NIWA
Taihoro Nukurangi

Scoping and development of a regional surveillance plan for marine pests in Northland

Prepared for Northland Regional Council (NRC)

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European green crab *Carcinus maenas* (Image: C. Woods)

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1. Executive summary

The Northland Regional Council (NRC) is responsible for the management and control of plant and animal pests in the Northland region. It has recently developed three Regional Pest Management Strategies (RPMS - marine, animal and plant pests) to address new threats while providing for more flexible management of existing pests. The purpose of this report is to assist the NRC in developing a regional framework for marine pest surveillance in Northland that builds upon existing programmes of work.

From a database of non-indigenous marine species that have established populations in New Zealand, the known locations of various marine pest species on NRC marine pest lists (*Exclusion*, *Suppression* and *Risk Assessment* pests) are reviewed. None of the six marine pest species of most concern (NRC *Exclusion pests*) are known to occur in Northland. Only one of the six pest species of most concern, the Mediterranean Fanworm (*Sabella spallanzanii*), has become established elsewhere in New Zealand. Four of five NRC *Suppression pests* are present at locations within Northland: the Asian paddle crab (*Charybdis japonica*); Didemnum sea squirt (*Didemnum vexillum*); Eudistoma sea squirt (*Eudistoma elongatum*); and Styela sea squirt (*Styela clava*). All of the NRC *Suppression (CPCA) pests* are established within Northland: the Asian date mussel (*Musculista senhousia*); the Australian tubeworm (*Ficopomatus enigmaticus*); the file shell (*Limaria orientalis*); and the Pacific oyster (*Crassostrea gigas*). Only one of the 12 NRC *Risk assessment pests*, the Pyura sea squirt (*Pyura stolonifera praeputialis*), occurs in the far north of Northland.

Non-indigenous marine species that are considered to pose a possible emerging risk to New Zealand marine environments are reviewed based on a list submitted by NIWA to MAFBNZ as part of its on-going development of a list of High Priority Organisms (HPO). None of the non-indigenous marine species on this list of emerging risk species occurs in Northland. Only one non-indigenous species considered to be of low risk, the ascidian *Clavelina lepadiformis*, has been detected elsewhere in New Zealand (the Port of Nelson).

International shipping is the primary pathway for the transport of non-indigenous marine species into New Zealand. The Bay of Islands and Whangarei Harbour are the primary nodes for commercial and recreational international shipping visits in Northland. For example, the Bay of Islands and Whangarei Harbour marinas are the ports of entry for ~73% of all international recreational vessels visiting New Zealand. Domestic vessel traffic represents a secondary pathway for non-indigenous marine pest incursion into Northland from other New Zealand locations and range extensions of established pests within Northland itself. Domestic commercial vessel traffic to Northland is concentrated at the vessel nodes of Whangarei Harbour and to a lesser extent the Bay of Islands, whilst domestic recreational vessel visits are concentrated at marinas in the Bay of Islands (Kerikeri, Opua and Russell), Whangaroa Harbour, Tutukaka, and Whangarei Harbour, and at other locations where there are concentrations of vessel moorings (e.g., Kaipara, Houhora and Mangonui harbours). Trailered recreational vessels associated with the numerous coastal boat ramps around Northland could also represent potential points of introduction for non-indigenous marine pests.

Marine aquaculture can also be an important vector for the domestic spread of non-indigenous species. Northland aquaculture is dominated by Pacific oyster (*Crassostrea gigas*) culture with 133 farm consents primarily located in the Kaipara, Parengarenga, Houhora and Whangaroa harbours, and the Bay of Islands. Smaller groups of Pacific oyster farms are located in Hokianga, Rangaunu and Whangarei harbours, and Te Puna and Kerikeri inlets (Bay of Islands). Regular movements of aquaculture equipment and/or stock (e.g., spat from the Kaipara Harbour to farms on Northland's northeast coast) represents an incursion risk. There are also five Greenshell™ mussel (*Perna canaliculus*) farm consents in Northland; four on the Houhora coast on the western side of Rangaunu Bay, and one in Kaipara Harbour. Annual transport of mussel spat from both Ninety Mile Beach ("Kaitaia spat") and the Marlborough Sounds to these mussel farms represents an incursion risk.

Sites where marine pests may have significant impacts on valued resources in Northland include: marine reserves (Poor Knights Islands and Whangarei Harbour marine reserves); marine parks (Mimiwhangata); aquaculture farms; known hotspots of species endemism and/or species diversity (e.g., Three Kings Islands, Spirits and Tom Bowling Bays, Parengarenga Harbour and the Bay of Islands); and designated habitats of international and national significance and/or areas of conservation value (e.g., Kaipara, Parengarenga, Houhora and Rangaunu harbours). Coastal customary areas of special significance to iwi/hapu either as a food source or for spiritual or cultural reasons in the Northland region (e.g., taiapure in the Waikare Inlet (Bay of Islands)) could be adversely impacted upon by non-indigenous marine organisms. The Northland coastal seafood industry and recreational fisheries could also be impacted upon by marine pests (e.g., commercial cockle and pipi fishery near Marsden Point (e.g. Marsden Bay, Snake Bank) and tuatua fishery near Dargaville in the Kaipara Harbour).

With regards to existing and potential capability for marine pest surveillance within Northland, MAF Biosecurity New Zealand (MAFBNZ) currently funds a national programme of targeted surveillance for marine pests in 12 high risk sites throughout New Zealand, two of which are in Northland (the Waikare Inlet (Opua) in the Bay of Islands and Whangarei Harbour). The Department of Conservation (DOC) also currently conducts limited marine biosecurity activities within Northland. The NRC is well-placed to facilitate the efficient resourcing of regional surveillance activities by taking advantage of its existing monitoring activities in the Northland coastal marine area (e.g., aquaculture consents, marine consented structures and water quality monitoring).

The NRC and DOC, through existing biosecurity activities, regulatory activities and Pest Management Strategies, possess skills, knowledge and infrastructure that could be readily utilised and further developed to form the backbone of an active targeted surveillance strategy for Northland. Tangata whenua also have potential for development as a key component of an active targeted surveillance strategy. Stakeholders/sectoral groups that could be engaged in the development of an enhanced passive surveillance network for Northland to complement active surveillance include: the aquaculture sector; tangata whenua; marina operators; port companies; fishing and yacht clubs; and recreational boaters.

Active targeted marine pest surveillance is required to ensure early detection of new incursions at higher priority locations. Ideally, this active surveillance should be supplemented with enhanced passive surveillance provided by stakeholders and the general

public at higher priority locations. At lower priority locations, enhanced passive surveillance is likely to be the most cost-effective surveillance strategy for the Northland region, although this does not prevent active surveillance activities at lower priority sites occurring if resources allow.

Potential sites for targeted surveillance in the Northland region are provided. These sites are given a priority ranking (*High*, *Medium* and *Low*) for surveillance activities based upon the vector risk and value factors examined in this report. For example, the Waikare Inlet in the Bay of Islands is ranked as a High priority site for active surveillance because of the presence of the Opua Marina (a major node for international and domestic recreational vessels), a large number of vessel moorings, a boat ramp, Pacific oyster farms and a taiapure. In contrast, whilst Mimiwhangata is of resource/ecological value and receives some recreational vessel traffic, it has no consented moorings, boat ramp or aquaculture farms and is ranked as a Low priority site for active surveillance.

We recommend that, given its proactive development of a Northland Regional Marine Pest Management Strategy (RMPMS), and its overarching statutory role, it is appropriate that NRC act as lead agency and governance architect in the coordination, implementation and reporting of a surveillance strategy for non-indigenous marine pests in Northland, but it is recommended that this be done in consultation with MAFBNZ. Preliminary recommendations are provided as to the implementation and reporting of this regional surveillance strategy.

2. Introduction

The coastal marine area of Northland provides significant economic, social and cultural benefits to the region. With ~3,000 km of coastline, offshore islands and stacks, 17 harbours of varying size, many smaller estuaries and extensive stretches of rocky and sandy open coast, Northland has the highest biodiversity of fish and invertebrates of any region in mainland New Zealand and contains marine ecosystems (including two marine reserves) of national and regional importance (Morrison, 2005; NRC, 2010a). These environments are under increasing threat from a variety of non-indigenous marine pests that have established in the region, are present elsewhere in New Zealand, or which may be introduced to Northland by international shipping.

The Northland Regional Council (NRC) is responsible for the management and control of plant and animal pests in the Northland region. The NRC has recently developed three Regional Pest Management Strategies (RPMS - marine, animal and plant pests) to address new threats while providing for more flexible management of existing pests. The purpose of the Regional Marine Pest Management Strategy (RMPMS) is to provide a strategic and statutory framework for management of marine pests in Northland. It places emphasis on greater engagement of local communities and resources in surveillance and management of marine pests. This is consistent with the national biosecurity surveillance strategy – *Biosecurity Surveillance Strategy 2020* – which seeks greater participation of stakeholders in the delivery of biosecurity surveillance throughout New Zealand, and the New Zealand Coastal Policy Statement (2010).

The purpose of this report is to assist NRC in developing a regional framework for marine pest surveillance in Northland that builds upon existing programmes of work, including the National Marine High Risk Site Surveillance (MHRSS), funded by MAF Biosecurity New Zealand (MAFBNZ – see Section 3.1.). The first phase of the work plan (this report) encompasses the following tasks:

1. Review and analysis of marine pest risks to Northland
    - 1.1 Identify and evaluate species of concern
        - 1.1.1 within Northland and New Zealand
        - 1.1.2 emerging risks
    - 1.2 Identify and evaluate pathways and vectors for the entry and spread of marine pests in Northland.
    - 1.3 Identify regional nodes/sites with high risk of incursion.
    - 1.4 Identify nodes/sites where marine pests may have significant impacts on valued resources.
2. Identify existing and potential capability for marine pest surveillance among stakeholder groups within Northland.
3. Evaluate needs for development of surveillance capability within Northland.

4. Prepare draft surveillance strategy that identifies and prioritizes potential sites for marine pest surveillance and includes a strategy for implementation and reporting.

A second phase of the plan is anticipated that will develop surveillance tools and training for regional stakeholders.

3. Review and analysis of marine pest risks to Northland

3.1 Species of concern

3.1.1 Non-indigenous marine species within Northland and New Zealand

In 1998, Cranfield et al. (1998) compiled an inventory of the non-indigenous marine species that had been reported in New Zealand by synthesizing existing literature and museum records. They found records of 148 species that had been introduced accidentally into New Zealand over the last 200 years, and 11 species that were introduced deliberately. They found a total of 133 non-indigenous species had established permanent populations in New Zealand (Cranfield et al., 1998).

NIWA has recently completed an update of information on the distributions of non-indigenous marine species recorded from New Zealand. This review incorporated the results of the earlier Cranfield et al. (1998) report, and more recent records of non-indigenous marine organisms recorded from nationally funded survey programmes, including:

- the MHRSS (MAFBNZ Projects ZBS20001-01 and ZBS2005-35, RFP10623);
- the national port biological baseline surveys (MAFBNZ Projects ZBS2000-04, ZBS2005-18, ZBS2005-19);
- the international vessel biofouling characterization project (MAFBNZ Project ZBS2004-03); and
- other intelligence sources (including public reports and taxonomic experts).

Currently, the NIWA database contains records of 300+ non-indigenous marine species that have established populations in New Zealand; 128 of which have been recorded from Northland.

As part of its RMPMS, the NRC has compiled a list of marine non-indigenous species classified as pest organisms (Table 1) of varying levels of concern (NRC, 2010b). The NRC pest list aligns closely with the primary and secondary target species of the MHRSS. NRC pest management definitions for these organisms are as follows:

- *Exclusion pests* are of the greatest concern. They are declared to be pests under the Biosecurity Act 1993, are on MAFBNZ's six most unwanted list (http://www.biosecurity.govt.nz/pests/salt-freshwater/saltwater), and are organisms which are not known to have established in Northland or have previously established and all known established populations have been eradicated. Many of them are also not currently known to be present in New Zealand. These pests all have the potential to establish in the region, and are capable of causing adverse effects. The intention is to prevent the pests in this category from entering and establishing within Northland;
- *Suppression pests* are deemed to be pests under the Biosecurity Act only, where they are subject to a NRC approved management plan for a specific control area. They may be widespread in suitable habitat throughout the region. The intention is to reduce pest densities so that their impacts on the community

and the environment are decreased. *Suppression pests* may be categorised as *Suppression pests* in Community Pest Control Areas (CPCA), where NRC assists communities and stakeholders to control such pests where they may have impacts upon local values; and

- *Risk assessment pests* are those pests which are of potential concern to the region, but little is known about the distribution or the risks posed to Northland. The intention is to improve understanding about the pest and its distribution, so that the pest can be classified and managed appropriately when the RMPMS is reviewed.

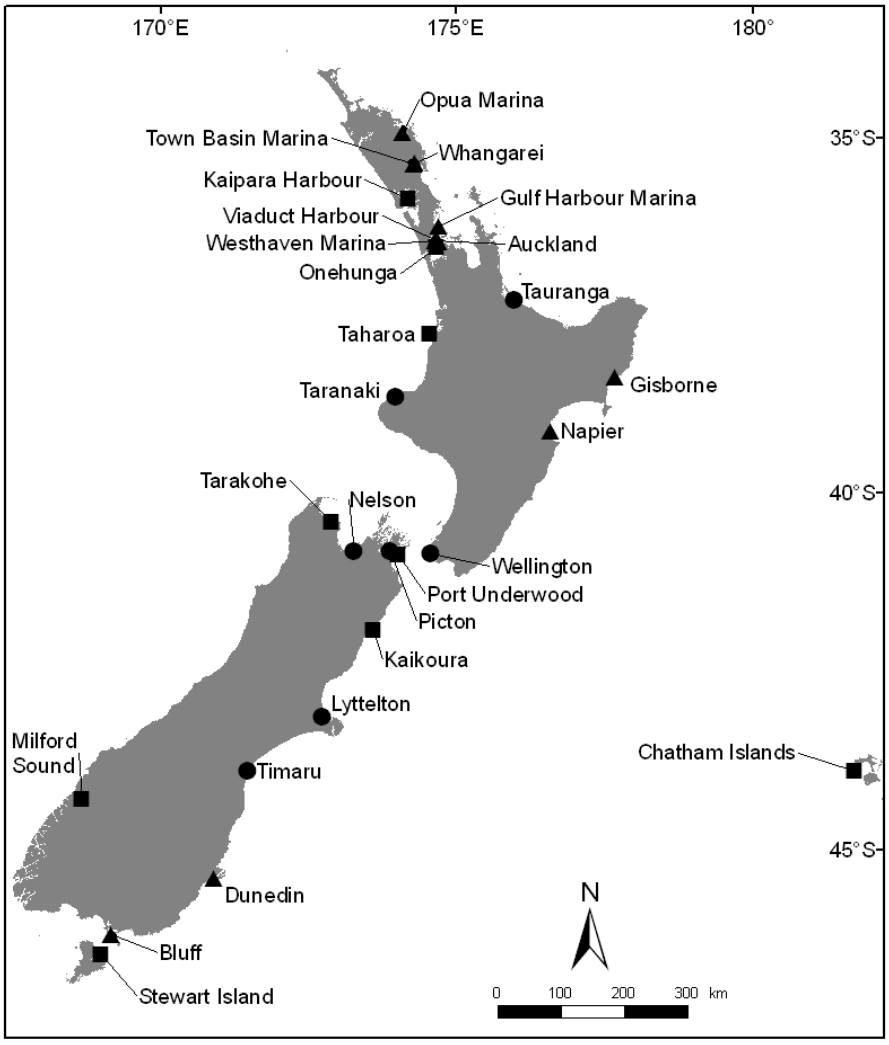

Figure 1: Ports and marinas in New Zealand where baseline non-indigenous marine species surveys were conducted. Group 1 ports (circles) were surveyed in the summer of 2001/2002 and resurveyed in the summer of 2004/2005, Group 2 ports (triangles) were surveyed in the summer of 2002/2003 and resurveyed in the summer of 2005/2006 (except for Viaduct and Westhaven marinas, which were surveyed for the first time during the 2005/2006 summer), and Group 3 ports (squares) were surveyed between May 2006 and December 2007.

From the NIWA database, the known locations of the various marine pest species, both within the Northland region (Figure 2) and within New Zealand, are presented in Table 1.

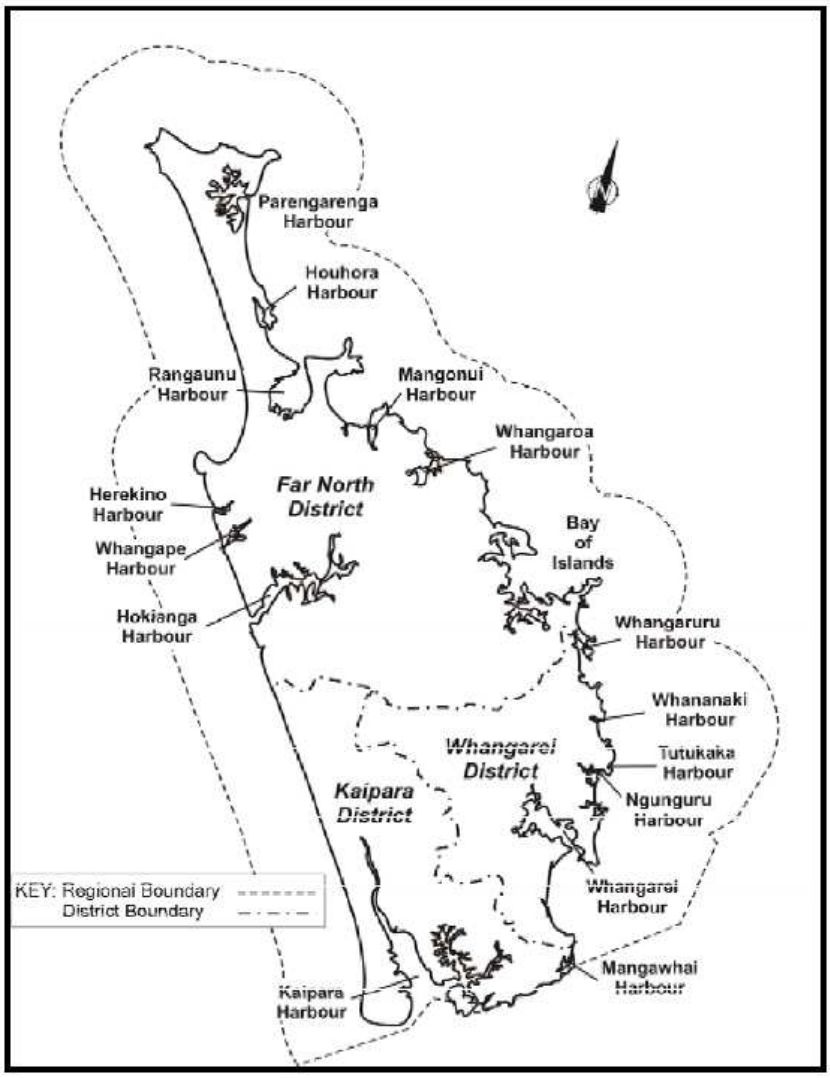

Figure 2: Northland coastal region (source: (NRC 2010b)). .

None of the six pest species of most concern (NRC *Exclusion pests*) is known to occur in Northland. Only one of the six pest species of most concern, the Mediterranean Fanworm (*Sabella spallanzanii*), has become established elsewhere in New Zealand (in the Waitemata Harbour and the Port of Lyttelton).

Four of five NRC *Suppression pests* are present at locations within Northland. These are: the Asian paddle crab (*Charybdis japonica*); Didemnum sea squirt (*Didemnum vexillum*); Eudistoma sea squirt (*Eudistoma elongatum*); and Styela sea squirt (*Styela clava*). The Asian paddle crab and Didemnum sea squirt are known only from Whangarei Harbour (inclusive of Marsden Cove Marina), whereas Eudistoma and Styela have been recorded from other Northland locations (Table 1). *Charybdis japonica* is established in the Hauraki Gulf, whilst *D. vexillum* is established from Whitianga to Lyttelton Harbour. The other NRC *Suppression pest*, the Japanese kelp (*Undaria pinnatifida*), is not known to be present in Northland, but is widespread within Waitemata Harbour, parts of the Hauraki Gulf and a wide range of ports and harbours south of Auckland (Table 1).

Table 1: Marine non-indigenous pest species, classified according to NRC Marine Pest Management Strategy and locations in Northland and other parts of New Zealand where they have been detected. Pest species that have been detected in the Northland region are highlighted in yellow.

Common Name	Scientific Name	Group	NRC Pest Classification	Northland location/s	Known NZ distribution
Asian clam	*Potamocorbula amurensis*	Mollusc	Exclusion	-	Not known from New Zealand
Caulerpa seaweed	*Caulerpa taxifolia*	Macroalgae	Exclusion	-	Not known from New Zealand
Chinese mitten crab	*Eriocheir sinensis*	Crustacean	Exclusion	-	Not known from New Zealand
European shore crab	*Carcinus maenas*	Crustacean	Exclusion	-	Not known from New Zealand
Mediterranean fanworm	*Sabella spallanzanii*	Annelid	Exclusion	-	Waitemata Harbour; Port of Lyttelton
Northern pacific seastar	*Asterias amurensis*	Echinoderm	Exclusion	-	Not known from New Zealand
Asian paddle crab	*Charybdis japonica*	Crustacean	Suppression	Whangarei Harbour	Hauraki Gulf (Mahurangi to Firth of Thames)
Didemnum sea squirt	*Didemnum vexillum*	Ascidian	Suppression	Whangarei Harbour	Whitianga; Port of Tauranga; Wellington Harbour; Marlborough Sounds; Nelson; Lyttelton Harbour
Eudistoma sea squirt	*Eudistoma elongatum*	Ascidian	Suppression	Parengarenga Harbour; Houhora Harbour; Whangarei Harbour; Bay of Islands	Northland
Japanese kelp	*Undaria pinnatifida*	Macroalgae	Suppression	-	Waitemata Harbour; Tauranga; New Plymouth; Gisborne; Napier; Wellington; Port of Nelson; Picton; Lyttelton Harbour; Timaru; Otago Harbour; Bluff Harbour; Stewart Island
Styela sea squirt	*Styela clava*	Ascidian	Suppression	Marsden Cove Marina; Opua; (Tutukaka)[1]	Gulf Harbour Marina; Waitemata Harbour; Firth of Thames; Port of Nelson; Lyttelton Harbour; Otago Harbour
Asian date mussel	*Musculista senhousia*	Mollusc	Suppression (CPCA)	Parengarenga Harbour; Opua; Whangarei Harbour; Kaipara Harbour	Kawhia Harbour; Raglan Harbour; Gulf Harbour Marina; Waitemata Harbour; Great Barrier Island; Firth of Thames; Port of Tauranga
Australian tubeworm	*Ficopomatus enigmaticus*	Annelid	Suppression (CPCA)	Whangarei Harbour	Waitemata Harbour; Tamaki estuary; Whitianga
File shell	*Limaria orientalis*	Mollusc	Suppression (CPCA)	Opua; Whangarei Harbour	Leigh; Gulf Harbour Marina; Waitemata Harbour; Wellington Harbour; Port of Nelson; Picton

Common Name	Scientific Name	Group	NRC Pest Classification	Northland location/s	Known NZ distribution
Pacific oyster	*Crassostrea gigas*	Mollusc	Suppression (CPCA)	Kaipara Harbour; Hokianga Harbour; Parengarenga Harbour; Houhora Harbour; Rangaunu Harbour; Whangaroa Harbour; Bay of Islands; Whangarei Harbour	Waikanae River; Gulf Harbour Marina; Waitemata Harbour; New Plymouth; Golden Bay; Tasman Bay; Port of Nelson; Marlborough Sounds; Lyttelton Harbour
Asian shore crab	*Hemigrapsus sanguineus*	Crustacean	Risk assessment	-	Not known from New Zealand
Dead man's fingers	*Codium fragile ssp. tomentosoides*	Macroalgae	Risk assessment	-	Waitemata Harbour, Port of Tauranga[2]
Red algae	*Grateloupia turuturu*	Macroalgae	Risk assessment	-	Wellington Harbour; Port of Nelson
Wireweed	*Sargassum muticum*	Macroalgae	Risk assessment	-	Not known from New Zealand
Asian green mussel	*Perna viridis*	Mollusc	Risk assessment	-	Not known from New Zealand
Asian rapa whelk	*Rapana venosa*	Mollusc	Risk assessment	-	Not known from New Zealand
Brown mussel	*Perna perna*	Mollusc	Risk assessment	-	* Detected in Tasman Bay and subjected to control operation. Considered unlikely to be established.
Black-striped mussel	*Mytilopsis sallei*	Mollusc	Risk assessment	-	Not known from New Zealand
European clam	*Variocorbulus gibba*	Mollusc	Risk assessment	-	Not known from New Zealand
Golden mussel	*Limnoperna fortunei*	Mollusc	Risk assessment	-	Not known from New Zealand
Pyura sea squirt	*Pyura stolonifera praeputialis*	Ascidian	Risk assessment[3]	North of Horokino Harbour to Ahipara Bay; The Bluff (Ninety Mile Beach); Scott Point to Cape Reinga; North Cape; Parengarenga Harbour	Northland

[1] Four *Styela clava* were detected and removed from Tutukaka Marina in 2005/2006 (Gust et al., 2008). It has not been observed in the marina subsequently.
[2] Originally identified as *Codium fragile ssp. tomentosoides*, but has been re-designated as non-indigenous *Codium fragile ssp. fragile*.
[3] Under investigation - MAFBNZ is currently working with technical and cultural/local area experts to determine the feasibility of management options for this species in Northland.

All of the NRC *Suppression (CPCA) pests* are established within Northland (as befits the CPCA categorisation). The Asian date mussel (*Musculista senhousia*) has been recorded from the Bay of Islands and Kaipara, Parengarenga and Whangarei harbours. It is established from Kawhia Harbour on the west coast of the North Island to Tauranga Harbour on the east. The Australian tubeworm (*Ficopomatus enigmaticus*) is established in Whangarei and Waitemata Harbours and Whitianga. The file shell (*Limaria orientalis*) is established in the Bay of Islands and Whangarei Harbour, and elsewhere from Leigh southwards to Picton. As an important aquaculture species in Northland, the Pacific oyster (*Crassostrea gigas*) is widespread throughout harbours and estuaries in Northland. It has established naturally from Northland down to Lyttelton Harbour.

Only one of the 12 NRC *Risk assessment pests*, the Pyura sea squirt (*Pyura stolonifera praeputialis*), occurs in the far north of Northland. It is not known to be established anywhere else in New Zealand. Of the other *Risk assessment pests*, *Codium fragile ssp. tomentosoides* was originally identified in the Waitemata Harbour and the Port of Tauranga, but has been re-designated as non-indigenous *Codium fragile ssp. fragile*. Identification of *Codium sp.* and *Grateloupia turuturu* (which has been identified from Wellington Harbour) requires genetic techniques because use of morphological characters alone is unreliable. The South African brown mussel, *Perna perna*, was detected in Tasman Bay following the de-fouling of an international oil-rig. The area was subjected to a clean-up/eradication effort and subsequent establishment is thought unlikely.

3.1.2 Emerging risks

MAF Biosecurity New Zealand (MAFBNZ) is developing an Organism Prioritisation Framework (http://www.biosecurity.govt.nz/pests/hpo-project). This framework focuses on the development of a list of High Priority Organisms (HPO) – including marine organisms – and aims to contribute to improved risk management by providing participants in the biosecurity system with standardised information for risk organisms, to support their risk analysis and decision-making.

Information from across MAFBNZ, external organisations/stakeholders, and other intelligence sources has been gathered to assist in the initial development of a framework for categorising biosecurity risk organisms. An initial organism “long-list” has been compiled containing organisms that are considered:

- likely to have a significant impact on one or more values, should they establish in New Zealand; and
- have a reasonable likelihood of entering and establishing in New Zealand, taking account of current distribution in relation to trade patterns and eco-climatic requirements.

To date, 129 marine non-indigenous organisms have been nominated for the MAFBNZ HPO “long list” (http://www.biosecurity.govt.nz/files/pests/hpo-project/hpo-update-2.pdf). Further work is now required to collate data for specific organisms, assess these organisms in greater detail, and develop the categorisation framework.

As part of the initial development of the HPO framework in 2008, NIWA submitted a list of 79 non-indigenous marine species (excluding cryptogenic organisms) not known to be

established in New Zealand that were considered to pose a risk to New Zealand marine environments. This list, with qualitative assessments of the magnitude of risk posed by each organism, was compiled principally from three sources: (1) the current NZ register of unwanted organisms, (2) the Australian list of priority pests (Consultative Committee for Introduced Marine Pest Emergencies (CCIMPE) Trigger List), and (3) the Australian National Priority Pests project conducted by CSIRO (Hayes et al., 2005). The list included input and review from a variety of taxonomic experts, who added organisms to the list that they also considered to be of concern.

The NIWA list has been updated for this report to include other non-indigenous marine organisms that are possible emerging risk as pest species (Table 2). It includes non-indigenous marine species that have recently become established in New Zealand, but which have not been assessed or rated for their risk, or for which there is insufficient information upon which to conduct a risk assessment. This list does not include marine organisms already declared to be pests under the Biosecurity Act and which are already identified in Table 1, or non-indigenous species that are established in New Zealand, may be widespread, and which have not exhibited any significant negative impacts, or have been assessed by MAFBNZ as being of no or negligible risk (e.g., *Theora lubrica*, *Arenigobius bifrenatus*, *Nassarius burchardi*, or *Styela plicata*). The list also does not include pathogens (bacteria, viruses or fungi). Diggles et al. (2002) provide an inventory of marine pathogens of concern, particularly with relevance to aquaculture, and identify non-indigenous pathogens (both established in, and not yet known from New Zealand) with their known distributions. The Office International des Epizooites (http://www.oie.int/), of which New Zealand is a signatory, provides scientific databases (and various support tools) on diseases of importance (and emerging concern) to aquaculture and international trade.

High risk organisms are typically those that have potentially high impact and invasion potential (usually with established histories of such). Examples of very high, to high risk organisms are: the algae *Hypnea musciformis* and *Acanthophora spicifera* which both have high dispersal, competitive and fouling capabilities; the ctenophore *Mnemiopsis leidyi* which is a zooplankton predator that can radically modify planktonic communities and compete with zooplanktivorous fish; the fanworm *Terebrasabella heterouncinata*, which deforms the shells of molluscs such as abalone. Examples of medium risk organisms are: the *Hydroides* sp. tubeworms, which are problematic fouling species; the portunid crab *Charybdis hellerii* which can compete with indigenous species and affect benthic communities. Examples of low risk organisms are: the corophiid *Laticorophium baconi* which may establish easily but is unlikely to add to the minor impacts of other non-indigenous corophiids already established in NZ waters; the small alga *Gymnogongrus crenulatus* which can be a nuisance fouler. The ascidian *Clavelina lepadiformis* was rated by MAFBNZ as being of low-negligible biosecurity risk following its discovery in the Port of Nelson in 2008 (http://fcs.maf.govt.nz/webtop/drl/object/09101b3803e2cf0).

Some non-indigenous organisms, which may be rated as relatively low risk overall (or have not been assessed), may still pose a significant risk to certain indigenous biota, environments or sectoral groups. For example, the non-indigenous hydroid *Ectopleura larynx* is established in Opua and Whangarei Harbour, as well as in the Waitemata Harbour and the Port of Tauranga. Hayes et al. (2005) rated the closely related *E. crocea* (also established in Whangarei Harbour) as a species that has low impact and low invasion potential relative to

Table 2: Non-indigenous marine species that may be of emerging risk to New Zealand. Priority risk rating as per Hayes et al. (2005) for Australia and NIWA rating of risk to the New Zealand environment, health and culture are provided. Species detected in the Northland region are highlighted in yellow.

Phylum	Species	Common name	NZ Legal Status	Status in NZ	Priority rating in Hayes et al. 2005	Risk to NZ environment, health & culture
Rhodophyta	*Hypnea musciformis*		No Status	Not known from New Zealand	Not rated	Very High
Rhodophyta	*Acanthophora spicifera*		No Status	Not known from New Zealand	Not rated	Very High
Chlorophyta	*Caulerpa racemosa var. cylindracea* (only in warmer regions of NZ)	Green macroalga	No Status	Not known from New Zealand	Not rated	High
Annelida	*Terebrasabella heterouncinata*		No Status	Not known from New Zealand	Not rated	High
Ctenophora	*Mnemiopsis leidyi*	Ctenophore	No Status	Not known from New Zealand	Low	High
Mollusca	*Crepidula fornicata*	American slipper limpet	No Status	Not known from New Zealand	Low	High
Rhodophyta	*Dasya sessilis*		No Status	Not known from New Zealand	Not rated	High
Annelida	*Myxicola infundibulum*		No Status	Not known from New Zealand	Not rated	Moderate
Annelida	*Myxicola aesthetica*		No Status	Not known from New Zealand	Not rated	Moderate
Annelida	*Hydroides dianthus*	Serpulid polychaete	No Status	Not known from New Zealand	Low	Moderate
Annelida	*Hydroides sanctaecrucis*	Serpulid polychaete	No Status	Not known from New Zealand	Medium	Moderate
Annelida	*Hydroides spp*		No Status	Not known from New Zealand	Not rated	Moderate
Annelida	*Pomatoleios kraussi*		No Status	Not known from New Zealand	Not rated	Moderate
Annelida	*Marenzelleria spp.* (invasive species and marine/estuarine incursions only)	Red gilled mudworm	No Status	Not known from New Zealand	Not rated	Moderate
Arthropoda	*Ampelisca abdita*	Amphipod	No Status	Not known from New Zealand	Low	Moderate
Arthropoda	*Rhithropanopeus harrisii*	White-tipped mud crab	No Status	Not known from New Zealand	Not rated	Moderate
Arthropoda	*Callinectes sapidus*	Blue crab	No Status	Not known from New Zealand	Low	Moderate
Arthropoda	*Charybdis hellerii*	Portunid crab	No Status	Not known from New Zealand	Not rated	Moderate
Arthropoda	*Hemigrapsus takanoi*	Pacific crab	No Status	Not known from New Zealand	Not rated	Moderate
Arthropoda	*Tortanus dextrilobatus*	Calanoid copepod	No Status	Not known from New Zealand	Low	Moderate
Chlorophyta	*Codium fragile spp. atlanticum*	Green macroalga	No Status	Not known from New Zealand	Not rated	Moderate
Rhodophyta	*Bonnemaisonia hamifera*	Red macroalga	No Status	Not known from New Zealand	Low	Moderate

Phylum	Species	Common name	NZ Legal Status	Status in NZ	Priority rating in Hayes et al. 2005	Risk to NZ environment, health & culture
Rhodophyta	*Schottera nicaeensis*	Red macroalga	No Status	Not known from New Zealand	Low	Moderate
Rhodophyta	*Womersleyella setacea*	Red macroalga	No Status	Not known from New Zealand	Low	Moderate
Annelida	*Sabellastarte spectabilis*		No Status	Not known from New Zealand	Not rated	Low
Arthropoda	*Monocorophium insidiosum*	Amphipod	No Status	Not known from New Zealand	Not rated	Low
Arthropoda	*Laticorophium baconi*	Amphipod	No Status	Not known from New Zealand	Not rated	Low
Arthropoda	*Fenneropenaeus chinensis (*syn. *Penaeus orientalis/P. chinensis)*	Fleshy prawn	Unwanted Organism	Not known from New Zealand	Not rated	Low
Arthropoda	*Sphaeroma walkeri*	Marine pill bug	No Status	Not known from New Zealand	Low	Low
Arthropoda	*Acartia tonsa*	Calanoid copepod	No Status	Not known from New Zealand	Not rated	Low
Arthropoda	*Notomegabalanus algicola*	Barnacle	No Status	Not known from New Zealand	Low	Low
Arthropoda	*Megabalanus rosa*	Barnacle	No Status	Not known from New Zealand	Medium	Low
Arthropoda	*Megabalanus tintinnabulum*	Barnacle	No Status	Not known from New Zealand	Medium	Low
Arthropoda	*Amphibalanus eburneus*	Barnacle	No Status	Not known from New Zealand	Medium	Low
Arthropoda	*Balanus albicostatus*	Barnacle	No Status	Not known from New Zealand	Not rated	Low
Arthropoda	*Pseudodiaptomus marinus*	Calanoid copepod	No Status	Not known from New Zealand	Medium	Low
Bryozoa	*Schizoporella unicornis*	Bryozoan	No Status	Not known from New Zealand	Low	Low
Bryozoa	*Scrupocellaria bertholetti*	Bryozoan	No Status	Not known from New Zealand	Low	Low
Chlorophyta	*Caulerpa filiformis*	Green macroalga	No Status	Not known from New Zealand	Not rated	Low
Chordata	*Clavelina lepadiformis*	Light bulb ascidian	No Status	New incursion - Nelson	Not rated	Low
Chordata	*Botryllus aurantius*	Colonial sea squirt	No Status	Not known from New Zealand	Not rated	Low
Ctenophora	*Beroe ovata*	Ctenophore	No Status	Not known from New Zealand	Low	Low
Mollusca	*Haliotis rufescens*	Red abalone	Unwanted Organism	Not known from New Zealand	Not rated	Low
Rhodophyta	*Antithamnionella spirographidis*	Red macroalga	No Status	Not known from New Zealand	Low	Low
Rhodophyta	*Gymnogongrus crenulatus*	Red macroalga	No Status	Not known from New Zealand	Low	Low
Bacillariophyta	*Pseudo-nitzschia seriata*	Diatom (pennate)	No Status	Not known from New Zealand	Low	Not rated
Bacillariophyta	*Chaetoceros concavicornis*	Diatom (centric)	No Status	Not known from New Zealand	Low	Not rated

Phylum	Species	Common name	NZ Legal Status	Status in NZ	Priority rating in Hayes et al. 2005	Risk to NZ environment, health & culture
Bacillariophyta	*Chaetoceros convolutes*	Diatom (centric)	No Status	Not known from New Zealand	Low	Not rated
Cnidaria	*Blackfordia virginica*	Black Sea jellyfish	No Status	Not known from New Zealand	Low	Not rated
Cnidaria	*Rhopilema nomadica*	Indo-Pacific jellyfish	No Status	Not known from New Zealand	Not rated	Not rated
Entoprocta	*Barentsia benedeni*	Nodding Head	No Status	Not known from New Zealand	Low	Not rated
Mollusca	*Mya arenaria*	Soft-shell clam	No Status	Not known from New Zealand	Low	Not rated
Mollusca	*Petricolaria pholadiformis*	False angelwing	No Status	Not known from New Zealand	Low	Not rated
Mollusca	*Ensis directus*	Jack-Knife clam	No Status	Not known from New Zealand	Low	Not rated
Mollusca	*Teredo navalis*	Shipworm	No Status	Not known from New Zealand	Low	Not rated
Mollusca	*Siphonaria pectinata*	Striped false limpet	No Status	Not known from New Zealand	Low	Not rated
Myzozoa	*Dinophysis norvegica*	Dinoflagellate	No Status	Not known from New Zealand	Low	Not rated
Myzozoa	*Alexandrium monilatum*	Dinoflagellate	No Status	Not known from New Zealand	Low	Not rated
Vertebrata	*Neogobius melanostomus* (marine/estuarine incursions only)	Round goby	No Status	Not known from New Zealand	Medium-low	Not rated
Vertebrata	*Tridentiger trigonocephalus*	Japanese goby	No Status	Not known from New Zealand	Low	Not rated
Vertebrata	*Tridentiger bifasciatus*	Shimofuri goby	No Status	Not known from New Zealand	Medium-high	Not rated
Vertebrata	*Liza ramado*	Thin-lip mullet	No Status	Not known from New Zealand	Not rated	Not rated
Vertebrata	*Siganus rivulatus*	Marbled spinefoot	No Status	Not known from New Zealand	Low	Not rated
Cnidaria	*Ectopleura larynx*	Ringed Tubularian	No Status	Established (Opua; Whangarei Harbour) (Waitemata Harbour; Port of Tauranga)	Not assessed	Not assessed
Bryozoa	*Membraniporopsis tubigera*		No Status	Undetermined[1] (Kaipara Harbour)	Not assessed	Not assessed
Arthropoda	*Oratosquilla ornata*	Japanese mantis shrimp	No Status	Established (Kaipara and Hokianga harbours)	Not assessed	Not assessed
Chordata	*Ciona savignyi*	Pacific transparent sea squirt	No status	Established (Nelson City Marina; Lyttelton Harbour)	Not assessed	Not assessed

[1]Sudden appearance in abundance in Kaipara Harbour in 2002 (Gordon et al., 2006), but has not been seen since.

other domestic non-indigenous species considered for Australia. However, in recent years in Norway *E. larynx* has become a problematic fouling species for salmon farmers, where it is often the dominant cage-fouling organism, and is propagated and spread via net-cleaning practices (Guenther et al., 2010). If finfish farming is to become established in Northland, *E. larynx* may become a nuisance fouling organism to this activity. *Ciona intestinalis*, rated as a medium priority pest in Australia by Hayes et al. (2005), is a widespread non-indigenous ascidian in New Zealand, and can be a nuisance fouling species in aquaculture. Recent research has confirmed that the closely related *C. savignyi* is established in the Nelson city marina (Smith et al., 2010) and Lyttelton Harbour (K. Smith, Cawthron Institute, pers. comm.). It may cause significant nuisance biofouling in shellfish aquaculture also.

3.2 Pathways and vectors for the entry and spread of marine pests in Northland

3.2.1 Vessel vectors

International shipping is the primary pathway (as biofouling or in ballast water) for the transport of non-indigenous marine species into New Zealand (Inglis et al., 2006a). In a recent survey of 500 international vessels arriving in New Zealand, non-indigenous species were recorded on almost 60% of the vessels, with over 30% having some non-indigenous species that were not known to be established in New Zealand (Inglis et al., 2010a). International shipping is the most likely pathway of introduction for 10 of the 11 unwanted (NRC *Exclusion* and *Suppression pests*) species in Table 1 – the notable exception being the aquarium weed, *Caulerpa taxifolia*, which is thought to have established non-indigenous populations internationally as a result of intentional release of aquarium specimens.

Merchant vessels

International traffic

Whangarei (including Marsden Point) is the only port of call for international cargo vessels >99 tonnes in Northland, accounting for around 3.9% of the international merchant vessel visits to New Zealand ports. International merchant vessels visiting Whangarei were bulk carriers (50.3%), container and general cargo (17.5%), reefers (15.6%), tankers (15.5%) and Roll-on/Roll-off's (1.2%) (Table 3).

Domestic traffic

Most large merchant vessel visits to Whangarei from other New Zealand ports were made by bulk carriers (61.3%), cargo (23.6%) and tankers (14.8%) (Table 4). These vessels originated from a variety of domestic locations, with Tauranga (34.8%), Auckland (15%), Napier (12.4%) and New Plymouth (10.1%) as the primary ports of departure. Large merchant vessel traffic to the Bay of Islands predominantly involved small volumes of vehicle/passenger/livestock class vessels (usually passenger vessels) from Auckland (mean annual movement of 0.8 vessels), Dunedin (0.2), Tauranga (1.7), and Wellington (0.2) (Hayden et al., 2009).

Table 3: Number of visits to Whangarei by different classes of international merchant vessel between 2000 and 2005. Source: Lloyds Maritime Intelligence Unit data base, NZ Foreign Vessel Visits (>99 gross tonnes) 2000-2005.

Vessel type	Number of vessel visits
Bulk	683
Container & General Cargo	237
Reefer	211
Heavy Lift	0
Roll-on/Roll-off	16
Tanker	210
TOTAL	1,357

Table 4: Mean annual movements of vessels >99 tonnes into Whangarei, by port of origin/vessel type between 2000 and 2005. Adapted from Hayden et al. (2009).

Origin	Bulk	Cargo	Containers	Other	Tanker	Total
Auckland	17.7	9.0	-	0.2	1.8	28.7
Bay of Islands	-	-	-	-	-	0
Bluff	1.3	0.2	-	-	0.7	2.2
Chatham Islands	-	-	-	-	-	0
Doubtful Sound	-	-	-	-	-	0
Dunedin	1.8	-	-	-	6.0	7.8
Gisborne	2.5	2.5	-	-	0.3	5.3
Greymouth	-	-	-	-	-	0
Lyttelton	3.0	2.0	-	-	3.2	8.2
Milford Sound	-	-	-	-	-	0
Napier	17.0	4.5	-	-	2.3	23.8
Nelson	4.0	0.2	-	-	2.8	7
New Plymouth	5.0	10.0	0.3	-	4.0	19.3
Onehunga	0.3	-	-	-	-	0.3
Picton	3.3	-	-	-	-	3.3
Stewart Island	-	-	-	-	-	0
Taharoa Terminal	0.2	-	-	-	-	0.2
Tarakohe	-	-	-	-	-	0
Tauranga	49.7	12.8	0.2	-	4.0	66.7
Timaru	0.8	0.2	-	-	1.7	2.7
Wellington	4.8	3.5	-	-	1.5	9.8
Westport	-	-	-	-	-	0
Whangarei	6.0	0.3	-	-	-	6.3
TOTAL	117.4	45.2	0.5	0.2	28.3	191.6

Recreational vessels

International

New Zealand is a popular destination for international recreational vessels, with more than 600 vessels arriving from overseas each year. Most of these (91.8% of all international recreational vessel arrivals from 1998-2010) enter New Zealand through northern ports of entry: Opua, Whangarei, Auckland and Tauranga (Table 5). Other New Zealand entry ports pertinent to recreational vessels, which together annually process <10% of arriving recreational vessels, are: Bluff; Dunedin (and Port Chalmers); Fiordland (Milford Sound); Gisborne; Lyttelton; Napier; Nelson; New Plymouth; Picton; Timaru; and Wellington.

Table 5: Numbers of international recreational vessel arrivals at the four main arrival ports for recreational vessels in New Zealand (Opua, Whangarei, Auckland, and Tauranga) between 1998 and 2007 from Floerl et al. (2008) (1998-2004 data), and from NZ Customs Service (2005-2010 data). Note: NZ Customs Service data (2005-2010) was provided as "small craft" which includes all vessels <25 m; the majority of small vessels are recreational vessels (yachts and motor yachts), but the data may include some small fishing vessels. The Northland arrival ports of Opua and Whangarei are highlighted in yellow.

Port of entry	1998/99	1999/00	2000/01	2001/02	2002/03	2004/2005	2005/06	2006/07	2007/2008	2008/2009	2009/2010	TOTAL
Opua	272	414	349	373	559	459	461	428	438	428	430	**4,611**
Whangarei	53	79	34	47	43	38	37	48	36	64	82	**561**
Auckland	95	150	90	104	97	108	107	116	91	93	98	**1,149**
Tauranga	13	40	14	22	42	7	10	17	16	19	17	**217**

International yachts arriving in New Zealand tend to come directly from the South Pacific (82.3%; principally Tonga, Fiji and New Caledonia) and Australia (17.7%) (Floerl et al., 2008). The peak arrival period is typically October to December (~90% of annual arrivals) to avoid the austral tropical cyclone season (Inglis & Floerl, 2002; Floerl et al., 2008).

Destinations in Northland that international recreational vessels visit during their stay are listed in (Table 6). The majority of visits are to the Bay of Islands (predominantly Kerikeri and Opua marinas) (48.2%), Tutukaka (18%) and Whangarei Harbour (27.6%).

Of concern to Northland, is that some international recreational vessels may overnight at northern coastal locations prior to arriving at an official port of entry in Northland (i.e. Opua and Whangarei).

Domestic

Modelled annual movements of recreational vessels to five Northland marinas (Kerikeri, Opua, Russell, Tutukaka, and Whangarei) from 36 marinas within New Zealand are presented in Table 7. This reveals that 67.8% of recreational vessel movements to Northland marinas were from locations outside of Northland. Of these, 49.7% originated from various Auckland marinas, 20% from Gulf Harbour Marina, and 12.2% from Great Barrier Marina. The origin marinas for the remaining recreational vessel movements were spread throughout New Zealand as far south as Dunedin.

Table 6: Numbers of international recreational vessels visiting locations in Northland between 2000 and 2004. Data are derived from a departure questionnaire facilitated by NZ Customs Service (Floerl, NIWA unpubl. data).

Location	Number of vessels
Ahipara Bay	1
Tom Bowling Bay	1
Whangaroa Harbour	2
Cavalli Islands	1
Bay of Islands	145
Whangamumu Harbour	2
Whangaruru Harbour	1
Poor Knights Islands	11
Tutukaka	54
Whangarei Harbour	83
TOTAL	301

Trailered recreational vessels may also pose a biosecurity risk because of non-indigenous organisms they may unknowingly carry between locations (e.g., in sediments and weeds associated with anchors, bilge water, nets, ropes and floats) (Dodgshun et al., 2004), and this has been identified as a vector risk for non-indigenous species such as the crab *Carcinus maenas* (Darbyson et al., 2009). Dodgshun et al. (2004) listed 2,730 registered trailered vessels in the Northland region, and 14,705 in the Auckland region. Although data on travel patterns of trailered recreational vessels are not collected, it would be reasonable to assume that slipways and boat ramps in Northland could represent potential points of introduction for non-indigenous species carried from other domestic locations. However, "moored" recreational vessels are considered to be a higher recreational vessel biosecurity risk than trailered vessels (Hayden et al., 2009).

Passenger vessels

International

International passenger vessels regularly call into the Bay of Islands. During the 2010/2011 cruise season, there are expected to be 37 cruise ship visits to the Bay of Islands (Cruise New Zealand, 2010). Of the cruise ships scheduled to visit the Bay of Islands during Summer 2010/2011, the last ports of call are: Auckland (38.2%); Sydney (29.4%), Nukulofa (5.9%), Tauranga (3%); Fiordland (3%); Noumea (3%); (remainder undeclared) (http://www.nrc.govt.nz/Living-in-Northland/On-the-water/Cruise-ships-visiting-Northland/). There are three anchorage options for these vessels in the Bay of Islands, all <3km from both Russell and Waitangi (Cruise New Zealand, 2010).

Table 7: Modelled mean number of annual recreational vessel movements among ports and marinas within Northland and other New Zealand locations from 2002-2004. Adapted from Hayden et al. (2009).

	Arrival port					
Departure port	**Kerikeri Marina**	**Opua**	**Russell**	**Tutukaka**	**Whangarei**	**Total**
Akaroa	0	0	0	0	0	0
AKL Bucklands Beach Marina	1	6	0	2	1	10
AKL Bayswater Marina	5	111	4	12	36	168
AKL Devonport	0	0	0	0	0	0
AKL Half Moon Bay	3	36	2	16	7	64
AKL Hobson Marina	1	1	0	1	0	3
AKL Okahu Bay	17	0	0	0	0	17
AKL Pine Harbour Marina	0	14	1	3	1	19
AKL Tamaki	0	2	0	3	0	5
AKL Viaduct	1	23	0	3	12	39
AKL Westhaven	48	288	6	76	35	453
AKL Westpark	7	33	5	19	12	76
Coromandel Harbour	0	1	0	1	8	10
Dunedin	0	40	0	0	1	41
Great Barrier Island	4	56	17	8	124	209
Gulf Harbour Marina	16	187	2	71	68	344
Havelock	0	0	0	0	0	0
Kawau Island	0	1	7	1	8	17
Kerikeri Marina	0	38	22	3	10	73
Lyttelton	0	6	0	1	3	10
Mahurangi Harbour	0	5	0	3	0	8
Milford Marina	0	0	0	0	0	0
Napier	0	2	0	0	1	3
Nelson	1	25	0	4	7	37
Opua	38	0	21	120	139	318
Picton	0	13	0	4	3	20
Port Chalmers	0	0	0	0	0	0
Russell	22	21	0	11	2	56
Thames	0	0	0	0	0	0
Tauranga	4	79	3	8	26	120
Tutukaka	3	120	12	0	43	178
Whitianga	0	5	0	1	2	8
Waiheke Island	0	2	0	1	10	13
Waikawa Bay Marina	2	5	0	7	1	15
Wellington	0	10	0	0	0	10
Whangarei	10	135	2	43	0	190
TOTAL	183	1,265	104	422	560	2534

Dodgshun et al. (2004) focused on international tourist and cruise vessels visiting New Zealand primarily to visit the subantarctic islands and Fiordland. They identified that these international tourist vessels typically originated from Hobart (Australia). Auckland was typically the last port of call for these vessels before passage to Northland. Dodgshun et al. (2004) identified Whangarei/Marsden Point as receiving between 6 and 26 of such vessels each summer.

Fishing vessels

International

From 2000-2007, an average of three international fishing vessels arrived annually in Whangarei/Marsden Point (Piola & Conwell, 2010).

Domestic

Hayden et al. (2009) carried out a dedicated survey between 2004 and 2006 of small fishing vessels (<99 tonnes) to collect vessel movement data. They found that approximately half of 307 small fishing vessels from which data were obtained made trips between ports and marinas (half of which only made one trip between locations per year); the other half only made trips to and from their home ports. According to the survey, small fishing vessel traffic to Northland locations was very light, with 2/3 of this traffic origination from within Northland (Table 8). Auckland, Great Barrier Island, and Lyttelton were departure origins for non-Northland small fishing vessel traffic. Hayden et al. (2009) found a mean annual movement of 0.2 large fishing vessels (>99 tonnes) into Whangarei Harbour from Auckland.

Towed structures and other slow moving vessels

International

International slow-moving vessel movements to New Zealand are relatively low but variable between years. Between 2003 and 2007, slow-movers comprised 0.8 ± 0.2% (26 vessels ± 7) of all international arrivals per year (Cawthron Institute, 2010). However, these vessel types may still pose a significant biosecurity risk as they often ply non-traditional shipping routes and can spend extended periods idle (Cawthron Institute, 2010).

International routes for tugs and towed barges are typically between New Zealand and Australia, and to a lesser extent the South Pacific Islands, with the most common source regions in recent years for oil rigs (dry-towed or towed in-water) being Australia and Singapore (Cawthron Institute, 2010). Between 2006 and 2008, Cawthron Institute (2010) examined nine slow-moving vessels that arrived from Australia and operating on New Zealand-Australia routes and found 7% of biofouling species to be non-indigenous, 6% cryptogenic and 32% of ‘unknown’ biosecurity status. Common port destinations near to Northland for slow-movers include Auckland and Tauranga (Cawthron Institute, 2010), with some vessel pathways to these ports presumably passing along the Northland coastline.

Domestic

Movements of domestic slow-moving vessels within New Zealand are typically not monitored. Between 2000 and 2005, Lloyds Maritime Intelligence Unit recorded mean annual movements of 0.2 slow-moving vessels (dredge; >99 tonnes) from Timaru into Whangarei Harbour (Hayden et al., 2009). According to NRC (2010a), until the 1980s there was a coastal barging system carrying sand and fertilizer between Auckland, Whangarei and the Far North (e.g., quartz sand from Parengarenga to Whangarei/Auckland); this has reduced in recent years, but it is anticipated that coastal barging will increase again for forestry and other products.

Table 8: Arrivals of small fishing vessels (<99 tonnes) at various ports and marinas within Northland from other New Zealand ports and marinas between 2004 and 2006. Adapted from Hayden et al. (2009).

	Arrival port							
Departure port	**Ruawai**	**Houhora Harbour**	**Russell**	**Paihia**	**Opua**	**Tutukaka**	**Whangarei Harbour**	**Total**
Auckland			1				1	2
Dargaville	1							1
Great Barrier Island						1		1
Lyttelton		1						1
Marsden Point							1	1
Opua					1		1	2
Paihia	1							1
Ruawai				1				1
Tutukaka						1		1
Whangaroa Harbour						1		1
Whangarei Harbour		1			1		1	3
TOTAL	2	2	1	1	2	3	4	15

3.2.2 Aquaculture

Marine aquaculture can be an important vector for the domestic spread of non-indigenous species, as aquaculture structures and cultured organisms can support biotic communities different to their surrounding natural environment (e.g., Mazouni et al., 2001; Locke et al., 2007; McKindsey et al., 2007; Forrest et al., 2009).

In Northland, there are 747 ha of consented marine aquaculture ENVECO (2010). Of this, 700 ha is consented intertidal oyster farming area, 313 ha of which is currently productive (ENVECO, 2010). There are also 43 ha consented for mussel farming, of which only 24 ha have been developed (ENVECO, 2010). The remaining area is allocated to mussel and oyster spat catching and 'other' (aquarium) (ENVECO, 2010). Detailed location maps of Northland aquaculture farms are held by NRC (e.g., http://xplorer.xgl.co.nz/nrcmaps/Default.aspx). Currently, there is no commercial finfish farming operating in the region. There is an aquaculture research facility (run by NIWA) and

commercial land-based paua farm located at Bream Bay near Ruakaka (Morrisey et al., 2010a).

There are currently 132 oyster (Pacific oysters, *Crassostrea gigas*; non-indigenous NRC *Suppression* (CPCA) *pest*) farms and 1 spat catching farm resource consents in Northland (ENVECO, 2010). These are primarily located in Kaipara (spat catching), Parengarenga, Houhora, and Whangaroa harbours, and Bay of Islands (Jeffs, 2003). Smaller groups of farms are located in Hokianga, Rangaunu and Whangarei harbours, and Te Puna and Kerikeri inlets (Bay of Islands) (source: NRC). Dodgshun et al. (2004) highlighted the movement of oyster spat between the Kaipara Harbour and farms in the northeast harbours as potential high-risk pathways for non-indigenous species. Morrisey et al. (2009) investigated the biology and ecology of the non-indigenous ascidian *Eudistoma elongatum* (NRC *Suppression pest*) at Parengarenga Harbour, Houhora Harbour and the Bay of Islands in Northland and noted that all of the locations in which it has appeared contain oyster farms and that its spread appears to be associated with movement of aquaculture equipment and/or stock between northeast Northland oyster farms.

There are currently five Greenshell™ mussel (*Perna canaliculus*) farm resource consents in Northland; four on the Houhora coast on the western side of Rangaunu Bay, and one in Kaipara Harbour. Annual transport of mussel spat from both Ninety Mile Beach ("Kaitaia spat") and the Marlborough Sounds to these Northland mussel farms represents an incursion risk.

3.3 Regional nodes/sites with high risk of incursion.

As primary vectors for the spread of non-indigenous marine species, nodes of high shipping and aquaculture activity in Northland are at particular risk of incursion by marine pests.

3.3.1 Vessel nodes

Ports

Whangarei Harbour

There are three ports within the confines of Whangarei Harbour: Marsden Point; Portland Cement Terminal; and Port Whangarei. These facilities are the most northern multi-purpose ports in New Zealand and the closest ports to the majority of New Zealand's international markets. International and domestic merchant vessel traffic to Northland is concentrated at Whangarei Harbour (see section 2.2.1.). Whangarei Harbour also has three marinas: Marsden Cove Marina; Riverside Drive Marina Ltd; and Whangarei Marina.

In 2007, Port Whangarei was closed to commercial shipping and all cargo operations were transferred to Marsden Point. Marsden Point - Northport is a three-berth port with a fourth berth recently consented. Although primarily built for the export of Northland's forest products, it can also cater for a range of cargoes and their associated vessel types. Marsden Point - Northport also has two oil jetties which serve the New Zealand Refining Company, with bulk oil brought from international fields and from Taranaki by around 350 tankers per year (NRC, 2010a). Smaller coastal tankers subsequently distribute some of the refined product to other domestic ports. There are proposals and consents granted for major expansion of the Marsden Point - Northport facility. Tug operations are based at Marsden Point - Northport. The Portland Cement Terminal has one jetty which serves the Golden Bay

Cement Company cement works. Currently one specialised bulk cement vessel uses this facility on a regular basis (www.northport.co.nz).

For large vessels anchoring outside of Port Whangarei and Marsden Point and awaiting pilotage, there is an anchoring position one mile east-south-east of the fairway buoy (35°53.24'S, 174°33.15'E). This anchoring position is not included in any current surveillance monitoring.

Non-indigenous species detected to date in Whangarei Harbour during MAFBNZ surveillance activities include: *Styela clava*; *Musculista senhousia*; *Eudistoma elongatum*; *Didemnum vexillum*; *Charybdis japonica*; *Ectopleura larynx*; the fish *Arenigobius bifrenatus*; the bryozoan *Celleporaria umbonatoidea* (the first record for New Zealand); the polychaete worm *Chaetopterus chaetopterus-A*; the shrimp *Lysmata vittata*; the spider crab *Pyromaia tuberculata*; and the bivalve *Theora lubrica* (Morrisey et al., 2010b). Inglis et al. (2006b) recorded 19 non-indigenous species from the Port of Whangarei and Marsden Point facility from a baseline survey conducted in 2002.

Opua

The Port of Opua in the Bay of Islands was once a significant meat export port, but now services only occasional cruise liners (see section 2.2.1.) – via tender vessels – and the wharf is used mainly for recreational and commercial boating activities. Customs and MAF were originally located at the port wharf, but relocated to the new Opua Marina in 2000. Pacific oyster farms are located in Te Puna, Kerikeri and Waikare inlets, and Orongo Bay.

Harbours

Kaipara Harbour

Once an important export/trading harbour with a port operated at the Kaipara Head lighthouse, there are now no commercial port facilities in Kaipara Harbour, due mostly to the shallow nature of the harbour and the treacherous bars and tides at its mouth. The Kaipara Harbour is home port for a local fishing fleet (n=60), charter and recreational vessels (Dodgshun et al., 2004; Inglis et al., 2010b). The Kaipara Harbour does not have significant commercial or recreational vessel connections with international or domestic locations (see section 2.2.1.). However, it has a long history of customary, commercial and recreational fishing and supports a major inshore fishery dominated by local commercial and recreational fishers (Haggitt et al., 2008).

Fishing vessels operate in the Arapaoa River area, landing at Whakapirau, Pahi, Batley and Tinopai, and also in the Northern Wairoa River, using wharfs at Ruawai (Inglis et al., 2010b). There are at least four boat ramps for trailered recreational vessels, which recreational fishers from other harbours and locations use; there is a strong seasonal component to this use. Non-local east coast commercial fishers also use these ramps when shifting their fishing effort to west coast harbours such as the Kaipara (http://www.kaiparaharbour.net.nz/management/issue.asp?PublicationIssues_ID=2).

The boating club in Dargaville has a wooden wharf with a floating pontoon, a marina that can hold around 40 boats, and a concrete all-tide boat ramp. There is a town wharf and pontoon at Dargaville town for recreational boats. Helensville has a marina for around 40-50 boats

and a boat ramp. At Te Kopuru on the Wairoa River there is a marina for around 20 boats, a concrete jetty and wooden wharf. Mooring areas also exist at Tinopai, Pahi, Pahi Point, Puriri Point and Whakapirau (Inglis et al., 2010b). Pacific oyster farms are located in the Arapaoa (Pahi) and Whakaki arms of the northern Kaipara Harbour, and from South Head to Shelly Beach in the southern part of the Harbour (Inglis et al., 2010b).

During a MAFBNZ baseline survey conducted in 2002 in the Kaipara Harbour, ten non-indigenous species were detected: the annelid *Dipolydora armata*; the crustaceans *Jassa slatteryi* and *Pyromaia tuberculata*; the bryozoans *Conopeum seurati*, *Anguinella palmata* and *Bowerbankia gracilis*; the molluscs *Musculista senhousia*, *Crassostrea gigas* and *Theora lubrica*; and the sponge *Amphilectus fucorum* (Inglis et al., 2010b).

Hokianga Harbour

Once a major node for coastal timber trading, Hokianga Harbour is now home port for a small local fishing fleet (*n*=7) (Dodgshun et al., 2004) and is popular with recreational fishers and charter vessels. Hokianga Harbour has seven jetties, seven boat ramps, one wharf (Opononi) and a game fish club. Several small Pacific oyster farms are located near Te Karaka.

Parengarenga Harbour

Parengarenga Harbour does not have a fishing fleet, any consented mooring structures or boat ramps, but does have one wharf (Te Hapua). Pacific oyster farms are located in the northern reaches of the harbour, Snipe Bay and Ngutukorari Bay.

Houhora Harbour

Houhora Harbour is home port for a local fishing fleet (*n*=23) (Dodgshun et al., 2004) as well as a safe haven for charter vessels and recreational fishers. Many fishermen come to Houhora in late summer to participate in the annual major fishing competitions hosted by the Houhora Big Game and Sports Fishing Club, particularly with trailered recreational vessels. Houhora Harbour has two wharves (Pukenui and Paua), two jetties, two boat ramps, and a game fish club. There are Pacific oyster farms located immediately south of Jackson Point (Pierce & Kerr, 2004) in the upper harbour, and mussel farms on the Houhora coast on the western side of Rangaunu Bay.

Rangaunu Harbour

Popular for recreational fishing, Rangaunu Harbour does not have a fishing fleet or any consented mooring structures, but does have two boat ramps and one wharf (Unahi). Pacific oyster farms are located on the eastern side of the harbour.

Mangonui Harbour

Once a busy whaling and coastal trading port, Mangonui Harbour is now home port for a local fishing fleet (*n*=41) (Dodgshun et al., 2004) as well as a safe haven for charter vessels and recreational fishers. It has a commercial fishing wharf and boat ramp.

Whangaroa Harbour

Whangaroa Harbour is home port for a local fishing fleet (*n*=17) (Dodgshun et al., 2004) as well as a safe haven for charter vessels and recreational fishers. It has a commercial marina (Whangaroa Marina Trust), fishing wharf and two boat ramps. Pacific oyster farms are located in the upper Whangaroa harbour, Waitapu Bay, Touwai Bay, and Pumanawa Bay.

Marinas

There are currently seven purpose-built marinas in Northland, ranging in size from 24-300 berths (Table 9). As shown in section 2.2.1., Northland marinas host a large number of visiting vessels, primarily recreational vessels (international and domestic). Four of these marinas – Opua, Whangarei Town Basin, Whangarei Riverside Drive Marina Ltd, and Marsden Cove Marina – are included in the current MAFBNZ targeted surveillance programme (see section 3.1.). In recent years, there have also been a number of proposals for the development of new marinas in the Northland region (e.g., Veronica Bay, Parua Bay) (http://www.nrc.govt.nz/Resource-Library-Summary/Plans-and-Policies/Regional-plans/Regional-Coastal-Plan/); the status of these needs to be considered as these could affect vessel movement patterns to and within Northland.

Table 9: Marinas in the Northland region. .

Marina	Location	No. berths
Whangaroa Marina Trust	Whangaroa Harbour	98 berths
Opua Marina	Opua, Bay of Islands	250 berths, 35 swing moorings and 14 pile moorings
Kerikeri Cruising Club & Marina	Doves Bay, Kerikeri Inlet, Bay of Islands	186 berths
Tutukaka Marina	Tutukaka	220 berths, 30 pile moorings
Marsden Cove Marina	Marsden Cove, Whangarei Harbour	240 berths
Riverside Drive Marina Ltd	Whangarei Harbour	24 berths
Whangarei Marina	Town Basin, Whangarei Harbour	300 berths

Whangaroa Marina Trust

The Whangaroa Marina Trust is New Zealand's most northerly marina with the closest access to Northland's famous game fishing grounds. It is not included in the present MAFBNZ targeted surveillance programme. The majority of vessels entering the Whangaroa Marina are domestic coastal cruisers and game boats, with 500+ such vessels entering the marina and/or Whangaroa Harbour during the busy fishing season (January to April). Most of these domestic vessels originate from the Bay of Islands, Auckland and Tauranga (Whangaroa Marina Trust, pers. comm). Less than 10 international vessels enter the marina each year.

Opua Marina

The Opua Marina services both domestic and international recreational vessels, and is the customs port of arrival for the Bay of Islands. It is often the first port of entry for recreational vessels entering New Zealand. Of MAFBNZ's target non-indigenous species, *S. clava* and *E. elongatum* have been detected in the marina to date (Morrisey et al., 2010c). Inglis et al. (2006c) detected 12 non-indigenous species (none of which are on the MAFBNZ unwanted list) during a baseline survey of the marina in 2002: (Annelida) *Polydora cornuta*; (Bryozoa) *Bugula flabellata*, *B. neritina*, *Watersipora subtorquata*; (Cnidaria) *Obelia longissima*; (Crustacea) *Apocorophium acutum*; (Mollusca) *Musculista senhousia*, *Crassostrea gigas*, *Limaria orientalis*, *Theora lubrica*, *Polycera hedgpethi*; and (Phycophyta) *Polysiphonia sertularioides*. Between 1998 and 2010, the Opua Marina received an average of 419 international recreational vessel arrivals per year (see section 2.2.1.). Of the domestic recreational vessels entering the Opua Marina (modelled mean number of 1,265 per year), 40.6% are from Auckland marinas, 24.8% are from other Northland locations, and 19.5% depart from marinas near to Auckland (e.g., Great Barrier Island, Gulf Harbour Marina) (and see section 2.2.1.). The remainder of domestic recreational vessels originate from other marinas as far south as Dunedin.

Kerikeri Cruising Club and Marina

The Kerikeri Cruising Club and Marina in the Bay of Islands are not included in the present MAFBNZ targeted surveillance programme. Of the domestic recreational vessels entering the Kerikeri Marina, 45.4% depart from Auckland marinas, 39.9% from other Northland marinas, and 10.9% from marinas near to Auckland (see section 2.2.1.). The remainder of domestic recreational vessels originate from other marinas as far south as the Waikawa Bay Marina.

Tutukaka Marina

The Tutukaka Marina is not included in the present MAFBNZ targeted surveillance programme. Tutukaka Marina is a relatively small but busy marina that is the "gateway" to the Poor Knights Islands Marine Reserve, with numerous commercial dive and sightseeing charter businesses transporting passengers to the Poor Knights Islands for one- or multi-day trips Gust et al. (2008). It caters to local and offshore game fishing charter vessels and is a common port of call for recreational vessels, including domestic and international yachts. For domestic recreational vessels entering Tutukaka Marina (modelled mean number of 422 per year), 42% are from other Northland locations, 32% are from Auckland marinas, and 19.2% depart from marinas near to Auckland (see section 2.2.1.). The remainder of domestic recreational vessels originate from other marinas as far south as Lyttelton. According to Gust et al. (2008), the most likely mechanism for the transport of marine NIS both to and from Tutukaka Marina is fouling of vessels or mobile structures.

Marsden Cove Marina

The Marsden Cove Marina, near Marsden Point - Northport, services both domestic and international recreational vessels and is the Customs port of arrival for Whangarei Harbour. It is the only location in Whangarei Harbour where the non-indigenous *A. bifrenatus* and *C. umbonatoidea* have been detected during MAFBNZ's targeted surveillance, and it also

appears to be the original site of incursion by *S. clava* detected in Whangarei Harbour (Inglis et al., 2008).

Riverside Drive Marina Ltd

The Riverside Drive Marina Ltd is a small marina servicing both domestic and international recreational vessels, the latter largely due to the on-site chandlery, haul-out and maintenance facilities (http://www.riversidedrivemarina.com). Of MAFBNZ's target non-indigenous species, only *Musculista senhousia* has been detected in the marina to date (Morrisey et al., 2010b).

Whangarei Town Basin Marina

The Whangarei Town Basin Marina services both domestic and international recreational vessels. Of MAFBNZ's target non-indigenous species, only *Musculista senhousia* has been detected in the marina to date (Morrisey et al., 2010b). Inglis et al. (2006d) recorded nine non-indigenous species (none of which are on the MAFBNZ unwanted list) from the Whangarei Marina in a baseline survey conducted in 2002: (Annelida) *Ficopomatus enigmatus* and *Polydora cornuta*; (Bryozoa) *Bugula neritina* and *Conopeum seurati*; (Crustacea) *Monocorophium acherusicum*, *Paracorophium brisbanensis* and *Melita matilda*; (Mollusca) *M. senhousia* and *Theora lubrica*. They suggested that most non-indigenous species located in the marina are likely to have been introduced to New Zealand accidentally by international shipping. The majority of international sailing vessels entering the marina have initially passed through customs in the Opua Marina (Inglis et al., 2006d). Of the domestic recreational vessels entering Whangarei Marina between 2002 and 2004 (modelled mean number of 560 per year), 36.1% departed from marinas near to Auckland, 34.6% are from other Northland locations, and 18.6% are from Auckland marinas (see section 2.2.1.). The remainder of domestic recreational vessels originate from other marinas as far south as Dunedin.

Between 1998 and 2010, Whangarei Harbour received an average of 51 international recreational vessel entries per year (see section 2.2.1.). Until the development of the Marsden Cove Marina in 2005/2006, the Town Basin Marina was the main recipient of international recreational vessels. It is currently not clear what proportion of domestic and international recreational vessels that each of the three marinas in Whangarei Harbour accrue. The original location of the Whangarei Customs port of arrival was at Marsden Point - Northport. Following the establishment of the Marsden Cove Marina, the Customs clearance berth for international recreational vessels shifted from the port to the Marsden Cove Marina in 2008 (Bruce Cooper, MAF Customs, pers. comm.).

Vessel moorings (exclusive of marinas)

The Northland region is one of the most popular areas in New Zealand for recreational boating, as well as various aquaculture and commercial boating activities. Many of these vessels require some form of permanent mooring, such as swing moorings, pile moorings, and mooring jetties. Depending on vessel traffic patterns and connectivity with other vessel nodes within New Zealand, aggregations of vessel moorings may represent areas of incursion risk.

At 1 July 2007, there were 2,812 permits for permanent moorings (including private moorings but excluding moorings associated with marinas, which are covered under the marina consent) in the Northland region (Table 10). NRC holds detailed location maps of current consented moorings within Mooring Management Areas in the Northland region (refer to: http://xplorer.xgl.co.nz/nrcmaps/Default.aspx for full maps), as well as Plan Change 1 - Moorings and Marinas Management under NRC's Regional Coastal Plan (http://www.nrc.govt.nz/Resource-Library-Summary/Plans-and-Policies/Regional-plans/Regional-Coastal-Plan/). NRC has an objective to reduce and restrict the proliferation of moorings within Northland's coastal marina area by concentrating moorings within specific areas.

Table 10: Location and number of moorings (including private moorings but excluding marina-associated moorings) within the Northland region.
(Source: http://www.nrc.govt.nz/upload/4015/6%20-%20Coastal%20management.pdf.).

Location	Mooring permits
Bay of Islands	1,189 (42%)
Whangarei Harbour	388 (14%)
Kaipara Harbour	46 (2%)
Whangaroa Harbour	208 (7%)
Doubtless Bay/Mangonui	164 (6%)
Houhora Harbour	98 (4%)
Kerikeri	404 (14%)
Whangaruru/Whananaki	67 (2%)
Tutukaka/Ngunguru	168 (6%)
Hokianga Harbour	10 (0.4%)
Mangawhai Heads	54 (2%)
Other*	16 (0.6%)
TOTAL	2,812

*Other includes Bream Bay, and Parengarenga and Rangaunu harbours.

Currently, there are concentrations of vessel moorings at the following locations that may represent a biosecurity risk (depending upon associated vessel movement patterns): Pahi (Kaipara Harbour); Houhora Harbour; Mangonui Harbour; Whangaroa Harbour (e.g., Whangaroa, Totara North, Waitapu Bay); Bay of Islands (e.g., Kerikeri Inlet, Paihia, Russell, Pomare Bay, Orongo Bay, Opua, Parekura Bay); Tutukaka (e.g., Pacific Bay); Whangarei Harbour (e.g., Parua Bay, McLeod Channel, Marsden Bay channel, Urquharts Bay); and Mangawhai Heads. To a lesser degree, areas of safe temporary anchorage should also be considered for incursion risk.

Boat ramps and small wharves/jetties

Northland has a large number of public boat ramps and launching facilities which trailered recreational vessels may use (http://www.nrc.govt.nz/Living-in-Northland/On-the-water/Boat-ramps-and-maps/) (Table 11). As they typically do not involve moored recreational vessels, public boating ramps may be considered to be of lower incursion risk compared to ports and marinas, but nonetheless are of concern. The NRC and the three Northland district councils hold location information for small wharves/jetties in addition to such structures that are part of the main Northland ports and marinas (e.g., http://www.fndc.govt.nz/services/community-facilities/maritime/maritime-facilities-in-the-far-north#a1)

Table 11: Boat ramps within the Northland region. (Source: http://www.nrc.govt.nz/Living-in-Northland/On-the-water//Boat-ramps-and-maps/).

Location	Ramp location
Kaipara Harbour	Kelly's Bay, Ruawai Boating Club (private), Tinopai (by wharf), Tinopai (by motor camp)
Hokianga Harbour	Horeke, Kohukohu, Koutu Point, Narrows, Omapere, Opononi, Rawene
Houhora Harbour	Pukenui, Houhora Heads (Motor Camp)
Doubtless Bay	Mangonui (Mill Bay), Taipa (below bridge), Taipa (above bridge), Tokerau Beach
Rangaunu Harbour	Kaimaumau, Unahi
Whangaroa Harbour	Totara North, Whangaroa (Ratcliffs Bay)
Bay of Islands	Opito Bay, Opua, Rangitane, Russell, Tapeka Point, Waipapa, Waitangi (above bridge)
Whangaruru Harbour	Tematateatai Point
Whananaki	Whananaki South, Whananaki North
Ngunguru and Tutukaka	Ngunguru Central, Kowharewa Bay, Tutukaka
Whangarei Harbour	Jetty at Onerahi, Limeburners Creek, Marsden Bay, One Tree Point, Oakleigh, Onerahi Road (Kissing Point Cruising Club), Onerahi, Onerahi Yacht Club, Parua Bay, Stephens Point (Sea Scouts), Tamaterau, Tamaterau (Browns Bay), Reotahi, Urquharts Bay
Waipu	Waipu river (by Waipu Boating Club)
Mangawhai Harbour	Mangawhai Heads, Mangawhai South

3.3.2 Aquaculture

Most current aquaculture activity in the Northland region is centred on Pacific oyster farming at: Kaipara Harbour (spat catching); Parengarenga Harbour; Houhora Harbour; Whangaroa Harbour; and Bay of Islands. Smaller groups of Pacific oyster farms are located at: Hokianga Harbour; Rangaunu Harbour; Te Puna inlet; Kerikeri inlet (Bay of Islands); and Whangarei Harbour (see section 2.2.2.). There is also a smaller amount of mussel farming activity at the Houhora coast on the western side of Rangaunu Bay, and in the Kaipara Harbour.

As outlined in section 2.2.2., marine aquaculture can be an important vector for non-indigenous species. Thus, the locations of aquaculture activity in Northland should be considered as sites at high risk of incursion, as well as potential sources of non-indigenous

species. Transfers of cultured Pacific oyster stock occur between harbours on the east coast of the region and from the east to west coasts, whilst mussel spat is transferred from both Ninety Mile Beach ("Kaitaia spat") and the Marlborough Sounds to mussel farms on the east and west coasts of Northland. Aquaculture-related vectors may be important even when there are few other vectors. For example, the risk of transfer from the east to west coasts by recreational vessels is probably small because the large distances involved mean that vessel numbers are small (see section 2.2.1.).

Growth in the aquaculture sector in Northland is likely to come from Pacific oyster farming and sea cage finfish farming (e.g., kingfish, hapuku) (NRC, 2010a) in areas such as the Kaipara, Hokianga, Parengarenga and Whangaruru harbours, and around Whangaroa Bay (Figure 3) (http://www.nrc.govt.nz/upload/7851/Our%20Coast%20-%20Background.pdf). The NRC Proposed Plan Change 4 (Policy and Regulatory Regime for Aquaculture Management Areas) to the Regional Coastal Plan (Plan Change 4) and Use and Value maps provides guidance on where new aquaculture in the Northland region may be located (www.nrc.govt.nz). Any new proposed aquaculture areas/farms should be considered as potential high risk sites if they proceed to development.

Figure 3: Map showing existing and potential future sites of aquaculture activity in the Northland region.
(Source: http://www.nrc/govt/nz/upload/7851/Our%20Coast%20-%20Background,pdf).

3.4 Nodes/sites where marine pests may have significant impacts on valued resources

3.4.1 Marine reserves and protected areas

Central government restrictive provisions in the marine environment pertinent to the Northland region are summarized by Froude & Smith (2004). Under the Marine Reserves Act 1971, the Department of Conservation (DOC) is responsible for caring for and managing marine reserves. Marine parks are protected by the Fisheries and Harbours Acts or under their own special legislation.

The Poor Knights Islands marine reserve

The Poor Knights Islands marine reserve (1,890 ha) is located 24 km off the east coast of Northland, with the Tutukaka Marina as the closest vessel node (Gust et al., 2008; Sim-Smith & Kelly, 2009). Mooring is permitted within the reserve, but there have been no permanent moorings in the reserve since 2004 (Sim-Smith & Kelly, 2009).

Recreational vessels visiting the Poor Knights Islands are a significant biosecurity risk as many of these vessels remain inactive for long periods of time in sheltered marinas where invasive organisms are prevalent. Gust et al. (2008) noted that the majority of vector risks for non-indigenous organisms, such as *Styela clava*, to the Poor Knights Islands arise from recreational and commercial vessels from the Auckland region and Tutukaka Marina. For example, there are regular 1-3 day trips to the Poor Knights Islands from Tutukaka Marina per day, with ecotourism and diving operations predominating (Gust et al., 2008).

International and local shipping traffic to and from the port of Whangarei, and also Auckland, is busy and passes near the Poor Knights Islands (Sim-Smith & Kelly, 2009). Vessels greater than 45 m in length are prohibited from travelling within the coastal region between Bream Head and Cape Brett, including the area around the Poor Knights Island (Sim-Smith & Kelly, 2009). The boundary of the protected area extends 5 nautical miles from land and passes east of the Poor Knights Islands. The only commercial ships exempt from this rule are fishing ships that are engaged in fishing operations and barges under tow, provided the cargo is not oil or other harmful substances (http://www.maritimenz.govt.nz/Environmental/Environmental-requirements/Requirements-for-installations/Safety-zones.asp) (Fisheries (Auckland and Kermadec Areas Commercial Fishing Regulations 1986, SR1986/216). Potentially, larger vessel traffic on the margins of the protected area could discharge ballast water containing the larvae or spores of non-indigenous species, for dispersal via local currents, in the vicinity of the islands (Dodgshun et al., 2004).

Whangarei Harbour Marine Reserve

The Whangarei Harbour marine reserve is made up of two sites - Waikaraka and around Motukaroro/Passage Island. The combined area of both sites is approximately 253.7 ha (source: http://www.nrc.govt.nz/Environment/Coast/Our-coast/Facts-about-coast/). Being marine reserves, both Waikaraka and Motukaroro Island are not included as sampling sites in the current MAFBNZ Whangarei Harbour targeted surveillance. The Motukaroro Island site is opposite, and in close proximity (<500 m) to the commercial port of Marsden Point -

Northport and, therefore, at high risk of incursion from non-indigenous species that may arrive at the port.

Mimiwhangata Marine Park

Mimiwhangata Marine Park (2,000 ha) is located on the Northland mainland east coast, 48 km from Whangarei and 52 km from Russell. All commercial fishing is prohibited and only certain amateur fishing methods are allowed within the park (De Buisson, 2010). The surrounding coastline and bays are frequented by recreational and charter vessels (e.g., from the nearby Bay of Islands).

Others

Known hotspots of species endemism and/or species diversity within the Northland region occur at the Three Kings Islands, at Spirits (Piwhane) and Tom Bowling Bays, around Parengarenga Harbour, the Bay of Islands and the Poor Knights Islands (Morrison, 2005). DOC has produced reconnaissance reports for each of 19 Ecological Districts in the Northland region for the Protected Natural Areas Programme describing biota and ecosystems within each district of significance (http://www.doc.govt.nz/publications/conservation/land-and-freshwater/land/northland-conservancy-ecological-districts-survey-reports/). For example, the Kaipara Harbour was considered to be a nationally and internationally important habitat for migratory and non-migratory bird species and Whangarei Harbour as an estuarine ecosystem of international importance and important habitat for migratory and non-migratory bird species. Parengarenga, Houhora, and Rangaunu harbours have been identified by the Minister of Conservation as Areas of Significant Conservation value and have been incorporated as areas of important conservation value in Marine 1 (Protection) Management Areas of the Northland Regional Coastal Plan (NRC, 2010a), as has the area around Urupukapuka, Motukiekie and Moturua Islands in the Bay of Islands (http://www.nrc.govt.nz/Your-Council/Have-your-say/Regional-Coastal-Plan/Plan-Change-4-Aquaculture-Management/Use-and-Value-Maps/). Other Marine 1 Management Areas in Northland include: Twilight Beach at Ohao Point; Karikari Peninsula; Cape Brett Peninsula; Whananaki; Horahora estuary; Hen and Chicken Islands; Mangawhai Estaury; and Kawerua Coast (NRC, 2010a). As part of its Regional Coastal Plan, the NRC is to identify habitats or habitat areas of indigenous fauna that have moderate, moderate high, high or outstanding value within Northlands coastal marine area (NRC, 2010a); these sites should be correlated with vector nodes/pathways of high risk.

3.4.2 Aquaculture

Aquaculture is an important industry in Northland that is estimated to contribute ~$30 million per year and 465 jobs to the Northland region (ENVECO, 2010). Combined oyster farming and processing from the existing productive 313-ha consented oyster farming area in Northland contributes 47% of New Zealand's Pacific oyster production, and has been estimated to directly contribute $19 million to regional income and create 336 FTE jobs (ENVECO, 2010)..

There is considerable potential for aquaculture development in Northland (Jeffs, 2003; ENVECO, 2010). Plan Change 4 to the Regional Coastal Plan for Northland sets out the new way aquaculture will be managed in Northland. It includes policies and rules for: managing

existing aquaculture; and directing how and where new aquaculture is located (http://www.nrc.govt.nz).

3.4.3 Customary areas

Coastal customary areas of special significance to iwi/hapu either as a food source or for spiritual or cultural reasons in the Northland region are marked on the National Aquatic Biodiversity Information System (NABIS) (http://www.nabis.govt.nz), and listed in Table 12. In Northland, there are currently two formally recognised traditional fisheries management initiatives in place. There is a taiapure in the Waikare Inlet (Bay of Islands) and a temporary closure of the Kaipara Harbour for taking scallops. There are also a small number of proposals for additional taiapure and Mätaitai areas (http://www.nrc.govt.nz/upload/7851/Our%20Coast%20-%20Background.pdf).

Table 12: Coastal customary areas of special significance to iwi/hapu in the Northland region. Rohe Moana = areas where Kaitiaki are appointed for the management of customary food gathering within the area/rohe. Taiapure = local fisheries in coast al waters which recognise the special significance of the area to local iwi/hapu, with commercial fishing allowed. Temporary closures = areas closed to fishing and/or method restrictions to help manage the impact of commercial and recreational fishing on customary fisheries.

Customary type	Location	NABIS Identifier	Tangata whenua
Rohe Moana	Bay of Islands	TK1011	Nga Hapu o Taiamai Ki Te Marangi
	Whangarei Harbour/Bream Bay	TK1042	Patuharakeke
	Kaipara Harbour	TK1035	Te Uri O Hau
Taiapure	Waikare Inlet, Bay of Islands	FT107	
s186 Temporary closures	Maunganui Bay	TC1045	

There are many coastal areas along Northland's extensive coastline that are of customary/recreational significance to iwi/hapu and local communities. These could be identified through consultation with pertinent Northland iwi/hapu and local community groups with regards to their importance/value and potential risk from non-indigenous marine organism incursions.

3.4.4 Fisheries

The Northland seafood industry contributes >$70 million to the Northland economy each year (http://www.nrc.govt.nz/upload/1643/Part%20I%20Northland.pdf). Northland coastal waters support a substantial commercial finfish fishery predominantly based on snapper (open coast) and flounder, mullet and rig (harbours). There are also important shellfish fisheries which tend to be quite discrete, with an important scallop fishery on the east coast, a commercial cockle and pipi fishery near Marsden Point (e.g., Marsden Bay, Snake Bank) and a tuatua fishery near Dargaville in the Kaipara Harbour. Scallop fishing in the Northland fishery is conducted within discrete beds in Spirits Bay, Tom Bowling Bay, Great Exhibition

Bay, Rangaunu Bay, Doubtless Bay, Stevenson's Island, the Cavalli Passage, Bream Bay, and the coast between Mangawhai and Pakiri Beach (www.fish.govt.nz).

In the Kaipara Harbour, there is a strong customary fishery for kingfish and gurnard, with the latter also starting to be targeted commercially. The Kaipara Harbour is a major fish nursery for both estuarine-based species and species that move out to the open coast with increasing age and size, including: snapper; trevally; red gurnard; sand and yellow-belly flounders; rig; school and hammerhead sharks; yellow-eyed mullet; and anchovies. Species commercially targeted are: yellow-belly flounder; rig; and grey mullet (Haggitt et al., 2008). School shark and trevally were commercially fished in the past but are no longer targeted, and commercial fishing for sand flounder has also reduced. Commercial fishers also operate longlines for dogfish for a short period each year in the Otamatea River area (Inglis et al., 2010b).

There are many locations in most Northland harbours/bays and along the coastline where finfish and shellfish species are recreationally fished (e.g., recreational scallop beds in Whangaroa Harbour; Morrison, 2005). On the eastern coast, boat-based fishing predominates – usually in close proximity to centres where moorings and boat ramps are available – whilst on the west coast the catch is still predominantly taken from small trailered boats, but shore-based fishing is also widespread (Morrison, 2005).

4. Existing and potential capability for marine pet surveillance within Northland

4.1 Existing marine pest surveillance in New Zealand

MAFBNZ currently funds a national programme of targeted surveillance for marine pests in 12 high risk sites throughout New Zealand. The primary objective of the Marine High Risk Site Surveillance (MHRSS) is:

- To detect incursions of non-indigenous organisms listed on the Unwanted Organisms Register at High Risk Sites throughout New Zealand.

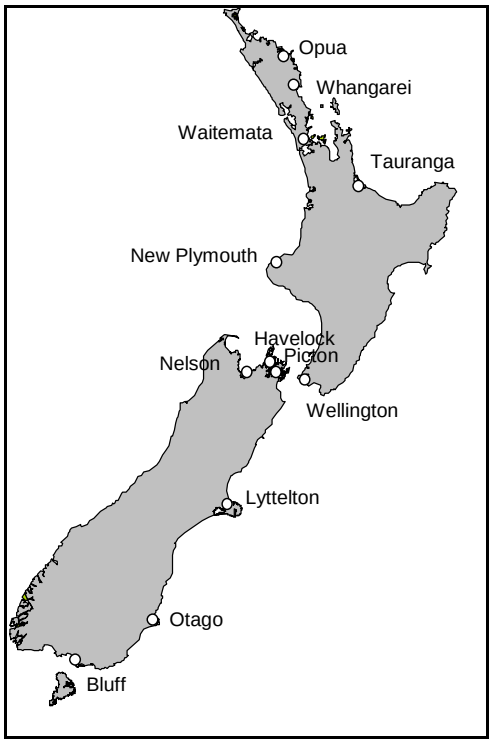

Figure 4: Locations of ports in the MAFBZ Marine High Risk Site Surveillance (MHRSS) programme.

At present, the programme is targeted primarily at five species that are on the New Zealand register of Unwanted Organisms, but which are not known to be present in New Zealand. These are:

1. Northern pacific seastar, *Asterias amurensis;*
2. European shore crab, *Carcinus maenas;*
3. Aquarium weed, *Caulerpa taxifolia*;
4. Chinese mitten crab, *Eriocheir sinensis;* and
5. Asian Clam, *Potamocorbula amurensis*.

The secondary objectives of the MHRSS are:

- To detect incursions of new non-indigenous or cryptogenic organisms not listed on the Unwanted Organisms Register at High Risk Sites throughout New Zealand; and
- To detect incursions (i.e., range extensions) of established non-indigenous or cryptogenic organisms that exhibit characteristics of Pests and Diseases.

The programme specifically targets four secondary objectives pests that are known to be present in New Zealand, but which currently have restricted distributions. These are the:

6. Mediterranean fanworm, *Sabella spallanzanii*;
7. Clubbed tunicate, *Styela clava*;
8. Asian Date Mussel, *Musculista senhousia*; and
9. Australian droplet tunicate, *Eudistoma elongatum*.

The 12 sites that are the focus of the surveys were selected according to risk, based on the volume of international shipping that occurs to them, the availability of suitable habitat for the target species, and their history of invasion by other non-indigenous species (Inglis, 2001). Only two of the sites – Opua and Whangarei Harbour – are in Northland, and whilst some secondary target species have been detected at these locations (see section 2.1.1), several pests (e.g., *Eudistoma elongatum* and the sea-squirt, *Pyura stolonifera praeputialis*) have also been discovered opportunistically in areas of Northland that are not currently covered by the national targeted surveillance programme.

4.2 The Northland Regional Council

As outlined earlier, the Northland Regional Council (NRC) is responsible for the management and control of plant and animal pests in the Northland region. In addition to current pest management/control activities, NRC also conducts other coastal activities that have potential to be built on for marine pest surveillance.

NRC carries out monitoring of the region's coastal environment to record the state of this resource and the effects of human activity. In 2009-2010, NRC undertook routine water quality testing at 16 sites in the Whangarei Harbour and Bay of Islands, and nine sites in the Kaipara Harbour to capture the main freshwater inputs into the systems, and to assess water quality (Table 13) (source: http://www.nrc.govt.nz/upload/8163/Coastal%20Water%20Quality%20Report%202009-10.pdf). NRC carries out annual benthic estuarine monitoring in Arapaoa river estuary (Kaipara Harbour), Whangaroa Harbour, Ruakaka, Kerikeri Inlet (Bay of Islands), and Whangarei Harbour. This benthic monitoring involves sampling for benthic epifauna/infauna and associated geochemical variables. NRC also conducts annual water quality testing during summer at six Northland marinas (Whangaroa Marina, Kerikeri Marina, Opua Marina, Tutukaka Marina, Whangarei Town Basin Marina, and Marsden Cove Marina) as part of their resource consents.

Table 13: Existing stakeholder activities within Northland that have potential for incorporation into a non-indigenous marine pest surveillance programme. NRC = Northland Regional Council; DOC = Department of Conservation.

Location	Stakeholder	Current activity	Periodicity
Kaipara Harbour	NRC	Water quality	Monthly/annual
		Coastal structures compliance	Bi-annual
	Aquaculture	Farming	Seasonal to Year-round
Arapaoa river estuary (Kaipara Harbour)	NRC	Estuary monitoring (benthic)	Annual
	Aquaculture	Farming	Seasonal to Year-round
Hokianga Harbour	NRC	Coastal structures compliance	Bi-annual
	Aquaculture	Farming	Seasonal to Year-round
Three Kings Islands	DOC	Weeding	Twice a year
North Cape	DOC	Baited underwater video monitoring	Every 3 years
Parengarenga Harbour	NRC	Coastal structures compliance	Bi-annual
	DOC	*Spartina* (cordgrass) removal	Annual (late summer)
	Aquaculture	Farming	Seasonal to Year-round
Houhora Harbour	NRC	Coastal structures compliance	Bi-annual
	DOC	Boat launching	Infrequent
	Aquaculture	Farming	Seasonal to Year-round
Rangaunu Harbour	NRC	Coastal structures compliance	Bi-annual
	Aquaculture	Farming	Seasonal to Year-round
Cape Karikari	DOC	Baited underwater video monitoring	Every 3 years
Mangonui Harbour	NRC	Coastal structures compliance	Bi-annual
Matai Bay	DOC	Boat launching	Camp manager on-site for one month per year
Whangaroa Harbour	NRC	Estuary monitoring (benthic)	Annual
		Coastal structures compliance	Bi-annual
		Marina water quality	Annual
	Aquaculture	Farming	Seasonal to Year-round
	Whangaroa Marina Trust	Marina infrastructure maintenance	Year-round
Bay of Islands	NRC	Water quality	Bimonthly + 3 rain-driven events/annual
		Coastal structures compliance	Bi-annual
	Aquaculture	Farming	Seasonal to Year-round
Kerikeri inlet (Bay of Islands)	NRC	Estuary monitoring (benthic)	Annual
		Coastal structures compliance	Bi-annual
		Marina water quality	Annual
	Aquaculture	Farming	Seasonal to Year-round

Location	Stakeholder	Current activity	Periodicity
	Kerikeri Cruising Club & Marina	Marina infrastructure maintenance	Year-round
Opua (Bay of Islands)	NRC	Marina water quality	Annual
	Opua Marina	Marina infrastructure maintenance	Year-round
Urupukapuka Island	DOC	Site maintenance	Rangers on-site over summer (one month) and bi-monthly throughout the year
Cape Brett	DOC	Baited underwater video monitoring	Every 3 years
Whangaruru Harbour	NRC	Coastal structures compliance	Bi-annual
Mimiwhangata Bay	DOC	Baited underwater video monitoring	Every 3 years
		On-site manager	All year
Poor Knights Islands	DOC	Weeding	Irregular
		On-water patrols	All year
		Dive surveys and Underwater Video Census	Annual
		Biosecurity dives	Annual
Tutukaka	NRC	Coastal structures compliance	Bi-annual
		Marina water quality	Annual
	Tutukaka Marina	Marina infrastructure maintenance	Year-round
Whangarei Harbour	NRC	Water quality	Bimonthly + 3 rain-driven events/annual
		Estuary monitoring (benthic)	Annual
		Coastal structures compliance	Bi-annual
		Marina water quality	Annual
	Aquaculture	Farming	Seasonal to Year-round
	DOC	Marine reserve work, dive surveys, biosecurity targeted surveillance	All year
	Northport Ltd	Port infrastructure maintenance	Year-round
	Marsden Cove Marina	Marina infrastructure maintenance	Year-round
	Riverside Drive Marina Ltd	Marina infrastructure maintenance	Year-round
	Whangarei Marina	Marina infrastructure maintenance	Year-round
Ruakaka	NRC	Estuary monitoring (benthic)	Annual
Hen and Chicken Islands	DOC	Weeding	Summer
Mangawhai Heads	NRC	Coastal structures compliance	Bi-annual

NRC tests water quality at a selection of coastal sites in the region which are popular for customary/recreational shellfish gathering. The majority of these sites (*n*=15 in 2007-2008) are on the east coast of Northland and generally away from high biosecurity risk sites (http://www.nrc.govt.nz/upload/4240/8%20-%20Coastal%20water%20quality_resize.pdf), but some sites (e.g., Tinopai in the Kaipara Harbour, McLeod and Taurikura bays in Whangarei Harbour) are near high biosecurity risk sites.

NRC is responsible for administering nearly all aspects of marine farming in the Northland region. This includes: monitoring existing farm consents (*n*=133 in 2007-08); ensuring compliance with resource consent conditions; granting resource consents for new marine farms; and writing the policies and rules determining where new aquaculture can and cannot go (source: http://www.nrc.govt.nz/Environment/Coast/Issues/Aquaculture/). The monitoring of the state of marine farms throughout Northland involves the examination of farm structures, seabed and surrounding area.

NRC conducts bi-annual compliance inspections of permitted coastal structures, the majority of which are in the Bay of Islands, Kerikeri inlet, and Whangarei Harbour. At 1 July 2007, there were 765 coastal permits coastal structures (e.g., boat ramps, jetties, seawalls etc.) (excluding approximately 200 deemed coastal permits, which were authorised prior to the RMA 1991) in the Northland region (http://www.nrc.govt.nz/upload/4015/6%20-%20Coastal%20management.pdf).

4.3 Department of Conservation

Department of Conservation (DOC) activities at the Poor Knights Islands and Whangarei Harbour reserves currently have an active biosecurity surveillance component (i.e., biosecurity targeted dive surveys) (Table 13). Within these marine reserves, DOC carries out regular diver surveys to monitor the overall biota of the reserves, with a watching brief kept for the non-indigenous species outlined in section 3.1. DOC also conducts baited underwater video monitoring to determine fish abundance at the lower incursion risk sites of North Cape, Cape Karikari, Cape Brett and Mimiwhangata (e.g., De Buisson, 2010).

DOC has on-site Camp Managers or Rangers at various Northland locations, which may be of lower incursion risk but nevertheless of high conservancy value (e.g., Matai Bay, Urupukapuka Island). Their roles may involve coastal activities such as marine biota protection and management, camp and track maintenance, etc. DOC vessels are launched at sites such as Houhora Harbour and Matai Bay. As part of its Regional Pest Management Strategy, DOC also carries out weeding programmes on the Three Kings, Poor Knights and Hen and Chicks Island groups, and *Spartina* removal in Parengarenga Harbour.

4.4 Aquaculture industry

As outlined in section 2.2.2., the Northland aquaculture industry – primarily Pacific oyster farming – is restricted to certain locations (individual lease details are held by the NRC and Ministry of Fisheries). The aquaculture industry has a vested interest in preventing incursions and spread of non-indigenous marine pest species. As the majority of oyster farms in the Northland region are intertidal rack systems (Forrest et al., 2007), inspection of oyster stock and farm structures by aquaculture staff during routine husbandry could be an important part of a surveillance strategy for high risk locations in which aquaculture is practiced.

4.5 Port and marina authorities

Port and marina operating companies typically carry out periodic inspections of their infrastructure, and their waterfront staff are often in close contact with facility infrastructure and vessels. Thus, Northland port and marina staff (Table 13) are potentially well-placed to detect the presence of certain pest species (i.e., intertidal or shallow subtidal species) at their facilities.

Northport Ltd in Whangarei Harbour, as part of their continued commitment to working with the community, is a member of both the Ruakaka Economic Development Group and Community Liaison Group (CLG). These groups ensure that Northport maintains a positive impact on the community and the environment. Northport sponsors the T.R. Kepa & H.M. Pirihi (Northport) Scholarship every year (www.northport.co.nz). This scholarship supports tertiary education to descendants of the Patuharakeke who have successfully completed one or more years of tertiary study. Patuharakeke Te Iwi Trust Board Incorporated Society (PTB) represents Patuharakeke Hapū, Tangata Whenua o Te Rohe o Patuharakeke with regards to Resource Management issues. These port-community linkages and scholarships could potentially incorporate a biosecurity surveillance capability.

4.6 Others

Other stakeholder groups that could be incorporated into a marine pest surveillance strategy for Northland include:

- tangata whenua – e.g., far north iwi were involved with MAFBNZ in an effort to clear the non-indigenous ascidian *Pyura praeputialis* from the Bluff at Ninety Mile Beach and Whareana Bay in late 2010;
- yachting/boating/fishing clubs;
- customary/recreational fishers (e.g., shellfish); and
- universities – e.g., The University of Auckland has carried out second-year ecology student studies at Motukaroro Island (Whangarei marine reserve) since the early 1980s to study and compare patterns of zonation between exposed and sheltered shores (http://www.doc.govt.nz/conservation/marine-and-coastal/marine-protected-areas/marine-reserves-a-z/whangarei-harbour/monitoring/).

5. Development of surveillance capability within Northland

In a review of post-border surveillance for non-indigenous species in New Zealand, Pearson (2002) defined two general types of post border pest detection activity that are distinguished by whether they are planned attempts to locate new species ("active surveillance") or the result of fortuitous discovery and reporting by members of the general public and/or interested sector groups ("passive surveillance"). The surveillance capacity of the general public and vested stakeholder groups for pest detection and notification can be further harnessed by raising their general awareness of non-indigenous pest species, and by making it easier for them to identify and report unusual occurrences ("enhanced passive surveillance"). Active and enhanced passive surveillance activities can not only detect new organisms previously exotic to New Zealand, but can also be used to monitor range extensions of established pest species.

NRC and DOC, through their existing respective biosecurity activities and Pest Management Strategies, have skills, knowledge and infrastructure that could be readily utilised and further developed to form the backbone of an active targeted surveillance strategy for Northland. Tangata whenua also have the potential for development as a key component of an active targeted surveillance strategy. As per the New Zealand Coastal Plan (http://www.doc.govt.nz/upload/documents/conservation/marine-and-coastal/coastal-management/nz-coastal-policy-statement-2010.pdf) and proposed National Policy Statement on indigenous biodiversity (Policy 7(c)), tangata whenua should be involved in the protection of areas and habitats when there are particular cultural values at stake. Involvement of tangata whenua in a Northland biosecurity strategy would take into account the principles of the Treaty of Waitangi and the Resource Management Act, recognising the role that Māori have as kaitiaki who are involved in all aspects of biodiversity management and ongoing and enduring relationship of tangata whenua over their lands, rohe and resources.

Harnessing the capacity of vested stakeholders and general public for the development of an enhanced passive surveillance network can be relatively low cost, can greatly increase the geographic and temporal coverage of surveillance, increases community awareness of the threats posed by non-indigenous species, engenders greater individual/group responsibility for reducing the risk of spread, and allows better identification of sites that are valued by the community and which may be under threat from non-indigenous organisms (Green, 2000; PCE, 2000). Stakeholders/sectoral groups that could be engaged in the development of an enhanced passive surveillance strategy for Northland are:

- aquaculture sector;
- tangata whenua;
- marina operators (New Zealand Association of Marina Operators);
- port companies (Northport Ltd);
- fishing and Yacht clubs; and
- recreational boaters.

Local engagement in enhanced passive pest surveillance will increase the chances of early detection of pests in the region, thereby enabling more options for eradication, containment and suppression. For example, the training and incorporation of aquaculture farm and marina/port staff into an enhanced passive surveillance strategy for Northland is highly desirable, as they are best placed to detect new incursions and the spread of non-indigenous marine species at aquaculture sites and vessel nodes. The on-site knowledge of existing (or "normal") site/node biota of aquaculture and marina/port staff could be exploited with training in the identification of target pest organisms to enhance pest detection efficacy. Supplemental periodic NRC inspection (active surveillance) alongside aquaculture and marina/port staff during monitoring of farms and other activities would be desirable to increase detection probabilities, and to reinforce stakeholder-NRC surveillance links. In addition, incorporation of the aquaculture industry and marinas/ports into the surveillance strategy could be used as an avenue to gather and synthesize industry information on farm activities/pathways and vessel traffic patterns relevant to the risk of translocation and spread of pest organisms. Active engagement of stakeholders in pest management raises awareness and encourages greater personal responsibility for mitigating risk from local pathways for spread for pest organisms.

6. Draft surveillance strategy for the Northland region

Active targeted marine pest surveillance is required to ensure early detection of new incursions at higher priority locations. Ideally, this active surveillance would be supplemented with enhanced passive surveillance provided by stakeholders and the general public at higher priority locations. At lower priority locations, enhanced passive surveillance is likely to be the most cost-effective surveillance strategy for the Northland region, although this would not prevent active surveillance activities at lower priority sites occurring if resources allow.

6.1 Potential sites for surveillance

Potential sites for surveillance in the Northland region are provided in Table 14. These sites are given a preliminary priority ranking (*High*, *Medium* and *Low*) for surveillance activities based upon the vector risk and value factors as outlined in the preceding sections. These preliminary rankings are relative, not absolute, i.e., a priority ranking of *Low* does not necessarily imply a low incursion risk, but that compared to other sites considered it is deemed to be of lower priority for surveillance activities when resources may be limited.

High priority sites are those that are usually significant vessel nodes for international and domestic coastal vessel traffic and are at greatest risk of an incursion from outside Northland. They usually possess consented vessel moorings, boat ramps, aquaculture farms, and/or are of high resource/ecological value. For example, the Waikare Inlet in the Bay of Islands has the Opua Marina – which is a major node for international and domestic recreational vessels – as well as a large number of consented moorings, boat ramp, Pacific oyster farms and a taiapure. Whilst the Kaipara Harbour does not receive any significant amount of international or domestic vessel traffic, it is deemed to be a High priority site as it acts as a major source of Pacific oyster spat for many oyster farms on Northland's north-east coast, has known occurrences of non-indigenous marine species, is a popular recreational fishing harbour and is of resource/ecological value.

Medium priority sites typically receive lower amounts of non-local vessel traffic (particularly international vessels) but may possess consented moorings, boat ramps, aquaculture farms and/or are of resource/ecological value. For example, Parengarenga Harbour is an important Pacific oyster farming area, has a fishing fleet and consented moorings, and is of resource/ecological value, but receives little non-local vessel traffic. The Poor Knights Islands Marine Reserve is of high conservation value and receives regular domestic and some international recreational vessel traffic, but has no consented moorings or aquaculture farms.

Low priority sites typically receive little non-local vessel traffic and have an overall lower degree of vessel- and aquaculture-associated activity. For example, Mimiwhangata is of resource/ecological value and receives some recreational vessel traffic, but has no consented moorings, boat ramp or aquaculture farms. Whilst the Hokianga Harbour has a small number of domestic fishing vessels, consented moorings and aquaculture farms, it receives little non-local vessel traffic with most recreational vessel traffic appearing to be trailered vessels.

Some of the High priority sites are currently included in MAFBNZ's MHRSS programme (i.e., Opua, Whangarei Harbour), and therefore, could be excluded from any specific Northland surveillance strategy. However, it may be advantageous to supplement the MAFBNZ surveys in specific sub-locations which are currently not covered. For example, the Whangarei

Harbour Marine Reserve is not included in the MAFBNZ surveillance activities (apart from no-take dives at Motukaroro), whilst the Opua surveillance does not extend to the major Pacific oyster farming areas in the Waikare Inlet and Orongo Bay, or recreational vessel moorings at Russell.

Table 14: Sites in the Northland region that are at risk of non-indigenous marine pest incursion, and where surveillance activities would be best targeted. Highlighted locations are currently part of MAFBNZ's marine High Risk Site Surveillance (MHRSS) programme. Resource/ecological value = site that is of value due to conservancy, customary, ecological and/or fisheries factors.

Priority ranking	Site		Port	Marina	Aquaculture	Moorings	Boat ramp	Resource/ecological value
High	Kaipara Harbour				√	√	√	√
High	Whangaroa Harbour			√	√	√	√	
High	Bay of Islands	Kerikeri Inlet		√	√	√	√	√
High		Waikare Inlet (incl. Opua)	√	√	√	√	√	√
High	Tutukaka			√		√	√	√[1]
High	Whangarei Harbour	Marsden Point - Northport	√					√
High		Marsden Cove Marina		√		√		√
High		Town Basin Marina		√		√		
High		North-eastern bays (e.g., Parua, McLeod, Urquharts etc.)			√	√	√	√
Medium	Parengarenga Harbour				√	√		√
Medium	Houhora Harbour				√	√	√	√
Medium	Rangaunu Harbour				√		√	√
Medium	Bay of Islands	Te Puna Inlet			√	√		√
Medium	Poor Knights Islands							√
Low	Hokianga Harbour				√	√	√	
Low	Mangonui Harbour					√	√	
Low	Whangaruru Harbour					√	√	√
Low	Mimiwhangata							√

[1]Tutukaka is an important source destination for vessels heading to the Poor Knights Islands Marine Reserve

6.2 Implementation and reporting

MAFBNZ is the lead agency in New Zealand's biosecurity system tasked with a "whole of system" leadership role, encompassing economic, environmental, social and cultural outcomes. Under the Marine Biosecurity Act, Regional Councils are the agencies responsible for processing and approving regional pest management strategies. Given its proactive development of a Northland Regional Marine Pest Management Strategy (RMPMS), and its overarching statutory role, it is appropriate that NRC act as lead agency and governance architect in the coordination, implementation and reporting of a surveillance strategy for non-indigenous marine pests in Northland, but it is recommended that this be done in consultation with MAFBNZ.

A Northland marine pest surveillance strategy should incorporate efficient resourcing of surveillance activities by taking advantage of existing monitoring activities in the coastal marine area. For example, by training NRC coastal and compliance monitoring staff in identification of high risk species and simple sample techniques it may be possible to greatly expand the surveillance for relatively little additional cost to existing NRC monitoring programmes. Similarly, many DOC monitoring activities could also be meshed-in with a regional marine pest surveillance strategy – consultation with DOC about the potential for this is recommended.

Table 13 describes the range of existing monitoring activities that could be harnessed to augment MAFBNZ surveillance in the high risk locations identified in Table 14. NRC would need to develop a coordinated management structure to take advantage of these activities for biosecurity surveillance. This would involve providing adequate training to personnel in field identification and collection of specimens and ensuring that observations were made regularly in a structured manner.

We envisage a three-tiered approach to identification of suspect organisms.

1. Field staff from NRC, DOC and other organisations undertaking monitoring activities could be trained to a basic level to recognise key features of a suite of high risk marine pests for Northland (predominantly those contained in the Northland Marine Pest Management Strategy) and equipped with suitable resources (basic identification guides and data recording templates) that would allow them to make field observations of new or unusual species and collect and preserve suspect specimens.

2. Core NRC biosecurity staff could receive more advanced training in identification of the high risk organisms that would allow them to act as a first point of reference for any suspected incursion reports.

3. Marine organisms that could not be identified reliably by NRC biosecurity staff would then be notified to the MAFBNZ 0800 80 9966 hotline number and passed on to the Marine Invasives Taxonomic Service (MITS) for formal identification.

MITS is a national clearing house for taxonomic identification of specimens obtained in MAFBNZ's marine biosecurity operations. It is managed by NIWA for MAFBNZ and has access to a wide range of taxonomic expertise and formal, standardised processes from receipt of specimens through to final curation, with a dedicated biosecurity database and a museum collection. Records of new non-indigenous species and range extensions of established species are likely to be made publically available by MITS through a searchable web portal that is being developed jointly by MAFBNZ and NIWA. As per its Regional Coastal Plan, NRC is to maintain records of the location and extent of any exotic species found within Northland coastal marina area, and encourage, through media releases, public reporting of any new sightings.

The formation of an enhanced passive surveillance capability in Northland will greatly increase the efficacy of any regional surveillance strategy. For example, port and marina staff represent enhanced passive surveillance potential for the detection of non-indigenous marine species associated with their facility structures, as well as limited potential for detecting non-indigenous vessel biofouling pest species. DOC site managers/rangers at sites which may be of lower incursion risk but nevertheless of high conservancy value (e.g., Matai Bay, Urupukapuka Island) could form part of an enhanced surveillance network and possible first point-of-contact for members of the community wishing to report suspected non-indigenous marine organisms at those locations through the MAFBNZ 0800 hotline. Identification of, and approach to, pertinent Northland stakeholders/sectoral groups that could be engaged in the development of an enhanced passive surveillance strategy could be followed by workshops with those stakeholders to develop the surveillance framework and the reporting process for suspected incursion of pest species.

All parties involved in biosecurity surveillance will have their own priorities and, therefore, their biosecurity commitments will be inherently vulnerable to trade-offs they are driven to make, particularly if biosecurity is not their core business (Pearson, 2002). Thus, NRC should take a lead role in coordinating surveillance activities for non-indigenous marine pests in Northland with sufficient resources allocated to allow for variation in, or withdrawal, of commitment of other stakeholders in the regional surveillance strategy for marine pests in Northland.

7. Acknowledgements

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