posed by their ballast water.'* This section discusses the options available in light of these criteria.

4.1 Physical capability

4.1.1 Overview

The means for managing ballast water are currently restricted in general terms to replacing it with low risk water. Other means of treatment are under consideration, but stakeholders agreed that there is unlikely to be a break-through in treatment methods in the foreseeable future. The following comments therefore assume that exchange will be the only management method apart from not discharging.

Generally vessels are designed with ballasting operations in mind. However, there is a wide range of approaches to the issue, depending on the intended purpose of the vessel. The most sophisticated are fully contained systems where captive or permanent ballast, usually fresh water, is transferred within the vessels to correct trim and list. This is particularly the case with vessels where faster loading is critical, such as ferry services. At the other end of the scale, some bulk carriers have fairly basic tankage and pumps/pipelines, and may even carry ballast in cargo spaces. This is particularly so in the case of specialised wood chip carriers, regular callers to ports in Victoria, Tasmania, NSW and WA. In view of the low density of their cargo, the holds are large and create some major issues of free surface effect on stability and, potentially, damage to the ships structure from slopping of ballast in slack tanks. It can therefore be said that exchange of ballast water is not the preferred option in the longer term, but there will be a long lead time before either ship design or other treatment methods will remove the risk elements to the vessel.

However, physical capability of ships to exchange ballast is more a question of a suitable location from the two viewpoints of risk assessment of the replacing water, and the operational and safety issues. Safety is dealt with in 4.2 below. Most vessels will be able to carry out the operations required, but safety and avoiding increased wear and tear on the vessel and its machinery will be issues for some years to come.

4.1.2 Deficiencies and recommended remedies

Objective: The Specification para 2 (iv) requires that appropriate options for vessels to manage the risk posed by their ballast water are such that they … *'are physically achievable'*.

Review of records during the duration of the Hastings trial does not provide any indications of a situation where physical capability was an issue. It is therefore found that the trial has proved the overall methodology is generally sound and this objective has been met.

However, there are some issues noted above that go to the effectiveness of the methods, the means of monitoring these, and the environmental effectiveness that will need to be borne in mind in carrying forward the ballast water management model developed for the trial.

The issues arising and associated recommendations are:

- Exchange of ballast water is not the preferred option in the longer term, but there will be a long lead time before either ship design or other treatment methods will remove the risk elements to the vessel. Changes in ship design to be more ballast management friendly will take many years to come through. It is recommended that Government at both Commonwealth and State level should be actively encouraging the development of alternative technologies, both within research bodies and industry. Industry should be encouraged through education and awareness programs to view developing technology as eventually constraining costs, as well as providing triple bottom line benefits.
- Ballast pumps are assumed to be able to pump volumes close to their nominal capacity. The pump will lose its efficiency with time, and such factors as back-pressure can result in further losses, resulting in a risk of the volume being less than recorded in the ballast log kept by the vessel. It is recommended that more research should be encouraged by trials and sampling to ensure that:

  a) the current protocols are environmentally effective

  b) pumping suggested volumes actually take place, given the shortcomings of the only verification (Newcastle method).

4.2 Safety issues

4.2.1 Overview

Safety issues are critical on several levels during ballast exchange operations. Stability has been dealt with in 4.1 above. However, the other aspect of this is that the stability and sea-keeping capability of a ship is a safety of life matter covered by international convention (SOLAS). Agencies involved have made it clear that they would not dictate that a vessel leave the berth or sheltered waters, but rather that they limit their enforcement/compliance measures to banning the discharge of ballast. This is particularly important as the master has ultimate responsibility for the safety of the vessel and people, and it is important that the decision rests there. Aside from the risk to life and property, there are also potential pitfalls in liability should a vessel leave a berth, forfeiting its place in a queue and, potentially, incurring significant delay.

Also of concern to ship operators is the safety of persons on deck when exchanging ballast at sea. Particularly with the flow-through method, which often involves large volumes of water being floated out of the tank on to the deck, safe access to the deck may be precluded. In addition, the large volume of salt water increases corrosion, will drench the ship's upper works as it lifts as spray from scuppers, and can even cause stability problems as water gathering at the after end of a deck against a bulkhead can represent significant free surface effect[4]. This further encourages research to provide alternatives to ocean exchange.

[4] A small container vessel capsized in the Mediterranean reportedly as a result of water accumulating on the main deck.

4.2.2 Deficiencies and recommended remedies

Objective: The Specification para 2 (iv) requires that appropriate options for vessels to manage the risk posed by their ballast water are such that they ... *' do not compromise the safety of the vessel and/or crew'*.

The potential dangers of ocean discharge reinforce recommendations to encourage research and industry development of alternatives to ocean exchange.

4.3 Inconvenience and costs

Objective: The Specification para 2 (iv) requires that appropriate options for vessels to manage the risk posed by their ballast water are such that they ...*' minimise inconvenience to the vessel '* and *' minimise negative economic impact to the shipping industry '*.

Ballast water management will inevitably have an impact on ship operations. This appears to be generally accepted by the industry but, as a stakeholder mentioned, the intent is not to put exporters or ship operators out of business. The system should seek to balance the rigor of the program with a minimisation of disruption to the ship.

Costs will be incurred throughout the process. For the ship, there are costs implicit in

- the need to access the risk assessment system if the option to direct access is exercised (using radio, telephone, satellite connections, fax, telex etc.) and staff time
- the deviation at sea necessary to access areas suitable for exchange (requiring fuel and, possibly, faster steaming)
- the use of machinery requiring fuel and maintenance on pumps etc., and additional deck maintenance as a result of ballast water floating on deck
- the resource costs – additional crew over the longer term with additional peak work load
- the delay – demurrage, despatch/half despatch costs under the charter parties.

There have been various estimates made of the cost of the ballast water management system to industry. These vary as can be expected since there is little hard data as yet, and most operators will not have separately accounted for costs, particularly where a deviation or delay was not involved. The additional costs tend to be absorbed into the everyday running costs of the vessels. However, although difficult to quantify, these costs should not be treated as negligible or incalculable, as they will reflect eventually in the cost of running vessels around Australia, and will, as the Australian Shipowners Association has pointed out, eventually surface as a cost to exporters and cargo interests through freight rates and charter costs.

The following can be treated as a guide to the more direct and quantifiable costs – ie. fuel use and daily costs, charter and operating. Various assumptions have been made that will need more in depth research to confirm. It should be noted that these estimates are only related to management of ballast, and do not attempt to assess cost of non-compliance. (See the following table relating to less quantifiable costs.)

Ballast management activity	Cost to	Impact *(A$)*	Cost per tonne of cargo/ballast *(A$)* *[/t ballast]*	*[/t cargo]*
Cost to vessel:				
Ocean exchange: 10,000dwt bulker – no deviation	Ship operator	4,200	1.05	0.53
Ocean exchange: 10,000dwt bulker – 15 hour deviation	Ship operator	16,700	4.18	2.09
Ocean exchange: 75,000dwt tanker – no deviation	Ship operator	10,080	0.34	0.16
Ocean exchange: 75,000dwt tanker – 18 hour deviation	Ship operator	51,086	1.70	0.79
Annual cost to industry*:				
Voyages without deviation	Industry	1.09M		
Voyages with deviation	Industry	3.68M		
Total annual cost		**4.77M**		**0.008**

* *Industry includes ship operators and cargo interests – ie. exporters and importers.*
** *The above does not include maintenance of the risk assessment system, including the cost of the port survey program.*

Other less quantifiable costs will be incurred. These need to be borne in mind, as they represent the downside of any situation that will delay a vessel. In the table below they are not quantified but indicative figures are given where appropriate.

Cost element	Ultimate cost to	How cost transmitted	Possible impact
Additional crew *(long term manning issues)*	Exporter/importer	Ship operator => cargo interest	Unquantifiable; long term
Maintenance *(Increased structure and machinery)*	Exporter/importer	Ship operator => cargo interest	Unquantifiable; long term
Delay*(direct berthing delay, or vacate berth and return)*	Exporter/importer	Ship operator => cargo interest either through charter party provisions or through freight rates	A$20,000 to A$50,000 per day, pro rata
Cargo constraint *(Reduced cargo volume)*	Ship operator	Loss of potential sale volume will be recovered from ship under charter party.	Unquantifiable. May be related to daily rates, but may also lead to claim for loss of price/sale.
Port costs *(Direct costs such as towage, linesmen, pilots)*	Ship operator	Costs of moves as a result of non-compliance	Varies. Towage alone can cost up to $20K per move for a big ship in a smaller port.

In evaluating the HNDP, performance is measured in terms of operational disruption and in costs.

The HNDP has identified some cost to industry in deviation to exchange ballast between Port Phillip Bay and Westernport. These deviations were seen as essential to compliance. The ballast water management system appears effective in avoiding unnecessary delay to vessels, and recommendations elsewhere in this report cover issues such as the timing of verification inspections to minimise – or at least optimise – operational delay.

From a cost perspective, this does not mean that such a system will be free of such risk, and the design of any nationally adopted ballast water management model will need to take account of the downside to industry of any action that unnecessarily slows or impedes the expediting of vessels through ports. The impact cannot be considered to lie only with ship operators, because costs will eventually find their way into the pricing of services through freight rates and negotiated charter hire. Ultimately the cost will fall on Australia's exports and imports, except where clearly associated with non-compliance, when the ship will usually carry the cost.

Ship operations can also suffer disruption from ballast operations, particularly where short voyages puts additional pressure on resource already minimised by commercial pressure. The expansion of the ballast water management model into the domestic ballast vector, where the number of short voyages is relatively higher, will increase the criticality of this issue. Recommendations elsewhere related to streamlining of communications and increased awareness and education will be central to sustaining industry support.

4.4 Minimising industry impact

4.4.1 Overview

Objective: The Specification para 2 (iv) requires that appropriate options for vessels to manage the risk posed by their ballast water are such that they minimise industry impact.

It is inevitable that any ballast management system will impact on industry. The intention of this objective is that the impact on industry will be kept as low as is compatible with an acceptable risk level environmentally.

An issue arising in various parts of this report relates to the propensity for the risk assessment process to produce a high percentage of high risk assessments (>90%). It will be essential as the ballast water management model is expanded to a national system that impacts are minimised where possible. The intent should be to reach a level of thresholds and settings in the decision support system that will permit an acceptably precautionary approach environmentally, whilst ensuring that industry does not carry any unnecessary burden in disruption or cost.

Recommendations are made elsewhere to ensure that the settings of thresholds etc. are cognisant of this.

4.5 Environmental effectiveness

4.5.1 Overview

Ballast treatment: Ocean exchange

An issue that exercises the minds of several of the stakeholders is the effectiveness of the prescribed methods of exchanging ballast.

Basically, these comprise a full exchange where the tank is pumped right out and fresh ballast taken, or the flow through method that relies on opening up apertures to the tank and flowing in water equating to a set volume, approximately three times the volume of the tank under current protocols, on the assumption that this results in an effective full replacement.

There is some conjecture as to how effective the flow through method may be in actually eliminating the risk, or whether in fact it only dilutes the risk. This conjecture raises policy questions with respect to how few organisms can be considered an acceptable risk. Essentially, the flow through method is subject to Type II error in much the same way that discharging directly into the port would be, although the Type II error rate for the flow though treatment is likely to be less than for direct port discharge. New tests using genetic markers are able to establish pest existence at very low levels (Hewitt and Patil 2002). Concentrations of five larvae of *Asterias amurensis* in a tonne of water have been suggested (C. Hewitt, personal communication) and sampling, due to get under way shortly, will provide some quantification. Until those results are known, the current protocol seems set to stay.

On a broader scale, Hobday et al (2002) sought to map contingency zones (i.e. the most appropriate places) for discharge and uptake of ballast water with respect to Australian ports. The problem was addressed in several ways, including the use of satellite imagery to differentiate oceanic and coastal waters based on colour and turbidity, bathymetry, currents, larval duration and potential depth of settlement of target pest species (e.g. *Asterias amurensis* can survive at depths of 200 m). This information was used to compute "baselines" which are contours of uniform probability or risk that a target species could become established once discharged. The 10% uptake baseline, for example, is the edge outside of which 10% of the boundaries between coastal and oceanic waters occur for the period from which oceanographic data were drawn.

Using the satellite data, maximum, minimum and mean distance from 44 Australian ports to different probability uptake baselines are shown as follow (source: Table 7 in Hobday et al 2002):

Distance (km)	0%	5%	10%	25%	50%
Maximum	403 km	345	343	305	274
Minimum	70	38	36	17	28
Mean	240	184	167	112	85

These distances are well outside the 12 nm limit (i.e. 22.2 km) and hence suggest that the present requirement has limited effectiveness. When discharge baselines are based on the ocean currents model, results are more complicated because there are sets of baselines for each larval period and depth of settlement condition (Hobday et al 2002). Obviously, as the larval period and survival depth increase, the distance offshore to the various baselines also increases, often up to several hundred kilometres.

The application of contingency deballasting zones to coastal shipping will require more specific localised analyses for bioregions, sensitive areas and particular port needs. This will require a review of the specified criteria for identifying zones with consideration of the relative risks involved, specific local oceanographic, geographic and socio-economic factors and the practicalities of coastal shipping operations (Hobday et al. 2002).

5. A NATIONALLY APPLICABLE MODEL

The Specification (2 (i)) defines the criteria for *'a nationally applicable model that integrates the management of internationally and domestically sourced ballast water'*.

This section discusses those characteristics and the way in which the Hastings project has validated the existing ballast water management system as employed for international sourced ballast. It considers how lessons learned in the administration of the Hastings project can be used in a nationally applicable ballast water management model.

5.1 The Hastings model: Transferability to other ports

Objective: The aim set out in the Specification 2 (i) is to *'provide a nationally applicable model that integrates the management of internationally and domestically sourced ballast water such that it will… be transferable to other ports .'*

The HNDP was conceived to trial the operational and management arrangements of an integrated ballast water management model to assess its suitability for Australia wide implementation. It is understood that the Port of Hastings was chosen due to the availability of baseline data, the variety and the number of traceable shipping movements and the ability to regulate both domestic and internationally sourced ballast water with existing state and Commonwealth legislation.

The trial ballast water management model used in the HNDP is not considered to have any major impediments to transfer to other ports. The view formed is that (a) the trial has operated without major problems and (b) the administrative arrangements put in place and issues arising and dealt with during the trial have established a framework that will work, with some modification, in a national situation.

One modification that is recommended is the reinforcement of direct interface between the regulator and the ship/agent. The model for the integrated ballast water management system as defined in section 1 of this report represents a system where the vessel interfaces directly with the regulator. Based on the HNDP, the conclusion of this report is that a single regulator or regulatory system is a preferred option. Whether this transpires or not, the ballast water management system will be more manageable and efficient in terms of communication, consistency of approach and feedback if there is a direct interface between ship and regulator. Whilst the involvement by the port operator/Harbour Master in Hastings is seen to have been beneficial in the trial situation in that it provide a local conduit for information flow, the port operator/Harbour Master is not recommended to adopt this role as part of a national integrated system. The port operator is considered an ineffective choice of point of contact in a system that is transferred to other ports because this would present a multiple interface with attendant inefficiencies and duplications for the industry. In order to optimise efficiency and effectiveness, it is recommended that a national system use a single point of contact for industry such as a national body. Identification of such a national body would require further investigation and would most appropriately be addressed as a high level policy decision.

Having a single point of national contact would also ensure that any differences in the administration or ownership of ports and channels from state to state will not impact on the effectiveness or consistent implementation of the ballast water management system

5.2 Administrative arrangements

Objective: The aim set out in the Specification 2 (i) is to *'provide a nationally applicable model that integrates the management of internationally and domestically sourced ballast water such that it will… 'have consistent/uniform administrative arrangements.'*

The HNDP has been administered by the following agencies:

Agency/organisation	Task
EPA Victoria	▪ Policy for the HNDP ▪ Day-to-day management of the decision system in respect of domestic ballast
AQIS	▪ Administration of the Decision Support System (DSS) ▪ Responsibility for international ballast ▪ Verification inspections by agreement with EPA Victoria
Port operators	▪ Overview of agents/ship input to system ▪ Acting as a conduit for information flow for the trial
Ships/agents	▪ Advice of calls ▪ Input of data to the risk assessment system; and ▪ Management of ballast water

In terms of criticality to the successful operation of the ballast water management model, the part played by the port has been useful in promoting and implementing the trial but, as mentioned above, this role is not seen as essential for the HNDP model to be effectively transferred to other ports. Although it is expected that there will be some ports that will wish to take an active interest in the operation of the ballast water management system and will include ballast water management in their EMP/EIP structure and triple bottom line approach, the area in which ports will have a specific ongoing role and commitment will be in the implementation of a rigorously applied port survey/re-survey program to provide data for the decision support system. These issues are discussed elsewhere in this report.

Currently there appears a clear dichotomy between Commonwealth, with its responsibility undertaken by AFFA/AQIS for international sourced ballast, and the States/Territory governments with responsibility for state based issues, as introduced pests in domestic sourced ballast risks could be defined.

The dividing line between international and domestic ballast appears initially clear cut based on where the vessel has come from and where it took ballast. However, the distinction becomes less clear when the vagaries of shipping are taken into account.

Whilst some vessels are totally dedicated to domestic voyages within Australia, the majority of vessels plying the coast are doing so as part of an international movement. Sometimes these vessels are on fixed routes (liner vessels), particularly container vessels, and their coastal schedule is fixed to a great extent. These vessels are easy to track. Many vessels, however, are employed on time or voyage basis to load and discharge specific parcels of cargo. Their schedule can change even after arrival on the coast and can include overseas visits, particularly to New Zealand ports, amongst the Australian port calls. Such vessel are deemed 'international' when returning from overseas but may well carry domestic ballast from previous visits to Australian ports. The administrative arrangements in place for the HNDP are such that vessels arriving as an international voyage are not expected to be carrying any domestic ballast water, and therefore report only to AQIS thereby satisfying the quarantine requirements for international vessels.

An actual example of the risk posed by the demarcation in responsibility based on the vessels last port of call occurred during the HNDP. A vessel whilst carrying out a multi port cargo discharge in Australia, took ballast in an Australian port. It then sailed to New Zealand, and subsequently returned to the port of Hastings carrying the Australian sourced ballast water. In this case AQIS inspectors boarded the vessel to conduct a verification inspection under their quarantine requirements. A verification inspection under the AQIS regime would consider the domestic ballast water low risk as AQIS have no role in regulating domestic ballast. EPA was unaware that the ballast water in question was domestic in origin and therefore did not request a domestic ballast water verification inspection. Fortunately, when AQIS became aware that the water was sourced domestically they advised EPA and verification inspection was eventually completed. In this particular case the water had been exchanged while the vessel was en-route from New Zealand and the environmental risk to port was low.

This scenario demonstrates that dividing the ballast management issue in an arbitrary fashion leaves the very real possibility of breakdown and gaps in the system with unacceptable environmental risk resulting.

The other issue that clouds demarcation is the length of voyage. Whilst there is a general assumption that international voyages are longer than domestic, this is not necessarily the case. A voyage from, for instance, a Pacific Island port to Australia may be shorter than many domestic voyages. Therefore the assumption that vessels can carry out ocean exchange without incurring substantive delay or diversion is not necessarily valid.

The conclusion reached by this evaluation is that, for the system to be effectively transferred to other ports, an integrated system of ballast water management for both international and domestic sourced ballast water is essential. The dividing lines are too blurred, and the potential for gaps, inconsistencies and incompatibilities may result in unacceptable exposure for a series of separate state based administrative programs for domestic ballast to be sustainable. The above comments underline the rationale for this view and reinforce the preference expressed in this report for a single regulatory system, or a body with responsibility for integrating nationally consistent regulatory arrangements. Such an approach will provide consistency and clarity – less risk in the overlap of administrative roles, less confusion regarding which paperwork applies and when and reduction in administrative costs.

5.3 National ballast water management model: Single interface

Objective: The aim set out in the Specification 2 (i) is to *'provide a nationally applicable model that integrates the management of internationally and domestically sourced ballast water such that it will… provide a single interface to industry .'*

A key issue identified in the project brief, and underlined in stakeholder consultation has been the desirability or necessity of a single point of contact for industry. The introduction of a further level of reporting and inspection in addition to the many calls made on ships' staff is an important one. However, the view is taken that this, whilst an important issue to be taken into account when designing or adapting a ballast water management model for national adoption, need not be critical provided that the model is such that risk assessment is carried out in advance. It is envisaged that physical presence will only be required then for verifications on a random or as-required basis. However, in terms of awareness and education, a single national body and a single, ~~or~~ consistent set of regulations for an integrated, national ballast water management system would allow simplicity and certainty that may well be difficult to achieve in a multi faceted system.

The environment and appetite of industry to dispense with discontinuity at borders is common in our experience and in our interviews. A seamless system with single standard settings, interpretations and compliance and enforcement approach is preferred.

5.4 Consistent interpretation of guidelines/regulations

Objective: The aim set out in the Specification 2 (i) is to *'provide a nationally applicable model that integrates the management of internationally and domestically sourced ballast water such that it will… ensure consistent interpretation of guidelines/regulations .'*

The HNDP dealt with one port, with tight management by Victoria EPA in close consultation with AQIS, effectively as a service provider. Consistency of interpretation is not seen as an issue in respect of the Hastings project.

However, if the ballast water management model is to be applied nationally under a scenario that does not allow for central control, a consistent set of guidelines and regulations will be difficult to achieve. A state by state approach to the interpretation and implementation of guidelines will lead to inconsistency, and potentially to incompatibility and gaps that will cause operational difficulty and loss of environmental effectiveness. This underlines again the need for an integrated approach with a single body, setting policy and overseeing the delivery of the ballast water management system.

In order to ensure consistent interpretation of guidelines/regulations and administrative arrangements, a national body is recommended to oversee and ensure delivery of an integrated national ballast water management system.

5.5 Consistency of risk assessment procedures

Objective: The aim set out in the Specification 2 (i) is to *'provide a nationally applicable model that integrates the management of internationally and domestically sourced ballast water such that it will… use consistent risk assessment procedures .'*

The Hastings project was based on the use of the same decision support system and the risk assessment that underpins it for both internationally and domestically sourced ballast water. Given the similarity of the two aspects of an integrated ballast water management system – the management of internationally and domestically sourced ballast water – use of a consistent procedure for the two tasks is clearly essential.

During the trial period, the DSS was used as the risk assessment model for both internationally and domestically sourced ballast. Once "switched on" for domestic purposes, it provided the common base that ensured compatibility of procedures and documentation during the HNDP project. No deficiency is therefore noted during the trial project. It is considered that for any nationally adopted integrated ballast water management model, a common and consistent risk assessment system and model is both feasible and desirable, both for international and domestic ballast, and between ports and across jurisdictions.

5.6 Cost efficient

Objective: The aim set out in the Specification 2 (i) is to *'provide a nationally applicable model that integrates the management of internationally and domestically sourced ballast water such that it will… be cost efficient..... for industry, government and community.'*

5.6.1 Overview

The model implemented for Hastings was cost efficient in that it provided a risk-based approach as opposed to mandatory ballast water exchange. This provided cost efficiencies to the shipping industry in that compliance could be achieved without unnecessary burdens when environmental risk was considered to be low. Greater cost efficiencies could be achieved by removal of duplications in the administrative arrangements that have been mentioned elsewhere in this report, ie involving both AQIS and EPA and requiring two sets of forms etc.

Relating this to cost effectiveness involves assessing the return that administrators and shipping industry stakeholders perceive on their investments. The investment itself is in the cost of:

- administration of the ballast water management system
- management or treatment of ballast water
- the decision support system
- data acquisition and maintenance.

Whilst industry will be able to quantify (and potentially pass on) direct costs, some indirect costs will be difficult to measure and will occur over a long period as consequential costs of the regulatory system.

For the regulator and the community, much of the measurement will be qualitative. The cost effectiveness of both the ballast water management system, and the decision support system model that underpins it, will be perceived in a positive light if there is a tangible result in terms of no IMP incursions. From the regulator's viewpoint, costs can be recoverable through a fee for service arrangement, but the cost effectiveness of maintaining and improving the decision support system will rely on a reasonable uptake by industry.

In turn, industry must see some savings in cost and inconvenience available to it through use of the DSS to amortise some quantified cost. If it is unable to see material costs savings, there is the danger that it will adopt a precautionary approach (already becoming evident with some owners/charterers including this in the their operating procedures and contracts/charter parties) by carrying out ocean exchange as a routine, thus impacting on the relevance of the decision support system and undermining its rationale. It must also be convinced that its investment in the decision support system is justified.

5.6.2 Administering the ballast water management model

Costs to administer the system comprise cost of the decision support system itself, operating costs for staff and operations, and the cost of acquiring and keeping updated data.

The current information indicates that the most cost effective way of administering the ballast water management system may be through a national body overseeing overall policy and administrative aspects, with delivery through a single, nation wide interface. Other models exist that would permit development of scenarios for comparing cost efficiencies. It is likely that the least cost effective option would be for the international and domestic issues to remain completely separate, with each state managing, implementing and administering its own domestic ballast water management system. This would also cause inefficiencies for the industry resulting from the need to deal with multiple administrative arrangements and a diversity of guidelines and regulations. Clearly the model outlined in section 1.6 of this report becomes very complex if each state/territory is to apply its own regime – or even implement and interpret individually a common ballast water management system. The opportunity for inconsistency, incompatibility and duplication of cost, is significant.

5.6.3 The ship operator

Cost effectiveness will be measured by the ship operator on the perceived benefits that the ballast water management system brings, compared to the level of cost and inconvenience involved in applying or avoiding the ballast management options available to them. Certainly the best value will be seen in a national system, integrating international and domestic ballast management issues in the same set of documents, procedures and management options.

In the future, ship design will start to take some of the cost and inefficiencies out of the equation, but this, like double hull tanker design, will take time to initiate, and far longer to permeate through a system where ships of twenty years of age or more are common.

Investment in the DSS has been seen in a positive light by the Australian industry, but in a world of reducing freight rates and constrained costs, any investment will be seen as suspect unless a level of transparency exists. Recommendations made in this report towards more transparency in procedures and decisions will assist the industry members and their representatives in understanding and supporting the ballast water management system.

5.6.4 The port

The port's role in ballast water management is limited and it is unlikely to incur significant cost. It is likely that the state environmental and natural resource regulators would be overseeing the system, and the single regulator would provide the communication link as set out in the structure of the ballast water management model depicted in section 6 of this report.

However, there is a benefit to the port operators who have a vested interest in seeing their ports as a low risk call for vessels. In many cases a ship does not have a choice of ports, with commercial pressures dictating where the cargo will be landed or uplifted. However, at the margin many bulk ports are competing and even containers are now being land-bridged extensively, while the oil industry has major decisions to make about how it refines and distributes product. Ballast water management will be one of the many factors that could influence those decisions.

Whilst the port does not have a pivotal role to play in the implementation of the ballast water management system, the decision support system itself requires population with data to make it work. The survey program that has seen half of Australia's ports surveyed for baseline data was originally part funded by public funds. To complete that program, and to establish a proper re-survey program is a high priority. This may be repeated every two to five years, and will require both a disciplined approach to ensuring consistent sampling protocols are adhered to, and close monitoring by the regulator to ensure compliance.

5.6.5 Port surveys

This report discusses the importance of the survey/re-survey of ports to establish and monitor the existence or arrival of marine pests.

Currently, approximately half of Australia's ports have been surveyed, and only two surveyed more than once. There are established and effective protocols (CSIRO/CRIMP) for the initial baseline survey, but standards for a program to re-survey have yet to be developed. Thus issues of subsequent marine pest invasion and data degradation are not yet fully addressed. The recommendation is made that the program be accelerated and that standards be established urgently.

This represents a significant initial and recurring cost. The decision has to be taken at some stage, and preferably at a high policy level, as to whether this provides an acceptable return on funds invested. The benefits are detailed elsewhere in this report, but can be summarised as reducing apparent and hidden transaction costs by reducing:

- long term, irreversible cost to the community from invasions
- operating cost to industry by optimising treatment/management options
- indirect but real costs to the port sector in loss of competitiveness as a result of high risk status for discharge and uptake of ballast water.

It is the recommendation of this report that the costs are justified provided that the increased and continuously updated data allows the DSS to become an increasingly effective tool in the risk assessment process.

5.7 Environmental effectiveness

Objective: The aim set out in the Specification 2 (i) is to *'provide a nationally applicable model that integrates the management of internationally and domestically sourced ballast water such that it will…be <u>environmentally effective for industry, government and community</u>.'*

The implementation of ballast water management requirements at Hastings and the processes (including but not confined to this review) that have been put in place to ensure that lessons are learnt and acted upon all make a significant contribution to improved management of environmental risks associated with introductions of pest species from ballast water. The availability of baseline and other survey information for Hastings prior to the introduction of the ballast water management requirements increases the rigour and usefulness of information collected from this particular trial. In addition, Hastings port has an environmental management plan that provides for marine pest contingency arrangements. These elements build capacity for future benchmarking for national and international purposes.

The existence of the integrated ballast water trial offers Australia a basis, and an opportunity, to begin to better understand management of these risks and to assess the effectiveness of this and other systems for controlling introduction of marine pest species via ballast water. At this stage however, it would be premature to attempt an absolute and quantified determination of how environmentally effective it has been.

In order to reach absolute conclusions there needs to be a much longer term assessment, perhaps over a ten year period. However, in the interim, the recommendation of this evaluation is for significant effort to be applied at government and industry level to populate the risk assessment model (DSS) with reliable data, and to ensure that an agreed standard is developed for ongoing resurvey protocols, taking account of the identification of invasions and the likely time-scale for data degradation.

From an environmental perspective the assessment of Type II error rates (i.e. failed alarms) is an important area for research. This is currently being undertaken by CSIRO-CRIMP and should assist in improving the process. In addition, close attention is being given to developing new risk assessment models for Component D (survival in discharge port) based on specific tolerance data for life stages of pest species (Hayes and McEnnulty 2002).

In assessing the effectiveness of the risk assessment model, a significant amount of work and consultation was required. It is considered that this research offers additional analysis of the DSS and insight into its strengths and short-comings. The result of this work is included in Appendix 4 of this report.

5.8 Recommendations

Issues regarding environmental effectiveness require attention irrespective of arrangements made to implement an integrated ballast water management model. It is understood that high level discussions are currently under way on this issue within Australian governments and with industry.

The areas for future consideration identified below concentrate on the physical implementation of nationally applicable system that integrates the management of internationally and domestically sourced ballast water. The focus of this section is on what could be achieved rather than further detailing issues that are subject to current discussion and technical investigation.

The project brief identified that an overarching objective of the trial was to:

> *...provide a nationally applicable model that integrates the management of internationally and domestically sourced ballast water*

In overall terms, the findings of the evaluation are that:

- The evaluation of the HNDP indicates no impediment to the establishment of an integrated ballast water management model across all Australian ports.
- An integrated national ballast water management model would benefit from being administered by a single national body or regulatory system to ensure cost effectiveness, single interface with industry, , consistent implementation across eight jurisdictions and the basis of the application of an auditable quality management system for the ballast water management model and associated risk assessments. However, the Hastings Project did not trial an option for integrating administrative functions across all jurisdictions.
- Given that the only resource required at an individual port is that needed to undertake shipboard verification inspections, advantage should be taken of the various service delivery options available across Australia including out-sourcing to authorised personnel.

Specific changes or improvements that would facilitate the model being adopted for a national integrated ballast water management system are discussed below.

Each criterion specified for a nationally applicable model is addressed below:

…an effective administration framework

The conclusion reached by this evaluation is that an integrated system of ballast water management for both international and domestic sourced ballast water provides an effective administrative framework. If the administrative arrangements adopt those of each of the States, the dividing lines are too blurred, and the potential for gaps, inconsistencies and incompatibilities may result in exposure too great for a series of separate, state based administrative programs for domestic ballast to be sustainable.

The results from this trial suggest a preference for a regime based on a single regulatory or administrative body with responsibility nation wide. However, the Hastings Project did not trial options for integrating administrative and regulatory functions, such as nationally uniform template legislation across all jurisdictions (including the Commonwealth, all States and NT).

A single regulatory system or an integrated administrative approach is needed to provide consistency and clarity – it would provide less risk in the overlap of administrative roles; less confusion regarding which paperwork applies and when; and consequent reduction in duplication and resultant administrative cost to regulators and the industry.

In seeking an effective administration framework, the evaluation identified specific issues of communication and response that should be addressed to facilitate the national acceptability of the ballast water management model trialled. These may be summarised as:

- A fail-safe approval notification system should be implemented so that ballast water is not permitted to be discharged until approval has been granted by the relevant authority.
- The dwell time between lodging data and receiving an assessment is critical if vessels are to access the decision support system directly.
- A channel should be established for ships or their agents to feed back suggestions on workability and possible improvements to both data capture and physical implementation.
- Communication channels should be clear and unambiguous, preferably covered by written procedures with third party audit capability.
- Advice from one agency to another of high risk vessels will be valuable, and a formal channel for timely communication is recommended.

…minimise the risk to the environment

It is considered essential for any nationally adopted integrated ballast water management model that a common and consistent risk assessment system and model is applied, both for international and domestic ballast, and between ports and across jurisdictions.

In refining the ballast water management model for future use or for national application, the following recommendations are made in relation to the decision support system:

- The transparency of the decision making process in relation to settings in the DSS is clearly critical.* A fully documented system capable of third party audit is recommended.
- Timeliness of changes to the DSS model has been an issue*. The quality system recommended above should incorporate a set of target timings, and an audit trail to ensure reasonable compliance.

(*Note: It is noted that these issues may be considered in the Post Implementation Review being carried out by AQIS.)

Given that currently the only means of treating ballast is to exchange it at sea, in terms of the physical processes, the current procedures may incur a risk of the volume of ballast exchanged being less than reported. It is recommended that more research should be encouraged by trials and sampling to ensure that:

a) the current protocols are environmentally effective

b) pumping suggested volumes does actually take place, given the shortcomings of the only verification method (Newcastle method).

…appropriate options for vessels to manage the risk posed by their ballast water

Safety and operational issues dictate that ocean exchange of ballast water is not the preferred option in the longer term, but there will be clearly a long lead time before either ship design or other treatment methods will remove the risk elements to the vessel. It is recommended that:

- Government at both Commonwealth and State/Territory level should be actively encouraging the development of alternative technologies, both within research bodies and industry.
- Industry should be encouraged through education and awareness programs to view developing technology as eventually constraining costs, as well as providing triple bottom line benefits.

6. CONCLUSIONS

The way forward appears clear. The concept is proven, it fits into what is happening internationally, and has been seen to work in overall terms during the valuable Hastings project.

It is clear that an integrated national approach to ballast water management is possible and also required for reasons of environmental effectiveness, cost effectiveness and consistency.

The evaluation indicates that it would be of benefit to consider seriously the vesting of a national body or regulatory regime to oversee and administer the national ballast water management system. Further analysis would be needed to identify the most effective and viable options for administering such a system. Progress towards this end has been made during the evaluation period. A high level officials working group has recently been formed to address the issues involved in implementing a National System . It is understood that, while the HNDP evaluation was limited to management of ballast water and more particularly the performance of the Hastings Project against its project objectives, the scope of the high level working group's considerations have extended well beyond this . It is considering options for either a single regulatory approach or one based on model template State/Territory legislation that will provide the required level of consistency identified as important in this review. Such an approach would need to be delivered through a single interface to ensure a single point of contact for industry.

A number of specific issues are identified for further consideration in this section that have emerged from the evaluation as critical to achieving the goal of an effective, consistent, and efficient national system.

It should be noted that it was considered beyond the scope of this evaluation to consider options other than replication of the model trialled in the Hastings Project across all States/Territories and Commonwealth. As a result alternative options were not considered.

The ballast water management model employed for the Hastings project has been proved conceptually. The risk assessment tool and the operating model are effectively the model developed over a longer period by AQIS and employed for international ballast water management. It is compatible with development of policy and protocols internationally.

With the exception of points made in this report, no major shortcomings were identified that would undermine the effectiveness of the ballast water management model itself. However, the administration of it will be critical if it is to be adopted on a national basis, and the lessons learned will need to be addressed in designing the national ballast water management model. The basic concept of the ballast water management model shown in Section 1 of this report is effective – in fact its simplicity makes it unarguable.

However, there are some major questions within the use of the decision support system itself (DSS). The issue of policy based changes within the DSS are critical. Currently a very few vessels are in fact seeking low risk assessments, AQIS report that most international callers are reporting the exchange of ballast at sea. There is the probability that already ship owners are taking the policy decision to report exchange to ensure that they do not run the risk of incurring operational delay and uncertainty on arrival. The danger is that the very few vessels now benefiting from a low risk assessment will represent a poor return on investment, if the estimates of costs for running the DSS system are considered. A policy decision to shift goal posts by changing thresholds, if taken without full consultation and support of the various jurisdictions and stakeholders, will undermine confidence in environmental effectiveness. In the worst case scenario, where a relatively few ship operators would be disadvantaged by blanket requirements for ocean ballast exchange, a decision to abandon the DSS may be even more fundamental to the administration of the ballast water management system, but would not defeat the concept.

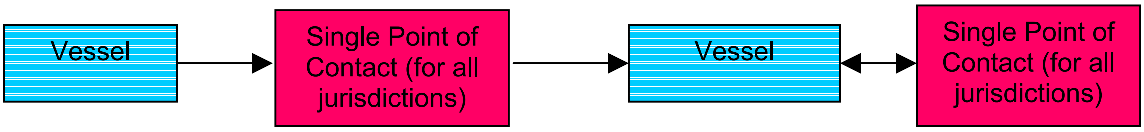
It is recognised that the current DSS system is not essential to the ballast water management model under evaluation. An alternative support system could be developed, and there are mechanisms suitable for promulgating and updating data. However, since the DSS is there, and can be made to work well in the domestic situation, it would be inappropriate not to endeavour to use this asset.

The seamless administration of the ballast water management model is critical if it is to be adopted Australia wide. Whilst each state has the ability to institute a system to protect its own environment and bio diversity there is the very real risk of gaps, inconsistencies and incompatibilities that will eventually bring the ballast water management system down if a national approach is not taken. It will also be costly for the industry, and will require substantially more resource in the public sector to run many separate systems.

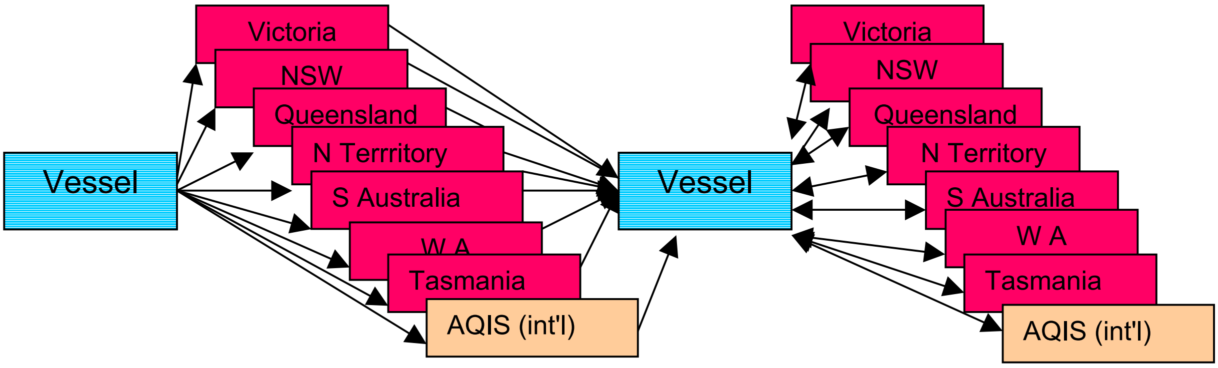
The simplicity of the ballast water management model set out in section 1 of this report could break down as soon as the model trialled in the Hastings Project is extended nation-wide. This is graphically depicted below.

Essentially the information flow changes between a national model and a separate jurisdictional based model as shown below.

A single point of contact model



A multiple point of contact model



Without an effective administrative model, the communication links, any of which inevitably provide opportunities for problems, increase from three to twenty five. The number of agencies for the vessel to interface with, each with its own unique approach to its responsibilities, increases from one to as many different states as its schedule takes it to.

For the industry, which, at both port and ship operator level, supports the initiative in general terms, a fragmented system where each state adopts a separate and different approach will be unacceptable. Costs are related not only to the physical aspects of handling ballast and accommodating exchange procedures during ocean or coastal transits, but also to staff and other resource that is already thinly spread with revenue under pressure and costs a major focus. Currently, to add to the ship and port operator's burden, the quickly increasing focus on security is also going to claim its own priorities and incur cost. The economic environment is not one in which to be seen to bringing in a system that is fragmented and thus cost and resource inefficient and burdensome.

Although not seen as a deficiency of the trial or the ballast water management model to date, there are initiatives being pursued in alternative treatment methods. In general, these seem to be confined to public sector research organisations.

There is the need to encourage industry to develop a response to the requirements. Their obligations are currently reactive to regulation, and they should be encouraged to consider developing proactive measures to be cost effective in the long run, and in line with the increasing interest in triple bottom line accountability.

The evaluation has highlighted the benefits of further research in the following areas:

- Port surveys – completion and resurveys –need to be increased for the DSS to be extended to domestic shipping.
- Methods of eradication and the development of a set of rules for eradication – integration of DSS with issues from the report by the National Taskforce on Prevention and Management of Marine Pest Incursions (1999/2000).
- Ballast water screening to determine what target species are present – this is currently being addressed by CSIRO-CRIMP in relation to Type II errors.
- Ballast water management – exchange and treatment options including verification of the efficacy of the 'flow through' method.

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APPENDIX 2: ACKNOWLEDGMENTS

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Organisation	Individual
EPA Victoria	Chris Bell, Teresa Hatch, Dr Anthony Boxshall
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CSIRO/CRIMP	Dr Chad Hewitt, Dr Keith Hayes
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BRS	Simon Barry, Adrian Bugg
EA	Warren Geeves
AAPMA	John Hirst
ASA	Jennifer Taylor
DNRE	Don Hough
DOI	Mark Curry

APPENDIX 3: OPERATIONAL REVIEW NOTES

Incident	Details	Critical to *(Section in report – reference)*
CONFUSION AS TO BALLAST ORIGINS *International (by AQIS definition) domestic (by EPA definition)*	This involves a vessel which arrived in Hastings in June 2002. The vessel arrived in ballast, from New Zealand, the latest water being taken on in Whyalla (high risk) and Brisbane (low risk). Under AQIS definition, it was an "international" vessel, but under EPA definitions, it carried domestic ballast. AQIS had not received the "Uptake / Discharge" log prior to boarding, and subsequently the EPA were not aware it was carrying "domestic" ballast water, with intent to discharge in Westernport. Therefore, as a further consequence, no Westernport ballast water reporting form was completed. The vessel was in port for several days, and the appropriate form was eventually completed. In this instance, the EPA did require a verification inspection, whereas AQIS did not. As it turned out, fortunately, there was no environmental threat as ballast water was exchanged on passage. The EPA sent out a reminder to the agent that international vessels can carry domestic ballast, and therefore both AQIS and EPA forms must be completed and forms submitted to both authorities.	2.4 Awareness & education 2.4 Awareness & education 3.3 Compliance
SHORT NOTICE OF ARRIVAL	Two vessels have arrived into Westernport with short notice for inspection - one due to a change in port rotation, the other unaware whether ballast discharge would occur or not.	

Incident	**Details**	**Critical to** *(Section in report – reference)*
	In the first instance, vessel A arrived in May 2002. The vessel was bound for New Zealand, but redirected to Hastings, having ballasted in Melbourne. The Harbour Master contacted the vessel by VHF and instructed it to exchange ballast if it intended to discharge ballast into Westernport. No paperwork was received prior to the vessel's arrival, but the AQIS officer managed to attend at such short notice. In any event, no ballast was discharged. The second case, vessel B arrived in June 2002, also from Melbourne. There was confusion as to whether or not ballast would be discharged. It appears the Melbourne agent was not aware of HNDP, and the vessel unaware likewise. The vessel signed a declaration that it would not discharge high risk ballast water into the port of Hastings.	2.2 Communications 3.3 Compliance 2.4 Awareness & education
HIGH RISK BALLAST WATER MANAGEMENT	Three vessels have voluntarily managed their ballast water by being aware of the HNDP & associated high risk sources. Vessel C (1st August 2001) retained high risk ballast on board which would otherwise have been discharged if HNDP were not operational. Vessel D had called several times in July 2001. There was some scepticism that ballast water was retained on board. The agent could not confirm, and there was no opportunity to query the ship's master. However, port operators confirm that the vessel has permanent ballast water.	2.5 Communications

Incident	**Details**	**Critical to** ***(Section in report – reference)***
	Vessel E (July 2002) minimised the uptake of high risk ballast in order to minimise the exchange requirements between Melbourne and Westernport. Vessel E (March 2002) avoided taking ballast water in Bonython, specifically because it was known as a high risk port.	3.3 Compliance
ISSUE OF NON-CONFORMITY FOLLOWING A VERIFICATION	Vessel E (April 2002) was found to be carrying undocumented ballast water, the uptake offshore whilst attending a rig. As it turned out, the distance off the coastline and depth of the source indicated "low-risk", but the ballast had already been discharged. On the strength of the oversight, a non-conformity was issued. It is believed this creates a conundrum on the part of the EPA as to the consequences arising from, and the action to take, in the event of high risk ballast being discharged, whether inadvertently or wilfully.	3.3 Compliance 3.3 Compliance
INADEQUACY OF AQIS DSS USED FOR DOMESTIC PURPOSES	Vessel F (January 2002) arrived at Westernport from Port Stanvac (high risk). The vessel had exchanged ballast on passage, but due to inadequate biological data, the AQIS DSS indicated the exchange location was also high risk. The exchange co-ordinates were plotted manually and confirmed as being beyond the 12nm limit.	

Incident	Details	Critical to *(Section in report – reference)*
		4.5 Ocean exchange
COMPLIANCE / VERIFICATION INSPECTIONS	Vessel G (September 2001) extended its voyage from Geelong to Westernport in order to exchange ballast beyond the 12nm limit. The vessel departed Westernport earlier than expected, and before AQIS had a chance to attend. It had been confirmed by virtue of co-ordinates only, that the ballast received at sea was low risk and the exchange was in order, but no other official documents had been sighted as a cross-reference. This instance, together with another two, indicates that HNDP had not working as intended. Another example was a vessel booked for an inspection on Saturday, but mistakenly taken as, and inspected on Sunday. The third example is where a vessel was delayed, and rather than have the AQIS officer wait around for about 5hrs, at the EPA's expense, instead, the Harbour Master collected the documents, as the ballast water source was low risk. In all three above cases, ballast water discharged was ultimately "low risk", but the first one was "high risk" prior to ballast exchange, and without the verification inspection, "high risk" ballast might have entered the harbour.	2.2 Communications 3.3 Compliance 2.2 Communications

General comments on operational issues

Activity	**Details**	**Critical to** *(Section in report – reference)*
WORDING OF THE INFORMATION BULLETIN	To cover an ambiguity that could be capitalised on by the industry, it is suggested that the wording of the information bulletin, which accompanies the reporting form, could be amended as follows: Left hand column, second-last paragraph, first line, replace "All vessels intending to discharge ballast water..." with "All vessels carrying ballast water capable of being discharged...". Cargo quantities, port rotations or a myriad of other factors can change the load / de-ballast plan. If no log is submitted in the first instance, in the heat of cargo calculations, the fact that on-board ballast might be high risk can be very easily overlooked. All vessels submitting a reporting form can act as memory-jog, and displaying a copy of the physical document next to the vessel's loading computer can only augment as a reminder.	3.3 Compliance
AGENTS' & VESSEL'S RESPONSIBILITIES IN DSS	We consulted with several agents, some already involved in the HNDP, others only aware of its existence. Though the additional efforts required because of domestic ballast water monitoring is a considered a bind to those already participating, the others also anticipate it will be so, believing government is passing the buck. Internet access by satellite communications are very expensive, still extremely slow (4800 or 9600bps) by shore standards, and both parameters are compounded by, in many instances, English on a vessel being a poor second language. Some agents instruct their vessels to access the AQIS DSS direct from the vessel. It is to be questioned whether self-regulation will be controlled with impunity.	2.5 Communications
INSTRUCTIONS FOR USE	Ship's crew should be advised that ballast uptakes in high risk areas, where deballasting is to	

Activity	Details	Critical to *(Section in report – reference)*
OF REPORTING FORM	occur, may be visited for a verification inspection, and that as such, it is recommended that all documents (working deck log, (official) deck log and engine room log, all tally).Failure may result in additional inspections and verification, likely delaying the vessel.	2.2, 2.4 Communications, Education & awareness
BALLAST / DE-BALLAST ISSUES FLOW THROUGH METHOD	In order to determine exchange amounts, only single or paired tanks should be pumped. If tanks are not transversely opposite (port & starboard - each side of a ballast line and the same distance from the pump/s), then ratios of cubic capacities received cannot be easily determined. This also applies when trying to work with two pairs of tanks or tanks that are fore and aft of each other but using the same ballast line (ie 3 tanks do not equate to 33% capacity, neither do 4 tanks mean 25% capacity each). Tanks closest to the ballast pump will always receive the lion's share.	
SEQUENTIAL EXCHANGE	Upon completion of the deballasting sequence, the remaining cubic capacity, as a percentage of the total capacity, should be observed and recorded before re-ballasting.	
USE OF TWO PUMPS	This should generally be discouraged as it can cause over-pressurisation of tanks (not ballast holds) when only a pair are being filled, and can blow out ventilator heads. In any event, using two pumps will not necessarily give twice the capacity unless the tank inlets and the supply lines are each equivalent to the pump capacities. The rule of thumb is one pump per pair of tanks, transversely separated.	

APPENDIX 4: ENVIRONMENTAL EFFECTIVENESS OF THE DSS

A 4.1 OVERVIEW

As can be seen from the discussion in Section 3.2, elements of the DSS, although developed for international shipping, are readily applicable for domestic shipping. The same target species apply, as they have already been introduced into some Australian ports (Barry and Bugg 2002). From a broader perspective, there is also a high level of endemism within different parts of Australia, particularly when temperate marine coastal waters are compared between the west and east coasts. Therefore, having a system in place for ballast water provides a framework for managing at least on vector of transfer.

The mechanics of the HNDP, including vessel inspections and transfer of information, are dealt with in other parts of this report. Here we discuss specific ecological issues, including port surveys in Westernport and we present the results of risk assessments done using the DSS for a set of hypothetical vessel trips within Australian waters.

A 4.2 Assessment of performance

Port Surveys

Objective: The aim set out in the Specification 2 (i) is to *'provide a nationally applicable model that integrates the management of internationally and domestically sourced ballast water such that it will… ' be cost efficient and environmentally effective for industry, government and the community '.'*

An essential component of the HNDP is baseline knowledge of any introduced pest species within the Port of Hastings. This is important in terms of vessels seeking to discharge in the port because if a pest species is currently believed to be absent, then the DSS applies to management of discharge (i.e. no discharge or ocean exchange). On the other hand, if the species is believed to be present, discharge may take place in the port, whilst any uptake of ballast water within the port will have implications for discharge in other Australian ports.

In the longer term, repeat surveys will theoretically assist in improving the baseline and serve as a means of auditing the success of managing introduced species. In practice, however, the close proximity of ports that already contain pest species (e.g. Port Phillip Bay) means that pest species may arrive in Westernport by non-human means, such as dispersal of propagules via currents.

There have been three surveys for marine pests in Westernport (Currie and Crooks 1997, Cohen et al. 2000 and Parry and Cohen 2001). There have also been numerous other surveys of biota in Westernport dating from the early nineteenth century (see Currie and Crookes for details).

The first survey of Westernport for marine pests was done in March 1997 (Currie and Crooks 1997), with the focus being on commercial wharves that were likely to be colonised by introduced species. Potential pest species were targeted based on the ABWMAC list. Sampling methods were consistent with the port survey protocol developed by CSIRO-CRIMP and included:

- net tows for phyto- and zooplankton
- trapping of crabs, shrimp and benthic scavengers
- diver observations and collections of biota from wharf piles
- visual searches
- tows over the seabed for epibenthos (i.e. organisms living on the seabed, such as starfish)
- core and grab sampling for infauna (i.e. organisms living within the sediments)
- Seine netting for fish and large invertebrates (e.g. squid).

Measures of water quality in 1973-74 indicated that water temperature ranges annually from 10 – 22 C while salinity ranges from 13 – 20 parts per thousand (Colemen 1978, cited in Currie and Crooks 1997). These parameters are well within the tolerance ranges of all the ABWMAC target species (Table 3.3).

Currie and Crooks (1997) collected 355 species, 7 of which were considered to be introduced, including:

- European shore crab (*Carcinus maenas*)
- Asian bivalve (*Corbula gibba* – called "the European clam" by Currie and Crooks)
- Asian date mussel (*Musculista senhousia*)
- Asian bivalve (*Theora lubrica*)
- The bryzoans – *Bugula dentata*, *B. neritina* and *Watersipora subtorquata.*

At that time, the only ABWMAC species was the European shore crab, but since that time the Asian clam and Asian date mussel have been added to the list. No toxic dinoflagellates were found, either as cysts in the sediment or during plankton tows. Japanese seaweed, *Undaria pinnatifida* was not observed, but it was considered that divers would not be likely to see the species at the time of the survey (March) as it would be present at that time (if at all) only in its microscopic growth form. (More recent work by Campbell and Burridge (1998) suggests that temperatures are cool enough to allow the persistence of the macroscopic sporophyte stage throughout the year.) A single European shore crab was collected – found in a bait trap set on an intertidal mudflat north of Steel Industry Wharf.

The left shell value of one juvenile Asian bivalve was found in a sediment core beneath the northern berth of Crib Point jetty (Currie and Crooks 1997). The polished nature of the shell interior and presence of an external periostracum layer suggested that the value belonged to an animal that was alive at least one or two months prior to the survey.

Six juvenile Asian date mussels were collected during the survey – four from one sediment grab sample taken near the Long Island Pier and three from a grab sample close to Steel Industry Wharf.

B. dentata was assessed to be the only introduced species within the port that was having an ecological impact, being dominant on pier pylons of all commercial wharves in the port. This species had been in the port for at least 20 years and was probably introduced on the hulls of ships or pleasure craft (Currie and Crooks 1997).

The most recent survey of Westernport (Parry and Cohen 2001) was commissioned by the Department of Natural Resources and Environment and the Environment Protection Authority. Its aim was to determine the status of four exotic taxa: Asian clam, Japanese seaweed and the dinoflagellates *Alexandrium* spp. and *Gymnodinium catenatum* in Westernport. Field surveys were done between July and November 2000. Unlike the earlier work by Currie and Crookes (1997), the most recent survey was much more focused on selected target species.

No Asian bivalves were found in any of 50 grab samples taken. It should be noted that the sediments were sieved through a 5 mm mesh, which would allow small individuals to escape. Japanese seaweed was not detected during the survey. Subsequently, however, 8 immature sporophytes were discovered on abalone shells near Flinders Pier (December 2001). These were removed and a follow up survey removed a further 4 sporophytes.

Phytoplankton tows contained small numbers of dinoflagellates cells, including species of *Alexandrium*. *A. minutum* and *A. tamarense* were detected in 6 and 2 samples, respectively. No cysts of *Alexandrium* or *Gymnodinium* were detected in sediments. Parry and Cohen (2001) reported that phytoplankton sampling done between September 1987 and December 1996 recorded *A. catenella* on two occasions and *A. tamarense* on three occasions.

Parry and Cohen (2001) concluded that several species that were present, or had been recorded in Westernport, did not have self-sustaining populations within the port:

- Japanese seaweed and Mediterranean fanworm (*Sabella spallanzanii*) were believed to have been eradicated from the waterway.
- Pacific oyster (*Crassostrea gigas*) was present in population densities much lower than would be found typically in infested areas.
- Asian bivalves (*Corbula gibba*) were detected only as juveniles or dead shells.

Parry and Cohen (2001) did conclude, however, that the following target pest species had established self-sustaining populations in the bay:

- European shore crab (*Carcinus maenas*) (although no further data were presented on population size and Currie and Crookes (1997) recorded only one individual).
- Asian date mussel (*Musculista senhousia*)
- The exotic dinoflagellates *Alexandrium catenella*, *A. tamarense* and *A. minutum.*

The above discussion clearly shows the complexity of undertaking port surveys and interpreting the information obtained. Here there are issues related to the intensity of sampling (were all suitable habitats surveyed? Were enough samples taken? Were identification and taxonomic resolution appropriate?). Moreover, for many Australian ports (and most international ones) there isn't any site-specific information available.

In assessing the risk of ballast water discharges into the Port of Hastings, the DSS must incorporate the findings of the port surveys. It is not immediately clear which species are considered to be present within the port, which has implications for discharge and acquisition of ballast water in the port.

For example, it is understood that Asian clams are considered, for the purposes of discharge, to be absent from the Port of Hastings. Therefore, a ship with a quantum of ballast water that has been assessed as high risk with respect to Asian clams would not be permitted to discharge into the Port of Hastings. However, for a ship seeking to take on ballast water within the port, risk of this species being present is assessed as high. Therefore, if that vessel took up ballast in the port, it would be considered to be high risk if it sought to discharge into another port that did not contain this species. The outcome of this approach is that it is conservative with respect to the environment, but imposes severe restrictions on shipping, despite the assessment by Parry and Cohen (2001) that there is no self sustaining population in the port.

Ballast Water Scenarios

Given the complexities associated with the information available on pest species in domestic ports, the DSS was used to provide an assessment of risk associated with discharge for a series of scenarios. As part of this consultancy, The Ecology Lab was provided with a User Name and Password by AQIS to access the DSS as would be permitted by a vessel operator and the system was accessed via the Internet using the AQIS Instruction Guide for the DSS, as supplied to vessel operators. A total of 118 scenarios (i.e. hypothetical vessel movements) were run between domestic ports. The methodology is described as follows.

Vessel movements from twenty-two Australian ports were selected to seek ballast water discharge into Westernport. In addition, vessel movements from Westernport to five other ports were investigated and finally, one vessel movement between two ports other than Westernport was assessed. The ports used were not selected at random, but represent a range of ports around Australia.

For each vessel movement, four possible trip profiles were assessed: trips made during winter (departing 30/6/02) or summer (departing 30/12/02) and for passages of short or long duration. The trips of short duration were either over seven days if in temperate waters or 14 days in tropical waters (and hence would arrive on 7/7/02 or 14/7/02 for winter trips; or on 7/1/03 or 14/1/03 for summer trips). Trips of long duration were all over 3 months (and hence would arrive on 1/10/02 or 1/4/03 for winter and summer, respectively). The three month period was selected as being a relatively extreme period which many target species would not survive, although cysts probably would (Barry and Bugg 2002). In one case (Twofold Bay), scenarios were also run for intermediate periods, being 4 weeks and 6 weeks for both summer and winter. All scenarios were run without specifying the use of strainers on the uptake pumps.

Procedurally, a single ballast tank was used for each trip. Thus, for each port to port comparison, there were four separate ballast tanks, two dates of uptake and four dates of discharge (the exception was Twofold Bay were addition runs were assessed for trips of intermediate duration).

The results of the risk assessments are summarised in Table 5.1. Sets of scenario runs are identified by individual Risk Assessment Numbers (RANs) allocated by the DSS and independently verifiable by anyone with appropriate access rights to the DSS. The main outcomes of the risk assessment scenarios are:

1. The search screen for the risk assessment provides four tabs that offer additional information:

a) Summary tab which provides a risk assessment at the Commonwealth level and an assessment at the local or state level. For the scenarios run here, no international trips were considered and the national assessment is listed as N/A (i.e. not applicable).

b) Advice tab which assesses which ballast tanks are high risk and which are low risk. For the high risk tanks a message warns that the vessel must take an approved ballast water management option.

c) Uptake/discharge tab, which summarised ports and dates of uptake and requested discharge.

d) Assessment tab, which identifies those discharges being assessed. To access the probabilities calculated for target species it is necessary to "mouse-click" on to text within the Assessment Tab. Access to this information is not explained in the DSS Instruction Guide, nor is it readily apparent from the screen.

2. The Assessment Tab indicates that the DSS recognises the occurrence of Alexandrium catenella, Carcinus maenas and Musculista senhousei within Westernport for the purposes of deballasting into that port. This is apparent in the model because the DSS assigned a threshold value of 1.0 individually for these species and hence the threshold cannot be exceeded for these species. Notwithstanding this, other target pest species not recognised as occurring within the port retain the 0.1 threshold and can be used to trigger a high risk assessment. The above three species were also reported by Parry and Cohen (2001) but they also identified A. tamarense and A. minutum as having self-sustaining populations within the port. Hence, it is not clear why these other two species were not recognised by the DSS as occurring in the port.
3. Of all the scenarios run, approximately 64% recorded a high risk and the remainder were low risk. Virtually all ports leaving from temperate regions were assessed as high risk, including Victorian ports (3) Tasmanian ports (2), South Australian ports (2) and Western Australian ports from Albany to Geraldton (3). Therefore, a ship leaving Port Phillip (either Melbourne or Geelong) cannot, without appropriate management, discharge ballast into Port of Hastings. In New South Wales, Twofold Bay recorded high risk for trips of short duration, irrespective of season, Port Kembla and Port Jackson recorded high risk, Botany Bay recorded low risk and Newcastle recorded high risk during summer and low risk during winter (Table 5.1).
4. In the tropics and subtropics, Port Hedland, Darwin, Mackay, Gladstone and Brisbane all recorded low risk. Townsville and Cairns were classified as high risk, however, regardless of season or duration of trip. Inspection of the details provided in the Assessment Tab indicate that P(A) for all target species within Townsville and Cairns were assigned a value of 1.0. This means either that all target species were present in these ports, which is highly unlikely, or that the results of the surveys, done in 2001, were not incorporated into the DSS at the time of writing this report and hence were assigned the maximal value as a precautionary approach. This finding (and that for Port Jackson, see below) suggests that it may take at least two years following the field survey for the data from a port survey to be incorporated into the DSS.
5. The risk assessment identified Port Botany as a low risk port with respect to discharge of ballast from there into Westernport (i.e. Hastings), whereas Port Jackson and Port Kembla were considered as high risk. In Port Botany, Alexandrium catenella was considered to be the only target species present and was accordingly assigned P(A) = 1.0. However, because it also occurs in the Port of Hastings, the risk threshold increases to 1.0 and ballast discharge from Botany to Hastings is considered low risk. In Port Jackson, every target species is assigned P(A) = 1.0, as was the case with Cairns and Townsville. The Port Jackson survey was done in 2001 and it is possible that the results had not yet been incorporated into the DSS. Hence any trip from Port Jackson to Westernport would be assigned a high risk, requiring ballast water management.

   In Port Kembla all the target dinoflagellates were assigned P(A) = 1.0 and all other target species were assigned P(A) = 0.05, indicating that the former group could be present but that the latter group is probably not.

6. As noted above, the risk assessment scenarios for trips from Twofold Bay to Westernport indicated high risk for short duration trips and low risk for longer durations. This issue was examined further for the scenario where a vessel with ballast water from Twofold Bay seeks to discharge into Westernport. Here trips of short duration were assessed as high risk and long trips (i.e. 3 months) were low risk. A trip of 6 weeks was also considered to be low risk, but further analysis indicated the cut off point was between 3 weeks (high risk) and 4 weeks (low risk).

    As noted above, the three target species occurring within Westernport for the purposes of discharge into that port include *A.catenella*, *C. maenas* and *M. senhousia*, the first of which is also present in Twofold Bay. The DSS recognises *A. catenella*, *C. maenas* and *Crassostrea gigas* (feral form) as occurring in Twofold Bay. However, Hewitt et al. (1997) also reported *Sabella spallanzanii* as occurring in Twofold Bay, hence we would expect it to also be assigned P(A) = 1.0 in the DSS. Given that *A. catenella* and *C. maenas* occur in both ports, the risk threshold is set at 1.0 for both species and hence would not be considered high risk for deballasting water from Twofold Bay into Westernport. *S. spallanzanii* is not recognised by the DSS as occurring in Twofold Bay, hence is assigned P(A) = 0.05 in the scenario. In these three cases the other risk components (i.e. risk of uptake, P(B), survival during transit, P(C) and survival in Westernport for at least 24 h, P(D)) would make no difference to the risk assessment. Therefore any assessment of high risk in the DSS would be based on the potential for *C. gigas* to be introduced into Westernport (i.e. components P(B), P(C) and P(D) would now become the focus of assigning an overall probability of viable pest introduction).

    For short trips from Twofold Bay to Westernport, the risk of introduction is assessed by the DSS as high in both summer and winter, triggered by a risk assessment value for *C. gigas* of 0.99999 which exceeds its threshold value of 0.1. In this case, the probability assigned for all risk components (i.e. A to D) is very high. For the long trip (3 months), the probability of being taken up into the ballast tanks is assigned as high (P(B) = 0.999999), but the probability of survival in transit, P(C) $\approx$ 0. This is the case for both summer and winter. Curiously, following a long voyage, the DSS also reduces the probability of survival in the recipient port, P(D), to 0.05 and it is unclear why, if larvae did survive the voyage, they would then appear to have a reduced likelihood of survival when introduced into the recipient port (i.e. Westernport).

    For the intermediate trips, a 6 week transit yields the same findings as for the 3 month transit while the 4 week transit yield the same result as for the 1 week transit, irrespective of season. This suggests the DSS assigns a larval survival within ballast for *C. gigas* at a little over 4 weeks. Interestingly, Hobday *et al.* (2002) provide an estimated larval duration of 3 months. Thus a precautionary approach in updating the model would be to assign a higher value of P(C) to prevent the viable introduction of *C. gigas* into Westernport. Hobday et al. (2002) also identify the period November to April as being the period when feral *C. gigas* are likely to be in the water column and hence have an increased probability of being drawn into ballast. This suggests that uptake in June, the winter period used for the scenarios, would be a relatively low risk time of the year for this pest and hence could be accommodated in the DSS.

This example provides an insight into potential inconsistencies in the DSS (e.g. assumed absence of *S. spallanzanii* for Twofold Bay) and potential improvements (e.g. incorporating information on *C. gigas* larval duration and seasonality). A detailed analysis of all the scenarios is beyond the scope of this engagement, but this and other examples presented suggest some ways in which the DSS could be refined.

A 4.3 Issues

Many of the issues identified in Section 3 with respect to risk assessment and the DSS are applicable at the domestic level, particularly in terms of the conservative nature of the assessments, although it should be noted that a lower percentage of the trip visits were considered high risk than found by Barry and Bugg (2002) for international movements.

The port surveys of Westernport have yielded complex results that are not clear cut in terms of the presence of target species as determined from port surveys, particularly how this is factored into the decision making process within the DSS model. This may be reflected in the scenarios run using domestic visits, as presented above.

Table 5.1 Summary of outcomes of scenarios using DSS for domestic shipping. RAN = Risk Assessment No. allocated by AQIS; Win = Winter, Sum = Summer; Sh, Lo & Int = short, long and intermediate trips, respectively. See text for details.

RAN	Port of Uptake	Season of Trip	Trip Duration	Port of Discharge	DSS Risk assessment
0043852-55	Melbourne	Win or Sum	Sh or Lo	Westernport	High
0043874	Geelong	Win or Sum	Sh or Lo	Westernport	High
0043872	Portland	Win or Sum	Sh or Lo	Westernport	High
0043875	Launceston	Win or Sum	Sh or Lo	Westernport	High
0043873	Hobart	Win or Sum	Sh or Lo	Westernport	High
0043877	Adelaide	Win or Sum	Sh or Lo	Westernport	High
0043876	Pt Lincoln	Win or Sum	Sh or Lo	Westernport	High
0043881	Albany	Win or Sum	Sh or Lo	Westernport	High
0043878	Fremantle	Win or Sum	Sh or Lo	Westernport	High
0043879	Geraldton	Win or Sum	Sh or Lo	Westernport	High
0043880	Pt Hedland	Win or Sum	Sh or Lo	Westernport	Low
0043862	Darwin	Win or Sum	Sh or Lo	Westernport	Low
0043861	Townsville	Win or Sum	Sh or Lo	Westernport	High
0044144	Cairns	Win or Sum	Sh or Lo	Westernport	High
0043882	Mackay	Win or Sum	Sh or Lo	Westernport	Low
0043883	Gladstone	Win or Sum	Sh or Lo	Westernport	Low
0043884	Brisbane	Win or Sum	Sh or Lo	Westernport	Low
0043885	Newcastle	Win	Sh or Lo	Westernport	Low
0043885	Newcastle	Sum	Sh or Lo	Westernport	High
0043886	Pt Jackson	Win or Sum	Sh or Lo	Westernport	High
0043870	Pt Botany	Win or Sum	Sh or Lo	Westernport	Low
0043859	Pt Kembla	Win or Sum	Sh or Lo	Westernport	High
0043889	Twofold Bay	Win or Sum	Sh	Westernport	High
0043889	Twofold Bay	Win or Sum	Lo	Westernport	Low
0043890	Twofold Bay	Win or Sum	Int(6 wk)	Westernport	Low
0043891	Twofold Bay	Win or Sum	Int(4 wk)	Westernport	High
0043863	Westernport	Win or Sum	Sh or Lo	Melbourne	N/A (Low)
0043864	Westernport	Win or Sum	Sh or Lo	Pt Botany	N/A (Low)
0043865	Westernport	Win or Sum	Sh or Lo	Pt Kembla	N/A (Low)
0043866	Westernport	Win or Sum	Sh or Lo	Townsville	N/A (Low)
0043867	Westernport	Win or Sum	Sh or Lo	Darwin	N/A (Low)
0043868	Melbourne	Win or Sum	Sh or Lo	Pt Botany	N/A (Low)

APPENDIX 5: SUMMARY OF SHIP CALLS

HNDP: SUMMARY OF DOMESTIC SHIP CALLS 2001-02

VESSELS CALLING - 1 JULY 2001 TO 30 JUNE 2002

Source: EPA database

Vessel Name	Last POC	Type	No of voy
Discharging ballast			
Gran Esperanza	Port Botany	Oil/gas	1
Barrington	Brisbane	Oil/gas	1
Berge Arrow	Port Botany	Oil/gas	1
Broadwater	Brisbane	Oil/gas	3
Broadwater	Port Botany	Oil/gas	4
Kyushu Spirit	Botany Bay	Oil/gas	1
Pacific W ave	Port Botany	Oil/gas	3
Palm Star Cherry	Brisbane	Oil/gas	1
Ross Sea	Port Botany	Oil/gas	1
Samar Spirit	Port Botany	Oil/gas	10
Seraya Spirit	Fremantle/Kwinana	Oil/gas	1
Caspian Sea	Port Stanvac	Oil/gas	1
Voc Sterling	Bell Bay	Steel	1
CSK Valiant	Melbourne	Oil/gas	1
Sveti Nikola 1	Port Kembla	Steel	1
Alam Selaras	Port Kembla	Steel	1
Seabravery 11	Melbourne	Oil/gas	1
Jin Cang	Bell Bay	Steel	1
Teekay Spirit	Port Stanvac	Oil/gas	1
Stellata	Geelong	Oil/gas	1
Packing	Melbourne	Steel	1
Barents Sea	Geelong	Oil/gas	1
Broadwater	Bonython	Oil/gas	1
Ormiston	Melbourne	Steel	1
Not discharging ballast			
Alfios	Port of Melbourne	Oil/gas	1
Clipper Viking	Geelong	Oil/gas	1
Crux	Port Botany	Oil/gas	1
Erasmusgracht	Melbourne	Steel	1
Fu Rong Yuan	Hobart	Oil/gas	1
Hebe	Devonport	Oil/gas	1
Hebe	Brisbane	Oil/gas	2
Helen	Brisbane	Oil/gas	2
Helen	Eden	Oil/gas	1
Helen	Port Botany	Oil/gas	2
Helen	Bell Bay	Oil/gas	1
Helen	Hobart	Oil/gas	1
Iron Monarch	Port Kembla	Steel	71
Kang Chang	Port Kembla	Steel	1
Kyoto	Kwinana	Oil/gas	1
Lady Martine	Cairns	Oil/gas	1
Lady Martine	Brisbane	Oil/gas	1
Lauriergracht	Port of Melbourne	Steel	1
Maritime Trader	Port Kembla	Steel	1
Mirande	Port Kembla	Steel	1
Namhae Gas	Devonport	Oil/gas	3
Namhae Gas	Hobart	Oil/gas	1
Namhae Gas	Townsville	Oil/gas	1
Philippine	Devonport	Oil/gas	1
Philippine	Tasmania	Oil/gas	1
Philippine	Brisbane	Oil/gas	4
Philippine	Hobart	Oil/gas	1
Royal Arrow	Melbourne	Oil/gas	1
Sanaga	Port Kembla	Steel	1
Sankuru	Port Kembla	Steel	1
Selendang Mayang	Port Kembla	Steel	1
Skauboard	Port Kembla	Steel	1
Stellata	Geelong	Oil/gas	1
Tauranga Chief	Melbourne	Steel	2
W yuna	Launceston	Other	1
W yuna	Sea	Other	6

HNDP: SUMMARY OF INTERNATIONAL SHIP CALLS 2001-02

VESSELS CALLING - 1 JULY 2001 TO 30 JUNE 2002

Source: EPA database

Vessel Name	Last POC	Type	No of voy
Discharging ballast			
Gohshu	Kawasaki, Japan	Oil/gas	1
Sea Maiden	Miike, Japan	Steel	1
Oval Nova	Hekinan, Japan	Oil/gas	1
Super Adventure	Tauranga, New Zealand	Steel	1
Isomeria	Singapore	Oil/gas	1
Flanders Gloria	Zhuhai, China	Oil/gas	1
Anne-Laure	Kawasaki, Japan	Oil/gas	1
North Sea Dowel	Singapore	Oil/gas	1
Gas Diana	Chiba, Japan	Oil/gas	1
Hanjin Houston	Kohsionang, Thailand	Steel	1
Flanders Gloria	Zhangjiagang, China	Oil/gas	1
Gas Aries	Kawasaki, Japan	Oil/gas	1
Cook Spirit	Senipah, Indonesia	Oil/gas	1
Ken Goh	Tauranga, NZ	Steel	1
Formosagas Apollo	Singapore	Oil/gas	1
Not discharging ballast			
Rainbow Quest	Singapore	Oil/gas	1
Kyoto	Singapore	Oil/gas	1
Batavia	Tanjong Pelepas, Malaysia	Oil/gas	1
Temasek	Yanbu, Saudi Arabia	Oil/gas	1
Helen	New Plymouth, NZ	Oil/gas	1
Probo Koala	Singapore	Oil/gas	1
Philippine	New Plymouth, NZ	Oil/gas	1
Rainbow Quest	Ningbo, China	Oil/gas	1