Ballast Water and Ship's Hull De-fouling:

A Government Strategy

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I. Foreword

The impact of organisms contained in ballast water on the New Zealand marine environment is, potentially, highly significant. The fact that New Zealand is blessed with a marine environment relatively free of damaging species and diseases is something that could easily change given this country's reliance on international shipping.

From toxic dinoflagellates to the northern pacific seastar, *Asterias amurensis*, there is a range of organisms which, if established in New Zealand, could do substantial harm to ecological, commercial, cultural and recreational values of the marine environment.

One recent study identified 61 marine organisms that appear to have arrived in New Zealand in the past 150 years. Of these, 54 were probably introduced via international shipping. Government is currently trying to eradicate one such species, *Undaria pinnatifida* (a large kelp), from Big Glory Bay on Stewart Island before it forever changes the underwater ecology of that area, and possibly moves on to Fiordland as well.

Government has, for some time, recognised the risk associated with organisms released into the marine environment from ballast water. It has been working towards the development of a strategy to manage these risks while recognising the engineering and safety constraints of international shipping.

This strategy recognises that essential shipping practices such as the discharge of ballast water and the de-fouling of ships' hulls create risks to the marine environment through the possible introduction or spread of potentially harmful species and diseases. It details current and new government actions, establishes a framework to allow for the co-ordination of central and local government response to the ballast water threat and acts as a guide for the further development of policy in this area.

As a further step in the management of biosecurity issues relating to ballast water discharge, this strategy has been developed co-operatively by government and organisations with a direct interest in minimising the risk of introducing new organisms into New Zealand waters. It also incorporates public input obtained from submissions on a public discussion paper.

Unlike other threats to our biosecurity, the impact of marine organisms carried in the 'moving cocktail' of ships' ballast water has gone largely unnoticed. The development of this strategy will provide the necessary focus for the ongoing management of this problem.

Hon John Luxton
Minister for Biosecurity

II. Introduction

Ships require ballast water for stability, steerage, safety, fuel efficiency and to limit hull stresses. Ballast water is normally taken on in one port, carried to another, then discharged as cargo is loaded onto the vessel. During de-ballasting, organisms from the point of uptake may be introduced into the port of discharge and subsequently become established. Marine organisms could also arrive in New Zealand on ships' hulls or external structures. These organisms could be dislodged or could liberate reproductive material into the marine environment. Exotic marine organisms may pose a risk to this country's natural marine ecosystems; commercial, recreational and customary fisheries; marine recreation and amenity; and human health.

This strategy describes how New Zealand will manage the risk of the introduction of exotic marine organisms by way of the discharge of ballast water or the de-fouling of ships' hulls. It has been prepared with input from the Ballast Water Advisory Group (BWAG), a group that includes people and organisations having a direct interest in the risk of the introduction of exotic marine organisms in the ballast water of ships. It also draws on submissions to a public discussion paper released in August 1996.

III. The Strategy

Desired Outcome

Government's desired outcome is that, to the maximum practical extent, New Zealand's territorial seas are kept free from the introduction of new harmful species and disease.

The Purpose of this Strategy

This strategy applies to:

- all discharges of ballast water in New Zealand territorial waters; and
- hull fouling/scraping from ships on slipways, dry docks and to all hull cleaning operations while anchored, moored or berthed.

This strategy will:

- detail current and new Government actions;
- co-ordinate actions at central government level, and provide a basis for co-ordination with local government;
- provide a reference document for research funders and providers;
- guide further policy development; and
- provide information about Government's intentions and actions for those involved in the shipping industry and other private sector stakeholders.

IV. Policy Framework

Policy Goals

The primary goal of this strategy is to, as far as is reasonably possible, avoid entry and establishment of exotic marine organisms in New Zealand from ship de-ballasting and hull de-fouling.

A supporting secondary goal is to help the development and implementation of the MARPOL Ballast Water Annex under the auspices of the International Maritime Organisation: Marine Environment Protection Committee within three years. If New Zealand were to impose strict controls and penalties unilaterally, shipping interests and trading partners could react in a way that undermines our objective of reducing biosecurity risk. International co-operation and agreement are therefore essential.

Principles

The principles that underlie this strategy are:

- controls must be environmentally acceptable, practicable to implement, and cost-effective compared with alternatives. Impacts on trade will be explicitly considered;
- ship and crew safety will not be compromised;
- implementing this strategy will not discriminate between New Zealand and foreign registered shipping;
- controls will be consistent, as far as possible, with any International Maritime Organisation (IMO) resolutions;
- regulatory controls will be enforced where they are supported by sound research and risk analysis, or where they can be justified on the grounds that they will prevent the introduction of specific organisms from specific ports; and
- there will be monitoring, continuous review, and education to encourage all reasonable measures to reduce the uptake and discharge of undesirable organisms.

Linkages

This strategy builds on:

- voluntary controls on the discharge of overseas ballast water within New Zealand and mandatory controls instituted re: Tasmania as a result of the establishment of the northern pacific seastar there;
- international negotiations on ballast water management; and
- provisions of the Biosecurity Act 1993, Resource Management Act 1991, and the New Zealand Coastal Policy Statement (NZCPS).

Policy Approach

New Zealand's preferred approach to all biosecurity risks is based on risk assessment. In this approach, risks from specific organisms are considered. These include the probability of entry and establishment and likely consequences if an organism becomes established. Considering these matters, a risk management response is developed.

This approach is widely accepted internationally as the accepted method of ensuring quarantine requirements are not used as a technical barrier to trade. New Zealand must be wary of imposing unjustified restrictions merely because organisms may enter by a particular pathway. At the same time, New Zealand will not hesitate to impose scientifically justified restrictions to protect the marine environment.

The policy approach needs to be based on sound scientific research. The Foundation for Research, Science and Technology has funded the Cawthron Institute to undertake risk assessment work on ballast water and investigate treatment options. Additional research will be funded through the Science Envelope and the Green Package in the 1997/98 Budget and administered by the Ministry of Fisheries.

V. The Biosecurity Risk from International Shipping

Numerous exotic marine species have already arrived and established in New Zealand. The full costs of these colonisations are not known, although some examples are cited below. Likewise, the risk of further marine species arriving in New Zealand has yet to be fully assessed. There is, however, ample evidence internationally that new species can cause serious impacts on natural marine ecosystems; commercial, recreational and customary fisheries; shipping; marine recreation and amenity; and human health.

Shipping is vitally important to an island nation such as New Zealand with more than 90% of imports and exports (by volume) travelling by sea. New Zealand's dependence on shipping must be taken into account when considering any proposals for risk management.

When ships are plying the seas empty or lightly laden, they require ballast water for stability, steerage, safety and fuel efficiency. Ballast water also limits hull stresses that can cause critical failures of ships' hull structures. The uptake, carriage and discharge of ballast water is essential to the operation of most vessels.

Ballast water is normally taken on in one port, carried to another and then discharged as cargo is loaded into the vessel. The quantity discharged maybe as much as 50,000 tonnes for a bulk carrier, or none at all in the case of some container vessels. During de-ballasting, organisms from the point of uptake may be introduced into the port of discharge and subsequently become established.

Besides introducing exotic organisms into New Zealand, vessels could transfer organisms from port to port within New Zealand. Once established in a port, some organisms could also spread to other areas by means of ocean currents.

Although modern antifouling paints are extremely effective, marine organisms could arrive in New Zealand on ships hulls or external structures. Fouling occurs on all vessels over time, especially in areas where the paint is damaged or difficult to apply. Organisms could be dislodged or liberate reproductive material into New Zealand's marine environment.

Hull fouling below the water line reduces ships' fuel economy. Where appearing above the waterline, it is regarded as unsightly. Consequently, hulls are sometimes scraped or cleaned while in port, increasing the risk of introduction of marine organisms.

Vessels are occasionally put into dry dock or slipways for maintenance. If scrapings are disposed of in the coastal marine area, exotic organisms or reproductive material may be released.

Possible Environmental Consequences

The potential impacts of the organisms contained in ballast water on the New Zealand marine environment are largely unknown. Evidence from Australia and around the world suggests that impacts could be very significant. Once established, exotic organisms are virtually impossible to eradicate.

Introduced organisms affect the balance of natural ecosystems and may displace some native species. The result may be a reduction in the overall diversity of species present. Loss of species may occur through loss of, or changes to, their habitat, competition for food or other resources, predation or behavioural impact on native species, or by introduction of parasites or disease organisms.

Introduced organisms may produce infestations such as reefs of shells or calcarious tubes or slimy growths that alter beaches, cover structures and block pipeline intakes and outfalls. Profuse organic material may result and can pile up on beaches to rot or turn lagoons eutrophic, causing noxious smells.

Introduced marine organisms could also have a significant impact on New Zealand fisheries. For example, the northern pacific seastar (*Asterias amurensis*, a type of starfish) is a voracious predator of bivalves. If introduced, it could cause losses to shellfish and aquaculture industries, exports of which are currently worth more than NZ$160 million (1995).

New Zealand's marine ecosystems have already been affected by introduced species such as the pacific oyster *(Crassostrea gigas)*, Asian date mussel *(Musculista senhousia)* and a type of lamarian kelp seaweed *(Undaria pinnatifida)*. These organisms may have arrived via ballast water or attached to vessels' hulls. They have displaced natural species and altered habitats to exclude naturally occurring species. The spread of *Undaria* and Asian date mussel invasions is presently being closely monitored.

In an extensive study of the Waitemata Harbour[1], the Auckland Museum found more than 60 new species of marine organism since a previous study in the 1950s. The Port of Tauranga has commissioned baseline studies. Other studies have been commissioned for particular terminals such as that for iron sands at Taharoa. Further systematic baseline biological inventory studies of New Zealand ports are necessary to learn what organisms are already present.

If a new organism is found in a port, it is currently impossible to determine how long it has been there or if it has been recently introduced via shipping operations. This strategy proposes that regional councils consider baseline biological inventory surveys to address this issue.

[1] B W Hayward, "Introduced Marine Organisms in New Zealand and Their Impact in the Waitemata Harbour, Auckland," in *Tane* 36 (1997).

Possible Economic, Social and Health Impacts

The possible establishment of exotic marine organisms represents a threat to commercial interests, recreational and amenity values, and public health. The commercial interests most directly at risk are fisheries, e.g. if the northern pacific seastar (*Asterias amurensis*) were to establish in New Zealand. The combined value of annual production of wild fisheries and aquaculture is estimated at NZ$1.363 billion (1995), some of which could be at risk from unwanted marine organisms.

For many New Zealanders, the country's harbours and coastlines, fishing, boating, water sports, or simply being in the outdoors, is a key part of their lifestyle. The pacific oyster has already affected these amenity values in the Auckland region where it has covered some beaches with sharp shell formations. In the Waitemata Harbour, authorities have attempted to crush the shells with rollers to return beaches to a more pleasant state.

As for possible public health effects, the cholera-causing bacterium *Vibrio* has been isolated from the ballast water of vessels in the United States. Toxic dinoflagellates (algae) can lead to human poisoning, e.g. via shellfish, although, there is no evidence that toxic algae that affected the New Zealand shellfish industry in recent years arrived via ballast water.

Impact on Maori

Exotic marine organisms can affect traditional Maori food gathering areas. For example, the Asian date mussel has displaced cockle beds in Waitemata Harbour and other harbours north of Auckland. Taking action to reduce potential risks to Maori food gathering areas is consistent with the Government's general obligations under the Treaty of Waitangi.

VI. Government's Strategy for Ballast Water and Hull De-fouling

Current Controls and Impetus for Change

A system of voluntary controls on the discharge of ballast water has been in place since March 1992. Vessels are requested to exchange ballast water in mid-ocean (away from coastal influences) *en route* to New Zealand and discharge only the exchanged water while in port. Controls are voluntary, i.e. there is no regulatory obligation to comply. However, where a specific biosecurity risk is identified, controls can be enforced. For example, following the discovery of the pacific seastar in Tasmania, the Ministry of Agriculture (MAF) imposed mandatory controls on discharge of ballast water from Tasmania. Controls on the discharge of sediment from overseas vessels are also mandatory. Sediment from the cleaning of holds, ballast tanks, or anchor chains can only be disposed of in a landfill approved by a New Zealand border official.

Compliance with the controls is monitored by MAF Quarantine Service officers as part of their routine vessel clearance duties. However, officers do not carry out detailed auditing of documentation, sample or analyse ballast water, or interview the master or crew. The rate of compliance has not been verified.

In June 1995 the Royal Society of New Zealand ran a symposium, "Ballast Water – A Marine Cocktail on the Move". The unanimous view of those attending was that New Zealand needs a co-ordinated policy on ballast water and hull fouling and that this should be achieved through a national strategy with clear objectives.

Since then, the Government has taken a number of steps.

Environment 2010, a statement of the Government's strategy for the environment, released in September 1995, sees "introduction of new harmful species and diseases, for example, through the discharge of ballast water from ships" as an environmental risk.

Action included "under the Resource Management Act, regulate the discharge of ballast water from vessels arriving from overseas". (Appendix II identifies relevant sections of legislation.)

In August 1996, the Government released a public discussion document – "Minimising the Risk of Introducing Exotic Marine Organisms into New Zealand via Ships' Operational Procedures."

At the same time the Government agreed to establish a consultative group of private and public sector interests, the Ballast Water Advisory Group (BWAG) to advise Government officials on the development of a strategy paper. The purpose of BWAG was to provide informed input to advice to Ministers on appropriate risk management policies. Such policies could include proposals to regulate shipping and involve a number of Government agencies.

Most recently, management of ballast water discharge is listed in the Coalition Government's agreement for environment policy – "Ensure adequate protections against undesirable species from ship ballast discharge."

To assess the risk posed by species arriving in ballast water and on ships' hulls, analysts require information about the species likely to arrive in ships and models to predict how these species might behave in New Zealand conditions. Research of this kind is still in its infancy. This was recognised in public submissions on the 1996 public discussion paper which overwhelmingly supported New Zealand adopting a precautionary approach until the risks were better understood.

New Measures to Reduce Biosecurity Risks from International Shipping

The risks posed by ballast water discharge and hull de-fouling could be managed under either the Resource Management Act 1991 (RMA) or the Biosecurity Act 1993. The Government has decided that ballast water should be managed under the Biosecurity Act. Controls on ballast water discharge are more appropriately applied at the national level. This ensures a consistent approach across the country and avoids undue costs on international shipping from different rules in different regions.

Central government agencies (especially the Ministry of Agriculture) have the expertise, staff resources and facilities to enforce and monitor ballast water controls on ships. Furthermore, control of ballast discharges from foreign ships is clearly possible under the Biosecurity Act but the situation under the RMA is unclear. RMA regulation-making powers relate to implementing international obligations, but currently no such international obligations exist for ballast water discharges.

A decision has yet to be taken on which legislation would be the most appropriate and effective to control hull de-fouling. It could potentially be addressed under the Biosecurity Act, or under the RMA using regional coastal plans or regulations. The Minister of Conservation, who has oversight responsibility for coastal management under the RMA, will be further investigating this issue with assistance from government departments (see "Measures to Address Ships' Hull De-fouling" below).

New Zealand's preferred approach to managing biosecurity risks is based on scientific risk assessment. For ballast water, however, a comprehensive risk assessment approach is currently not possible. The full range of organisms contained in ballast water is still to be determined. The probability of exotic marine organisms becoming established if released is unknown, as is the likely survival and spread of these organisms under New Zealand conditions and their likely impact on natural, cultural, commercial, and amenity values.

Where risks are unknown, all reasonable cautionary measures should be taken. New Zealand Authorities and ships' masters must assume that ballast water discharges may contain unwanted organisms. At a minimum, this means complying with existing voluntary guidelines (Appendix I), and the new import health standard when this is

promulgated[2]. New Zealand also expects mariners to consider other ways to reduce the uptake and discharge of undesirable organisms.

Ballast Water Discharge Strategy

In respect of ballast water discharge, the strategy comprises the following key elements:

- international advocacy;
- education;
- regulation;
- training;
- monitoring and research;
- research co-ordination; and
- further policy development.

[2] Import Health Standards are issued under the Biosecurity Act 1993. They describe the conditions that must, if an import of a specified kind is to be allowed, be met in the country of origin or export, during transit, during importation and quarantine, and after introduction.

International Advocacy

New Zealand intends to continue to press vigorously for ballast water controls or protocols through the International Maritime Organisation (IMO), drawing on support from Australia and the United States. With the United States, Canada and Australia, New Zealand has taken a leading role on these issues in the Ballast Water Working Group of the IMO's Marine Environment Protection Committee (MEPC). New Zealand has raised awareness of the risks and strongly advocated international regulation. Public submissions strongly supported the quest for international co-operation.

Actions: International Advocacy

1. New Zealand will press vigorously at MEPC for an international agreement to deal with ballast water. Meetings are held in London approximately every eight months.

Rationale
More than 95% of our sea-borne exports (by both weight and value) are carried by foreign-flagged vessels. A long-term, cost-effective solution, possibly involving modifications to ship design, on-board treatment and monitoring, cannot be achieved unless there is international support. International agreement will also promote compliance, as flag state controls can complement New Zealand's coastal and port state jurisdiction over foreign ships.

Benefits
Advocacy will ensure the international maritime community is aware of the issues and possible mitigation measures. Awareness will create additional international pressure to find a solution. Long term, an appropriate international agreement should provide more effective protection from unwanted organisms without imposing unreasonable costs on trade.

Time Frame	*Costs*
Three years	$24,000 (Ministry of Fisheries).

2. New Zealand will pursue alignment/harmonisation of compliance/enforcement with Australia. This will include both compliance and research matters.

New Zealand has recently sought and obtained observer status on the Australian Ballast Water Management Advisory Council and the Research Advisory Sub Group. This should ensure trans-Tasman alignment on compliance, research and international activities.

Rationale
New Zealand and Australia are already aligned over the issue internationally. There is a need to avoid duplication of effort in research and compliance/enforcement.

Benefits
This action should result in New Zealand having a stronger voice internationally, less duplication of work, lower research cost through collaboration and sharing of results, improved alignment under the agreement on Closer Economic Relations (CER), and greater recognition of the issue by mariners and shipping companies operating in the South Pacific.

Time Frame	*Costs*
Immediate	$5,000 – $10,000 per annum (Ministry of Fisheries).

Education

Educational material will be prepared in several languages for distribution to ships. It will outline ballast water risks from a New Zealand perspective and inform ships' officers how to comply with New Zealand requirements.

It is believed the vast majority of ships' officers are willing to comply with New Zealand requirements if these are well-defined, practicable, cost-effective, and reasonable opportunity is given to forward-plan ship operations.

Action: Education

Educational material will be produced for mariners, ships' agents, and ship owners. This may include videos, posters or brochures.

More study is required to ensure that, for particular target audiences, the most cost-effective media are used. An initial general distribution may be followed by more targeted, specific material as warranted by new information and the availability of funding.

Rationale
Any change to the current regime will require understanding and acceptance. Ways suggested to reduce risks must be practical. Avoiding uptake in shallow water or beside dredging, and regular flushing of tanks at sea to free them from sediment are methods that a master should consider.

Benefits
Ballast water risks will be reduced if masters understand the issue, and can adopt measures with reasonable ease.

Time Frame
Initial distribution by 1 June 1998.

Costs
Funding will be from the Ministry of Fisheries, with possible contribution from other agencies. The cost will be dependent on the nature of material distributed.

Regulation

An import health standard (IHS) under the Biosecurity Act 1993 (Appendix II) will be developed for ballast water. An IHS describes the conditions which must be met, in respect of biosecurity risk, before any "risk goods" can be brought into New Zealand. The IHS will be developed in consultation with the shipping industry and other stakeholders. It will outline New Zealand's requirements for ballast water discharge and options to satisfy an inspector. The desired outcome is that water that does not comply with this standard will not be discharged within New Zealand territorial waters.

An IHS provides the regulatory approach called for by most of the submissions on the 1996 public discussion paper. However, it is not intended to impose sanctions unless a specific organism present in a specified overseas port is considered a risk to New Zealand. These instances will be made known to mariners. Reasons for this approach to regulation include:

- Other countries may not accept that blanket regulation of ballast water discharge using an IHS is based on accepted risk assessment principles. Retaliatory action is possible. This implies a need for international agreement.
- The linchpin of any enforcement approach will be the ability to find out definitively if ballast water has been exchanged mid-ocean. Mid-ocean exchange and non-discharge is part of the present voluntary regime and 95% of ships claim to comply.
- New Zealand authorities may sample ballast water, and by the salinity and/or log book entries infer that a claimed mid-ocean exchange has never taken place. However, it seems reasonable that, before moves are made to prosecute, there would need to be a fair degree of certainty that, if an exchange had taken place, biosecurity risk would have been significantly reduced.
- Some scientific opinion questions the presumption that mid-ocean exchange reduces risk. As the monitoring database (see below) is built up, there will be greater certainty on this point. Meanwhile, good management practice should be encouraged rather than try to impose penalties for failure to comply. Controls are not yet fully supported by risk analysis. Penalties may engender a backlash from shipping interests and trading partners.

Action: Regulation

An import health standard (IHS) for ballast water will be developed under the Biosecurity Act 1993.

Rationale
The Biosecurity Act provides for issuance of an import health standard (IHS) for risk goods such as ballast water. Before an inspector can permit a ship to discharge ballast water it must meet relevant IHS requirements. The initial IHS will reflect current requirements for ballast water, but can be altered following future risk assessments, changing international regulations or advances in science and technology.

Benefits
This action will tighten and clarify legal requirements.

Time Frame	*Costs*
31 March 1998	Nominal (Ministry of Fisheries).

Training

Effective implementation of ballast water controls, including the import health standard to be promulgated, requires that border inspectors be kept up to date with current requirements, the ability of ships to comply, overseas developments and the latest information regarding biosecurity risks from international shipping.

The Ministry of Fisheries will develop a training programme for border inspectors of the MAF Quarantine Service and the Maritime Safety Authority and provide on-going training as required.

Action: Training

A comprehensive enforcement training package for officials carrying out ballast water compliance activities on vessels will be developed.

Rationale
Enforcement of ballast water policy is a new area and inspectors may be lacking the necessary skills. For example, Maritime Safety Authority Inspectors are not trained in quarantine work whilst Quarantine Inspectors are not technically skilled in ship design.

Benefits
The action should result in enhanced compliance, better trained inspectors, and a better chance of successful prosecutions.

Time Frame	*Costs*
To be determined.	To be determined.

Monitoring and Research

Most submitters on the 1996 public discussion paper accepted the need to monitor. Monitoring comprises both scientific monitoring of organisms and compliance monitoring by border authorities. Scientific monitoring will involve the analysis of ballast water whereas compliance monitoring may involve inspecting ships' logs and interviewing masters on arrival. Monitoring allows:

- a check on the accuracy of ships' reports;
- a means to decide the effectiveness of mid-ocean exchange;
- construction of a database that better identifies organisms that may be present in ballast water from differing ports of origin; and
- a means to decide whether risk correlates with type or class of ship, port of origin, or other unknown factors.

Monitoring should enable future refinement of the import health standard and a means of better targeting compliance efforts.

Additional research will be undertaken, to the extent funding allows, to improve management of biosecurity risks from international shipping. The Ministry of Fisheries will collaborate with the Australian Quarantine Inspection Service (AQIS) to determine research priorities and, where appropriate, may jointly sponsor research projects of benefit to both countries.

Action: Monitoring and Research

A programme will be designed and carried out to assess the rate of compliance with the voluntary guidelines (later, the import health standard). This may involve assessing the capability of ships to comply. Also, additional research will be undertaken to improve management of biosecurity risks from ballast water. The Ministry of Fisheries will seek to co-ordinate this work with research funded by the Foundation for Research, Science and Technology and other bodies.

Rationale
Sampling will help to identify the true rate of compliance with the existing guidelines (probably lower than the claimed rate) and how successfully the guidelines reduce risk. Analysis will allow better targeting of future efforts, (for example what type of education and enforcement packages are needed). Sampling may engender greater compliance.

Benefits
This action will allow an assessment of the effectiveness of current policies. It should result in greater compliance and better targeting of future policies and measures.

Time Frame	*Costs*
Ongoing.	Approximately $500,000 over three years (Ministry of Fisheries). Additional funding is currently provided by the Australian Quarantine and Inspection Service. See *Research Co-ordination* below.

Research Co-ordination

Research critically underpins the strategy in most areas. Current research is detailed in Appendix IV. Results of may lead to revisions of this strategy. For example, predictive modelling work and results of the compliance monitoring programme might allow New Zealand to focus border control procedures on particular classes of ships or particular ports of origin.

Topics for research include developing risk assessment models, assessing the effectiveness of mid-ocean exchanges, and assessing survival of organisms in ballast tanks. Other research to identify better shipping procedures and better targeting of compliance effort to ships that present the greatest risks is also required.

The major funder of ballast water research is the Foundation for Research Science and Technology. There are two major providers: the Cawthron Institute and the National Institute of Water and Atmospheric Research (NIWA). The Ministry of Fisheries will endeavour to co-ordinate research efforts by the various funders and providers involved.

Appendix III provides a summary of recent and current research in New Zealand on ballast water and the introduction of exotic marine organisms via international shipping.

Action: Research Co-ordination

National symposiums on ballast water issues will be held at least biennially. The symposiums will involve funders, providers and policy makers. The symposiums will be aimed at co-ordinating research efforts among various funders and providers, including those in Australia, wherever possible.

Research funders need to co-ordinate to improve synergies and prevent duplication. Research providers need to co-operate to optimise outputs for a given level of funding.

Rationale
Scientific research on ballast water is currently funded and provided by a number of organisations. Research priorities can be identified, prioritised, and discussed through focused workshops.

Benefits
This action should result in marine scientists of various disciplines and organisations directly sharing research directions, discussing research results, and identifying possible future needs, thereby improving co-ordination of research efforts.

Time Frame	*Costs*
First seminar Aug/Sept 1998 . Ministry of Fisheries	Seminar costs may be recovered as necessary.

Further Policy Development

There remains some concern that areas of high natural, amenity, commercial or cultural (including customary) value may need additional protection from ballast water discharges. The Ministry of Fisheries and the Department of Conservation will work together to examine this issue and consider the need for, and practicality of, additional measures.

Action: Further Policy Development

The need for stricter controls to protect marine areas of special significance will be investigated. There may be a need for controls on the discharge of ballast water picked up in other New Zealand ports. There may also be a need for controls on hull de-fouling for ships that have never left New Zealand waters.

Rationale
New Zealand may need domestic ballast water controls. It is possible that transfer of organisms throughout New Zealand via natural methods (for example currents or physical movements of organisms) would negate the efficacy of domestic controls. Some research into domestic transfer of ballast water is currently underway.

Some areas (for example Fiordland) are within national parks and are pristine. The Marlborough Sounds are used extensively for aquaculture. A higher degree of protection may be justified for these, and perhaps other, areas.

Benefits
Adequate protection for marine areas of special significance.

Time Frame	*Costs*
30 March 1999.	Funding issues are still to be addressed.

Ship's Hull De-fouling Strategy

Organisms attached to hulls of ships and smaller vessels can be liberated into marine ecosystems through:

- hull de-fouling while ships are berthed or anchored; and
- where de-fouling occurs in dry dock or on slipways, by disposal of the residues in the coastal marine area.

The Resource Management Act (RMA) and the Biosecurity Act provide possible mechanisms to reduce the risk of foreign organisms being released. As the Minister responsible for coastal management under the RMA, the Minister of Conservation will investigate the need and options for controls to reduce the biosecurity risks associated with hull de-fouling. Options for national action include:

- encouraging regional councils, either informally or through a formal submission process, to include provisions in their regional coastal plans (some councils have taken such steps already);
- enforcing existing provisions of the New Zealand Coastal Policy Statement (NZCPS) (refer Appendix II) for appropriate disposal of vessel maintenance residues using the Minister of Conservation's plan approval process;
- enforcing new controls through the NZCPS, regulation, or possibly through review of the NZCPS in some years time;
- formally requesting variations or changes to regional coastal plans; and
- enforcing controls using the Biosecurity Act.

Investigation of these options will include an analysis of whether regional coastal plans already address these issues. Investigation of the options may include the Department of Conservation, the Ministry of Fisheries, and the Ministry for the Environment, as well as consultation with regional councils.

Action: Policy Development
Government will investigate the need and options for policy on hull de-fouling. Current policies in regional coastal plans will be assessed. A document may be produced to guide regional councils on policy development for hull de-fouling and related issues, or other action may be taken using national regulations or controls under the Biosecurity Act.

Rationale
There is a need to ensure national coverage that is consistent across regional council areas.

Benefits
This action should achieve uniformity of approach to the issue.

Time Frame	*Costs*
28 February 1998	Nominal (DoC, MfE and MFish).

VII. Agency Roles in Strategy Implementation

The Ministry of Fisheries is the lead policy agency on ballast water discharge and hull fouling and cleaning. It will consult with other departments, regional councils, industry, non-government environmental organisations (NGO's) and other stakeholders.

Responsibility for implementation varies. The Ministry of Fisheries will be responsible for implementing ballast water discharge policy. The Quarantine Service of the Ministry of Agriculture provides front-line services, including checking of ships' logs and interviewing ships' masters, under an agreement with the Ministry of Fisheries. The Maritime Safety Authority (MSA) has responsibility for all aspects of ship safety. MSA advises other departments on the practicality of proposed measures, helps to promote awareness within the shipping industry, and its officers are available to assist MAF officials at ports if a question arises about ballast water discharge. The Department of Conservation and Ministry for the Environment will work with the Ministry of Fisheries to examine options for policy regarding hull de-fouling and cleaning, the disposal of hull scrapings to the marine environment, and possible protection for special marine areas. Regional councils have a part to play in surveillance and emergency response, though these roles need to be clarified.

No single agency will fund or co-ordinate all ballast water research. However, the Ministry of Fisheries will manage most of the dedicated funding for input to policy and will seek to co-ordinate research efforts between the various funders and providers involved.

VIII. Monitoring, Surveillance and Review

Monitoring of the Strategy

This strategy will be monitored to ensure that the desired outcome is achieved.

Compliance with the import health standard for ballast water will be monitored by:

- a sampling regime; and
- analysis of interview forms.

These results will be audited and circulated to key industry media for publication.

Sampling is also a way to obtain scientific information on the range of organisms likely to be contained in ballast water from particular ports and in water exchanged in mid-ocean. Results would be published by the researcher concerned.

The Ministry of Fisheries will monitor success of the education programme, awareness of issues among ship officers etc, using cross-analysis of interview results and sampling data from compliance monitoring.

Surveillance

Under the Resource Management Act, regional councils are responsible for monitoring their regional environments, including establishment of unwanted organisms. The Ministry of Fisheries and the Department of Conservation will be further examining current capabilities for surveillance (i.e. monitoring for presence of new unwanted organisms) and emergency response.

Action: Surveillance
Regional councils and the Department of Conservation will be asked to consider the need for standardised baseline biological inventories in ballast water receiving ports. A possible programme could include five ports per annum starting with ports that receive the most ballast. Several ports have already conducted such surveys.

Rationale
If an exotic organism is found, it may not be known whether it has been there for some time or whether it is a recent introduction via ships' operations.

Benefits
Improved ability to identify and determine the survival and spread of new organisms, as well as to react quickly to control or eradicate such organisms if warranted. Baseline surveys are also a prerequisite for predictive modelling.

Time Frame	*Costs*
To be considered	Funding issues still to be addressed.

Review of the Strategy

The suggested review date of the strategy is 30 June 2000. Both compliance monitoring and scientific monitoring will contribute information. At that time, the need for a regulatory approach to the discharge of all ballast water may be reassessed. A review will need to take into account new knowledge/risk assessments based on research findings; new international agreements and new technology (for example ballast water treatment).

The review may also consider whether there should be cost recovery from beneficiaries and/or shipping and related interests of the on-going costs, for example costs associated with compliance, monitoring and surveillance.

APPENDIX I. New Zealand Controls on Ballast Water

THE 1992 GUIDELINES

This Appendix contains:

- A copy of the "Voluntary Controls on the Discharge of Ballast Water Within New Zealand" as is distributed to ships' masters; and
- A marine notice issued by the Maritime Safety Authority in June 1997 providing guidance on the voluntary controls.

VOLUNTARY CONTROLS ON THE DISCHARGE OF OVERSEAS BALLAST WATER WITHIN NEW ZEALAND

NB: These guidelines are mandatory for any vessel that has taken on ballast water from Tasmania, Australia during a period beginning 1 July of each year and ending 31 January of the following year, and is still carrying such ballast water. Section 4 regarding disposal of sediment is mandatory for all vessels at all times. Mandatory compliance and enforcement of other controls will be introduced as research, technology and legislation allows.

Notes to the controls are in italics.

1. Ballast water which has been loaded within the territorial waters of a country other than New Zealand should not be discharged within New Zealand territorial waters without reporting to an Inspector prior to discharge.

   An Inspector means a Border Protection Officer employed by the Ministry of Agriculture and Fisheries.

2. Vessels requiring to discharge ballast within New Zealand should provide to an Inspector documented evidence of the origin of the ballast; and

   Documented evidence means an entry in a log book that identifies the location of the ballast aboard the vessel and the location where the ballast was taken on, either by latitude and longitude or naming the port if applicable.

2.1 Certification from a government or other approved agency that the water and seabed of the port at which the ballast was loaded has been tested within the previous 6 months and found to be free of toxic dinoflagellates; or

2.2 Documented evidence that the ballast water has been exchanged at sea on route to New Zealand; or

   An entry in a log book identifying the latitude and longitude where ballast exchange commenced and what ballast was exchanged. Where ballast exchange is carried out by using a flow through technique then the length of time the ballast pump/s were run and suitable proof of the pump's capacity.

   Where possible ballast water should be exchanged on route to New Zealand. Unlike coastal and estuarine waters that are rich in nutrients and life forms, the deep ocean and open seas contain few organisms. Organisms from shallow waters are not likely to survive in deep water and any deep water organisms taken on are unlikely to survive in shallow or estuarine waters. As the cysts of toxic dinoflagellates are more likely to be present in sediment, flushing out of ballast tanks which may be not be in use can be undertaken. Flushing out of ballast tanks which are not in use should be undertaken in open waters before entering port. Care should be taken to ensure that the anchor chain lockers are

kept free of sediment by washing sediment off at each port as the anchor is weighed.

2.3 Documented evidence that the ballast has been disinfected; or

There is no approved treatment of ballast as yet. MAF would consider any treatment proposed by a master or the shipping industry.

2.4 Have entered into a Ballast Water Compliance Agreement with the Ministry of Agriculture and Fisheries.

To be developed and implemented when controls are subject to mandatory compliance.

3. If the vessel cannot provide documented evidence of the origin of the ballast water or otherwise comply with the conditions of 2 above and requires to discharge ballast during loading in New Zealand then the master should report to an Inspector that it is intended to:

3.1 Discharge ballast in another area in New Zealand; or

No suitable areas have been identified as yet.

3.2 Discharge the ballast into an onshore facility; or

No onshore facility is approved as yet. It may be possible for certain vessels, eg tankers to discharge ballast into an existing onshore holding tank(s).

3.3 Treat the ballast; or

No commercial treatment of ballast has been approved by MAF as yet. However, if a vessel requiring ballast discharge was known to have ballast water containing toxic dinoflagellate organisms or had taken on ballast during an algal bloom and, because of any reason could not comply with any option in this section then the best treatment options at the time would be considered.

3.4 Allow a representative sample of ballast water to be taken for testing for the presence of toxic dinoflagellates (a nil result would allow ballast discharge in situ); or

This would entail a delay of several days while the tests were undertaken.

3.5 Discharge ballast in situ.

This option should only be considered in exceptional circumstances. Factors taken into consideration for assessing the risk of allowing discharge would be: the origins of the ballast, the reasons for requiring discharge, the salinity of the ballast water in relation to the area where ballast discharge is proposed, proximity to an aquaculture industry or area of shell fish gathering or the environmental sensitivity of the area. Any decision to discharge ballast in situ

should entail an initial pumping of ballast to another tank or area aboard the vessel to ensure that any sediment located at the base of the tank is removed before discharge the ballast into New Zealand water commenced. Only the minimum required amount of ballast should be discharged.

If the conditions in 3 are not acceptable then the vessel may proceed to sea as required for ballast discharge.

4. No sediment or mud from the cleaning of holds, ballast tanks, or anchor chain lockers may be landed (or discharged in the sea) in New Zealand without the permission of an Inspector.

Sediment or mud may be landed for disposal at any landfill approved by an Inspector.
NB. Section 4 will be enforced.

Compliance with these controls must be consistent with the safety of the crew and the vessel. Nothing in these controls is to be read as relieving masters of responsibility for the safety of the vessel.

Maritime Safety Authority Marine Notice, June 1997

GUIDANCE ON NEW ZEALAND'S BALLAST WATER VOLUNTARY CONTROLS

Exotic organisms may be carried in ballast water and in the sediments in ballast tanks aboard foreign going ships. If these organisms are discharged into coastal waters in New Zealand they may become established in the local environment. This could displace native species, damage the ecology and affect human health and the economy.

New Zealand currently has in place voluntary controls on discharge in New Zealand territorial waters of ballast water loaded in foreign waters. The controls, based on International Maritime Organisation recommendations are presently administered by the Ministry of Agriculture Quarantine Service under the Biosecurity Act 1993 and after 1 July 1997, by the Ministry of Fisheries under the same Act.

To minimise the risk of introducing exotic marine organisms into New Zealand via ballast water discharges, masters and officers of ships observing the voluntary controls are asked to take note of the following:

WHEN DISCHARGING BALLAST WATER

The best way to prevent exotic organisms from entering through ballast discharges is to avoid discharging ballast in New Zealand waters.

If ballast discharges cannot be avoided they should be limited to that required for safety and stability requirements and should follow this given order of preference –

a) ballast from deep ocean exchange;
b) ballast loaded in New Zealand waters;
c) ballast loaded in foreign open sea waters;
d) ballast loaded in foreign ports.

When carrying out deep ocean or open sea ballast exchange

Exchanging ballast water in deep ocean areas or open seas may minimise the risk of transferring exotic organisms into coastal waters. This is because deep ocean or open sea water contains fewer organisms than coastal or estuarine waters which are rich in nutrients and life forms. Coastal conditions, such as in a port, are less likely to favour those few organisms present in deep ocean or open sea waters.

Deep ocean ballast water exchanges are best carried out in water depths of 2000 metres or more well clear of coastal and estuarine influences. Where ships do not encounter water depths of 2000 metres, open sea exchange of ballast water should occur well clear of coastal and estuarine influences.

When emptying and refilling tanks to exchange ballast water

Each tank or hold should preferably be completely emptied (or until suction is lost) and then refilled.

Flushing of tanks for exchange of ballast water

Tank flushing is an alternative when it is not possible to empty and re-fill a tank. The effectiveness of a tank flush depends on the length of time that water is pumped through the tank.

When flushing a tank (pumping water into it while allowing it to overflow) the volume of water that must be pumped through to remove 95 % of the original water is about three times the tank's volume.

For example a 1000 tonne ballast tank being flushed through with a pump capacity of 1000 tonnes per hour would require 3 hours pumping.

Precautions

When emptying and refilling or flushing a tank or hold, ships must ensure safe procedures are followed including –

- stability must be maintained at all times in accordance with the ship's approved stability book, in particular with regard to free surface effect;

- longitudinal and other stress values must not exceed those permitted by the ship's approved loading manual;

- exchange of ballast in tanks where significant structural loads may be generated by sloshing action in the partially filled tank or hold, needs to be carried out in favourable sea and swell conditions such that the risk of structural damage is minimised.; and

- contingency plans should be in place for situations such as deteriorating weather conditions, pump failure and loss of power.

SEDIMENT

Many marine organisms are present in sediments.

In ballast water tanks

Sediment in ballast water tends to settle on the bottom of the tank and the top surfaces of any internal structure

When sediment settles at the bottom of a tank this may be close to the ballast outlet pipe. If a ship has not undertaken a deep ocean or open sea ballast water exchange, the discharge of a small quantity of ballast water in a safe location prior to entering a port should clear out any sediment likely to be discharged from around the outlet pipe and from the ballast pump sea chest.

However deep ocean or open sea water is likely to contain less suspended sediment, and therefore exchange of sea water (in accordance with the safety precautions mentioned above) is recommended to guard against a large build up of sediment in tanks.

On anchoring equipment

Care should be taken to ensure that the chain lockers are kept free of sediment by washing all sediment oil the anchor and cable each time the anchor is weighed.

APPENDIX II. New Zealand Legislation Relevant to Ballast Water and Hull De-fouling

This Appendix contains relevant sections from:

The Biosecurity Act 1993;
The New Zealand Coastal Policy Statement (NZCPS)

The following sections of the Resource Management Act 1991 may also be relevant:

s.15	*Discharge of contaminants into environment*
s.43	*National Environmental Standards*
ss 56-58	*New Zealand Coastal Policy Statement*
s. 360	*Regulations* (Empowers the Marine Pollution Regulations).

Extracts from the Biosecurity Act

Sect. 2. Interpretation

"Import health standard" means a statement approved under section 22 (1) of this Act by a chief technical officer of the conditions that must, if an import is to be made, be met in the country of origin or export, during transit, during importation and quarantine, and after introduction:

"Risk goods" means any organism, organic material, or other thing or substance, that (by reason of its nature or origin) it is reasonable to suspect to constitute, contain, or otherwise pose a risk that its presence in New Zealand will result in:

a) Exposure of organisms in New Zealand to damage, disease, loss, or harm; or
b) Interference with the diagnosis, management, or treatment, in New Zealand, of pests or unwanted organisms:

Sect. 19. Persons in Charge of Certain Craft to Obey Directions Of Inspector Or Authorised Person

(1) This section applies to a craft, and place in New Zealand, if:

(a) The craft arrives in New Zealand there; or

(b) The craft is carrying risk goods that it was carrying when it arrived in New Zealand at some other place.

(2) Where this section applies to a craft and place, the person in charge of the craft shall:

(a) Obey every reasonable direction given by an inspector as to:

(i) The movement of the craft in the place; or

(ii) The unloading or discharge of risk goods or the disembarkation of crew or passengers from the craft; or

(iii) Measures (including any bond required under section 18 (2) of this Act) to ensure that any risk goods not intended to be unloaded or discharged from the craft are maintained in a secure place under the control of that person; and

(b) Within the required time or times, deliver to an inspector a report, in such manner and form, and containing such particulars verified by declaration, and with such supporting documents, as may be required; and

(c) Answer all questions relating to the craft or its cargo, crew, passengers, stores, or voyage, asked by an inspector and every person disembarking from the craft shall, on request.

Sect. 26. Clearances

Subject to sections 27 and 28 of this Act, any inspector may give a clearance for the entry into New Zealand of any goods.

Sect. 27. Inspector to Be Satisfied of Certain Matters

An inspector shall not give a biosecurity clearance for any goods unless satisfied that the goods are not risk goods; or satisfied:

(a) That:

(i) There is in force an import health permit in respect of the goods (or goods of a kind or description to which the goods belong), and the goods comply with the requirements of that permit and the associated import health standard; or

(ii) The goods comply with the requirements of an exemption under section 24 of this Act; or

(iii) The goods comply with regulations made under this Act providing for the importation without an import health permit of goods of a kind or description to which those goods belong; and

(b) That there are no discrepancies in the documentation accompanying the goods (or between that documentation and those goods) that suggest that it may be unwise to rely on that documentation; and

(c) In the case of an organism, that the goods display no symptoms that may be a consequence of harbouring unwanted organisms; and

(d) That the goods display no signs of harbouring organisms that may be unwanted organisms; and

(e) There has been no recent change in circumstances, or in the state of knowledge, that makes it unwise to issue a clearance.

Sect. 33. Risk Goods on Board Craft

(1) Where there are any risk goods on board a craft that has entered New Zealand territory from outside New Zealand territory, an inspector may direct the master or other person in charge of the craft to take (as the master or person thinks fit) one of the following steps:

(a) Deal with the goods in a manner specified by the inspector while the craft is in New Zealand territory; or

(b) Move the craft outside New Zealand territory (immediately, or within a period specified by the inspector); or

(c) Destroy the goods in a place and manner approved by the inspector for the purpose.

(2) Subject to subsection (3) of this section, where the master or person in charge of a craft fails or refuses to comply with a direction under subsection (1) of this section, any inspector may:

(a) Direct the master or other person in charge of the craft to move the craft outside New Zealand territory (immediately, or within a period specified by the inspector); or

(b) Seize and destroy the risk goods concerned.

(3) Where:

(a) An inspector gives a direction under subsection (1) of this section in respect of goods of a particular kind or description on board a craft of a particular kind or description; and

(b) There are for the time being in force under this Act regulations prescribing the manner in which risk goods of that kind or description should be dealt with while on board a craft of that kind or description, compliance with those regulations shall be deemed to be a sufficient compliance with the direction.

(4) Nothing in this section limits or affects the generality of section 32 of this Act.

The New Zealand Coastal Policy Statement

Policies that apply are:

Policy 1.1.1
It is a national priority to preserve the natural character of the coastal environment by...taking into account the potential effects of ...use...on the values relating to the natural character of the coastal environment, both within and outside the immediate location...

Policy 1.1.2
It is a national priority for the preservation of the natural character of the coastal environment to protect areas of significant indigenous vegetation and significant habitats of indigenous fauna in that environment by...avoiding any actual or potential adverse effects of activities on the following areas or habitats:

- *areas and habitats important to the continued survival of any indigenous species;*
- *areas containing nationally vulnerable species or nationally outstanding examples of indigenous community types.*

Policy 1.1.4
It is a national priority for the preservation of natural character of the coastal environment to protect the integrity, functioning, and resilience of the coastal environment in terms of...natural biodiversity, productivity and biotic patterns and intrinsic values of ecosystems.

Policy 2.1.2
Protection of the characteristics of the coastal environment of special value to the tangata whenua should be carried out in accordance with tikanga Maori.

Policy 3.1.1
Use of the coast by the public should not be allowed to have significant adverse effects on the coastal environment, amenity values, nor on the safety of the public nor on the enjoyment of the coast by the public.

Policy 3.3.1
Because there is a relative lack of understanding about coastal processes and the effects of activities on coastal processes, a precautionary approach should be adopted towards proposed activities, particularly those whose effects are as yet unknown or little understood. The provisions of the (RMA) Act which authorise the classification of activities into those that are permitted, controlled, discretionary, non-complying or prohibited allow for that approach.

Policy 5.1.3
Rules (on water quality) *should also provide that, after reasonable mixing, no discharge... may give rise to any significant adverse effects on habitats, feeding grounds or ecosystems.*

Policy 5.2.1
Provision should be made (in RMA plans)... *for the provision of facilities for the collection and appropriate disposal of the residues from vessel maintenance.*

APPENDIX III. New Zealand Research on Ballast Water and Marine Adventives

This Appendix summarises recent and current research in New Zealand on the introduction of exotic marine organisms. Table A3.1 lists research details by research provider for individual projects. Table A3.2 lists research by topic, and refers to the projects in Table A3.1. Information on port studies is still being collected.

Table A3.1. Research Information by Project and Research Provider.

	Project Information	**Objectives, Reports/Publications**
1. Project Title	Impacts and sources of introduced species in NZ harbours.	Obj 1. Develop risk assessment model to predict viability and impact of introduced species.
Organisation	Cawthron Institute	Obj 2. Describe spread and impact of introduced organisms (to contribute to Objective 1).
Lead Scientist	C Hay	
Duration	July 1996 to June 1998	Obj 3. Quantify and identify transport of marine organisms from Australia.
Funding amt	$396,000 (total for 2 yrs)	**Reports & Publications:**
Funding source	FRST	
2. Project Title	Foreign organisms entering NZ coastal waters via ships' ballast.	Obj 1. Develop standard method of sampling ballast water.
Organisation	Cawthron Institute	Obj 2. Collection and analysis of ballast water samples.
Lead Scientist	C Hay	
Duration	October 1995 to October 1997	Obj 3. Preliminary analysis of risk posed by organisms found in samples, incl estimates of efficacy of purported mid-ocean exchanges, based on current sample analysis.
Funding amt	$369,000 (total for 2 yrs)	
		Reports & Publications:
Funding source	MAF (Vote: Research)	Final project report to MAF (Oct 1997).

3. Project Title	Ballast Water Treatment	
Organisation	Cawthron Institute	Obj 1. Test BW treatment procedures, including one shipboard experiment based on oxygen removal or heating.
Lead Scientist	D Mountfort	
Duration	July 1996 to June 1998	
Funding amt	$270,000 (total for 2 yrs)	**Reports & Publications:**
Funding source	FRST	
4. Project Title	Introduced marine organisms in Waitemata Harbour	Obj 1. List and describe known new marine organisms in NZ and how they have been introduced.
Organisation	Auckland Museum	Obj 2. Describe impacts of introduced organisms, esp re Waitemata Harbour.
Lead Scientist	B Hayward	
Duration	completed 1997	
Funding amt	n/a	**Reports & Publications:**
Funding source	n/a	"Introduced marine organisms in New Zealand and their impact in the Waitemata Harbour, Auckland," in *Tane* 36 (1997).
5. Project Title	Ecology and environmental impact of introduced Asian date mussels	Obj 1. Document reproductive cycle & life history of Asian date mussel.
Organisation	Auckland University/ Uniservices	Obj 2. Investigate ecology & dynamics of mussel beds.
Lead Scientist	R.G. Creese	
Duration	July 1995 to July 1998	Obj 3. Investigate mechanisms of spread within New Zealand.
Funding amt	$33,875 (total for 3 yrs)	Obj 4. Determine short- and long-term impacts of Asian date mussels.
Funding source	Dept of Conservation	**Reports & Publications:** Final report to DoC (Nov, 1996) MSc thesis by Wharton 1997. Paper in NZ J Mar. & Freshwater Res. vol 31 (1997); preliminary results.

6. Project Title	Molecular probes for toxic phytoplankton	Obj 1. Develop diagnostic probes for algae.
Organisation	Auckland University	Obj 2. Design field deployable testing equipment.
Lead Scientist	P Berquist	
Duration	June 1994 to July 1998	Obj 3. Extend technology developed for algae to other organisms, e.g. Asterias, Sabella.
Funding amt	$550,000 (total for 4 yrs)	**Reports & Publications:**
Funding source	FRST	Tyrrell J.V., Bergquist P.R., Gray R.D., MacKenzie L., & Bergquist P.L., 1996, "Phylogeny of the Raphidophytes Heterosigma carterae and Chatonella antiqua using "V4" Domain SSU rDNA", Syst. & Ecology. vol 24, No 3: 221-235 & other publications.
7. Project Title	Crab-like Crustacea in NZ	Obj 1. Maintain an inventory of native and introduced crab-like crustacea in NZ.
Organisation	Univ of Canterbury, Dept of Zoology	
Lead Scientist	C McLay	
Duration	continuing	**Reports & Publications:**
Funding amt		"Brachyura and Crab-like Anomura of NZ" Leigh Lab Bulletin No. 22, 1988.
Funding source	internal funding	
8. Project Title	Biosystematic Research	Obj 1. Identifying biodiversity of NZ and the presence of adventive species, through analysis of specimens, particularly marine algae and marine invertebrates.
Organisation	Museum of New Zealand (Te Papa Tongarewa)	
Lead Scientists	W Nelson, N Adams et al	**Reports & Publications:**
Duration	on-going	Adams, N M. 1983. "Checklist of marine algae possibly naturalised in NZ", NZ Journal of Botany. vol 21, p 1-2.
Funding amt	not specifically identified	Nelson, WA and Maggs, CA, 1996. "Records of adventive marine algae in NZ….." NZ Journal of Marine and Freshwater Research. vol 30, pp 449-453.
Funding source	Internal	

9. Project Title	Introduction of exotic marine organisms by shipping	Obj 1. Determine risk associated with the introduction of marine organisms on hulls of vessels
Organisation	NIWA	Obj 2. Analysis of data on Vessel Ballast Report Forms on ballasted ship movements in NZ
Lead Scientist	B. Hayden	
Duration	October 1996 to October 1998	Obj 3. Assess risk of organisms surviving in ballast tanks (trans-Tasman and USA voyages). Includes some evaluation of efficacy of mid-ocean exchange
Funding amt	$160,000 NSOF (total for 2 years) + unspecified commercial contribution	Obj 4. Determine likelihood of transfer of marine organisms by ocean currents in NZ region
Funding source	FRST (NSOF), MSA, MFish, DoC, port companies, NZ Shipping Fed., NZ Assoc. of Shipping Agents	**Reports & Publications:** Stanton, B. 1997. The likelihood of transfer of marine organisms by ocean currents in the NZ region. NIWA Client Report CHC97/52
10. Project Title	Impacts and dispersion of introduced Asian alga *Undaria pinnatifida*	Obj 1. Determine patterns of dispersion of *U. pinnatifida* in Wellington Harbour and Queen Charlotte Sound
Organisation	NIWA	Obj 2. Determine impact of *U. pinnatifida* on understorey communities in Wellington Harbour and Queen Charlotte Sound
Lead Scientist	K. Miller	
Duration	July 1996 to June 1998	
Funding amt	$122,000 (total for 2 yrs)	**Reports & Publications:**
Funding source	FRST (NSOF)	Miller, K; Cole, R.; Battershill, C. 1997. The spread of the introduced Asian alga, *Undaria*, in New Zealand waters. *Water & Atmosphere*, 5(2): 8-9
11. Project Title	Biosystematics	Obj 1. To Identify all marine fouling Bryozoa in N.Z. ports and harbours
Organisation	NIWA	Obj 2. Evaluate marine foulers by origin
Lead Scientist	D. Gordon	
Duration	until 1992	Obj 3. To produce an identification key
Funding amt	An unknown proportion of Marine Biosystematics programme	
Funding source	FRST	**Reports & Publications:** Gordon, D.P.; Mawatari, S.F. 1992. Atlas of marine-fouling Bryozoa of NZ ports and harbours. *Miscellaneous Publications, New Zealand Oceanographic Institute*, 107:1-52.

Table A3.2. Summary of Research by Topic

Topic	Project and Objective
Ship and ballast movements to NZ	Cawthron: Project 1, Obj 3 NIWA: Project 9, Obj 2
Inventory and biology of adventives present in NZ	Auckland Museum: Project 4, Obj 1 NIWA: Project 11, Obj 1-3 Cawthron: Project 1, Obj 1 Auckland Univ: Project 5, Obj 1 Cawthron, NIWA & universities: port surveys Canterbury Univ: Project 7, Obj 1
Inventory of potential adventives	Cawthron: Project 1, Obj 1 NIWA: Project 9, Obj 1 NIWA: Project 11, Obj 1
Methodology for sampling ballast water	Cawthron: Project 2, Obj 1 Auckland Univ: Project 6, Obj 1,2&3 NIWA: Project 9, Obj 3
Organisms present in ballast water discharged in NZ	Cawthron: Project 2, Obj 2
Organisms found on ships' hulls	Cawthron: Project 1, Obj 1 NIWA: Project 9, Obj 1 NIWA: Project 11, Obj 1
Impact of marine adventives	Auckland Museum: Project 4, Obj 2 Cawthron: Project 1, Obj 2 Auckland Univ: Project 5, Obj 4 NIWA: Project 10, Obj 2 NIWA: Project 11, Obj 1 & 2
Vulnerability of NZ habitat to adventives	Cawthron: Project 1, Obj 1&2 NIWA: Project 10, Obj 1 NIWA: Project 11, Obj 1 Cawthron: Project 2, Obj 3 Auckland Univ: Project 5, Obj 2&3 Dept of Conservation: Bio-geographical studies Some port studies contain relevant information
Translocation and invasion process	Cawthron: Project 1, Obj 1 NIWA: Project 9, Obj 3 & 4 NIWA: Project 10, Obj 1
Ballast Water Treatment Options	Cawthron: Project 3, Obj 1
Effectiveness of mid-ocean exchange	Cawthron: Project 2, Obj 3 NIWA: Project 9, Obj 3