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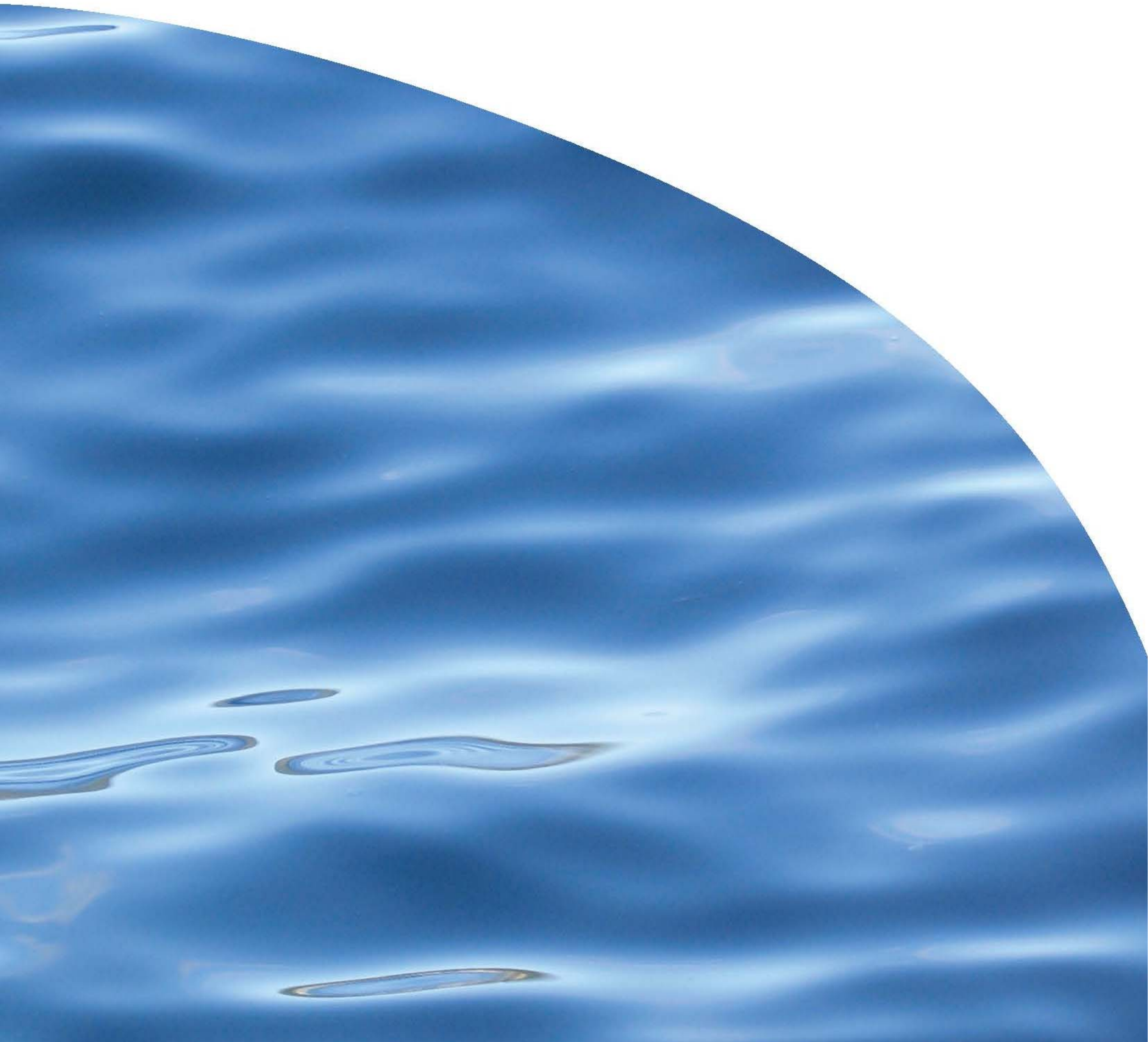
MANAGING THE DOMESTIC SPREAD OF HARMFUL MARINE ORGANISMS, PART B: STATUTORY FRAMEWORK AND ANALYSIS OF OPTIONS



MANAGING THE DOMESTIC SPREAD OF HARMFUL MARINE ORGANISMS, PART B: STATUTORY FRAMEWORK AND ANALYSIS OF OPTIONS

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Prepared for Ministry for Primary Industries (MPI) Preparedness and Partnerships Directorate

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EXECUTIVE SUMMARY

Amendments to the Biosecurity Act 1993 (BSA) in November 2012 created more scope for measures to manage the spread of harmful marine organisms in New Zealand. The Ministry for Primary Industries (MPI) commissioned the National Institute of Water and Atmospheric Research (NIWA) and the Cawthron Institute (Cawthron) to undertake a review of practical measures for reducing the spread of potentially harmful marine organisms via human transport pathways within New Zealand, and policy options for promoting the implementation of risk reduction measures.

During two workshops held in Wellington in 2013, representatives of the aquaculture, commercial fishing, marine transport, mining and exploration, research and education, and sport and recreation pathways were invited to identify and discuss risk reduction options and potential barriers to their implementation. The aim was to engage industry, government, tangata whenua, councils, and other stakeholders in the development of a recommended package of measures and policies for reducing the domestic spread of marine pests within New Zealand.

The project resulted in two reports. A companion report (hereafter referred to as the ‘Part A report’) describes the nature of the biosecurity risk in six sectoral pathways, including how harmful species can be spread within each pathway (‘modes of infection’, Table 1), and identifies practical measures that could be taken to reduce this risk. This report assesses policy options and presents recommendations for six different modes of infection across the pathways. This Executive Summary provides an overview of both reports and follows the structure of Part A, presenting findings by sector, whereas the main body of this Part B report presents findings by mode of infection.

Table 1. Modes of infection by sector pathway. (√= mode of infection applies to most activities in the sector. * = mode of infection applies to relatively few activities in the sector.)

Mode of infection	Maritime transport[1]	Mining & exploration	Commercial fishing	Aqua-culture	Recreation & sport[2]	Research & education
	Sector pathway					
Ballast water	√	√	*			*
Bilge[3]	√	√	√	√	√	√
Hull fouling	√	√	√	√	√	√
Gear	*	√	√	√	√	√
Livestock[4] & bait			*	√	*	*
Structures[5]	√	√	√	√	√	√

[1]Includes merchant ships, barges, cruise ships, ferries and water taxis
[2]Includes customary and recreational fishing
[3]Includes water retained on deck
[4]Includes harvested fish and other organisms that may be dead
[5]Includes moveable structures such as marine farms and swing moorings.

Each option is assessed for its effectiveness, feasibility, cost and likely rate of uptake. Given the breadth of this report and the available budget, these assessments are based on limited information and should be seen as preliminary only. In many cases, the performance of a measure on any one of these criteria is likely to vary considerably across different sectors. Further investigation and consultation is therefore recommended prior to implementing such measures.

Biosecurity management is most cost-effective when it aims to reduce the risk of spread at scales greater than what organisms could achieve by natural spread within, for example, a 5-year time-frame. This project aims to address risk primarily at an inter-regional scale, but also to inform risk management measures at a more local level. Although regional council boundaries have little or no ecological significance in the coastal marine environment, they can in some cases provide useful boundaries for implementation of biosecurity measures.

The biosecurity regime in New Zealand is governed primarily by the Biosecurity Act 1993. Under that Act, pest management plans, pathway management plans, controlled area restrictions and unwanted organism declarations are among the tools available to central and regional governments to manage the spread of harmful marine organisms. The Resource Management Act 1991, and associated regulations and policy statements, also provides authority for measures, especially with regard to discharges to the coastal marine environment, that can be used to manage marine pests. Subject to further legal analysis, it appears that existing legislation provides sufficient statutory authority for all of the regulatory measures contemplated in this report. Such measures must still, of course, be justified under the criteria and processes set out in the relevant legislation.

Maritime transport pathway

The maritime transport pathway involves the domestic movement of cargo and people by New Zealand-registered and foreign merchant shipping. It also includes movement within New Zealand of passenger vessels, slow-moving barges, dredges and other non-trading commercial vessels (e.g., tugs, tenders, pilot vessels, cargo barges, marine safety vessels, ferries, etc). Transport of harmful marine organisms by maritime shipping can occur through uptake in ballast water, as biofouling attached to submerged surfaces of the vessels, in bilge or seawater used for ship-board operations, as contaminants picked up unintentionally during retrieval of maritime equipment (e.g., anchors, chains, mooring ropes, etc) and as contaminants picked up unintentionally in material removed from the seabed (e.g., dredge spoil).

Ballast water

Options for treating ballast water include exchange of coastal ballast water for low risk mid-ocean water, ship-board installation of approved ballast water treatment systems or direct chemical treatment prior to discharge. While exchanging a vessel's ballast water mid-ocean is required of international vessels to reduce the risk of transporting unwanted organisms to New Zealand, it is only partially effective and is not practical on most voyages within New Zealand due to their short duration. Treatment of ballast water has been endorsed by the International Maritime Organisation (IMO) as the best option for international shipping in the medium to longer term. For managing domestic spread within New Zealand, requiring vessels to retrofit with ballast water treatment facilities to meet the IMO standard would be costly and difficult to justify prior to international implementation (*i.e.* entry into force of the IMO standard). Such a requirement could be initiated some time subsequent to international implementation (*e.g.*, after a further five years to allow more time for adapting the existing fleet).

Another option would be for New Zealand to require treatment but to a lesser standard if, for example, considerable risk reduction can still be achieved but at much lower cost. Further investigation and consultation with the relevant sectors is required to assess the costs of ballast water treatment options and the degree of risk reduction that could be achieved. These factors will largely determine the degree of uptake by domestic shipping and therefore the risk reduction that would be achieved by such an approach.

Bilge water

Options for managing risks from bilge water include discharge and emptying of water before departing from a location, retention and storage of water for discharge to shore-based treatment, installation of an approved filtration system, regular flushing with freshwater or an approved treatment as a preventative measure, or treatment of water spaces with an approved treatment. In general, the most practical and cost-effective risk reduction measure is for vessels to discharge all non-oily bilge and retained seawater in the area where it was taken on-board, and to wash down all deck areas (with freshwater if possible), prior to departure for other areas. The use of chemical treatments may also be appropriate where approved by the relevant authorities. It would be impractical to regulate the discharge and/or treatment of bilge, but good management practice should be promoted through codes of practice (CoPs).

Given the perception amongst some boat operators that bilge poses little or no biosecurity risk, and only limited evidence to prove otherwise, compliance with any bilge water measures might be low and non-compliance difficult to verify. To achieve a high uptake, therefore, measures to manage bilge would need to be simple and practical and be widely communicated. Research is needed to quantify the biosecurity risk from bilge water and to determine the efficacy of current treatment systems (*e.g.*, oil-water separators, in-line filters) for mitigating risk.

Vessel biofouling

Biofouling risk can be mitigated through appropriate use and maintenance of antifouling coatings that are suited to a vessel's operational profile and by regular inspection and removal of biofouling in ship-yard facilities or by in-water cleaning. The limited capacity of ship-yard facilities in New Zealand and current legal restrictions mean that neither haul-out nor in-water cleaning is practical for most merchant shipping in the short-term. The proposed introduction of a Craft Risk Management Standard (CRMS) for international shipping, consistent with IMO guidelines for biofouling management, will encourage foreign-flagged commercial vessels to develop and maintain an auditable biofouling management plan (BMP) that details how biofouling is being managed. Similar requirements should be considered for domestic shipping.

Recent guidance recommends that in-water cleaning be allowed for vessels that have local biofouling at a level of fouling (LOF) ≤ 3 and biocide-free anti-fouling systems. Another option would be to allow in-water cleaning in designated areas with containment of biofouling waste. We recommend that MPI obtain legal advice on whether it would be necessary to amend the Marine Pollution Regulations to enable regional councils to authorise in-water cleaning in some circumstances, as recent court decisions have cast some doubt on this.

Movement controls should be considered for vessels with very high levels of fouling, particularly if they are seeking to visit high value areas. We recommend starting with movement restrictions on vessels with LOF ≥ 4 (*i.e.* greater than 15% of hull area fouled) and signalling an intention to move to controls on vessels with LOF ≥ 3 in the future. Commercial vessels with LOF > 4 are most likely to have been inactive for some time and are being relocated to undertake specific projects (*e.g.*, barges, dredges, *etc*) or for cheaper berthage fees (*e.g.* derelict or decommissioned vessels). In these instances, movement controls or requirements for cleaning may be implemented through resource consents or as a condition of anchorage.

Dredging and dredge material

Consents to undertake dredging programmes should require Assessments of the Environmental Effects (AEEs) to consider the biosecurity risks of the activity. Approved consents should include measures to mitigate the risk of spreading harmful organisms in biofouling and seawater carried by dredges and hopper barges, and in dredged material.

Mining and exploration pathway

The mining and exploration pathway includes activities involved in prospecting for and extracting petroleum (oil and gas) and minerals from within New Zealand's Territorial Sea, Exclusive Economic Zone and Extended Continental Shelf. Offshore exploration and production involves a range of vessel types and equipment that is used at different stages in the development life-cycle of a field.

The mining and exploration pathway includes activities involved in prospecting for and extracting petroleum (oil and gas) and minerals from within New Zealand's Territorial Sea, Exclusive Economic Zone and Extended Continental Shelf. Offshore exploration and production involves a range of vessel types and equipment that is used at different stages in the development life-cycle of a field. Harmful organisms can potentially be spread as biofouling attached to wetted surfaces of vessels, Mobile Offshore Drilling Units (MODUs) and production platforms, as biofouling attached to immersed equipment, through uptake in ballast water and seawater used for other ship-board operations (e.g. bilges, cooling water, etc), through uptake in seawater used to slurry dredged material, as contaminants on maritime equipment (e.g. seismic streamers, side-scan sonar, magnetometers, ROVs, etc), and as contaminants picked up unintentionally in material removed from the seabed (e.g. dredged material, corers, traps, ROVs, benthic sleds, *etc)*.

International best-practice in the offshore oil and gas industry is now to consider biosecurity risks at an early stage of project planning and to build mitigation strategies into the overall Environmental Management Plan (EMP) for the life-cycle of the project. This would include development of Standard Operating Procedures (SoP) for: (i) managing ballast water, bilge, biofouling and contaminants on vessels (see the measures described above for Merchant shipping) and equipment, (ii) for relocation of plant and equipment, and (iii) for decommissioning fields. Practical options for decontaminating plant and equipment include high pressure water blasting, washing and air drying.

There are few feasible options within New Zealand to treat MODUs and large drill ships that arrive clean but become fouled after working for several weeks or months in one location. Any general policy should allow for users to comply through equivalent risk reduction measures, for example through MPI approval of a BMP that achieves an appropriate level of protection prior to movement. Such a plan could provide for inspection and assessment of fouling communities prior to movement within New Zealand, though the question remains what could be done if an inspection were to find marine organisms not established in the destination region.

Commercial fishing

The commercial fishing pathway includes more than 1,500 registered commercial vessels in New Zealand that target inshore stocks of finfish, shellfish and seaweed, deep water and middle-depth stocks of finfish and invertebrates, or highly migratory species such as tuna. Commercial fishing can potentially spread harmful marine organisms through uptake in ballast water and other seawater used for ship-board operations, in vessel biofouling or as biofouling attached to immersed equipment, as contaminants on fishing equipment (e.g., nets, chains, pots, etc), through movement of livestock and bait (e.g., holding pens, bait wells, etc), as contaminants picked up unintentionally from the seabed (e.g., benthic trawls), through deliberate movement of live catch of harmful organisms, as contaminants associated with the movement of live catch and associated equipment, and as waste discharged from processing facilities.

Biofouling risk can be mitigated through appropriate use and maintenance of antifouling coatings that are suited to the vessel's operational profile and by regular inspection and removal of biofouling in ship-yard facilities. Consideration should be given to development and maintenance of an auditable BMP for fishing vessels and to an industry Code of Practice that details SoPs for managing risks from bilge water, biofouling and contaminants on fishing equipment and for movement of livestock and bait. Practical options for decontaminating equipment include streaming of nets prior to relocation, water blasting, washing and air drying. Industry training in the CoPs and independent audit will encourage greater uptake of best-practice within the sector.

Aquaculture

The aquaculture pathway includes activities involved in the capture, breeding, hatching, cultivating, rearing, and on-growing of marine organisms in coastal environments. Marine aquaculture can contribute to the spread of harmful marine organisms by providing artificial habitat on which populations develop, by transporting biofouling on vessels or mobile equipment (e.g., spat catching gear, buoys, ropes, anchors, mooring blocks, finfish cages, etc), through uptake in seawater on vessels, as contaminants on marine equipment (e.g., anchors, chains, mooring ropes, etc), through deliberate movement of spat/seed stock or adult product, as contaminants associated with the movement of spat/seed stock and associated equipment, and as waste discharged from processing facilities.
Internationally, measures introduced to reduce biosecurity risk within the aquaculture sector have involved the development of industry Codes of Practice (CoP) to complement official regulation of activities. These should cover the range of industry operations and can include procedures for appropriate harvesting and transfer of livestock, cleaning and disinfection of vessels, cages, and other farming equipment, treatment of diving equipment, managing biofouling on vessels and equipment, preventing escape of livestock, and managing waste from processing. Practical tools for each of these operations are discussed in Section 6 of the Part A report.

Sterilisation of equipment might not be feasible for some marine farming activities (*e.g.*, movement of large salmon cages and transfer of mussel spat on frames). Further consideration and consultation with industry is necessary to identify a workable approach. Improved record-keeping of stock and equipment transfers would improve the ability to manage pest outbreaks and could also provide product traceability, which industry could promote in its marketing materials. Industry training in the CoPs and independent audit will encourage greater uptake of best-practice procedures for reducing risk.

A requirement for biosecurity certification of hatcheries and wild spat could be justified because of potential to spread harmful organisms quickly to multiple locations. The practical feasibility and cost would depend on the nature of the measures, which require further investigation.

Recreation and sport

The recreation and sport pathway includes an estimated 600,000 private vessels, comprising trailered power and sailing boats, kayaks and canoes, jet-skis, motor launches and keeled boats. Harmful marine organisms can potentially be spread in seawater taken on board the vessels in bilges, catch or bait holding tanks, as contaminants entangled on the vessel or trailer or in biofouling growing on the submerged surfaces of vessels. Other associated equipment including anchors and chains, moorings, fishing gear, live bait, and diving equipment, can also transport marine species. Fixed structures such as wharves, marinas, and jetties, can also play an important role in the spread of marine organisms by providing artificial substrata for the growth of harmful biofouling organisms that can then reproduce and infect moving vectors.

Trailered recreational vessels
Simple measures are available to reduce risks from trailered vessels, including inspection, cleaning and drying of the vessel, trailer and equipment after each journey or trip, removing attached biofouling or entangled organisms and rinsing and drying hull compartments. Uptake of these practices could be encouraged through greater availability of wash-down facilities, and targeted education/awareness campaigns.

Non-trailered recreational vessels
To manage risks from passive biofouling on vessels (*i.e.* the discharge of larvae or viable organic material not caused by cleaning), five complementary measures could be implemented:

- provide education and/or incentives for use and maintenance of antifouling coatings that are suited to the vessel's activity
- encourage regular cleaning of vessels in approved shore-based facilities, particularly prior to movement to another region

- require vessel operators to follow an approved BMP (as recommended by the IMO)
- require vessel operators to notify authorities in advance of intentions to visit specified high value areas, some of which could require approval and possibly an inspection
- impose movement controls on vessels that exceed a threshold LOF unless they can demonstrate compliance with an approved BMP.

Given that there is currently no registration or licensing requirement for non-commercial vessels, there would be significant agency costs in establishing and maintaining a vessel register and a record of approved BMPs, as well as monitoring compliance and taking enforcement action. The measure could also encounter substantial public opposition, undermining the rate of uptake.

Movement controls on boats with LOF ≥ 3 (*i.e.* macrofouling cover > 5% of hull area), would be impractical in the short term, given that over 25% of moored vessels in this sector are likely to be in this category. We recommend starting with movement restrictions on very heavily fouled vessels (*i.e.* LOF ≥ 4 or greater than 15% of hull area fouled) and signalling an intention to move to controls on vessels with LOF ≥ 3 in the future. More stringent requirements could be implemented for vessels intending to travel to high value areas. Short-term closures of infested areas should also be considered during response to an incursion to reduce the rate of infestation of vessels and other mobile equipment. The spatial extent and duration of closure will be important influences on the feasibility of implementation.

Fixed and mobile structures

We recommend that local authorities require, as a condition of resource consents or permits (*e.g.*, for moorings), that any new structures in the coastal environment be made using only new or sterilised materials. Existing structures or associated materials that have been in the marine environment should not be moved to another region, or substantial distances within a region, without first being sterilised (by encapsulation, heat treatment or removal from the water for cleaning). Alternatively, a risk assessment could be undertaken to determine the likelihood of trans-locating potentially harmful species. This could be promulgated through resource consents, where appropriate, and otherwise through CoPs and public awareness campaigns. Guidance on these matters could be provided in a national pathway management plan under the Biosecurity Act.

Research and education

The research and education sectors include science providers, environmental consultancies, universities, polytechnics (including marine laboratories), and commercial aquaria that are involved in marine research or education. Activities undertaken by these organisations that can spread harmful marine organisms include the use of vessels (trailered and non-trailered) and scientific equipment in field surveys (*e.g.*, diving gear, sampling equipment, and deployed instruments), deliberate movement of equipment or live organisms for experimentation, and the keeping and breeding of organisms in aquaria and hatcheries.

Although there are individual measures that can be taken to mitigate many of the risks involved in this sector (many of which are common to the other pathways described above), knowledge about them and their management is patchy within institutions and few have well-articulated, overarching policies for biosecurity that cover all of their operations.

The sector should be encouraged to consolidate and improve on existing measures by developing auditable CoPs to manage biosecurity risks across their operations. These should include: a requirement for BMPs for all non-trailered vessels, wash-down/sterilisation protocols for trailered vessels and mobile equipment (including diving equipment), SoPs for field surveys and experimental studies that require assessment of the risks of spreading non-indigenous species (and propose mitigation strategies), and SoPs for managing risks from hatcheries and aquarium facilities.

Uptake could be encouraged by an awareness campaign at a high level within the organisations (*e.g.*, general managers of operations) and by provision of template examples. Training in the CoPs and independent audit will encourage greater uptake of best-practice within the institutions.

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GLOSSARY

Term	Definition
Anti-fouling system	A coating, paint, surface treatment, surface, or device that is used on a vessel or submerged equipment to control or prevent the attachment of organisms.
Ballast water	Water, including its associated constituents (biological or otherwise), placed in a ship to increase the draft, change the trim or regulate stability. It includes associated sediments, whether within the water column or settled out in tanks, sea-chests, anchor lockers, plumbing, *etc*.
Bilge	Any seawater that • accumulates within the hull of a vessel, including in the engine room of larger vessels (*i.e.* seawater that enters the vessel via the stern glands) and in the bilge sumps of smaller vessels; • is contained in or on the vessel (*e.g.* for fish or bait); or • is uncontained on the deck area of a vessel, including in gear storage areas.
Biofouling	The accumulation of aquatic organisms on surfaces immersed in, or exposed to, the aquatic environment.
Biofouling Management Plan (BMP)	Biofouling Management Plan and Record Book. A document that contains details of the antifouling systems and operational practices or treatments used to manage biofouling on a vessel. A BMP should contain a description of the vessel and its operating profile, including hull locations susceptible to biofouling, and a schedule of planned inspections, repairs, maintenance, and renewal of anti-fouling systems. The associated record book should detail all inspections and biofouling management measures undertaken on the ship.
BSA	Biosecurity Act 1993.
BWE	Ballast water exchange, a procedure in which the ballast water on a vessel is discharged and replaced by other water with the intention of reducing the risk of transferring harmful marine organisms to destination ports.
Clean of biofouling	Having no visible aquatic organisms on the hull, including niche areas, except as a slime layer.
COP	Code of practice
Biological contaminant	A living organism that is unintentionally carried within or on transported equipment, goods, living stock or other materials. For the purposes of this study, this does not include pathogens or parasites.
Controlled area	An area for the time being declared, under section 131 of the Biosecurity Act 1993, to be an area that is controlled to: • enable the limitation of the spread of any pest or unwanted organism, or • minimise the damage caused by any pest or unwanted organism, or • protect any area from the incursion of pests or unwanted organisms, or • facilitate the access of New Zealand products to overseas markets, or • monitor risks associated with the movement of organisms from parts of New Zealand the pest status of which is unknown.

Term	Definition
Craft	An aircraft, ship, boat, or other machine or vessel used or able to be used for the transport of people or goods, or both, by air or sea; and includes: • an oil rig • a structure or installation that is being towed through the sea.
Craft Risk Management Plan (CRMP)	A plan approved under section 24K of the Biosecurity Act 1993.
Craft Risk Management Standard (CRMS)	A standard issued under section 24G of the Biosecurity Act 1993.
Dead Weight Tonnage (DWT)	A measure of the maximum amount of weight that a ship can safely carry. It is the sum of the weights of cargo, fuel, fresh water, ballast water, provisions, passengers, and crew.
EEZ Exclusive Economic Zone	The EEZ of New Zealand comprises those areas of the sea, seabed, and subsoil that are beyond and adjacent to the territorial sea of New Zealand, having as their outer limits a line measured seaward from the baseline described in sections 5 and 6 and 6A (of the Territorial Sea, Contiguous Zone, and Exclusive Economic Zone Act 1977), every point of which line is distant 200 nautical miles from the nearest point of the baseline.
Extended Continental Shelf (ECS)	The seabed and subsoil of New Zealand's submerged landmass where it extends beyond the EEZ.
Gross tonnage (GT)	A measure of a ship's overall internal volume.
Harmful marine organisms	Any marine organism, indigenous or exotic, that has the potential to cause harm to valued marine species, ecosystems or environments. For this report, pathogens and other disease-causing agents are excluded from this definition as measures to manage these risks are outside the scope of the project.
HSNO Act	Hazardous Substances and New Organisms Act 1996.
International Maritime Organisation (IMO)	The United Nations specialized agency with responsibility for developing and maintaining a comprehensive regulatory framework for international shipping.
Internal waters	Harbours, estuaries, and other areas of the sea that are on the landward side of the baseline of the territorial sea of a coastal state, and rivers and other inland waters that are navigable by ships.
Marine growth prevention systems (MGPS)	An anti-fouling system used for the prevention of biofouling accumulation in internal seawater cooling systems and sea chests and can include the use of anodes, injection systems and electrolysis.
MARPOL	The International Convention for the Prevention of Pollution from Ships 1973/78 is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes.
Merchant vessel	A vessel that has the primary role of the transport of cargo. Merchant vessels can be divided into different categories depending on their purpose and/or cargo (*e.g.*, bulk carrier, tanker, container, refrigerated vessel, *etc*).
MPI	Ministry for Primary Industries
New organism	An organism: • belonging to a species that was not present in New Zealand immediately before 29 July 1998,

Term	Definition

	• belonging to a species, subspecies, infrasubspecies, variety, strain, or cultivar prescribed as a risk species, where that organism was not present in New Zealand at the time of promulgation of the relevant regulation,
	• for which a containment approval has been given under the HSNO Act,
	    ▪ an organism for which a conditional release approval has been given
	    ▪ qualifying organism approved for release with controls
	• that is genetically modified
	• that belongs to a species, subspecies, infrasubspecies, variety, strain, or cultivar that has been eradicated from New Zealand.

Niche areas	Areas on a ship that are susceptible to biofouling due to, different hydrodynamic forces, susceptibility to coating system wear or damage, or being inadequately, or not, painted. They include, but are not limited to, the wind/waterline, sea chests, bow thrusters, propeller shafts, inlet gratings, jack-up legs, moon pools, bollards, braces and dry-docking support strips.
New Zealand waters	The internal waters of New Zealand and the territorial sea of New Zealand.
Passenger vessel:	A vessel that has the primary role of carrying passengers. A cruise liner is a type of passenger vessel that is used for pleasure voyages, where the voyage and the ship's amenities form part of the experience.

Pathway	Movement that
	• is of goods or craft out of, into, or through:
	    o a particular place in New Zealand, or,
	    o a particular kind of place in New Zealand, and
	• has the potential to spread harmful organisms.

Pathway management plan	A plan to which the following apply: • it is for the prevention or management of the spread of harmful organisms • it is made under Part 5 of the Biosecurity Act 1993 • it is a national pathway management plan or a regional pathway management plan.
Recreational vessel	A vessel that has the primary role of recreation (that is, not intended for commercial use or hire, regardless of length or tonnage).
RMA	Resource Management Act 1991
Sedimentary basin	A major geographical region with a common geological history and continuous stratigraphy. New Zealand sedimentary basins can be subdivided into 'Petroleum Basins', and 'Frontier Basins'. All or part of each 'Petroleum Basin' has been licensed for exploration. Within a basin are expected to be, a number of petroleum fields. Maui, Kapuni, Pohokura and Kupe are all examples of fields in the Taranaki Basin.
Slime layer	A layer of microscopic organisms, such as bacteria and diatoms, and the slimy substances that they produce.
Small-scale management programme	A small-scale management programme declared by a regional council consisting of:

Term	Definition
	• small-scale measures to eradicate or control an unwanted organism • provisions for compensation for losses caused by the programme.
SOP	Standard operating procedures.
Structure (as defined in the RMA)	"Any building, equipment, device, or other facility made by people and which is fixed to land; and includes any raft." In this report, we also refer to 'moveable structures' meaning structures that are generally fixed to land (including the seabed) but can be shifted to another location.
Territorial sea	Comprises those areas of the sea having, as their inner limits, a baseline described in sections 5 and 6 and 6A (of the Territorial Sea, Contiguous Zone, and Exclusive Economic Zone Act 1977) and, as their outer limits, a line measured seaward from that baseline, every point of which line is distant 12 nautical miles from the nearest point of the baseline.
Vector	The physical means by which harmful organisms may be transported.
Vessel	A mobile structure of any type whatsoever operating in the marine environment and includes floating craft, fixed or floating platforms, and floating production storage and off-loading units (FPSOs).

1. INTRODUCTION

1.1. Background to this report

There are more than 170 non-native (exotic) species known from New Zealand's coastal environments, including some that cause significant harm (Kospartov *et al.* 2008). Once they are present in our waters, harmful marine organisms[1] can be spread throughout the country by a variety of means ('pathways'). The impacts that these species have on New Zealand's marine environments and resources can be minimised by restricting their distribution and/or by reducing the rate at which they are spread.

To reduce the risk of harmful marine organisms entering New Zealand coastal waters, the Government has introduced mandatory controls on the discharge of ballast water from vessels arriving from overseas and is working toward the introduction of a craft risk management standard (CRMS) for managing biofouling risk on such vessels. To reduce the spread of harmful marine organisms within New Zealand, the Ministry for Primary Industries (MPI) is exploring the potential of national and regional pathway management plans, developed in collaboration with regional councils, industry and other stakeholders, to reduce the spread of marine pests.

MPI commissioned the National Institute of Water and Atmospheric Research (NIWA) and the Cawthron Institute (Cawthron) to undertake a review of practical measures for reducing the spread of potentially harmful marine organisms via human transport pathways within New Zealand, and policy options for promoting the implementation of risk reduction measures. Pathogens and other disease agents are outside the scope of this review. A companion report (Inglis *et al.* 2013, hereafter referred to as the 'Part A report') describes the nature of each pathway and the practical options available to reduce risk. This Part B report describes the statutory framework for management, assesses policy options for implementing risk reduction measures and makes recommendations regarding options that are most likely to be practical and effective.

1.2. Pathways, vectors and risks

The Biosecurity Act 1993 (BSA) defines a 'pathway' as movement that:

- a) *is of goods or craft out of, into, or through:*
    - i. *a particular place in New Zealand, or*
    - ii. *a particular kind of place in New Zealand, and*
- b) *has the potential to spread harmful organisms.*

[1] For this report, 'harmful marine organism' is defined as any marine organism, indigenous or exotic, that has the potential to cause harm to valued marine species, ecosystems or environments, but excluding any pathogen or disease, which are outside the scope of this report. See the Glossary for definitions of this and other terms.

Pathways are human activities that, intentionally or unintentionally, may move a harmful organism from one place in New Zealand to another.
This review focuses on six pathways that may spread harmful marine organisms within New Zealand:

- maritime transport
- mining and exploration
- commercial fishing
- marine aquaculture
- sport and recreation
- research and education.

Within each of these pathways, marine organisms can be transported in a variety of ways ('vectors'). The most studied vectors for the transport of marine pests are movement of vessels (of all sizes) and immersed moveable structures (Biodiverse Limited 2010). Ballast water and hull biofouling are widely regarded as key mechanisms of transport of harmful marine organisms by these vectors (Hewitt *et al.* 2004, Inglis *et al.* 2010).

There are, however, a number of other vectors and transport mechanisms for potentially harmful marine organisms where the risk is less well understood (Carlton 2001, Elston 1997, Hayes *et al.* 2005, Ruiz & Carlton 2003). These include:

- bilge water (Darbyson *et al.* 2009)
- overland movements of small craft such as trailered boats and kayaks (Dodgshun *et al.* 2007, Sinner *et al.* 2009)
- contamination of equipment associated with marine activities. Examples are entrained water on dive gear, entrained sediments on anchors; and fouling or entanglement in equipment such as nets, lobster pots, ropes, floats, and ground tackle (Acosta & Forrest 2009, Dodgshun *et al.* 2007, Sant *et al.* 1996a)
- movement of bait and live organisms for marine farming, aquaria, research and education. For example, the unwanted seaweed *Caulerpa taxifolia* is an aquarium species.

Because harmful marine organisms may be spread by humans through diverse means, there is unlikely to be a single best approach to risk mitigation. All pathways must be addressed to achieve the desired outcome of reducing the rate of spread. The best outcome is likely to be achieved through a variety of mechanisms that are tailored to address specific risks within each pathway.

This report summarises the statutory authority and assesses policy approaches that could be applied to promote the implementation of these measures by marine users.

2. METHODOLGY AND CRITERIA FOR ASSESSMENT

The project team reviewed published and unpublished information on risks associated with each of the marine pathways and options for their management. To engage with industry, government, tangata whenua, councils, and other stakeholders, two workshops were held in Wellington (on 4-5 March and 24 April 2013) to identify and discuss risk reduction options and potential barriers to their implementation. Inputs from the literature review and the workshops were then used to develop a recommended package of measures and policies for reducing the domestic spread of marine pests within New Zealand. Attendance at the workshop included representatives from the following sectors:

- commercial fishing
- government
- iwi
- marine aquaculture
- maritime transport
- scientific research.

2.1. Considerations for pathway management

From the first workshop, a number of considerations were identified that, while not intended to cover all aspects of pathway management, could support evaluation and selection of measures to reduce risk.

- Where practical, domestic biosecurity measures should be aligned with measures being implemented at the border and internationally to simplify compliance and reduce complexity and cost. Measures should also be aligned between regions and across sectors, as they are more likely to be effective if applied consistently, while allowing for appropriate variation in detail.
- Risk reduction measures should be applied wherever practicable and cost-effective. The goal is to reduce risk across all pathways, not necessarily equivalence in the residual risk across sectors. However, risk reduction effort should not be significantly out of proportion to the relative risk from a given pathway.
- Implementation should be aligned with changes to regional coastal plans and other instruments (*e.g.*, codes of practice) to ensure consistency and facilitate uptake.
- Effective risk reduction requires high levels of compliance with risk reduction measures, since even small numbers of non-compliant vectors can substantially

reduce effectiveness. There is a role for both voluntary and regulatory measures. Compliance with voluntary measures needs to be monitored and evaluated and regulatory measures should include consequences for non-compliance.

- This project aims primarily at inter-regional scale, but should also inform measures for management at local scales (either on an on-going basis or to inform incursion response). Biosecurity management should aim to reduce the risk of spread at scales greater than what organisms could achieve by natural spread within, for example, a five-year time frame. The rate of natural spread varies by organism, so some rough approximations may need to be made.

2.2. Criteria for assessing management options

The options identified in the literature review and Workshop 1 was assessed using the following criteria, which are based on earlier marine biosecurity work for MPI (Inglis *et al.* 2012):

- **Effectiveness** — the degree to which biosecurity risk would be reduced if the measure is appropriately applied in all relevant circumstances, *i.e.* the *technical efficacy* based on biology and ecology.
- **Practical feasibility** — the degree to which practical considerations, including feasibility of monitoring and enforcement, are conducive to adoption by stakeholders.
- **Cost of compliance** — the financial and non-financial costs to stakeholders of complying with the measure, plus the costs to central and local government of promoting, monitoring and enforcing compliance.
- **Rate of uptake** — taking into consideration effectiveness, cost and feasibility, the likely proportion of stakeholders who would adopt the measure and apply it appropriately.
- **Other considerations** — other factors to consider, including alignment with principles for this project and wider government policies and strategies.

Collectively, these criteria suggest a wider **benefit-cost criterion**, where benefit:cost (B:C) is a ratio defined as follows:

B:C = [effectiveness*rate of uptake] / [cost of compliance]

where rate of uptake = *f* (effectiveness, practical feasibility, cost of compliance, other considerations).

That is, the likely benefits (*i.e.* risk reduction) from a measure are a function of the measure's effectiveness and rate of uptake, and can be compared to the cost of compliance for marine users and government agencies. For example, if a measure has a technical effectiveness of 80% but only 50% of marine users were likely to implement it, the risk reduction in practice would be only 40%. Furthermore, the likely rate of uptake of a measure by marine users will be influenced by its effectiveness, practical feasibility and cost of compliance, and possibly other considerations.

The overall assessment of options is then a consideration of likely risk reduction relative to the costs, taking into account other relevant factors. Information to assess options against these criteria was obtained during the literature review and the workshops and complemented by the authors' own experiences. In many cases, only limited information was available to assess a measure against these criteria, and the assessments must therefore be seen as preliminary and indicative only. This project did not extend to developing quantitative estimates of these criteria, however, so the benefit-cost criterion has been applied only implicitly.

It is worth noting that, in management of harmful marine organisms, high levels of uptake of new practices, across a range of stakeholders, may be required to ensure a programme's success (Polonsky *et al.* 2004). Behavioural change requires not just knowledge of the problem and potential solutions, but the ability to overcome relevant constraints. These might include cost, technological barriers and social pressure (Kollmuss & Agyeman 2002). The ability of individuals to change their behaviour can be unevenly distributed, so change can be patchy even when there is a willingness to change (Blake 1999, Reaser 2001).

3. NEW ZEALAND'S STATUTORY AND LEGAL FRAMEWORK

To manage biosecurity risks, the Government has powers available under legislation and undertakes important complementary efforts to educate and raise public awareness. This section gives an overview of the legal and institutional framework governing New Zealand's marine biosecurity regime.

The biosecurity regime in New Zealand is governed primarily by the Biosecurity Act 1993 (BSA). The Resource Management Act 1991 (RMA) and the New Zealand Coastal Policy Statement (NZCPS) also play significant roles in the management of harmful marine organisms. Other legislation and regulations with relevant provisions include the Fisheries Act 1996, the Local Government Act 2002, the Maritime Transport Act 1994, the Resource Management (Marine Pollution) Regulations 1998 and the Hazardous Substances and New Organisms Act 1996 (HSNO Act).

In addition, the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012 (the EEZ Act) was enacted on 3 September 2012. The EEZ Act will come into force when the first set of regulations is promulgated, which is expected to occur in 2013[2]. The EEZ Act manages the environmental effects of activities in New Zealand's oceans, *i.e.* beyond the territorial sea but within the 200 mile limit. The legislation aims to protect our oceans from environmental risks of activities like petroleum exploration, seabed mining, marine energy generation and carbon capture developments. While biosecurity measures could be implemented under the EEZ Act, analysis of how the BSA, RMA and EEZ Act will align can only be done once the EEZ regulations are available.

Measures that sit outside of the legislative framework, such as the Government's Aquaculture Strategy and Five-year Action Plan and industry codes of practice (CoPs), also contribute to the management of potentially harmful marine organisms.

The discussion below is limited to the main biosecurity provisions of New Zealand legislation, which are found within the BSA, the RMA and the associated NZCPS, the Fisheries Act and the HSNO Act.

3.1. Biosecurity Act 1993

The Biosecurity Act 1993 (BSA)[3] is the key legislation for managing marine pests in New Zealand. Key provisions and regulatory mechanisms available under the BSA to manage marine pests include:

- national policy direction

[2] http://www.mfe.govt.nz/issues/oceans/current-work/
[3] Biosecurity Act 1993: http://www.legislation.govt.nz/

- national and regional pest management plans
- national and regional pathway management plans
- government-industry agreements
- craft risk management standards
- controlled area restrictions
- small-scale management programmes
- unwanted organism declarations.

The statutory provisions enabling pathway management plans and government-industry agreements were added by amendments to the BSA in late 2012.

3.1.1. National policy direction

The purpose of a national policy direction under the BSA is to ensure that activities align with one another to optimise the use of available resources for New Zealand's best interests. National policies contain directions on the setting of 'good neighbour rules' in regional pest management plans, and may include directions on the process for making plans or small-scale management programmes; the content of plans or small-scale management programmes; and any other matter that the Minister considers necessary. While a national policy direction is not in itself used for managing marine pests, it can directly affect how other mechanisms are used.

3.1.2. National and regional pest management plans

A pest management plan can be a national or regional plan and provides for the management of one or more organisms specified as a pest by the plan. Plans enable access to the powers in Part 6 of the BSA and can include rules that have the force of law as well as funding and compensation provisions. Regional pest management plans can be developed by regional councils to identify pest species and establish methods to manage them over all or part of a region. While the BSA places no requirement on regional councils to control harmful organisms, it does specify how a regional pest management plan must be set out if a council chooses to develop one.

3.1.3. National and regional pathway management plans

Sections 79–98 of the BSA enable pathway management plans to reduce risks from potentially harmful species. Unlike pest management plans, pathway plans do not require identification of a particular species of concern, but can instead be used to reduce risk generically across a range of related activities (*i.e.* a pathway). Pathway management plans enable access to the powers in BSA Part 6 and can include rules that have the force of law as well as funding and compensation provisions. Rules can require persons in charge of goods or craft to carry out specific treatments, or to do or refrain from doing certain activities, to reduce the spread of harmful marine organisms.

A pathway management plan can be national or regional in scope and may address a single or multiple pathways. A national plan requires Ministerial approval, based on criteria set out in the BSA, and then an Order-in-Council to be signed by the Governor-General. A regional pathway plan can be established by a regional council that is satisfied that criteria in the BSA have been met, but can be challenged in the Environment Court.

3.1.4. Government-industry agreements

Government-industry agreements are made between the Director-General of MPI and legally established organisations that represent the interests of a sector. The agreements address readiness and response activities for unwanted organisms that are of concern to primary industries. Government-industry agreements may specify, among other things, activities that will be undertaken by the parties, joint decision-making on such activities, funding arrangements (including levies) and compensation provisions. The legislation is sufficiently broad to enable harmful marine organisms to be the subject of an agreement between MPI and the seafood industry if this is provided for in the Deed of Agreement template that is under development.

3.1.5. Craft risk management standards

Sections 24E through 24K of the BSA, inserted via the 2012 amendments, provide for the establishment of craft risk management standards (CRMS) by the Director-General of MPI to manage the risk that craft arriving into New Zealand will introduce exotic organisms. MPI must first assess the risk presented by such craft, have regard to the potential costs, and then consult with affected parties before issuing such a standard. MPI has indicated its intention to issue a CRMS in 2013 to address biosecurity risks from ship's biofouling, with full application of the standard expected to take place in 2017. More detail on this proposed CRMS is included in Section 6.1 of this report.

3.1.6. Controlled area restrictions

Section 131 of the BSA enables the institution of movement controls within particular geographic areas, which might be done as part of a pest management plan, a pathway management plan, or in the exercise of BSA Part 6 powers that apply to unwanted organisms. While a declaration of a controlled area is in force, no person shall (without the permission of an inspector or authorised person):

> *remove any organism, organic material, or risk goods; or any other goods that may have been in contact with any organism, organic material, or risk*

goods, from the place to which the notice relates; or introduce any goods of any kind to the place.

A controlled area may be established to:

- limit the spread of any pest or unwanted organism
- minimise the damage caused by any pest or unwanted organism
- protect an area from the incursion of pests or unwanted organisms
- facilitate the access of New Zealand products to overseas markets
- monitor risks associated with the movement of organisms from parts of New Zealand where the pest status is unknown.

3.1.7. Small-scale management programmes

Small-scale management programmes consist of measures at the regional and sub-regional scale to eradicate or control an unwanted organism; they may also include provisions for compensation for losses caused by such measures. Under s100V of the BSA, a regional council may undertake small-scale management of unwanted organisms without a pest management strategy, so long as the provisions of that section are met. This may occur if an unwanted organism poses serious adverse and unintended effects unless early action is taken to control it; and the organism can be eradicated or controlled effectively by small-scale measures within three years of the measures starting — for example, if the organism's distribution is limited; and technical means to control it are available.

3.1.8. Unwanted organism declarations

Under s 164C of the BSA, a Chief Technical Officer of MPI may declare an organism an unwanted organism if he or she believes it capable of causing unwanted harm to any natural and physical resources or human health. Unwanted organisms also include any new organism the Environmental Protection Authority has declined approval to import and any organism specified in the Second Schedule of the HSNO Act. A declaration of 'unwanted organism' applies New Zealand-wide; it cannot be limited to a region or other locality. MPI maintains a public list of unwanted organisms[4].

Unwanted organisms are banned from sale, propagation, and distribution, unless permission is obtained from a Chief Technical Officer. A current example is that MPI may give approval for farming *Undaria* in certain areas[5]. A regional council cannot carry out a small-scale management programme in respect of an organism unless that organism has first been declared 'unwanted'. Declaration of an unwanted organism

[4]http://www1.maf.govt.nz/uor/searchframe.htm
[5]http://www.fish.govt.nz/en-nz/Press/Areas+designated+for+Undaria+farming.htm

imposes obligations (BSA s 52 and s 53) on people to, among other things, not transport goods that they know or suspect may carry the organism and also makes available a range of powers under BSA Part 6, for example the institution of movement controls within particular geographic areas ('controlled areas', see 3.1.5 above).
Pest declarations are somewhat different and are done as part of a pest management plan, which invokes the powers entailed in BSA Part 5 (see Section 3.1.2 above).

3.2. Resource Management Act1991

The purpose of the RMA[6], set out in Part 2 s 5, is to promote the sustainable management of natural and physical resources. Of particular relevance to biosecurity are the requirements to enable people and communities to provide for their well-being, and to safe-guard the life-supporting capacity of ecosystems and to avoid, remedy, and mitigate any adverse effects of activities on the environment.

In order to give effect to the RMA in the coastal marine area, s 30(1)(d) gives to regional councils (in conjunction with the Minister of Conservation) the function of controlling the following:

- occupation of space
- discharge of contaminants into or onto land, air or water and discharges of water into water
- dumping of waste or other matter
- activities in relation to the surface of water.

Section 30(3) enables the Council and the Minister of Conservation to perform the functions specified in s 30(1)(d) to control aquaculture activities for the purpose of avoiding, remedying or mitigating the effects of aquaculture activities on fishing and fisheries resources.

3.2.1. National policy statements and the New Zealand Coastal Policy Statement

National policy statements are instruments available under the RMA that state national objectives and policies to which local government must give effect. The NZCPS (2010), led by the Department of Conservation (DOC), provides direction on the planning and consenting activities of councils for the coastal marine area.

Policy 12 of the NZCPS directs councils to provide for, in their RMA policies and plans, the control of activities that contribute to the spread of harmful aquatic organisms. With reference to Policy 12.2a, a draft guidance note by DOC suggests

[6]RMA, http://www.legislation.govt.nz/

that policy and plan provisions could be included for movements of vectors between regions of New Zealand. For example, the Guidance Note suggests that a vector could be required to be inspected, cleaned and declared free of any harmful aquatic organisms before it could enter another region. The term vector is defined in the Guidance Note to include 'structures, equipment and vessels'.

3.2.2. Rules on discharges, movement and dumping

Sections 12, 14 and 15 of the RMA restrict certain activities in the coastal marine area unless expressly allowed by a rule in a regional coastal plan or resource consent. Section 12 sets out the restrictions on the use of the coastal marine area. Section 12(1)(d) states that no person may deposit in, on or under any foreshore or seabed any substance in a manner that has or is likely to have an adverse effect on the foreshore or seabed. Under s 12(1)(f), no person may introduce or plant any exotic or introduced plant in, on, or under the foreshore or seabed. These restrictions apply unless activities are expressly allowed in a national environmental standard, a rule in a regional coastal plan or proposed regional coastal plan, or a resource consent.

The restrictions applying to the discharge of contaminants into the environment are set out in s 15 of the RMA. Discharge is defined in the RMA as "emit, deposit and allow to escape". Under s 15, no person may discharge any contaminant (which includes any substance that, when discharged into water, changes or is likely to change the physical, chemical or biological condition of water) or water into water unless the discharge is expressly allowed by a rule in a regional plan or proposed regional plan, or by a resource consent.

Under s 15A, the dumping of waste or other matter in the coastal marine area from a ship or offshore installation has to be expressly allowed by a resource consent. The discharge of harmful substances[7] or contaminants from a ship or offshore installation into water in the coastal marine area is prohibited under s 15B unless the discharge is specifically permitted or controlled (see s 15B, which concerns all discharges from ships and offshore installations).

Under Regulation 4 of the Resource Management (Marine Pollution) Regulations 1998 (the Regulations), the dumping of dredge material and organic material of natural origin (which could include biofouling) is deemed to be a discretionary activity in any regional coastal plan or proposed coastal plan.

The discharge of ballast water is also governed by the Regulations. Regulation 14 states:

[7] The definition of harmful substances is outlined in Part 1(3) of the Resource Management (Marine Pollution) Regulations 1998, and includes 'drainage from spaces on a ship or offshore installation containing living animals'.

1. Any person may discharge in the coastal marine area, from a ship or offshore installation, clean ballast water or segregated ballast water.
2. This regulation does not authorise the discharge of clean ballast water or segregated ballast water in contravention of the Biosecurity Act 1993, regulations made under that Act, or import health standards made under s 20 of that Act.

In addition, Regulation 16 states that no rule may be included in any regional coastal plan or proposed regional coastal plan, nor any resource consent granted, relating to a discharge to which Regulation 14 applies.

The implications of Regulations 4, 14 and 16 are discussed in Section 6.5 of this report.

3.3. Fisheries Act 1996

Under s 301(i) of the Fisheries Act 1996[8], the Governor-General is authorised to make regulations, among other things,

> "prescribing the measures to be taken to avoid the outbreak, or on an outbreak, of any disease among the fish, aquatic life, or seaweed, and authorising or requiring the taking of any specimen, the testing of anything, or the sampling of any substance present on any fish farm, and authorising or requiring the removal of any specimen or sample, or the destruction of diseased fish, aquatic life, or seaweed, whether with or without payment of compensation."

This provision supersedes an earlier provision in the Fisheries Act 1983, which is the basis for the Freshwater Fish Farming Regulations 1983[9]. Sections 26 through 32 of these regulations pertain to disease control and include a requirement to notify MPI of a listed disease and a prohibition on transfer of diseased fish to another fish farm or into any waters.

3.4. Hazardous Substances and New Organisms Act 1996

The purpose of the HSNO Act[10], as set out in Part 2 s 4, is to protect the environment, and the health and safety of people and communities, by preventing or managing the adverse effects of hazardous substances and new organisms. Under Part 5, no new organism can be intentionally imported, developed, field tested, or released in New Zealand without approval from the Environmental Protection Authority.

[8] Fisheries Act, http://www.legislation.govt.nz/
[9] Available at http://www.legislation.govt.nz/regulation/public/1983/0278/latest/DLM93756.html
[10] HSNO Act, http://www.legislation.govt.nz/

Probably more relevant to marine biosecurity management is that any hazardous substances (*e.g.*, chemicals that might be used to treat ballast water or gear and equipment) must be authorised for that use under the HSNO Act.

3.5. International agreements

Three international agreements are relevant for biosecurity management at the border: the *International Convention for the Control and Management of Ships Ballast Water and Sediments 2004* (hereafter the Ballast Water Management Convention, or BWMC, which New Zealand has yet to ratify), the *Guidelines For the Control and Management of Ships' Biofouling to Minimize the Transfer of Invasive Aquatic Species* and the *Anti-fouling and In-Water Cleaning Guidelines*. Each of these is discussed below.

More generally, the Convention on Biological Diversity (CBD), of which New Zealand is a party, obliges member states to take measures to protect biodiversity. The CBD recognises that there is an urgent need to address the impact of invasive alien species. Article 8(h) of the CBD states that, "*Each contracting Party shall, as far as possible and as appropriate, prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species.*" The CBD has adopted guidance on prevention, introduction and mitigation of impacts of alien species that threaten ecosystems, habitats or species.

3.5.1. International Convention for the Control and Management of Ships' Ballast Water and Sediments 2004 (Ballast Water Management Convention)

The primary purpose of the BWMC is "to prevent, minimize and ultimately eliminate the risks to the environment, human health, property and resources arising from the transfer of harmful marine organisms and pathogens through the control and management of ships' ballast water and sediments."

Before the BWMC comes into force, it needs ratification by more countries. When this occurs, the BWMC will provide a binding set of international regulations to control discharges of ballast water by shipping. The key provisions of the BWMC (see Part A report for more detail) are:

- a requirement (for all ships to which the Convention applies) to implement a ballast water management plan and maintain records of their ballast management actions, and
- the phased introduction of a stringent performance standard for ballast water discharges based on a maximum concentration of viable organisms, requiring the installation and use of on-board treatment systems. Ballast water exchange can

be used as an interim treatment measure until compliance with more stringent standards for ballast water discharges becomes mandatory (MAFBNZ 2007).

Although yet to ratify, New Zealand has already given effect to some of the convention's provisions, *e.g.*, implementing the *Import Health Standard for Ships' Ballast Water from all Countries* (IHS) under s 22 of the BSA. With the exception of emergency discharge, the IHS requires that no ballast water originating from territorial seas outside of New Zealand may be discharged into New Zealand waters without the permission of an inspector. To satisfy the standard, ships have four options:

- demonstrate the ballast water has been exchanged *en route* to New Zealand in areas free from coastal influences, preferably 200 nautical miles (nm) from the nearest land and in water over 200 m in depth,
- demonstrate that the ballast water is fresh water (not more than 2.5 parts per thousand sodium chloride),
- treat ballast water using a shipboard treatment system approved by MPI, or
- discharge ballast water into an onshore treatment facility approved by MPI[11].

Vessels wanting to discharge ballast in New Zealand waters are required to submit to MPI a Vessel Ballast Water Declaration form and seek approval before arrival into New Zealand waters. The IHS also prohibits the discharge of sediment to New Zealand waters from ballast tanks, anchor lockers, sea chests or other sources.

3.5.2. International Maritime Organisation Biofouling Guidelines

In 2011, the Marine Environmental Protection Committee of the International Maritime Organisation (IMO) adopted detailed guidelines for management of biofouling[12]. The guidelines recommend measures that vessel operators can take to minimise the risks of transporting biofouling. These include guidance on appropriate choice and maintenance of anti-fouling systems for vessels and operational practices to reduce the development of biofouling. A central feature is maintenance of a biofouling management plan (BMP) and record book for the vessel that detail how it manages biofouling. The BMP should document the vessel's schedule of surveys and hull inspections, replacement of anti-fouling systems, cleaning at dry-docking, and any in-water cleaning that contributes to reduction of biofouling. Although the guidelines are voluntary, the IMO has requested Member States to take 'urgent action' to apply them, including disseminating the guidelines to the shipping industry and other affected parties.

[11] The authors are not aware of any MPI-approved onshore treatment facilities in New Zealand.

[12] *Guidelines For the Control and Management of Ships' Biofouling to Minimize the Transfer of Invasive Aquatic Species*. The original 2011 version and MEPC decision 207(62) can be found at http://www.imo.org/blast/blastDataHelper.asp?data_id=30766&filename=207%2862%29.pdf. A revised edition was published in 2012.

3.5.3. *Australia-New Zealand Anti-Fouling and In-Water Cleaning Guidelines*

In June 2013, the Standing Council on Primary Industries, a joint Australia-New Zealand body, approved a revised version of the *Anti-fouling and In-Water Cleaning Guidelines,* originally established in 1997 by the Australian and New Zealand Environment and Conservation Council (ANZECC)[13]. The guidelines provide vessel operators with best-practice methods for the application, maintenance, removal and disposal of anti-fouling coatings and the management of biofouling and harmful marine organisms on vessels and movable structures in Australia and New Zealand. The guidelines, which are meant to be consistent with the IMO biofouling guidelines, have no statutory effect in New Zealand but can be used as the basis for the development of CoPs, RMA rules or measures under biosecurity instruments such as pathway management plans.

3.6. Voluntary measures

3.6.1. *Aquaculture industry codes of practice*

Aquaculture New Zealand has established routine practices to reduce generic marine pest risk, through the implementation of CoPs to operationalise management measures. There are CoPs in place for the mussel, oyster, and salmon industries through the Greenshell™ Mussel Industry Environmental Code of Practice (Aquaculture New Zealand 2007a), the New Zealand Oyster Environmental Code of Practice (Aquaculture New Zealand 2007b), and the Finfish Aquaculture Environmental Code of Practice (New Zealand Salmon Farmers Association Inc 2007), respectively. Some of these CoPs refer to other more specific codes (*e.g.*, on the transfer of seed stock). Aquaculture New Zealand administers the CoPs which provide guidance on day to day practices to reduce the risk of spreading harmful marine organisms, as well as directions for best practice during emergency biosecurity events. Audit provisions vary across the different CoPs and the extent of compliance is not publicly available.

3.6.2. *Research codes of practice*

Some universities have CoPs to reduce biosecurity risk from their research and educational activities. For example, the coastal ecology laboratory at Victoria University of Wellington has an operations manual that specifically refers to use of non-native organisms[14]. Nelson Marlborough Institute of Technology has documented procedures for students visiting aquaculture facilities. Waikato University has CoPs for managing microbiological hazards associated with working in water, soil and biological materials, and for cleaning methods for freshwater activities. Although the

[13] http://www.daff.gov.au/animal-plant-health/pests-diseases-weeds/marine-pests/anti-fouling-and-inwater-cleaning-guidelines, accessed on 21 August 2013.
[14] http://www.victoria.ac.nz/sbs/research-centres-institutes/vucel/resources/operations-manual. See pp.17-18 relating to potential holding of non-native species.

latter were developed for freshwater work (*e.g.*, in relation to didymo[15]), the CoPs are apparently also used for marine work. These are described in more detail in the Part A report.

NIWA and Cawthron both have informal procedures for managing biosecurity risks in the course of research and commercial field work, including pre-trip planning and adherence to biosecurity management plans and other measures in place on marine farms or other locations. Both organisations are working to document standard operating procedures for managing biosecurity risks during field-based research and other work.

Cawthron has standard operating procedures for handling pacific oysters at its shellfish breeding facility at Glenduan, and is regularly audited by MPI (Section 9).
Guidance and information

MPI provides guidance for the voluntary management of marine biosecurity risks for vessel operators in New Zealand. A campaign to change behaviour is encouraging the owners of moored vessels to clean their boats regularly and have well maintained anti-fouling. Initiatives under this campaign include advertising in specialist boating media and websites, meetings with boat clubs, roving advisors in marinas, and a water-resistant guide to marine biosecurity which describes the potential impacts of harmful marine organisms as well as the importance of good vessel hygiene. The guide, Clean Boats — Living Seas[16], advises boat operators on many aspects of biosecurity management, including:

- good hull maintenance
- not transferring live bait between regions
- cleaning before travelling between locations
- reporting unwanted organisms to MPI.

In April 2012, the New Zealand Government released an Aquaculture Strategy and Five-Year Action Plan to Support Aquaculture[17] that, among other things, recognises the importance of biosecurity and states that MPI will establish biosecurity plans for key growing regions by 2014. As part of this strategy, MPI has been developing environmental standards and consenting guidance for aquaculture development, part of which considers biosecurity. To this end, MPI has published information sheets concerning the aquaculture sector (MPI 2013).

[15]The invasive freshwater algae *Didymospheniageminata*.
[16]http://www.biosecurity.govt.nz/files/pests/salt-freshwater/boaties-guide-to-marine-biosecurity.pdf
[17]http://www.fish.govt.nz/NR/rdonlyres/20A0ED89-A20B-4975-9E63-6B302187840D/0/AQUAStrat5yrplan2012.pdf

4. BALLAST WATER

The remaining sections of this report present and assess policy options for reducing the human-mediated spread of harmful marine organisms within New Zealand. The sections are organised by mode of infection, for example this section addresses ballast water.

For the purposes of this report, ballast water refers to water and its associated constituents (biological or otherwise) placed in a ship to increase the draft, change the trim or regulate stability. It includes associated sediments, whether within the water column or settled out in tanks, sea chests, anchor lockers, and plumbing.

Ballast water is carried by merchant vessels and cruise ships, some drilling rigs, some large fishing vessels and potentially some research vessels (Table 2). A merchant vessel arriving in a port to take on cargo will usually arrive ballasted and need to discharge ballast water to compensate for the weight increase during cargo loading. Both domestic and foreign ships load and unload cargo in New Zealand ports and hence may discharge or recharge their ballast tanks with water from within New Zealand territorial waters, transferring water and potentially marine organisms from one port to another. The Part A report has additional information on the nature of the risk posed by ballast water each different pathway.

Table 2. Major and minor pathways where ballast water is relevant. (√= mode of infection applies to most activities in the sector. * = mode of infection applies to relatively few activities in the sector.)

	Marine transport	**Mining & exploration**	**Commercial fishing**	**Aqua-culture**	**Recreation & sport**	**Research & education**
Ballast water	√	√	*			*

4.1. Options to reduce risk from ballast water

Under the Resource Management Act (RMA, 1991), councils are unable to include rules in regional coastal plans and unitary plans that relate to the discharge of ballast water (see Section 3.2.2 above). Prior to the 2012 amendments to the Biosecurity Act 1993 (BSA), councils could only adopt methods outside of the formal resource management framework to discourage the discharge of ballast water in certain areas coastal marine areas (*e.g.*, in relation to areas of special value) as far as practicable. This could include voluntary codes of practice (CoPs), or a Deed of Agreement similar to that between the cruise ship industry and Environment Southland with regard to ballast water discharge in the Fiordland Marine Area[18]. That deed prohibits ballast water discharge within Fiordland except in event of an emergency.

With the recent amendments to the BSA, however, a national pathway management plan (or regional plan) enables formally sanctioned measures for the management of ballast. Policy options include:

- require vessel operators to treat ballast water
- require vessel operators to undertake mid-voyage ballast water exchange
- provide guidance on preferred locations for discharge, based on *e.g.*, currents and avoidance of high value areas
- prohibit discharge in specified high value areas
- encourage the development of a voluntary accreditation scheme that recognises vessels that actively reduce the biosecurity risk from ballast water discharge
- provide accessible assessment tools and require treatment for vessels wanting to discharge ballast water assessed as high risk.

4.2. Assessment of policy options — ballast water

For each of the options described above, this section comments on the option's likely effectiveness, practical feasibility, cost, expected rate of uptake and other considerations, and concludes with recommendations about measures to reduce the domestic spread of harmful marine organisms via ballast water.

4.2.1. Ballast water treatment

When the Ballast Water Management Convention (BWMC) comes into force, it will require ballast water treatment systems to be of a high standard (Section 3.5.1). As of May 2013 over 30 treatment systems had been approved by relevant authorities as able to meet the standard, and an International Maritime Organisation (IMO) committee concluded that sufficient technologies are now available so that no changes to implementation timelines are required.[19]

Vessels could be required to comply with the forthcoming IMO ballast management rules for all voyages within New Zealand (as well as from overseas). This could be implemented either immediately; or when IMO rules come into force (likely to be 2016 or later); or after a set period, for example, five years after IMO rules come into force. A variation on this would be to require, perhaps as a transitional measure, treatment

[18] The parties entered into a Deed of Agreement for the purpose of setting out their respective rights and obligations and as an alternative to regulatory provisions in the Environment Southland Regional Coastal Plan. Parties to the agreement pay Environment Southland a fee which is used to assist that council to manage the Southland Coastal Marine Area.
[19] http://www.imo.org/OurWork/Environment/BallastWaterManagement/Pages/Default.aspx#3

of ballast water that was loaded in locations with known populations of unwanted organisms (*e.g.*, that are identified as unwanted by the Ministry for Primary Industries (MPI) or listed in a regional pathway management plan).

Treatment systems that meet the BWMC standards are by definition highly ***effective*** — to be approved they must reduce the number of viable organisms present in ballast water to very low levels (see Part A report for more detail). Some forms of treatment, such as heating ballast tanks, will require retrofitting of older vessels and hence, until new IMO rules enter into force, these treatments could not be ***practically*** required within New Zealand waters for vessels originating overseas. However, other forms of treatment might be feasible, *e.g.*, ballast tanks could be dosed with chlorine prior to discharge. Depending on volumes involved, chemical treatment requirement could be ***feasible*** to implement and also to enforce from an agency perspective, by simply sampling the tank or discharge to confirm it has the stated concentration of the treatment chemical.

Some research would be required to assess whether discharge of chemically-treated water would, over time, have significant adverse effects on receiving environments. Treatment protocols for chemical usage also need to comply with human health and safety requirements. The US Coast Guard has recently approved some systems that involve chemical treatment of ballast discharges so there may be opportunities to build upon research already done.[20] Unless appropriate chemicals are already authorised for such use, it is likely to be necessary to obtain regulatory approval under the Hazardous Substances and New Organisms Act (HSNO) to use these chemicals for treating ballast water.

Costs of complying with treatment requirements would depend on what treatments were authorised. The most expensive option is to retrofit IMO accredited treatment facilities to vessels; see the Part A report for further discussion of treatment options. There are relatively few New Zealand vessels that carry ballast so the total cost would be modest. However, costs per vessel could be high (in the range of $0.5 million to $1 million; see Part A report) and might not be feasible for companies that are not able to achieve economies of scale from retrofitting a large fleet.

Mandatory measures that are practical to monitor and enforce, even if they are high cost, are likely to have a high ***rate of uptake.*** This could apply to requirements for ballast water treatment, depending on the approved systems.

Finally, one of the ***other considerations*** for pathway policy development is alignment with measures being implemented at the New Zealand border and internationally. This would suggest not getting ahead of the entry into force of IMO rules or at least

[20] http://www.uscgnews.com/go/doc/4007/1749835/Coast-Guard-accepts-ballast-water-treatment-systems-as-Alternate-Management-Systems

ensuring that shippers have practical and reasonably low cost ways they can meet any treatment requirements.

4.2.2. Ballast water exchange

This option would effectively extend the current ballast water IHS to domestic voyages, prohibiting discharge of any ballast water unless it was exchanged in areas defined as 'mid-ocean' with exceptions only for emergencies.

Although there is consensus that ballast water exchange (BWE) reduces the supply of viable organisms discharged into ports, the extent of reduction in risk varies and there is still some debate about the ***effectiveness*** of BWE. As described in Section 3.6.1 of the Part A report, estimates of risk reduction achieved by BWE range from 60% to 99% depending on the type of vessel and distance from the coastline.

Regarding ***feasibility***, most large merchant vessels are able to carry out BWE without needing additional plant to be installed. However, completing a full exchange on larger vessels may take one to three days, making it impractical for voyages of short duration without imposing delays on the vessel (Gollasch *et al.* 2007, Knight *et al.* 2007). Because of the short distances between New Zealand ports, transit times will often be shorter than the time required for effective BWE. As a result, requirements for mid-ocean exchange of ballast water would be very ***costly*** if imposed on domestic routes, as vessels would have to lengthen their voyage to comply (see Part A report), and would be difficult to monitor.

Finally, ***safety*** must take precedence over any proposed requirements for BWE, as required under the International Convention for Safety of Life at Sea (SOLAS). There are many parts of the New Zealand coast that would be too dangerous to carry out BWE in many conditions. In light of all these matters, the ***rate of uptake*** of any requirement for BWE on domestic routes would be low.

4.2.3. Specify areas for discharge or no discharge

The third option would require identification of preferred discharge locations through regional plans or through an industry code of practice. This would reduce risk by encouraging discharge in low risk areas while leaving full flexibility for ship's masters to ensure ship safety and operational efficiency. A risk-based approach could involve protocols for exchange or treatment of ballast for certain routes or areas. This would likely necessitate public consultation, and it might be challenging to get public acceptance that some areas would be designated as preferred discharge areas.

A fourth option is to apply this same idea but make it a mandatory measure by prohibiting discharge in specified areas. Concerning ***effectiveness***, the smaller the number of high value areas that are identified for protection, and the further they are from common shipping routes, the more likely this approach is to be effective. Thus, agencies might need to choose between more effective provisions for a few select areas (*e.g.*, Fiordland and sub-Antarctic islands) and less effective and possibly impractical attempts to protect a much larger set of high value areas, which could result in burdensome and possibly impractical restrictions on maritime transport.

Regarding ***feasibility***, the requirements for BWE to occur at least 50 nautical miles (nm) from the nearest land and in water at least 200 m depth, as set out in the BWMC, cannot be met by most domestic coastal shipping without significant deviation from schedule and potential delay (see Part A report).

New Zealand has a voluntary CoP that applies only to oil and chemical tankers passing through New Zealand's coastal waters (Land Information New Zealand 2013). The CoP recommends that ships keep at least 5 nm away from land as long as possible and identifies a few high value areas (the Three Kings and Poor Knights Islands) to be avoided.

If preferred locations for discharge were on common shipping routes and voluntary, it might be ***practical*** for most vessels to comply without significant cost provided there is time to discharge without compromising the safety of the vessel as it approaches port. Conversely, it could be difficult to enforce prohibitions on discharges in specified areas if these are near shipping lanes. Essentially, the ***cost of complying*** with preferred or prohibited discharge areas will depend on the extent of the areas so defined, with costs ranging from negligible to prohibitive if they required significant detours. It is also not clear how agencies could monitor compliance; this could involve significant cost if it were possible at all.

Finally, as for BWE, ***safety*** is of paramount importance and on some vessels a safe BWE may only be undertaken under certain weather conditions or may not be undertaken at all.

Further consultation with the shipping industry would be required to understand the practical implications of any requirements for ballast water exchange, as no industry representatives attended the workshops convened for this project.

4.2.4. Accreditation schemes

A fifth option is to encourage the development of a voluntary accreditation scheme for domestic vessels that recognises those that actively reduce biosecurity risk. Such a scheme could involve approval and audit of Vessel Biosecurity Management Plans that address risks from ballast water as well as bilge, biofouling, gear *etc*. A vessel plan would describe the routes the vessel operates on, identify specific organisms of concern and set out risk reduction procedures. For ballast water, these might include mid-ocean exchange, treatment, or avoiding discharge near high value areas. Vessels that meet criteria established by the scheme could be awarded accreditation and entitled to publicise this, subject to regular audit and review. This idea is discussed further below under biofouling and other areas. In the Australian State of Victoria, vessels operating under an accreditation programme run by the state are eligible for reduced fees paid to the state's ballast water programme (see Part A report).

Effectiveness of such a scheme at reducing risk would of course depend on the criteria for accreditation. Accreditation schemes would seem, in principle, to have high ***feasibility***, *i.e.* there are no obvious operational reasons why ships could not develop and implement vessel biosecurity management plans. An accreditation scheme could be established by a non-government organisation in a manner similar to the scheme developed by the Marine Stewardship Council (MSC)[21]. But until such a scheme is in place and been shown to be both practical and effective, it is premature to draw conclusions about such an option.

Compliance ***costs*** associated with accreditation schemes are also difficult to assess until such a scheme were in place. These would have some benefits to vessel operators, however, in that they could use their accreditation in promotional material. There would be some additional costs for setting up and running certification and audit systems.

We expect that ***uptake*** of accreditation schemes, if voluntary, would be moderately low initially and build over time. For example, the MSC fishery certification scheme has, after 13 years, resulted in the certification of 200 fisheries worldwide, but this still represents only 8% of the global wild harvest[22]. The shipping industry is far more concentrated than fisheries, so support from a few major players could result in a high level of uptake in terms of shipping volume.

4.2.5. Risk-based treatment requirements

A final option is to implement provisions akin to those in Victoria, Australia (see Part A report). Under that policy, a vessel master must assess ballast water discharge risk using an online tool and, if discharge is assessed as high risk, the vessel must treat the water prior to discharge using a method approved by Victorian authorities or complete BWE at least 12 nm off the Australian coast.

The ***effectiveness*** of such a policy depends on how good the risk assessment tool is and how it is set (*i.e.* what threshold of risk triggers a treatment requirement). But since not all ballast water would be assessed as requiring treatment, this option would reduce risk less than the first option. ***Feasibility*** is only low to medium, even assuming that New Zealand could develop an online tool for vessel masters to use to assess risk, because BWE is not a realistic option for most New Zealand domestic voyages. In practice, any vessels operating on high risk routes (*i.e.* routes that

[21] See www.msc.org.
[22] http://www.msc.org/business-support/key-facts-about-msc.

triggered the treatment requirement) would need to have on-board treatment systems. Rather than assessing the risk of each voyage, it might be more appropriate to assess each route and to update this as new information comes to hand or as new populations of unwanted species become established. Either way, assessing risk based on the presence of certain species moves away from a pathway approach that seeks to reduce risk wherever practical to do so.

Costs of compliance for vessels would depend on the risk thresholds set in the assessment tool – lower thresholds would trigger more frequent treatment requirements. All domestic vessels carrying ballast might have to install treatment capability, making this little different in practice to the first option. ***Uptake*** would probably be reasonably high if it were mandatory as it is in Victoria.

4.3. Policy recommendations — ballast water

Table 3 presents a summary of the assessment of each of the policy options against the criteria described in Section 2.2 of this report. Note that the assessments are based on information accessed for this study; estimates could be improved with further time and resources. These recommendations apply to any ballast water carried by merchant vessels, some cruise ships, some large fishing vessels, and certain types of drilling rig. While the feasibility and cost of the different options vary by type of vessel, there is insufficient information available at this stage to warrant recommending different policies for different sectors.

Table 3. Summary of assessment of policy options for ballast water. Assessments are generalisations; actual data will vary between and within sector pathways. Many assessments are based on limited information.

Policy options for ballast water	Effectiveness	Feasibility	Cost	Uptake	Other
1. Treatment as per BWMC	High	Varies by vessel type	Varies by vessel type; moderate total cost	High if mandatory	Aligns with IMO rules; transition time required
2. Mid-ocean exchange	Medium	Low	High	Low	Could affect vessel safety
3. Specify areas for discharge — optional	Low-Medium	Low	Medium? Depends on locations	Low	Few suitable areas along NZ coastline
4. Prohibited areas for discharge — mandatory	High	Depends on extent of prohibited areas	Low-High. Depends on locations	Medium-High	Best for remote areas; less practical near ports
5. Accreditation scheme	Depends on scheme criteria; tighter criteria will lead to higher effectiveness but possibly lower uptake, though the small size of the NZ fleet suggests uptake could be reasonably good				
6. Risk-based requirements	Medium	Low to Medium	Depends on risk settings	High if mandatory	In practice could be similar to option 1

Based on the above analysis, treatment of ballast water to reduce domestic spread of harmful marine organisms appears the best option in the medium to longer term. There are two policy options – treatment to the level of the forthcoming IMO standard or treatment to a lower standard – and considerations as to when treatment might be required for domestic voyages.

New Zealand could adopt a lesser treatment standard than the IMO if considerable risk reduction can be achieved at much lower cost. Before developing a different standard, however, more analysis is required of what systems are available, at what cost for different types of vessels, and how much risk reduction can be achieved.

Requiring domestic vessels to retrofit with ballast water treatment capability to meet the IMO BW D2 standard prior to international implementation would be costly and difficult to justify given that overseas vessels present much greater risk. A treatment requirement could be initiated either at the same time as the international convention comes into force, provided there is sufficient lead-in time, or some time subsequent to international implementation of the scheme, *e.g.*, a further five years to allow more time for adapting the existing fleet.

Further investigation and consultation with the relevant sectors is required to assess the feasibility and cost of a treatment requirement for ballast water. The cost per vessel appears to be high at present, though the cost of treatment systems is likely to fall over time as technology advances to meet the IMO D2 standard.

5. BILGE AND RETAINED WATER

Bilge and retained water refers to any seawater that accumulates within the hull of a vessel; including in the engine room of larger vessels (*i.e.* seawater that enters the vessel via the stern glands) and in the bilge sumps of smaller vessels; seawater contained in or on the vessel (*e.g.*, for fish or bait); and uncontained water on the deck area of a vessel, including in gear storage areas. Vessels from all pathways carry bilge and retained water (Table 4) and therefore pose some risk of transporting harmful marine organisms via this mode of infection.

Table 4. Bilge and retained water are relevant for most activities (√) on all pathways.

	Marine transport	Mining & exploration	Commercial fishing	Aqua-culture	Recreation & sport	Research & education
Bilge	√	√	√	√	√	√

Bilge has been identified as a potential mechanism for transferring marine organisms (Darbyson *et al.* 2009, Sant *et al.* 1996b, Schaffelke *et al.* 2005; see Part A report), but the extent of risk is not well understood. The biosecurity risk of bilge water has been subject to very little analysis or discussion in New Zealand. The Part A report provides more detail on the nature of this risk for some of the pathways covered in that report, but further work would be required to better understand the risk from this mode of infection.

5.1. Options to reduce risk

Based on work undertaken by Cawthron Institute for the Ministry of Primary Industries (MPI) and discussion at the two workshops for this project, the following were identified as policy options to reduce the risk of transferring harmful marine organisms in bilge and retained water:

- require the discharge of bilge before moving
- require retention of bilge for discharge to facilities on land
- identify prohibited discharge locations
- require or encourage treatment of bilge.

Each of these options could be implemented under the Biosecurity Act 1993 (BSA) through a national pathway management plan or as part of a code of practice. A deed of agreement might be possible between the domestic maritime transport sector and MPI.

Discharge of bilge could also be regulated via coastal plans under the Resource Management Act 1991 (RMA). Under s 15 of the RMA, discharge of bilge would appear to require a resource consent or authorisation in a regional coastal plan. We did not investigate for this study how regional councils are interpreting or enforcing this requirement at present.

The Part A report also identified “regular flushing with freshwater or an approved treatment as a preventative measure” as an option to reduce risk from bilge water. This is considered here under the fourth option. Flushing with freshwater has also been incorporated into the first option.

5.2. Assessment of options

Discharge before you go

Cawthron has undertaken work for MPI on managing risk from bilge water in Fiordland and concluded that discharging bilge before departing a location would be an ***effective*** method of reducing the risk of marine pest spread via bilge. Bilge and retained water discharged in the same location where it was taken on-board by definition poses a very low risk of spreading marine organisms to new locations. For boat spaces that tend to retain water, flushing with freshwater is recommended prior to departure.

The ***feasibility*** of this approach depends on the ability of a vessel master to discharge all bilge and retained water; some residual bilge water will remain in most vessels and could contaminate new bilge taken on after the discharge. On the other hand, vessels that have continuous bilge pumps are almost by definition discharging their bilge, if not prior to departure, at least en route and probably well before they reach the new destination. So a change in practice might only be required for retained water not in the bilge system and for vessels with manual rather than automatic bilge pumps. Subject to further investigation, this appears to have medium to high feasibility assuming a freshwater supply is readily available.

For similar reasons, ***compliance costs*** for vessel owners would probably be low, but actual compliance would be difficult to monitor by agencies wanting to do so.

The ***rate of uptake*** is likely to be low, perhaps medium at best, because the risk from bilge water has not been well researched and public awareness is low, at least initially. With no practical way to monitor compliance, even a mandatory measure is unlikely to achieve a high rate of uptake.

Any measure promoting ‘discharge before you go’ would rely on an effective education campaign. This might include a check list of things a vessel should do before leaving for a different location.

5.2.1. Require retention for land-based disposal

Many merchant vessels have systems for retention of bilge water, and discharge of these often oily wastes is regulated under marine pollution regulations. According to Maritime New Zealand, all New Zealand ports have facilities for receiving oily wastes[23]. In theory, all vessels could be required to discharge bilge water only to land-based facilities to reduce the risk of domestic spread of harmful marine organisms.

If in fact all bilge water were retained on-board and disposed of only in land-based facilities, ***effectiveness*** would be high. While ***feasibility*** is probably good for merchant vessels that only operate between ports, it would be very low for fishing vessels and probably most other non-merchant vessels as well, because not many have capacity to store bilge and many operate away from the main ports for extended periods. The ***cost of compliance*** would therefore be very high, because vessels would need retrofitting of their bilge systems. Compliance could be difficult to monitor, and ***rate of uptake*** would likely be low.

5.2.2. Identify prohibited discharge locations

Restricting bilge pumping in designated areas could be effective at reducing risk to high value areas in the short term. Other areas would remain at risk however, so overall ***effectiveness*** is only medium.

The majority of bilge systems operate continuously, but can be switched to manual mode, for at least short periods. Therefore, the ***feasibility*** of prohibiting the discharge of bilge water in designated areas would appear to be fairly high.

Ideally, vessel operators would discharge all bilge prior to departure for a new area and turn off the automatic bilge system when entering high value areas. One consideration is that this could pose a safety risk in that the vessel master could forget to re-start the bilge system; a timer on the bilge pump could be one way to address this. There could also be vessels that need to remain in the designated areas for extended periods and need to activate their bilge pumps.

Some vessels are able to retain bilge water on-board for later discharge and treatment at approved facilities, thus avoiding discharge to coastal waters. Cruise ships visiting Fiordland follow this practice, but it is unlikely to be practical for most other vessels.

The ***costs of compliance*** will probably relate more to operational procedures than to financial outlays. The cost to vessel operators of implementation could be fairly modest. For agencies, enforcement would be a matter of monitoring designated high value areas to ensure that vessels are not discharging bilge, which is typically visible at the stern of a vessel. Because compliance monitoring in these areas is feasible,

[23] http://www.maritimenz.govt.nz/Environmental/Oil-and-oily-waste/

and as long as safety and operational efficiency are not compromised, a moderate rate of uptake might be possible if a high level of awareness could be achieved. One way to simplify compliance for agencies and vessel operators would be to apply such a policy only to marine reserves, at least initially, as these areas are already recognised through other legal mechanisms as having high value.

5.2.3. Require or encourage treatment of bilge

Chemical treatment of bilge and retained water might be an option in some cases, but ***effectiveness*** and ***feasibility*** are likely to vary by sector. Bilge and retained seawater come in different forms and require different measures. Options appropriate for some vessels (*e.g.*, adding salt to the bilge area in a wooden boat) are not suitable for others (*e.g.*, aluminium boats), so general guidance and a suite of options are needed. Previous guidance has identified chemical treatment as a non-preferred option because of contaminant concerns; see Section 3.7 of the Part A report.

New Zealand King Salmon Company Limited (NZKS) has an aquaculture biosecurity protocol designed to reduce transmission of disease between regions via movement of gear (see Section 7.2.1); protocols and codes of practice (CoPs) such as these could be adapted to also include measures to manage bilge and retained water.

While several cost-effective 'off-the-shelf' bilge treatment options are available, the use of bleach, detergents, or other chemicals for treating bilge water should be assessed by relevant authorities prior to recommending for widespread use. Assessment should include the legality of discharging the chemicals into the sea; the relative effectiveness of those treatments; and the potential toxic exacerbation brought about by chemical reactions between bilge treatments and oily water (New Zealand Marina Operators Association, no date). For example, treatment of bilge water spaces with an Environmental Protection Agency (EPA)-approved compound (ideally a combined detergent and disinfectant) before departure to a different site may be effective.

As with the previous option, the ***costs of compliance*** and hence the ***rate of uptake*** will probably relate more to operational procedures than to financial outlays. If the risk of bilge and retained water can be documented and communicated to vessel masters, and if treatment can be done quickly and easily at low cost, we would still expect only a moderate uptake at best. A high uptake is unlikely because it is difficult to change behaviour (Kollmuss & Agyeman 2002) and it would be difficult to monitor compliance across the many sector pathways. Experience with hull fouling (Forrest, 2013), where biosecurity risks are much more recognised and there is self-interest in vessel efficiency, suggests it is difficult to get owners of all but the largest commercial vessels to adopt voluntary measures that impose some inconvenience on the operator.

A further consideration is whether discharge of chemically treated bilge would need EPA approval and/or a resource consent from the relevant regional council. It is worth exploring whether these discharge rules could be addressed in a pathway management plan to achieve consistency across regions and avoid the need for each regional council to amend its regional coastal plan.

5.3. Recommended policy framework — bilge

Table 5 presents a summary of the assessment of each of the policy options described above. The assessments are based on information accessed for this study; estimates could be improved with further time and resources.

Table 5. Summary of assessment of policy options for bilge and retained water. Assessments are generalisations; actual data will vary between and within sector pathways. Many assessments are based on limited information.

Policy options for bilge and retained water	Effectiveness	Feasibility	Cost	Uptake	Other
1. Require discharge before departure	High	Medium-high	Low	Low to medium	Difficult to monitor
2. Require retention for disposal on land	High	Very low	High	Low	Merchant vessels are an exception
3. Prohibit discharge in designated high value areas	Medium	Medium-high	Low	Medium	Could be some safety issues
4. Require treatment of bilge	Likely to vary	Likely to vary	Low	Low to medium	Legal questions and toxicity concerns re discharges

Discussions with users of the Fiordland Marine Area as part of work by Cawthron for MPI suggested that most vessel operators in Fiordland perceive bilge water as unimportant from a biosecurity perspective. Indeed, the question of whether, or to what extent, bilge poses a biosecurity risk was raised several times at the engagement workshops for this project.

Given this, irrespective of practical feasibility and efficacy, compliance with any bilge water measures might be low and, perhaps more importantly, non-compliance would be difficult to verify. To achieve a reasonable level of uptake, therefore, measures to manage bilge would need to be simple and practical and be widely communicated.

In the marine transport sector, merchant vessels already are required to retain oily bilge for discharge to land-based facilities in ports. In general, across all other pathways, the most practical and cost-effective risk reduction measure is for vessels to discharge all non-oily bilge and retained seawater in the area where it was taken on-board, and to wash down all deck areas (with freshwater if possible) prior to departure for other areas. The use of chemical treatments may also be appropriate as an additional precaution where approved by the relevant authorities.

It is impractical to require via regulation the discharge and/or treatment of bilge prior to departure, but it should be promoted as good management practice through CoPs. As noted above, a significant communications effort would likely be required to raise awareness of the issue and recommended practice.

Information could be made available at locations frequented by sport and recreational vessel operators, for example, boat ramps, fuel berths, and dive-bottle filling stations. Uptake could be increased by providing washing facilities and/or disinfectants at boat launching areas, particularly in high-risk or high-value locations.

New Zealand's Clean Boating Programme[24], developed by the New Zealand Marina Operators Association, provides guidance on bilge water management for reducing pollution. Recommended practices include keeping bilge free of oil, preventing water entering the boat, use of bilge socks to soak up oil, and avoiding discharge of oily bilge. To this could be added advice regarding wash down and discharge of all bilge prior to departure.

Prohibitions on discharge of bilge in specified high value areas could also be considered for inclusion in national or regional pathway management plans, to underpin the voluntary measures. Exceptions would likely be needed to allow for discharges to maintain the safe operation of the vessel.

[24] www.cleanboating.org.nz

6. HULL BIOFOULING

Hull biofouling refers to the accumulation of aquatic organisms on the hull and other submerged areas of vessels in the marine environment. The risk of marine pest spread via hull biofouling applies to all pathways (Table 6).

Table 6. Hull biofouling is relevant for all pathways.

	Marine transport	**Mining & exploration**	**Commercial fishing**	**Aqua-culture**	**Recreation & sport**	**Research & education**
Hull fouling	√	√	√	√	√	√

Biofouling can lead to the spread of harmful marine organisms either a) through passive (unintentional) discharge of reproductive or other viable organic material or b) through the intentional removal of biofouling through hull cleaning during which viable material enters the marine environment, survives and becomes established. Different measures are required to address these two situations; these are described separately below. First, though, New Zealand policy on hull fouling on vessels arriving from overseas is described to set the context.

6.1. Craft Risk Management Standard

As indicated in Section 3.1.5 above, the Ministry of Primary Industries (MPI) is working toward the introduction of a Craft Risk Management Standard (CRMS) that will specify requirements for managing biofouling on vessels entering New Zealand territorial waters.

Under the CRMS, all vessels will be required to complete a biofouling declaration prior to entering New Zealand and to have a clean hull on arrival or demonstrate equivalent risk reduction. Clean will be defined as entailing only limited biofouling growth, although there are likely to be different criteria for vessels with short turnaround in New Zealand ports (*e.g.*, commercial ships staying less than 20 days) and for vessels intending longer stays. The latter will be allowed only a slime layer and goose barnacles. The declaration will provide information on the vessel's recent operational profile, its biofouling management history and intended length of stay in New Zealand. Some of this is already collected under other provisions of the Biosecurity Act 1993 (BSA), but the CRMS will provide more comprehensive data.

Intended for release in 2013, the CRMS is proposed to enter into force in 2017. The 4-year lead-in period will allow time for ship operators to implement improved regimes for managing biofouling and for better technologies and capability to be developed for hull maintenance and cleaning both within New Zealand and overseas. During the transition phase, MPI has indicated that it will take action only against vessels arriving from overseas with biofouling that it considers poses a severe risk to New Zealand resources (Liz Jones, MPI, pers. comm.).

The CRMS will list three ways in which vessel operators can meet the requirements for a clean hull:

1. Cleaning before visit to New Zealand. All biofouling must be removed from all parts of the hull and this must be carried out less than 30 days before arrival to New Zealand (or within 24 hours of arrival in a facility approved by MPI)
2. Continual maintenance using best practice including regular application of anti-foul coatings, operation of marine growth prevention systems on sea-chests, and in-water inspections with biofouling removal as required
3. Application of approved treatments.

Alternatively, a vessel operator may submit, for MPI approval, a Craft Risk Management Plan that describes steps that will be taken to reduce risk to the equivalent degree as meeting the other requirements of the CRMS. This was recently done for an oil rig that arrived in New Zealand waters earlier this year (Hopkins *et al.* 2013).

At this stage, the CRMS does not extend to vessels or rigs arriving to operate in New Zealand's Exclusive Economic Zone (EEZ), unless they also arrive at a destination in the Territorial Sea. However it is expected that, under the EEZ Act 2012, MPI could direct vessels arriving in the EEZ to deal with biofouling or prevent defouling activities where it assesses that there is sufficient biosecurity risk.

The CRMS will reduce the risk of organisms being introduced via biofouling on vessels arriving from overseas and, to some extent, the risk that overseas vessels will spread organisms that are already present in New Zealand. However, as overseas vessels constitute only a small fraction of total vessel traffic within New Zealand, the greater risk of spread is from domestic vessels. Even though most of these stay within their home region (see Part A report), local movements can still spread harmful organisms from port environments to more remote areas. Thus, regardless of how vessels arriving from overseas are managed, measures to manage the domestic spread of harmful organisms by biofouling would appear to be warranted.

Unlike ballast water, where older vessels will need to retrofit new technology to comply with International Maritime Organisation (IMO) guidelines, most vessels can comply today with improved practices such as those recommended in the IMO biofouling guidelines. However, new technology might be required for some vessels (*e.g.*, those that are too large for dry dock facilities in New Zealand and therefore require in-water cleaning).

6.2. Policy options for managing biofouling — passive discharge

The following options have been identified for managing the risk of domestic spread of harmful marine organisms via hull biofouling:

- restrict the movement of vessels that exceed a threshold level of fouling, including the ability to post 'no movement' notices on heavily fouled vessels
- require all vessels to adopt and comply with an approved biofouling vessel management plan that includes anti-fouling at regular intervals
- require vessels to report intentions to enter specified high value areas and to ensure that biofouling does not exceed a specified threshold level.

As discussed below, these options may be implemented under one or more of several statutory or voluntary tools. These could be, for example, rules in a coastal plan under the Resource Management Act 1991 (RMA), a pathway management plan under the BSA, or vessel management plans as part of a voluntary industry code of practice.

6.3. Assessment of policy options for biofouling — passive discharge

6.3.1. Restrict the movement of heavily fouled vessels

Heavily fouled vessels can present high risk. Movement restrictions could involve requiring a resource consent for the movement of any heavily fouled vessels within and between regions, perhaps with a *de minimis* distance to allow movement to a contained facility for cleaning. This would apply to all vessels whether they were moving within, into or away from a region. Biosecurity authorities could be empowered to place a notice on a heavily fouled vessel that prohibits movement except for the purpose of traveling to a cleaning facility. For example, a heavily fouled boat would not be allowed to leave a port or marina. Rules in RMA plans or a pathway management plan under the BSA could require heavily fouled vessels to have remedial treatment (*i.e.* to be at least cleaned, and perhaps anti-fouled) prior to being moved to a new location.

The definition of 'heavily fouled' (or a similar term) could follow a simple system used in New Zealand to classify biofouling (Floerl *et al.* 2005). That system refers to six levels of biofouling (LOF) starting with no visible fouling (LOF 0), followed by slime that contains no macrofouling (LOF 1) through to very heavy biofouling (LOF 5). See Appendix 1 for details.

Piola and Forrest (2009) suggested that a vessel could be deemed high risk if hull biofouling reaches or exceeds LOF 4, although this analysis was for recreational vessels rather than merchant ships. At LOF 4, biofouling is advanced to the point that there has clearly been a failure of any anti-fouling coating and an increased likelihood of harmful marine organisms being present. Vessels with fouling to this degree also have a heightened risk of sloughing of organisms to the water column and seabed from physical forces during in-water transit (Coutts *et al.* 2010a, Coutts *et al.* 2010b) and loss of organisms when removing the vessel from the water for maintenance (Coutts *et al.* 2010c). There is also a greater risk of emission or loss of propagules of biofouling species as a result of physical disturbance or change in environmental conditions (*e.g.*, during voyage between source and destination (Hopkins & Forrest 2008)).

Even where LOF <4, however, vectors can be contaminated by harmful marine organisms. Vessels with good maintenance on external hull surfaces may have heavy fouling in sea chest cavities and other niche areas; see discussion in the Part A report. Domestic measures could therefore be aligned to the CRMS and require vessels to be free of visible macrofouling. However, extensive biofouling is prevalent amongst recreational vessels (Forrest, 2013).
Adopting a 'clean hull policy' for domestic vessels, or even restricting movement of vessels with LOF 3, is therefore not realistic at this time. The option considered here is to start with a policy of restricting movement of heavily fouled vessels (LOF $\geq$ 4) and considering tightening this over time.

Only Auckland, Lyttleton and Whangarei have dry dock facilities for large vessels. Given the speed with which biofouling can develop, a fouled vessel would need to be permitted to move to a different region for cleaning, although there could be a requirement to inspect the vessel prior to movement to check for unwanted organisms. Vessels or drilling rigs with LOF $\geq$ 4 that are too large to be dry-docked in New Zealand would need a risk assessment and approval from MPI or the relevant regional council to move between regions; more on this below.

Such an approach could be strengthened by a code of practice (CoP) for marinas that includes a requirement, as a condition of berthage, that vessels maintain a clean hull (*e.g.*, LOF $\leq$ 2, which is a slime layer with minor macrofouling in niche areas). Other sectors could also be encouraged to adopt corresponding CoPs. For instance, the aquaculture industry has CoPs that could be amended to specify that vessels should have LOF $\leq$ 2 and should maintain their anti-fouling paint in accordance with a vessel biofouling plan as part of an environmental CoP. This would establish having a clean hull as good practice while using regulatory measures against the worst offenders.

Slow-moving vessels have been associated with a number of high profile biosecurity events (Coutts *et al.* 2010a, Sinner & Coutts 2003). Under this option, slow-moving vessels would be subject to at least the same fouling restrictions as other vessels (*i.e.*

not allowed to move if LOF ≥ 4). Because of their typically long residence times in any given area, a more stringent standard for barges could be justified. In addition, barges are often used for activities that are consented under the RMA (*e.g.*, large construction projects or forestry harvesting) and therefore consent conditions could include provisions for marine biosecurity including hull maintenance for barges.

For very large vessels (*i.e.* too large for dry dock facilities in New Zealand), it will not always be feasible for vessels to meet a strict biofouling standard. Such vessels could be required to comply with an approved biosecurity management plan or undertake a biosecurity risk assessment before moving. Such an approach is found in the proposed regional coastal plan for the Kermadec and sub-Antarctic Islands (DOC 2012), which contains policies and rules to minimise biofouling risks posed by vessels operating within one kilometre of the islands. Under Policy 3, access within one kilometre is granted only to those vessels that can either[25]:

- provide evidence of a dry dock cleaning and hull maintenance regime, appropriate to the vessel and its operating environment, that is consistent with the specifications of the manufacturer of the anti-fouling system and,
- demonstrate that vessels present a low risk of introducing organisms not native to the islands by an in-water diver inspection and certification; or,
- obtain a discretionary coastal permit — for which the application must include an independent risk assessment by a qualified contractor.

In terms of ***effectiveness*** at reducing risk, given the risk that would remain from biofouling on other vessels, restricting movement of vessels with LOF ≥ 4 would probably have low-medium effectiveness at reducing domestic spread of marine organisms. However, effectiveness would increase over time if the threshold were lowered, *e.g.*, to LOF ≥ 3.

From the perspective of ***feasibility***, there would seem to be few technical or practical impediments to vessel owners maintaining vessels to a higher standard. Availability of facilities can be an issue for very large vessels and for vessels resident in more remote locations, but mostly this is just a matter of planning and booking in advance.

There would be some ***cost of compliance*** for both vessel owners and agencies. Forrest (2013) found that 15-30% of recreational vessels in Nelson and Marlborough marinas were heavily fouled, so a substantial number of vessels owners would have to spend more on boat maintenance than they are at present. And, given the prevalence of heavily fouled vessels, MPI or regional councils would need to expend

[25] Note that this wording is taken verbatim from the proposed regional plan. The use of 'and' after the first bullet point and 'or' after the second leaves ambiguity as to how these alternatives are grouped. It appears, however, that the intent is that the first two conditions must both be met or the vessel operator must obtain a discretionary coastal permit (as opposed to the first condition and either of the second or third).

some time and resources on compliance activities or risk having the regulations ignored.

With sufficient resources devoted to compliance, the ***rate of uptake*** might be medium increasing to medium-high over time. Compliance is most easily monitored while vessels are berthed, and agencies could impose ‘no movement’ notices on the most heavily fouled vessels. A few well publicised cases would help to raise awareness and improve rates of compliance.

6.3.2. Require vessels to implement a biofouling management plan

A second option is to require vessel operators to implement an approved biofouling management plan (BMP) in line with international measures such as the forthcoming IMO guidelines (see Section 3.5.2 of this report). This would apply to all vessels that remain in the water for an extended period, *e.g.*, more than 90 days. Such a plan could require vessel operators to undertake agreed actions to reduce marine biosecurity risks *e.g.*, anti-fouling at an interval of 12 months or other interval consistent with paint specifications and operational requirements. This plan could be combined with the ballast water management plan, discussed above (Section 3.5.1), to create a whole-of-vessel BMP. If accompanied by an accreditation scheme, whole-of-vessel biosecurity management plans would provide vessel owners and possibly an entire industry with achievements that could be used in marketing campaigns.

If BMPs such as these were developed, approved and implemented, then biosecurity ***effectiveness*** would be medium to high. For most (but not all) vessels, maintenance at an interval recommended by the manufacturer of the anti-fouling paint would probably achieve the same or better results as requiring vessels to have a LOF $\leq$ 3.

As for ***feasibility***, the majority of commercial vessels have low levels of biofouling due to the economic costs associated with hydrodynamic drag resulting from a fouled hull (AMOG Consulting 2002). As a result, most marine transport vessels already undertake regular anti-fouling, so compliance of that sector with such a scheme would likely be high and additional costs likely to be low.

Recreational vessels could be required to carry their BMPs while sailing and to maintain records of compliance with the plan (*e.g.*, receipts from the most recent application of anti-fouling paint).

The main practical issue is how the BMPs would be approved. Those selling and/or applying anti-fouling coatings would seem to be well-suited, although others could be accredited to approve plans as well (*e.g.*, harbourmasters and marina operators). Forms and procedures would need to be developed, and a training and accreditation programme, with some central government staffing to oversee implementation.

There would be some ***costs of compliance***. A large number of recreational vessels would probably need more frequent anti-fouling than is presently done, and hence there would be an increased cost to owners of these vessels. There would also be substantial agency costs for establishing and maintaining a vessel register and record of approved biosecurity management plans. Monitoring compliance could be challenging, since vessels are usually unattended when moored and therefore papers cannot be inspected. Monitoring could be done on the water, much as fisheries inspectors do random checks of compliance with fisheries regulations.

The ***rate of uptake*** is difficult to predict. Public information campaigns have been successful overseas at controlling the spread of harmful marine organisms. In Arizona, USA, for example, the 'Don't Move a Mussel' campaign helped prevent the spread of quagga mussels and zebra mussels by encouraging boat operators to voluntarily clean, drain, and dry trailered watercraft between waterbodies. The measures were made compulsory in 2009[26]. The State of Minnesota has a similar campaign, also backed up with regulatory measures (see Section 4 above).

In New Zealand there is some research that suggests that public information campaigns have little effect on the number of heavily fouled recreational vessels. A survey in the Nelson and Marlborough regions in early 2013 showed that 15-30% of recreational vessels were heavily fouled both before and after a public awareness campaign targeted at boat owners to clean their hulls (Forrest 2013). This suggests that mandatory measures are likely to be required to achieve a high rate of uptake for regular anti-fouling. Since there is currently no registration or licensing requirement for non-commercial vessels, a requirement to have an approved biosecurity management plan could encounter substantial public opposition. This could undermine the rate of uptake of such a measure.

6.3.3. Require vessels to report intentions to visit high value areas

A third option for managing biofouling is to require vessels to report their intentions to visit specified high value areas, at which time they would be advised of the importance of having a clean hull. This would best be done in conjunction with one of the first two options, so that the relevant agency (*e.g.*, MPI, a regional council or Department of Conservation [DOC]) can advise vessel operators of their biosecurity obligations and to improve agencies' ability to monitor compliance. Visits to some high value areas could require prior approval, possibly involving an inspection to confirm the vessel has a clean hull. This is essentially the approach administered by DOC for the sub-Antarctic islands, discussed under the first option above.

Effectiveness of such an approach would be moderately high for the designated areas, and would be highest for the most remote areas because these would be less vulnerable to natural spread from 'undesignated' areas nearby. Remote areas are

[26] http://www.azgfd.gov/h_f/zebra_mussels.shtml

also visited by only a small number of vessels, so compliance is easier to monitor. It is difficult to say whether designating more areas would increase or reduce overall effectiveness. It could detract from the perceived 'specialness' of the requirements to protect places like the sub-Antarctic islands, but it could also help to increase awareness that extra care is required when visiting all of New Zealand's high value areas.

There are no technical or legal obstacles to setting up an intentions register and requiring vessel operators to use it: ***feasibility*** would be high. Environment Southland already has a voluntary online intentions register for vessels traveling to Fiordland, although awareness is low and only a few vessels have used it (Derek Richards, Environment Southland, pers. comm.). Commercial fishers and others that visit a high value area frequently could be allowed to register multiple trips at one time (*e.g.*, up to a year's worth of fishing trips). The information in the register could be used to target inspections of vessels that are suspected of having poor maintenance practices, as it is not unusual for harbourmasters and others to be aware of vessels that are used infrequently and not well maintained. If prior approval is required for areas that are visited frequently, this would reduce feasibility as it could be difficult for agencies to process applications quickly enough to satisfy public expectations.

The ***cost of compliance*** for an intentions register would be low if the process were kept simple; *e.g.*, if frequent visitors were able to register once per year. Adding the need for approval for some high value areas would add to the cost of compliance.

While the cost of such a system would be relatively low, even with some establishment and promotion costs, it would need to have a high ***rate of uptake*** to be effective. The Southland experience noted above suggests that achieving this will not be easy. The owners of vessels with the worst biofouling might be among the least likely to comply with an intentions register. One option would be to have a voluntary register for a period of, say, three years, with an active communications programme, after which it would become mandatory. It would also be advisable to start with only a few designated areas, to minimise public resistance, and then consider adding other high value areas once the system is working.

6.4. Recommended policy framework for biofouling — passive discharge

Table 7 summarises the assessment of the three options described in the previous section. A requirement for vessels to prepare and follow an approved BMP appears the best single option, but could encounter substantial public resistance to an idea with similarities to registration or licensing. Instead, we recommend that all three options, or the first and third, could work well together, and should be complemented by education initiatives and incentives. Vessels that are poorly maintained would be subject to movement controls unless they can demonstrate compliance with an approved BMP.

Table 7. Summary of assessment of policy options for passive discharge from biofouling. Assessments are generalisations; actual data will vary between and within sector pathways. Many assessments are based on limited information and could be improved with further analysis.

Policy options for biofouling – passive discharge	Effectiveness	Feasibility	Cost	Uptake	Other
1. Restrict movement of heavily fouled vessels (LOF ≥ 4)	Low to medium; would increase if threshold lowered over time	Medium to high	Increased cost for poorly maintained vessels	Probably medium initially; could improve with education and enforcement	Complement with CoPs to establish LOF ≤ 2 as good practice. Consent conditions for operations using barges
2. Require BMP	Medium to high assuming compliance with plans	Medium to high	Increased paperwork for all vessels and higher cost for some; agency cost could be substantial	Probably low initially; could improve with education and enforcement	Requires programme to approve vessel plans; could face strong public opposition
3. Require vessels to report intentions to visit high value areas and obtain prior approval for some (in conjunction with 1 or 2)	Medium-high (for defined areas)	High	Low	Probably low if voluntary, medium or better if mandatory	

Some central government coordination would be needed to establish procedures, forms and training for approval of vessel BMPs. The feasibility of movement controls would depend on the level of fouling to be controlled. Controls on movements of boats with LOF ≥ 3, or macrofouling cover of > 5% of hull area, for example, would be impractical given that many (if not most) vessels in the country would not meet the standard, resulting in an overwhelming task for compliance officers. We recommend starting with movement restrictions on vessels with LOF ≥ 4 and signalling an intention to move to controls on vessels with LOF ≥ 3 in the future.

This could be complemented with CoPs to encourage operators to maintain their vessels to LOF ≤ 2 through regular cleaning at shore-based facilities. Research and educational organisations, for example, should be encouraged to develop BMPs for all non-trailered vessels and wash-down and sterilisation protocols for trailered vessels. Large vessels, such as drilling rigs, wanting to move between regions within New Zealand could undertake a risk assessment and obtain approval that their fouling does not pose a risk to the destination region.

Special provisions, such as an intentions register and a more stringent biofouling threshold, could be made for highly valued areas. Experience in Southland suggests that an intentions register would need to be mandatory to be effective, although this could be preceded by a period during which it is voluntary.

To summarise, to manage risks from passive biofouling on vessels, five complementary measures could be implemented:

- provide education and/or incentives for use and maintenance of antifouling coatings that are suited to the vessel's activity
- encourage regular cleaning of vessels in approved shore-based facilities, particularly prior to movement to another region
- require vessel operators to follow an approved BMP (as recommended by the IMO)
- require vessel operators to notify authorities in advance of intentions to visit specified high value areas, some of which could require approval and possibly an inspection
- impose movement controls on vessels that exceed a threshold LOF unless they can demonstrate compliance with an approved BMP.

6.5. Policy options to reduce risk — hull cleaning

In addition to passive (unintended) discharge of viable organisms from biofouling on vessels, discharge also occurs during the active removal of biofouling from hulls and other surfaces on vessels, hereafter referred to as 'hull cleaning'. As all vessels accumulate biofouling to a greater or lesser degree, and this fouling must be removed at some point to maintain efficient vessel operation, the risk of marine pest spread via hull cleaning applies to **all pathways**.

The nature of the biosecurity risk from hull cleaning, as presented by various sector pathways, is described in the Part A report.

Under s 15 of the RMA, in-water cleaning within the coastal marine area of New Zealand may only be carried out if authorised by the relevant regional council in a regional plan or via a resource consent. Based on Regulation 4 of the Resource Management (Marine Pollution) Regulations 1998 and a judicial decision regarding in-water cleaning[27], our understanding is that RMA plans cannot legally include a permitted activity rule for the deposition of biofouling associated with hull cleaning. However, the new provisions for pathway management plans might be able to be used to allow in-water cleaning in specific circumstances. We recommend that MPI obtain legal advice on this question, as it might be necessary to amend the Marine Pollution Regulations to create an appropriate legal framework for managing the biosecurity risk from hull cleaning activities.

If it is possible to allow some in-water cleaning, the question becomes under what circumstances it should be allowed. In an ideal world, all hull cleaning of vessels would occur at land-based facilities that have appropriate containment systems in place (*e.g.*, settling tanks, filters) to ensure that organic material (*e.g.*, > 50µm) is not discharged to the coastal environment. In practice, some vessels and drilling rigs are too large for any dry dock facility in New Zealand, and for the owners of many other vessels the cost of land-based hull cleaning is a disincentive to regular maintenance. While commercial vessels have mandatory survey requirements and associated maintenance schedules, and well as commercial incentives to minimise fouling in order to reduce friction and maintain fuel efficiency, recreational vessels owners have no survey requirements and generally weaker incentives for fuel efficiency than do commercial operators.

As a result, anecdotal evidence suggests there are many vessels that undertake in-water cleaning, including on tidal grids and careening on beaches, and many others that allow heavy fouling to develop prior to cleaning. This is despite the fact that haul out is much cheaper for vessels < 20 m than for large vessels and there are many facilities where the work can be done (see Appendix 2 to Part A report).

Recognising these circumstances, a study for MPI recently assessed the biosecurity and chemical contamination risks of in-water cleaning, including of domestic vessels (Morrisey *et al.* 2013). Vessels cleaned in their port of origin were considered to present relatively low biosecurity risk. Consequently, the study recommended that recreational and commercial vessels with LOF ≤ 3 and biocide-free anti-fouling systems be encouraged to in-water clean with capture of waste before departure to a new port (ibid*.).* The same study advised that, for both commercial and recreational vessels with LOF > 3, in-water cleaning in the receiving port is considered unacceptable, even when capture technologies are used.

[27] The case concerned the defouling of the Ocean Patriot mobile platform in Tasman Bay (Nelson City Council v Diamond Offshore Netherlands BV [2009] CRN08042500436).

Drawing upon this study and other work, in June 2013 the Australia-New Zealand Standing Council on Primary Industries (SCoPI) endorsed guidelines for anti-fouling and in-water cleaning of vessels. The guidelines were jointly developed by Australian government departments and the New Zealand Ministry for Primary Industries, in conjunction with industry stakeholders from Australia and New Zealand[28], and were in draft form for many years. The guidelines include a tool to assist local authorities to make decisions about in-water cleaning practices within their jurisdictions.

The guidelines (SCoPI 2013) state that:

- Microfouling (*i.e.* a slime layer), regardless of origin, may be removed without the need for full containment of biofouling waste, provided the cleaning method is consistent with the coating manufacturer's recommendations. Where microfouling is removed using a gentle, non-abrasive cleaning technique, the contamination risk is likely to be acceptable.
- Macrofouling of regional origin (as defined by the relevant authority) may be removed without the need for full containment of biofouling waste provided the cleaning method is consistent with the coating manufacturer's recommendations and the contaminant discharges meet any local standards or requirements.
- Macrofouling of domestic origin may be removed without the need for full containment of biofouling waste following risk assessment by the relevant authority. If the relevant authority determines containment of biofouling waste is required, capture and on-land disposal of organic matter > 50 micrometres in diameter is recommended. In either case, the cleaning method must be consistent with the coating manufacturer's recommendations and contaminant discharges must meet any local standards or requirements.

The SCoPI guidelines also suggest that if non-indigenous species (NIS) are encountered during in-water maintenance, the relevant authority should be notified immediately and cleaning activities ceased. If strictly interpreted, this would require the notification of NIS already well-established in the region (*i.e.* many of the common fouling organisms found on vessels throughout New Zealand) and is therefore not practical or sensible. This guidance also assumes that operators undertaking in-water cleaning activities are capable of identifying marine fouling organisms *in situ*, which can be a challenging exercise even for trained taxonomists.

Accepting that in-water cleaning can be acceptable in some situations, we considered three options to reduce the risk of domestic spread of harmful marine organisms as a result of hull cleaning:

[28] http://www.daff.gov.au/animal-plant-health/pests-diseases-weeds/marine-pests/anti-fouling-and-inwater-cleaning-guidelines

- allow in-water cleaning without containment in defined situations based on the origin of the biofouling,
- allow in-water cleaning with containment and in designated areas if LOF = 2 or 3, with some additional conditions, or
- require containment during in-water cleaning if LOF > 1 (*i.e.* more than a slime layer).

The first option is based on the SCoPI guidelines but is more restrictive than those guidelines for vessels that are heavily fouled. The second alternative is similar but includes some variations that could make implementation more feasible. The third option is a very precautionary approach.

These options address inter-tidal cleaning of small vessels as well as cleaning of larger vessels, *e.g.*, on a mooring or alongside a wharf. The options are only assessed in terms of biosecurity risk, however. Morrisey *et al.* (2013) consider issues of environmental risk from the discharge of contaminants associated with anti-fouling substances, which has resulted in more complex guidance than that found in the SCoPI guidelines.

6.6. Assessment of options — hull cleaning

6.6.1. Allow in-water cleaning without containment in specific circumstances

Considering the advice in Morrisey *et al.* (2013), and the SCoPI guidelines summarised above, in-water cleaning could be allowed as follows:

- for any vessel with a slime layer only (LOF $\leq$ 1)
- for any vessel with biofouling of local origin with LOF $\leq$ 3, unless the fouling is known to include harmful marine organisms not established in the locality
- for vessels with biofouling of non-local origin with LOF $\leq$ 3, and *any* vessel with LOF $\geq$ 4, provided a risk assessment determines that the risk of harmful marine organisms is low, subject to containment of all organic material if indicated by the risk assessment
- all in-water cleaning must be consistent with the coating manufacturer's recommendations and must meet local standard for contaminant discharges
- notwithstanding the above, in-water cleaning would not be allowed in specified places of special value (*e.g.*, marine reserves).

'Local' would be defined based on New Zealand's regional council boundaries, although these are arbitrary in terms of coastal ecology and a case could be made for a much tighter definition (*e.g.*, within 10 to 15 km of the boat's primary residence).

In effect, under this option, for any non-local vessel with LOF $\geq$ 2 and for *any* vessel with LOF $\geq$ 4, in-water cleaning would be a discretionary activity and require a resource consent application or similar authorisation under a biosecurity pathway management plan. Risk assessment for such applications would follow the criteria in SCoPI guidelines (2013), and vessels with LOF $\geq$ 4 would be unlikely to be approved for in-water cleaning.

In terms of ***effectiveness***, this approach would be an improvement compared to the current situation. Slime layers and minor macrofouling can contain non-indigenous marine species that are difficult if not impossible to identify *in situ*, so effectiveness would likely be moderate rather than high.

The need to determine whether biofouling is of local origin raises questions of ***feasibility***. Recreational vessels are not required to maintain log books, so it could prove impossible to enforce compliance with permitted activity rules that distinguish between local and non-local biofouling. Rules could instead allow in-water cleaning of vessels that are domiciled locally and have not been outside the region for more than two weeks since the vessel was last serviced. For vessels that do not maintain logbooks, this will also be difficult to prove, but if an agency has reason to suspect a vessel has been outside the region, it may be able to obtain evidence to that effect. Because of these challenges, feasibility is rated as medium.

Another consideration is the fact that, across New Zealand's regions, there is variable capacity of maintenance facilities and hull cleaning operators (*e.g.*, the number of slipways, large dry dock and haul-out facilities). Nationwide operators with devices capable of capturing defouled material using in-water devices are limited. To our knowledge Diver Services Ltd (Auckland) and New Zealand Diving and Salvage Ltd (Wellington) are the only two companies in New Zealand that have rotating brush tools capable of collecting organic material (Inglis *et al.* 2012; see also Report A).

This option (*i.e.* allowing in-water cleaning for boats with local biofouling up to LOF 3), would keep the cost of maintenance low for small boat owners and facilitate regular cleaning, which in turn reduces the likelihood of heavy fouling developing. It also creates clear expectations and an application process for in-water cleaning of vessels with moderate to heavy fouling.

For some in the recreational sector, the containment requirements when LOF $\geq$ 4 will represent an increase in ***cost of compliance***. As a result, ***rate of uptake*** might still be only moderate, at least initially, but might improve as awareness increases.

For commercial or recreational vessels that routinely travel between regions, compliance with such an approach would add cost to existing survey requirements where moderate fouling (LOF > 2) or fouling with harmful marine organisms develops relatively quickly. It might be possible to develop some risk-based procedures by sector that involve BMPs and record-keeping that would enable regional councils to authorise in-water cleaning quickly, or even in advance for entire classes of vessels that meet specified conditions. This would be consistent with the discussion of BMPs in the previous section on passive discharges from biofouling.

Drilling rigs and other vessels that are too large to be slipped for land-based cleaning in New Zealand typically already require a resource consent for in-water cleaning, and this situation would not change under the approach proposed here unless they had only a slime layer, in which case in-water cleaning would be allowed. Rigs and large vessels with macrofouling that want to move from one region to another within New Zealand would also require a risk assessment to determine whether the biofouling contains species of concern in the destination region. These matters would need to be addressed by regional councils taking into account local populations of marine species and those that may be present in adjoining regions.
As biofouling organisms may survive the de-fouling process (*e.g.*, *Perna perna* de-fouled from the *Ocean Patriot* oil rig (Hopkins *et al.* 2011)), cleaning activities should be carried out before a vessel moves to a different area wherever possible. Because of the lack of dry dock facilities in New Zealand for these vessels, if regional councils do not accept risk assessments that indicate no species of concern, it could impose substantial ***compliance costs*** on mineral exploration activities.

6.6.2. Allow in-water cleaning with capture in designated areas, with conditions

The difficulty of determining the origin of biofouling, and the consequent risk that could arise from uncontained fouling material being removed and left in the coastal environment, leads us to suggest a variation on the first option.

Under this option, in-water cleaning would be allowed as follows:

- for any vessel with a slime layer only (LOF $\leq$ 1),
- for any vessel with biofouling of LOF 2 or 3, provided that:
  - the in-water cleaning is performed in an area designated for that purpose by the regional council
  - all organic matter is captured and disposed of at a landfill or council-provided facility
  - the vessel has not been overseas or outside the region for more than 14 days since the most recent full application of anti-fouling, and
  - the fouling does not include harmful marine species not established in the locality or species that are established locally but being actively managed
- for any other vessel, in-water cleaning can only be done if a risk assessment approved by the regional council determines that the risk of harmful marine organisms is low, subject to containment of all organic material if indicated by the risk assessment

- all in-water cleaning must be consistent with the coating manufacturer's recommendations and must meet local standard for contaminant discharges.

This option would require councils to designate areas for in-water cleaning and, preferably, provide basic facilities for the disposal of biofouling waste. This would allow boat owners to still get the benefit of low-cost maintenance while enabling better monitoring of compliance with conditions, including level of fouling and containment of the biofouling waste.

In terms of ***effectiveness***, this approach imposes tighter restrictions than the first option in terms of containing biofouling waste and limiting in-water cleaning to designated areas.
Effectiveness would likely be moderate to high.

In terms of ***feasibility***, the condition about travel outside the region will be difficult to enforce, but it is at least feasible to prove where a vessel has been based on sightings and activities of those on-board, whereas proving the origin of biofouling, as suggested in the first option, is likely to prove impossible in practice.

This option has a higher ***cost of compliance*** than the first option because it limits the areas in which vessel owners can undertake in-water cleaning and requires containment of waste. It also would require councils to designate areas where in-water cleaning can occur and, if they want to promote the use of these areas, councils would also be encouraged to provide facilities for the disposal of organic waste.

Uptake may be initially less than the first option in terms of the numbers of vessel owners who undertake in-water cleaning, because of the greater restrictions in this option. But because compliance and enforcement would be simplified under this option, uptake might eventually be greater, assuming that councils provide facilities and take enforcement action against those who undertake in-water cleaning outside designated areas.

6.6.3. Require risk assessment for in-water cleaning if levels of biofouling is less than 1

A more precautionary alternative would be to make all in-water cleaning subject to a risk assessment and regulatory approval for vessels with LOF > 1, regardless of origin of biofouling. This would remove the need to identify non-indigenous species and the need to distinguish between biofouling of local vs. non-local origin. The risk assessment would be based on the SCoPI guidelines and therefore it would generally be expected that, after assessment, in-water cleaning with proper containment would be allowed when LOF $\leq$ 3 and no non-indigenous species are likely to be present.

This approach would have high ***effectiveness*** (*i.e.* achieve significant risk reduction compared to current practice). The option also has good technical ***feasibility*** for small to medium-sized vessels, in that it would be straightforward to implement. For those vessels that fail the risk assessment and require land-based cleaning, there are sufficient facilities for all but the largest of vessels (Inglis *et al.* 2012). It would not be feasible, however, for drilling rigs and other very large vessels for which there are no dry dock facilities in New Zealand, so different arrangements would be needed for them if they require cleaning for operational or statutory reasons.

In terms of ***cost of compliance***, this approach would impose greater costs on vessel owners than the first option. For small vessels, the cost of obtaining regulatory approval for in-water cleaning would make it non-viable, and they would face the costs of haul-out if LOF > 1. While these costs are not prohibitive (Inglis *et al.* 2012), they could undermine compliance with such a measure. The ***rate of uptake*** would therefore depend to a considerable extent on the investment in education and compliance activities, including whether agencies would prosecute vessel operators who do not comply.

6.7. Recommended policy framework — biofouling cleaning

Table 8 summarises our assessment of the policy options for managing the active discharge of biofouling from vessels, particularly in terms of in-water cleaning.

The SCoPI guidelines (SCoPI 2013) and Morrisey *et al.* (2013) both recommend allowing in-water cleaning when some macrofouling is present because “it is an effective measure to limit development of biofouling” (SCoPI 2013, p.14). It is likely to be difficult to enforce rules based on a distinction between biofouling of local and non-local origin, so we recommend an approach based on where a vessel has been since its last servicing, and even this is likely to be difficult to enforce. On the other hand, trying to enforce a rule that requires regulatory approval for in-water cleaning for vessels with any macrofouling could also prove politically and practically very challenging. We have therefore presented another option that would allow in-water cleaning in designated areas with containment of biofouling waste, and suggest this could be the best of the three options.

Implementation of any of these options could be done by establishing pathway management plans and/or amending statutory documents such as the Marine Pollution regulations and then using the RMA. At the same time, tighter regulations could be applied to more heavily fouled vessels, particularly those that contain fouling from outside the region or country.

Under any of these options, we recommend that relevant agencies designate high value areas, such as marine reserves, where no in-water cleaning would be allowed.

Table 8. Summary of assessment of policy options for active discharge from biofouling. Assessments are generalisations; actual data will vary between and within sector pathways. Many assessments are based on limited information and could be improved with further analysis.

Policy options for biofouling — active discharge	Effectiveness	Feasibility	Cost	Uptake	Other
1. Allow in-water cleaning without containment in defined circumstances (including whether fouling is of local origin)	Medium	Medium	Low, but increased cost for those who do in-water cleaning infrequently	Medium initially, likely to increase with education &compliance efforts	Drilling rigs and large vessels present special challenges
2. Allow in-water cleaning with containment in designated areas, with conditions	Medium to medium-high	Medium to medium-high	Low to medium; requires some action by councils	Medium-low initially, likely to increase with education & compliance efforts	Drilling rigs and large vessels present special challenges
3. Require risk assessment for in-water cleaning if LOF > 1	High	Medium-high	Moderate	Low-medium, depends on level of enforcement activity	Drilling rigs and large vessels present special challenges

In any situation requiring containment (except for moderate biofouling of local origin), a professional operator should be used to ensure a high standard of work. To facilitate risk assessment of applications for in-water cleaning, councils or MPI could maintain a database of authorised operators that have demonstrated that their system or device meets appropriate containment standards. This would entail some cost, which could perhaps be recovered through a user-pays system.

As suggested elsewhere in this report (Section 5.3), MPI and councils could promote initiatives such as New Zealand's Clean Boating Programme and other programmes. In particular, and relevant to this section, vessel owners and operators could be encouraged to clean their vessel hull when a slime layer has formed (*i.e.* not wait until biofouling becomes more extensive). Vessel operators should also ensure their hull is clean (LOF < 1) before moving to a new location. If it is not clean, they should be encouraged to undergo appropriate maintenance prior to departure lest they encounter restrictions on their movement (see beginning of this section regarding movement restrictions on vessels with moderate to heavy biofouling).

7. MARINE GEAR AND EQUIPMENT

Marine gear and equipment (hereafter referred to as simply 'gear') encompasses a wide variety of equipment used in association with the marine environment, including, for example, diving gear, kayaks and trailered watercraft, fishing gear, ropes and chains, anchors and other ground tackle and marine farming lines. There is a close relationship between some aspects of gear and water (classed as bilge in this report) that is brought on-board with gear and retained on deck spaces of a vessel. Objects that stay in one place for extended periods, such as swing moorings and mussel farm buoys, arguably could be considered as gear but have instead been classed as moveable structures for the purpose of this report.

The risk of spreading harmful marine organisms due to the movement of gear exists for all pathways, but is probably greatest in the commercial fishing, aquaculture and recreational sectors due to the volume of gear movements in those sectors. Good practice generally entails thoroughly drying gear before it is returned to the marine environment, possibly preceded by washing with freshwater. The nature of the risks from gear movement and possible risk reduction practices are described in the Part A report.

Table 9. Marine gear and equipment are relevant modes of infection in all pathways.

	Marine transport	**Mining & exploration**	**Commercial fishing**	**Aqua-culture**	**Recreation & sport**	**Research & education**
Gear	√	√	√	√	√	√

7.1. Options to reduce risk

The following policy options to reduce risk were discussed at the workshops:

- promote codes of practice (CoPs) related to cleaning and treatment of gear
- restrict movement of gear with any macrofouling.

These two options can also be combined, which will be discussed after they are considered separately.

7.2. Assessment of options — gear and equipment

7.2.1. Voluntary codes of practice

Codes of practice could be developed and promoted for all pathways to describe good practice for the management of marine gear and equipment. This could include, for example, washing and/or treatment of all gear prior to deployment in a new area, methods for defouling, containment of defouling where any macrofouling exists, reporting of unfamiliar organisms, and taking extra precautions when risks are particularly high (*e.g.*, before visiting high value areas or after visiting areas where harmful marine organisms are known to be established). To maximise uptake, any such scheme should be accompanied by a public information and awareness raising campaign.

The Ministry of Primary Industries (MPI) already provides guidance to the aquaculture sector on biofouling management of gear through an information sheet (MPI 2013). The sheet recommends that marine farmers avoid moving equipment between regions, or, if this is not possible, clean and sterilise equipment prior to movement using one of several suggested techniques. Another example is the New Zealand Oyster Industry Code of Practice 2007 (Aquaculture New Zealand, 2007b), which includes a guideline that farmers remove biofouling from posts and rails as the crop is harvested or before the farm is re-stocked, and it is noted that farmers should minimise farm discharge (including biofouling) during operations. Farmers are required to dispose of farm waste to an approved disposal site on land. An appendix to the oyster industry CoP contains an Aquaculture New Zealand (AQNZ) CoP for the sea squirt *Styela clava*; this CoP says marine farming equipment should not be transferred from an affected area to a clear area or, if transfer is necessary, “must be inspected, cleaned of all tunicates, washed and dried prior to re-use”.

New Zealand King Salmon Company Limited (NZKS) has an aquaculture biosecurity protocol designed to reduce the transmission of unwanted organisms between or within designated ‘control regions’ pertaining to its salmon farming operations (NZKS 2012). As part of normal operations, prior to leaving a site for a different control zone, every item of equipment (dive gear, personal protective equipment, dip nets, assessment gear, ropes *etc*.) and transport (vessels, vehicles, transport tanks *etc*.) is to be treated as though it is contaminated and the cleaning and disinfection procedure followed accordingly.

Other aquaculture CoPs could be amended to include such provisions for managing the transfer of gear between sites. Cleaning and inspection of gear, for example, could be included as an auditable process. For example, designated persons within companies who have been trained in biosecurity pest identification would assess cleaned gear and sign-off that it is free of macrofouling before movement to a new location.

MPI has a guide for recreational boat operators[29] that provides advice on many aspects of biosecurity management, including not transferring live bait between regions and cleaning gear and equipment before travelling between locations. Many if not most of the recommended practices could apply generically to a wide range of circumstances (*e.g.*, the 'clean, check, dry' advice from the campaign against the spread of the freshwater algae didymo is equally applicable to marine situations).

The research and education sector should be encouraged to consolidate and improve on existing measures by developing auditable CoPs to manage biosecurity risks across their operations. These should include SoPs for field surveys and experimental studies that require assessment of the risks of spreading non-indigenous species (and propose mitigation strategies). Uptake could be encouraged by an awareness campaign at a high level within the organisations (*e.g.*, general managers of operations) and by provision of template examples. Training in the CoPs and independent audit will encourage greater uptake of best-practice within such organisations.

Development and promotion of CoPs would be a ***feasible*** and ***low-cost*** option for managing the domestic biosecurity risk from movement of gear and equipment, but the ***rate of uptake*** and hence the overall ***effectiveness*** would depend on the practicality of specific measures and the extent of any awareness campaigns. Given the diversity of gear and associated practices, and the wide range of locations in which the gear is used, it would be impossible to monitor compliance with CoPs.

7.2.2. Restrict movement of gear with any macrofouling

Restricting the movement of gear with visible macrofouling could be implemented under a pathway management plan under the Biosecurity Act 1993 (BSA), and could emulate the policy recommendations for fouled hulls discussed in Section 7 of this report. In other words, gear that is fouled to a certain degree would be restricted from moving. The simplest rule would be that gear with any visible macrofouling cannot be transferred to a new location without prior approval, which would be based on a risk assessment. This is stricter than suggested for hull fouling for the simple reason that it is much more feasible, in most cases, to clean gear than to clean vessel hulls. For gear that is difficult to clean, alternative provisions might be required (*e.g.*, developing and implementing an approved biosecurity management plan).

The ***effectiveness*** of movement restrictions at reducing biosecurity risk would be high assuming full compliance. Some transfer would probably still occur through microfouling (*e.g.*, larval stages in a slime layer).

In terms of ***feasibility*** and ***cost of compliance***, movement controls could place unworkable requirements on vessel owners in some pathways. For example, in some

[29] http://www.biosecurity.govt.nz/files/pests/salt-freshwater/boaties-guide-to-marine-biosecurity.pdf

cases, fouling of gear can occur below the water line where vessel operators cannot detect it, or in places where it is difficult to access for cleaning. This is particularly relevant for larger vessels with a diverse array of gear, such as fishing boats. A policy involving movement restrictions would need to provide for applications to move gear that might be fouled, which could cover a series of activities over an extended time frame, *e.g.*, with an approved biofouling management plan (BMP) to reduce risk. This might include regular checks for fouled gear as part of a pre-trip checklist for commercial operators and recreationalists alike. The ability to apply for approval would provide practical options under such a policy, but securing approval for an application would entail costs both for applicants and the agencies involved.

For very large gear, especially if it is partially or fully submerged, determining whether it is fouled can be difficult and, if it is, cleaning it would need to comply with any in-water cleaning rules that were in place at the time. For purposes of this discussion, gear of such a size (*e.g.*, a salmon cage), is considered a moveable structure and dealt with in Section 10 of this report.

As with voluntary measures, a public awareness campaign would be an essential component of any mandatory measures restricting movement of fouled gear, which would probably need to be at least on the scale of the campaign against the spread of didymo. While movements of gear would be difficult to monitor, the existence of a rule may help to set expectations and provide a backstop for enforcement action against serious cases, even if rarely enforced.

The ***rate of uptake*** is therefore difficult to predict. But given the diversity of gear movements, low public awareness and inability to monitor and enforce such restrictions, uptake would probably be low unless considerable sums were spent on communications and compliance.

7.3. Recommended policy framework – gear and equipment

Table 10 summarises the assessment of policy options for gear and equipment. Operational requirements vary widely and any generic regulatory controls on movement of gear would be both impractical and difficult to enforce. Targeted measures may be justified to deal with a particular pest incursion; these can be implemented as and when appropriate using risk-based measures under the BSA such as controlled areas.

Generally, the recommended approach would be to encourage good practice through CoPs for industry and research and educational organisations, and awareness campaigns for recreational boaters and fishers. This could be combined with a campaign around hull biofouling, as the messages are closely linked. Realistically, however, the poor response to communications efforts concerning hull biofouling (see

Section 6.3.2) has not been very encouraging. Experience in developing and implementing voluntary measures would provide information on the cost, practicality and uptake of risk reduction measures and could thus provide a basis for considering whether any mandatory measures are warranted.

Table 10. Summary of assessment of policy options for gear and equipment. Assessments are generalisations; actual data will vary between and within sector pathways. Many assessments are based on limited information and could be improved with further analysis.

Policy options for gear and equipment	Effectiveness	Feasibility	Cost	Uptake	Other
1. Codes of Practice	Depends on measures and uptake	Medium to High	Low, but could spend large sums on communication	Depends on practicality of measures and communication	Very large gear treated as structures; see Section 10
2. Restrictions on movement of gear with macrofouling	High if fully complied with	Low to medium	Medium to high	Low to medium	

Ultimately, some mix of voluntary and mandatory measures may prove the best approach. (*e.g.*, relying on codes of practice to provide the main motivation but supporting this with regulatory restrictions on movement of heavily fouled gear, *e.g.*, with LOF > 4 initially and moving to LOF > 3). This would align with proposals above regarding hull fouling and also serve as a means of signalling community expectations while providing a means to address egregious behaviour.

A mix of these two approaches has been successfully implemented for the management of the freshwater quagga mussel, Dreissena bugensis, in Arizona, USA. Following a successful information campaign that saw most boat operators adopt voluntary measures to clean, drain, and dry trailered boats and gear, the measures were made mandatory (Arizona Game and Fish Department 2013).

Measures to slow the spread of didymo in New Zealand provide a local example. Given its status as an unwanted organism under the BSA, it is illegal to knowingly spread didymo from one location to another, and felt-soled waders were banned in 2008 because of their ability to carry didymo. However, MPI's strategy has been based primarily not on regulation but on a public awareness and behaviour change campaign to encourage freshwater users to 'check, clean and dry' equipment when moving between waterways to slow the spread of didymo[30].

[30] http://www.biosecurity.govt.nz/pests/didymo/control

8. LIVESTOCK AND BAIT

The movement of livestock and bait poses risks for the transfer of harmful marine organisms in New Zealand. For the purposes of this report, 'livestock' refers to marine organisms being held for use or sale including juveniles for growing in aquaculture facilities. It includes harvested fish or other marine species that are returned to the marine environment, even though they may no longer be alive. 'Bait' refers to living or dead organisms or their parts, used to attract target species in fisheries operations. Bait is defined as any organic substance used to attract aquatic prey. Note that management of the spread of pathogens and disease is outside the scope of this report.

Transfer of livestock and bait occurs in the activities of the aquaculture, commercial fishing, research and education, and sport and recreation pathways (Table 11). Aquaculture moves large quantities of livestock and probably has a higher risk profile than other sector pathways because livestock are held in close proximity for farming purposes, which increases the potential for economic losses if a harmful marine organism is transferred to a new location. Most transfers are of spat (*i.e.* seed stock) collected in the wild or transferred from hatcheries and juvenile organisms transferred between farms.

These pathways and the associated risk are described in more detail in the Part A report. We note also that a review of biosecurity management at land-based aquaculture facilities is underway; the results of that review should also be considered along with this report.

Table 11. Major (√) and minor (*) pathways where livestock and bait are relevant modes of infection.

	Marine transport	Mining & exploration	Commercial fishing	Aqua-culture	Recreation & sport	Research & education
Livestock and bait			*	√	*	*

8.1. Options to reduce risk

The following policy options could be used to reduce the risk of marine spread via transfers of livestock and bait:

-
- control movement of livestock or bait between regions,
- certification of biosecurity practices of hatcheries and wild spat operations,

- require record-keeping on transfer of livestock between regions, and/or
- promote good practice for the movement of livestock between regions.

8.2. Assessment of options

8.2.1. Control movement of livestock and bait

Some regulation of movement of livestock already exists through the Fisheries Act 1996, through special permits for harvesting and translocation of fish. Further rules could be developed through a pathway management plan under the Biosecurity Act 1993 (BSA). Such rules could specify the conditions under which transfers would be allowed, including what treatment or testing if any would be required prior to transfer.

The ***effectiveness*** of any movement controls would obviously depend on the nature of the controls (*i.e.* what movements would be allowed and what would not be). If movement of livestock and bait was strictly controlled, biosecurity effectiveness would most likely be high.

Participants at the workshops convened for this project reported that large volumes of fish and spat are moved around the country and the scale of movement varies widely by pathway and by industry. Wild fish harvested for food are rarely returned to the marine environment and thus pose negligible biosecurity risk; the main exceptions are crayfish that are being held for later sale and shellfish spat used for marine farming.

Similarly, large volumes of bait are regularly moved between regions (*e.g.*, fish waste for lobster bait). Almost all of the bait is frozen which substantially reduces the risk of harmful marine organism transfer. While movement restrictions would reduce risk, generic restrictions would be highly disruptive and costly to the seafood sector. The risk is probably already very low and can be better managed by reacting to pest incursions if they occur.

For the sport and recreation pathway, discussions from the workshops convened for this project suggest that the movement of live bait over long distances or between regions is uncommon. Movements are typically of a small distance, with live bait usually being used near its source. Monitoring compliance with mandatory movement restrictions would be costly and difficult to justify given the low frequency of live bait transfers over significant distances.

Thus, for both commercial and recreational fisheries, movement controls on livestock and bait are unlikely to be ***feasible*** or ***effective*** because there is little risk to be managed. Controls would impose large ***costs*** for little gain, and ***uptake*** is therefore likely to be low.

8.2.2. Certification and audit of hatcheries and wild spat collection

There may be a role for biosecurity certification of biosecurity practices within hatcheries and wild spat collection due to their potential to spread harmful marine organisms to multiple locations. Some measures are already being implemented under codes of practice (CoPs) (*e.g.*, the Fin-fish Aquaculture Environmental Code of Practice (New Zealand Salmon Farmers Association Inc 2007)). Under freshwater fisheries regulations, fish transfers between farms are regulated by the Ministry of Primary Industries (MPI) to manage the spread of didymo. As part of certification, hatcheries and those transferring wild spat could be required to undergo periodic audits.

The ***feasibility*** and ***cost of compliance*** for hatchery operators of mandatory measures would depend on the measures. These could include procedures for disinfection of personnel and gear prior to entry and exit of a facility and record-keeping of all stock transfers. Containment could be required in the case of pest outbreaks, but containment beyond normal holding times can add considerable cost and in some cases could be completely impractical.

For wild spat collection, more information is required on the nature of these operations, existing practices to reduce biosecurity risk and the potential for additional measures. For both hatchery and wild spat operations, it would be important for the industry and MPI to identify 'good practice' that could be incorporated into biosecurity management plans as part of a certification scheme.

The ***effectiveness*** of a certification scheme would ultimately depend on the measures it contains; a balance needs to be struck between effectiveness on one hand and feasibility and ***cost of compliance*** on the other, in order to achieve good ***uptake***. There would also be agency costs to consider, in order develop and implement a certification system.

8.2.3. Require record-keeping of transfers of livestock

Records of stock movement can be used in the event of a pest outbreak to trace the source of the incursion and isolate at-risk stocks, which can reduce the need to impose movement bans on an entire sector. Such records provide traceability that might be sought by consumers and thus may also provide some benefit to industry.

Under the Fisheries Act 1996, for purposes of monitoring compliance with the quota management system, fishers must maintain records showing the disposition of all harvests from wild stocks. For biosecurity purposes, records could be required of any transfer of wild or farmed organisms or waste materials (*e.g.*, oyster shells or fish carcasses) that may be returned to the marine environment, including stock from an aquaculture hatchery or processing facility that is returned to the sea (*e.g.*, for on-growing to improve its marketability).

Record-keeping of transfers will not prevent initial transfers of organisms, but it can be ***effective*** at reducing spread by enabling identification of source material. Requiring record-keeping would seem to be low ***cost***, although further consultation with industry is recommended to define what transfers should be recorded and in what form, and to assess the practical ***feasibility*** of doing so and therefore the likely ***rate of uptake***. The aquaculture industry already has CoPs that includes some measures on translocation (see next section), so it would be a matter of building on these.

8.2.4. Voluntary measures regarding movement of livestock

The aquaculture industry has CoPs that include measures concerning the translocation of livestock within the mussel, oyster and fin-fish sectors. These CoPs include preventive measures and, in the case of the mussel industry, additional provisions that are triggered in the case of an incursion of an unwanted marine organism (Aquaculture New Zealand 2007a).

For example, both the mussel and oyster industries have processes for cleaning spat and stock to reduce biofouling. A mussel industry CoP for seed-stock specifies that mussels should be subjected to a de-clumping and washing process before transfer between three geographic regions of New Zealand (Forrest & Blakemore 2002). This procedure greatly reduces or even eliminates macrofouling, but appears less effective against microscopic life-stages (*e.g.*, of *Undaria*) (Forrest & Blakemore 2006; Keeley *et al.* 2009). The oyster industry has a similar process referred to as 'rumbling' (Taylor *et al.* 2005). The fin-fish sector's CoP includes measures, for example, to prevent the spread of *Didemnum* in seawater and operational practices are in place to prevent the potential spread of risk organisms between sites (New Zealand Salmon Farmers Association Inc. 2007).

Aquaculture sector CoPs are described in more detail in the Part A report, although the current rate of compliance with these CoPs is unknown. Research to document the effectiveness of current provisions would be help. The CoPs could then be further developed to describe conditions under which transfers should and should not be undertaken, including what treatment if any would be required prior to movement, and could include some external auditing of compliance.

Research and educational organisations should have auditable CoPs and SOPs for field surveys and experimental studies that require assessment of the risks of spreading non-indigenous species (and propose mitigation strategies), and for managing risks from hatcheries and aquarium facilities.

Codes of practice could be reasonably ***effective*** for managing risk from livestock and bait if they include rigorous measures, assuming the measures are fully implemented, although the risk of transfer *via* microscopic life stages is very difficult to manage. ***Feasibility*** and ***cost*** will depend on the measures included in the CoPs, and could well be at odds with effectiveness. That is, a CoP that is highly effective might be costly and/or not feasible. Conversely, if practical and low-cost measures can be identified that require little or no change to existing industry practice, ***uptake*** could be reasonably good since it is in the industry's self-interest to limit the spread of harmful marine organisms. Enhanced monitoring and reporting of compliance with CoPs (*e.g.*, based on random external audits) would enable both industry and government to target communication and training efforts.

8.3. Recommended policy framework — livestock and bait

Table 12 summarises the assessment of policy options for livestock and bait.

Regulatory restrictions on all movement of livestock and bait could impose significant cost, given the diversity of movements within the seafood industry. Movement of wild fish harvested for food and movement of bait do not appear to pose a significant biosecurity threat and probably do not warrant the imposition of generic controls.

In contrast, the movement of spat and stock for on-growing in other locations is a known mechanism for transfer of marine pests, and precautionary measures that are consistent with good industry practice could be justified to manage this risk.

Table 12. Summary of assessment of policy options for livestock and bait. Assessments are generalisations; actual data will vary between and within sector pathways. Many assessments are based on limited information and could be improved with further analysis.

Policy options for Livestock and bait	Effectiveness	Feasibility	Cost	Uptake	Other
1. Control movement of livestock and bait	Medium-high	Low	High	Low	
2. Certification and audit of hatcheries and those transferring wild spat	Medium-high, depends on measures	High	Medium	High if mandatory	
3. Require record-keeping of transfers of livestock that will be returned to marine environment	Medium	Need to define what transfers would be covered	Low	Medium-high but depends on details	
4. CoPs for movement of livestock	Requires study of existing practices	Medium	Low-medium	Medium, could be increased with random external audits	Assessments depend on actual COP measures

Improved record-keeping and industry CoPs are therefore the preferred options for managing the transfer of livestock including spat, focusing on good hatchery practice, monitoring and reporting of unusual organisms and contingency measures in case of a pest incursion. The aquaculture industry has existing CoPs that can be adapted to include industry-specific as well as general measures aimed at managing the spread of marine pests within domestic pathways. Improved record-keeping of stock transfers would improve the ability to manage pest incursions and could also provide product traceability, which industry could promote in its marketing materials.
MPI can support this approach by alerting industry to emerging biosecurity risks and signs to watch for, as already envisaged under MPI's initiative to establish an emerging risks alert system (MAF Biosecurity New Zealand 2009). The aquaculture sector could in return provide MPI with prompt reporting of suspicious organisms, disease or pest outbreaks, and unexplained stock mortality. This should already be happening, using MPI's toll-free number (0800 80 99 66), as it is a duty under BSA s 44, but there may be scope to increase awareness of this.

A requirement for biosecurity certification of biosecurity practices within hatcheries and those transferring wild spat could be justified because of potential to spread pests quickly to multiple locations. The practical feasibility and cost would depend on the nature of the measures.

In the event of a suspected pest outbreak, it is expected that MPI would take a lead role in implementing appropriate management measures under the BSA, which could include controls on movement of livestock and/or bait between areas.

Although gear, livestock and structures are addressed separately in this report, in the case of aquaculture they are closely linked, and management of biosecurity risks needs to approach these in an integrated way. People can also be a vector for transfer of marine pests and other risk organisms *e.g.*, via contaminated clothing, so human movements should also be included in biosecurity management plans for aquaculture facilities.

9. MARINE STRUCTURES

As defined in the Resource Management Act 1991 (RMA), structure means any building, equipment, device, or other facility made by people and which is fixed to land, and includes any raft. In this report, we also refer to ‘moveable structures’ meaning structures that are generally fixed to land (including the seabed) but can be shifted to another location. Fixed structures thus include wharves, marinas, jetties and buildings in the coastal environment. Moveable structures include objects that tend to stay in one place for months or years, such as marine farming structures (and associated lines, buoys *etc*.), accommodation barges and swing moorings, for example.

Fixed structures are generally not, per se, a mode of transporting harmful marine organisms from one location to another, although moveable structures can be. Even fixed structures, however, play an important role in the spread of marine organisms by providing substrate for colonisation and hence establishment of populations that can then reproduce and infect moving vectors. For that reason, consideration of structures is included in this report.

Because vessels of all types and from all sectors utilise ports and other coastal infrastructure at one time or another, fixed structures play a role in the risk of spreading harmful marine organisms by all pathways. Moveable structures are particularly relevant in the aquaculture pathway.

Table 13. Marine structures are relevant to spread of marine organisms in all pathways.

	Marine transport	Mining & exploration	Commercial fishing	Aqua-culture	Recreation & sport	Research & education
Structures	√	√	√	√	√	√

9.1. Options to reduce risk — structures

The following policy options have been identified to reduce risk associated with marine structures. These measures would be complementary, as they deal with different aspects of risk:

- require new or clean materials to be used for new structures
- restrict movement of structures
- encourage maintenance of structures via codes of practice (CoPs).

9.2. Assessment of options — structures

9.2.1. Require new or clean materials only to be used for construction of structures

An option for limiting spread of harmful marine organisms is to require new structures in the marine environment to be constructed from new or sterilised materials. This could be implemented through the resource consent process.

Such an approach would be highly ***effective*** and is already being used in some regions, so it is ***feasible*** for at least some structures. For example, resource consents for open ocean mussel farms (*i.e.* well offshore) in Hawke Bay, Pegasus Bay and Jacksons Bay have conditions requiring farm construction to use equipment (*e.g.*, ropes, floats) that is either new or has been treated to remove risk organisms. Similarly, a resource consent for oyster farm development in the Kaipara Harbour required a biosecurity management plan which focused on pathway management to reduce the risk of harmful marine organism spread (Taylor *et al.* 2005).

Under this option, where a person wishes to use sterilised rather than new materials, the sterilised materials would need to be inspected and certified by a qualified person prior to installation, although even then the presence of microscopic life stages can be difficult to detect. If implemented via consent conditions, councils would have discretion to determine who is a qualified inspector and what inspection procedures and criteria that person should apply. Guidance on these matters could be provided in a national pathway management plan under the Biosecurity Act 1993 (BSA).

This approach is likely to be effective, practical and of moderate ***cost***, and the ***rate of uptake*** is likely to be good for permanent structures. For structures that get moved periodically, such as marine farming gear, such a provision could effectively mean that gear from one farm could not be used on another, which could impose significant cost and result in a poor uptake or, in a more extreme scenario, driving farmers out of business. Movement of existing structures is therefore addressed in the next option.

9.2.2. Restrict movement of structures

As noted above, some structures or parts thereof are sometimes transferred to another location. The Ministry of Primary Industries (MPI) already provides guidance to the aquaculture sector on biofouling management of structures (MPI 2013). MPI recommends that marine farmers avoid the movement of equipment between regions or, if this is not possible, clean and sterilise equipment prior to movement using one of several suggested techniques. The New Zealand Oyster Industry Code of Practice 2007 (Aquaculture New Zealand 2007b) recommends that farmers remove biofouling from posts and rails as the crop is harvested or before the farm is re-stocked, and notes that farmers should minimise farm discharge (including biofouling) during operations. Farmers are required to dispose of farm waste to an approved disposal site on land.

Because structures often stay in one place for a long time, fouling organisms have ample opportunity to mature and reproduce. Tighter movement restrictions may therefore be justified for structures than for vessels. This could involve requiring prior to movement to another region or substantial distances within a region, that structures be sterilised or undergo a risk assessment and approval. Movement for the purpose of removing the structure from the environment and/or taking it to an on-land cleaning facility would be allowed. Restrictions on the movement of structures could be implemented under a pathway management plan under the BSA or via conditions on resource consents issued under the RMA.

In terms of ***effectiveness***, restrictions on movement of marine structures as described above would be moderately effective at reducing biosecurity risk. It will be difficult to reduce risk to a low level given the likely presence on all marine structures of microscopic stages of some organisms. Removing structures from the water to be cleaned and air-dried on land can be an effective way to kill most fouling organisms, but some species can survive in wetted areas for a long time. See Section 6.2.3 of the Part A report for further discussion on the effectiveness of air-drying. In addition, some structures are too large to be removed from the water without major expense.

Movement controls would probably be technically ***feasible*** but the aquaculture industry could incur significant ***costs*** to clean structures prior to movement. Marine farming structures such as salmon cages and accommodation barges are examples of moveable structures that would be difficult if not impossible to sterilise. Those wanting to move such structures would therefore need to undertake a risk assessment and seek approval from the relevant regional council on the basis that movement would present a low risk of having organisms that are not already established at the proposed destination. The distance of movement that triggers such requirements will affect feasibility of this approach. A short distance such as 10 km would increase technical effectiveness but reduce feasibility, whereas applying such controls to only inter-regional movements would make them more feasible and reduce costs of compliance.

For activities with a relatively high profile, such as marine farming, we would anticipate medium to high ***uptake*** of any mandatory restrictions on movement of structures. Such activities are easily noticed by members of the public and the consequences of being found out of compliance can be significant. On the other hand, activities such as moving a swing mooring or re-using materials from a private jetty in a new location are much harder to detect and the people undertaking them are less likely to be aware of any restrictions on movement. Uptake from the recreational sector is therefore likely to be much lower.

9.2.3. Voluntary measures, for example, codes of practice

Codes of practice and other voluntary measures (*e.g.* awareness campaigns) could be used to promote the regular maintenance of marine structures to reduce the level of fouling. These would cover controlling pest populations on permanent structures but also more stringent practices for any structures or parts thereof to be moved to another location. Codes of practice could include, for example, methods for defouling, containment of defouling, and reporting of unfamiliar organisms.

Moveable structures

As noted above, some guidance already exists on managing biofouling on aquaculture structures (MPI, 2013; Aquaculture New Zealand, 2007b). Codes of practice with similar provisions could be developed to describe good practice for other sectors.

The ***feasibility*** of developing and implementing CoPs is high, but their ***effectiveness*** would be similar (low to medium) to the movement controls described above, for similar reasons. That is, any marine structure is likely to have microscopic life stages and the typically long residence time of structures provides ample time for growth and reproduction.

For moveable structures, for both commercial and non-commercial operators, even if costs can be kept low, experience with hull biofouling suggests that ***uptake*** is likely to be low (see Section 7). On the positive side, in terms of ***costs of compliance***, using a voluntary approach would avoid imposing mandatory measures that could be very costly for some operations.

Fixed structures

In addition to addressing moveable structures, existing CoPs (such as the clean marinas programme) could be amended to include provisions for managing the biofouling of fixed structures, for example suggesting that fouling should be kept below some defined level. There is also research underway into coatings and other methods that could be used to treat fixed structures (see Section 7 in Part A report). To facilitate maintenance of structures, owners should be permitted to undertake routine in-water cleaning provided the structure has not been moved (and therefore the fouling is likely to be of local origin) and water quality guidelines are not breached.

There is only limited research available on the ***effectiveness*** of these methods. In terms of ***feasibility***, the surface area of structures in ports, marinas and marine farms can be vast, with some surfaces very difficult if not impossible to service. For example, an intensive effort to control the well-established *Undaria* population in Bluff harbour was determined to not be cost-effective compared to other options (Sinner *et al.* 2009) and was terminated. The high ***cost*** of controlling fouling on permanent marine structures should be considered in light of the extent of an infestation, the risk it poses of infecting other vessels that could spread the organism and the feasibility of significantly reducing that risk. For example, control of the Sabella population in Lyttleton harbour has suppressed that population to very low levels, which is likely to reduce the inoculum pressure on visiting vessels (Inglis *et al.* 2009).

Because of the cost, the ***uptake*** of voluntary measures to maintain structures is likely to be low except for controlling new and limited populations, where uptake might be better if prospects for limiting infection of other vessels look promising.

9.3. Recommended policy framework — structures

Table 14 summarises the assessment of policy options for marine structures.

We recommend that regional councils require, as a condition of resource consents (or permitted activities in coastal plans, *e.g.*, for moorings) that any new structures in the coastal environment be made using only new or sterilised materials. Existing structures or associated materials that have been in the marine environment should not be moved to another region, or substantial distances within a region, without first being sterilised or undergoing a risk assessment (except for the purpose of removing the structure from the environment and/or taking it to an on-land cleaning facility).

Such a requirement could be included on resource consents where appropriate and otherwise promoted through CoPs and public awareness campaigns. Guidance on these matters could be provided in a national pathway management plan under the BSA. However, such an approach might not be feasible for some marine farming activities, *e.g.*, movement of salmon cages (too big and complex to be sterilised) and transfer of mussel spat on frames (sterilisation would kill the spat). Further consideration and consultation with industry is necessary to identify a workable approach.

Table 14. Summary of assessment of policy options for marine structures. Many assessments are based on limited information and could be improved with further analysis.

Policy options for marine structures	Effectiveness	Feasibility	Cost	Uptake	Other
1. Require new (or fully sterilised) materials for all new marine structures	High	Low to high (varies by sector)	Medium to high	Low to medium-high (varies by sector)	More feasible for fixed structures than moveable
2. Restrict movement of structures — require sterilisation or risk assessment and prior approval	Medium	Low to medium (depends on distance threshold)	Medium to high	Low to medium-high (varies by sector)	
3. COPs for regular maintenance of marine structures	Low to medium	Medium	Medium to high	Low to medium	Could have positive effect on vessel owners' hull maintenance

To prevent heavy fouling from developing, owners of structures should be permitted to undertake routine in-water cleaning provided the structure has not been moved (so the fouling will be of local origin) and water quality guidelines are not breached.

In the longer term, there could be merit in owners of vector hubs such as ports and marinas minimising fouling on structures to reduce the inoculum pressure on vessels, especially in locations where vessels are likely to reside for periods of weeks or months. This could be promoted through CoPs and public awareness campaigns. Given the diversity of artificial and natural habitats in a port environment, effectiveness at reducing risk is likely to vary between ports and costs could be quite high. Each port or marina operator would need to consider the viability and effectiveness of controlling fouling in their own circumstances.

10. REFERENCES

Acosta H, Forrest BM 2009. The spread of marine non-indigenous species via recreational boating: A conceptual model for risk assessment based on fault tree analysis. Ecological Modelling, 220(13-14), 1586-1598.

AMOG Consulting. 2002. Hull fouling as a vector for the translocation of marine organisms. Phase I: Hull fouling research. Ballast Water Research Series, Report No. 14. Canberra, Department of Agriculture, Fisheries and Forestry Australia. 142 p.

Aquaculture New Zealand. (2007a). GreenshellTM Mussel Industry Environmental Code of Practice. Version 06/2007.

Aquaculture New Zealand. 2007b. New Zealand Oyster Industry Code of Practice. 07/06/2007, Version 1.0.

Arizona Game and Fish Department. 2013. Don't move a mussel – NOW it's the LAW. Retrieved 4 June, 2013, from http://www.azgfd.gov/h_f/zebra_mussels.shtml

Biodiverse Limited. 2010. Slowing Pest Spread: Domestic Pathways of Human Mediated Pest Spread and Opportunities for their Management. MAF Biosecurity New Zealand Technical Paper Wellington: MAF Biosecurity New Zealand.

Blake J 1999. Overcoming the 'value–action gap' in environmental policy: tensions between national policy and local experience. Local Environment, 4(3), 257-278.

California State Lands Commission. 2012. Proposed Rulemaking: Amendment to Article 4.8: Biofouling Regulations for Vessels Operating in California Waters Retrieved 5/04/2013, from http://www.slc.ca.gov/spec_pub/mfd/ballast_water/Laws_Regulations.html

Carlton JT 2001. Introduced species in U.S. coastal waters: environmental impacts and management priorities. Arlington Virginia. U.S.A.: Pew Oceans Commission.

Chiswell SM, Inglis GJ, Hayden B 2001. Alternative biosecurity management tools for vector threats: ballast water discharge and exchange areas. Final Research Report, Ministery of Fisheries Research Project ZBS2000/02, Objectives 1, 2 & 3. Wellington, New Zealand.: National Institute of Water and Atmospheric Research.

Coutts ADM, Piola RF, Hewitt CL, Connell SD, Gardner JPA 2010a. Effect of vessel voyage speed on survival of biofouling organisms: implications for translocation of non-indigenous marine species. Biofouling: The Journal of Bioadhesion and Biofilm Research, 26(1), 1 - 13.

Coutts ADM, Piola RF, Taylor MD, Hewitt CL, Gardner JPA 2010b. The effect of vessel speed on the survivorship of biofouling organisms at different hull locations. Biofouling: The Journal of Bioadhesion and Biofilm Research, 26(5), 539 - 553.

Coutts ADM, Valentine JP, Edgar GJ, Davey A, Burgess-Wilson B 2010c. Removing vessels from the water for biofouling treatment has the potential to introduce mobile non-indigenous marine species. [Article]. Marine Pollution Bulletin, 60(9), 1533-1540.

Darbyson E, Locke A, Hanson JM, Willison JHM 2009. Marine boating habits and the potential for spread of invasive species in the Gulf of St. Lawrence. Aquatic Invasions, 4(1), 87-94.

DOC. 2012. Proposed Regional Coastal Plan for the Kermadec and sub-Antarctic Islands. Department of Conservation. 99p. (draft).

Dodgshun TJ, Taylor MD, Forrest BM 2007. Human-mediated pathways of spread for non-indigenous marine species in New Zealand. Department of Conservation Research & Development Series 266 Wellington, New Zealand: Department of Conservation.

Elston RA 1997. Pathways and Management of Marine Nonindigenous Species in the Shared Waters of British Columbia and Washington. A report prepared for Puget Sound Water Quality Authority, U.S. Environmental Protection Agency, Region 10 and the Department of Fisheries and Oceans, Canada Carlsborg, USA.

Floerl O, Inglis GJ, Hayden BJ 2005. A risk-based predictive tool to prevent accidental introductions of nonindigenous marine species. Environmental Management, 35(6), 765-778.

Forrest B 2013. Vessel hull fouling as a marine biosecurity indicator in the top of the south: 2013 monitoring survey: Top of the South Marine Biosecurity Partnership. Final draft report prepared May 2013. 27p.

Gollasch S, David M, Voigt M, Dragsund E, Hewitt C, Fukuyo Y 2007. Critical review of the IMO international convention on the management of ships' ballast water and sediments. Harmful Algae, 6(4), 585-600.

Hayes K, Sliwa C, Migus S, McEnnulty F, Dunstan P 2005. National Priority Pests: Part II. Ranking of Australian marine pests. A report prepared for the Department of Environment and Heritage by CSIRO Marine Research. Accessible from http://www.marine.csiro.au/crimp/reports/PriorityPestsFinalreport.pdf Parkes, ACT, Australia.

Hewitt CL, Willing J, Bauckham A, Cassidy AM, Jones L, Wooton DM 2004. New Zealand marine biosecurity: delivering outcomes in a fluid environment. New Zealand Journal of Marine and Freshwater Research, 38, 429-438.

Hopkins GA, Castinel A, Forrest BM 2013. Marine Biosecurity Craft Risk Management Plan for the Semi-submersible Drilling Rig, Kan Tan IV. Prepared for Frigstad Offshore Pte Limited. Cawthron Report No. 2329. 15 p plus appendices.

Hopkins GA, Forrest BM 2008. Management options for vessel hull fouling: an overview of risks posed by in-water cleaning. ICES J. Mar. Sci., 65(5), 811-815.

Hopkins GA, Forrest BM, Piola RF, Gardner JPA 2011. Factors affecting survivorship of defouled communities and the effect of fragmentation on establishment success. Journal of Experimental Marine Biology and Ecology, 396, 233-243.

Inglis G, Morrisey D, Woods C, Sinner J, Newton M 2013. Managing the Domestic Spread of Harmful Marine Organisms Part A: Operational Tools for Management. MPI Technical Paper No: 2013/xx. A report prepared for the Preparedness & Partnerships Directorate. Ministry for Primary Industries Wellington.

Inglis G, Floerl O, Woods C 2012. Scenarios of vessel biofouling risk and their management. MAF Technical Paper No: 2012/07. A report prepared for MAF Research Project RFP11832. 117p. plus appendices.

Inglis GJ, Floerl O, Ahyong S, Cox S, Unwin M, Ponder-Sutton A. *et al.* 2010. The Biosecurity Risks Associated with Biofouling on International Vessels Arriving in New Zealand: Summary of the patterns and predictors of fouling. Biosecurity New Zealand Technical Paper No: 2008/ XX. A report prepared for MAF Biosecurity New Zealand Policy and Risk Directorate Project RFP0811321.

Inglis GJ, Floerl O, Seaward K, Woods C, Read G, Peacock L 2009. Sabella Local Elimination Programme - Phase 1. Final Assessment Report Prepared for MAF Biosecurity NZ Research Project MAF11199. NIWA, Christchurch. 43pp.

Knight E, Barry S, Summerson R, Cameron S, Darbyshire R 2007. Designated Exchange Areas Project - Providing informed decisions on the discharge of ballast water in Australia (Phase 2). Bureau of Rural Sciences, Australia.

Kollmuss A., Agyeman J. 2002. Mind the Gap: Why do people act environmentally and what are the barriers to pro-environmental behavior? Environmental Education Research, 8(3), 239-260.

Kospartov M, Inglis G, Seaward K, van den Brink A, D'Archino R, Ahyong S 2008. Non-indigenous and cryptogenic marine species in New Zealand - Current state of knowledge: Interim report. NIWA Research Report prepared for MAF-BNZ Project BNZ10740. 25 pp + tables + appendices.

Land Information New Zealand. 2013. Annual NZ Notices to Mariners New Zealand Nautical Almanac 2012-13 (Vol. 2012-13). Wellington: Land Information New Zealand.

MAFBNZ. 2007. Managing and controlling the risk to the marine environment from ballast water discharges. Discussion Paper No: 2007/04. Ministry of Agriculture and Forestry, Wellington.

Morrisey D, Gadd J, Page M, Floerl O, Woods C, Lewis J, *et al.* 2013. In-water cleaning of vessels: biosecurity and chemical contamination risks. MPI Technical Paper No: 2013/11, Ministry of Primary Industries, Wellington, New Zealand. 265 pp.

MPI. 2013. Biosecurity information for aquaculture industries. Wellington: Ministry of Primary Industries.

New Zealand Marina Operators Association. No date. New Zealand's clean boating programme. Available at www.cleanboating.org.nz.

New Zealand Salmon Farmers Association Inc. 2007. Finfish Aquaculture Environmental Code of Practice. Version 2.

NZKS. 2012. Aquaculture Biosecurity Protocol. Available at http://www.epa.govt.nz/Publications/4(c)%20Mark%20Preece%20-%20Operations%20Annexure%203%20-%20v1.pdf New Zealand King Salmon.

Piola RF, Forrest BM 2009. Options for managing biosecurity risks from recreational vessel hubs. Cawthron Report 1591, Cawthron Institute Nelson. 45p. plus appendices.

Polonsky MJ, Binney W, Hall J 2004. Developing better public policy to motivate responsible environmental behavior – an examination of managers' attitudes and perceptions towards controlling introduced species. Journal of Nonprofit & Public Sector Marketing, 12(1), 93-107.

Pricewaterhouse Coopers. 2011. Proposed Australian Biofouling Management Requirements - Consultation Regulation Impact Statement. A report prepared for the Commonwealth Department of Agriculture, Fisheries and Forestry Canberra, Australia.

Reaser JK 2001. Invasive alien species prevention and control: the art and science of managing people. In J. A. McNeely (Ed.), The Great Re-shuffling: Human Dimension of Invasive Alien Species (pp. 89-104). Gland, Switzerland: IUCN - World Conservation Union.

Ruiz G, Carlton J 2003. Invasive species - vectors and management strategies. Washington, DC: Island Press.

Sant N, Delgado O, Rodriguez-Prieto C, Ballesteros E 1996a. The spreading of the introduced seaweed Caulerpa taxifolia (Vahl) C. Agardh in the Mediterranean Sea: testing the boat transportation hypothesis. Botanica Marina, 39(5), 427-430.

Sant N, Delgado O, Rodriguez-Prieto C, Ballesteros E 1996b. The spreading of the introduced seaweed Caulerpa taxifolia (Vahl) C. Agardh in the Mediterranean Sea: testing the boat transportation hypothesis. Botanica Marina, 39, 427-430.

Schaffelke B, Campbell M, Hewitt CL 2005. Reproductive phenology of the introduced kelp Undaria pinnatifida (Phaeophyceae, Laminariales) in Tasmania, Australia. Phycologia, 44, 84-94.

SCoPI. 2013. Anti-fouling and in-water cleaning guidelines: Department of Agriculture, Fisheries and Forestry, for the Australia-New Zealand Standing Committee on Primary Industries.

Sinner J, Coutts ADM 2003. Benefit-cost analysis of management options for Didemnum vexillum in Shakespeare Bay. Prepared for Port Marlborough New Zealand Limited. Cawthron Report No. 924. 5p.

Sinner J, Forrest BM, Piola RF, Roberts B 2009. Fiordland marine biosecurity risk management: operational plan recommendations 2009-2013. Cawthron Report 1621, Prepared for MAF Biosecurity New Zealand and Fiordland Marine Guardians.

Taylor M, Dodgshun T, de Zwart EJ 2005. Biosecurity Management Plan for a Proposed South Kaipara Oyster Farm. Prepared for Biomarine Limited. Cawthron Report No. 1123. 39p.

11. APPENDIX

Appendix 1. Level of fouling.

The following table describes six levels of fouling (LOF) as defined by Floerl *et al.* (2005). The method was initially developed for use by visual assessment of recreational vessels from the surface. While it does not always accurately reflect the underwater coverage of biofouling especially in niche areas, surface inspection is considered to be adequate as a screening tool for potentially high risk vessels, and can be followed up if necessary by in-water inspection (*e.g.*, using divers or surface-operated underwater video).

LOF	Description	Visible estimate of fouling cover
0	No visible fouling. Hull entirely clean, no biofilm on visible submerged parts of the hull	Nil
1	Slime fouling only. Submerged hull areas partially or entirely covered in biofilm, but absence of any macrofouling.	Nil
2	Light fouling. Hull covered in biofilm and 1–2 very small patches of macrofouling (only one taxon).	1–5 % of visible submerged surfaces
3	Considerable fouling. Presence of biofilm, and macrofouling still patchy but clearly visible and comprised of either one single or several different taxa.	6–15 % of visible submerged surfaces
4	Extensive fouling. Presence of biofilm and abundant fouling assemblages consisting of more than one taxon.	16–40 % of visible submerged surfaces
5	Very heavy fouling. Diverse assemblages covering most of visible hull surfaces.	41–100 % of visible submerged surfaces