Opua Marina

Baseline survey for non-indigenous marine species (Research Project ZBS 2000/04)

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Executive Summary

This report describes the results of a November 2002 survey to provide a baseline inventory of native, non- indigenous and cryptogenic marine species within the Opua Marina.

- The survey is part of a nationwide investigation of native and non-native marine biodiversity in 13 international shipping ports and three marinas of first entry for yachts entering New Zealand from overseas.

- Sampling methods used in these surveys were based on protocols developed by the Australian Centre for Research on Introduced Marine Pests (CRIMP) for baseline surveys of non-indigenous species in ports. Modifications were made to the CRIMP protocols for use in New Zealand port conditions.

- A wide range of sampling techniques was used to collect marine organisms from habitats within the Opua Marina. Fouling assemblages were scraped from hard substrata by divers, benthic assemblages were sampled using a sled and benthic grabs, and a gravity corer was used to sample for dinoflagellate cysts. Mobile predators and scavengers were sampled using baited fish, crab, starfish and shrimp traps.

- The distribution of sampling effort in the Opua Marina was designed to maximise the chances of detecting non-indigenous species and concentrated on high-risk locations and habitats where non-indigenous species were most likely to be found.

- Organisms collected during the survey were sent to local and international taxonomic experts for identification.

- A total of 122 species or higher taxa was identified from the Opua Marina survey. They consisted of 76 native species, 12 non-indigenous species, 14 cryptogenic species (those whose geographic origins are uncertain) and 20 species indeterminata (taxa for which there is insufficient taxonomic or systematic information available to allow identification to species level).

- Five species of marine organisms collected from the Opua Marina, all of which are considered cryptogenic, have not previously been described from New Zealand waters. The five species included a species of mussel whose taxonomic affinities are uncertain (*Mytilus* sp.), an ascidian (*Pyura* sp.) and three species of sponge that do not match existing species descriptions and may be new to science.

- The 12 non-indigenous organisms described from the Opua Marina included representatives of six phyla. The non-indigenous species detected (ordered alphabetically by phylum, class, order, family, genus and species) were: (Annelida) *Polydora cornuta*, (Bryozoa) *Bugula flabellata*, *Bugula neritina*, *Watersipora subtorquata*, (Cnidaria) *Obelia longissima*, (Crustacea) *Apocorophium acutum*, (Mollusca) *Musculista senhousia*, *Crassostrea gigas*, *Limaria orientalis*, *Theora lubrica*, *Polycera hedgpethi*, (Phycophyta) *Polysiphonia sertularioides*.

- None of the species recorded from the Opua Marina are on the New Zealand register of unwanted marine organisms. Two species – the Pacific oyster, *Crassostrea gigas*, and the cryptogenic toxin-producing dinoflagellate, *Gymnodinium catenatum* – are on the ABWMAC list of unwanted marine pests in Australia.

- Most non-indigenous species located in the marina are likely to have been introduced to New Zealand accidentally by international shipping or through domestic translocation or spread from other locations in New Zealand.

- Approximately 58 % (seven of 12 species) of NIS in the Opua Marina are likely to have been introduced in hull fouling assemblages, 8.5 % via ballast water and 33.5 % could have been introduced by either ballast water or hull fouling vectors.

- The predominance of hull fouling species in the introduced biota of the Opua Marina (as opposed to ballast water introductions) is consistent with findings from similar port baseline studies overseas

Introduction

Introduced (non-indigenous) plants and animals are now recognised as one of the most serious threats to the natural ecology of biological systems worldwide (Wilcove *et al.* 1998, Mack *et al*. 2000). Growing international trade and trans-continental travel mean that humans now intentionally and unintentionally transport a wide range of species outside their natural biogeographic ranges to regions where they did not previously occur. A proportion of these species are capable of causing serious harm to native biodiversity, industries and human health. Recent studies suggest that coastal marine environments may be among the most heavily invaded ecosystems, as a consequence of the long history of transport of marine species by international shipping (Carlton and Geller 1993, Grosholz 2002). Ocean-going vessels transport marine species in ballast water, in sea chests and other recesses in the hull structure, and as fouling communities attached to submerged parts of their hulls (Carlton 1985, 1999, AMOG Consulting 2002, Coutts *et al.* 2003). These shipping transport mechanisms have enabled hundreds of marine species to spread worldwide and establish populations in shipping ports and coastal environments outside their natural range (Cohen and Carlton 1995, Hewitt *et al.* 1999, Eldredge and Carlton 2002, Leppäkoski *et al.* 2002).

Biosecurity[1] is important to all New Zealanders. New Zealand's geographic isolation makes it particularly vulnerable to marine introductions because more than 95 % of its trade in commodities is transported by shipping, with several thousand international vessels arriving and departing from more than 13 ports and recreational boat marinas of first entry (Inglis 2001). The country's geographic remoteness also means that its marine biota and ecosystems have evolved in relative isolation from other coastal ecosystems. New Zealand's marine biota is as unique and distinctive as its terrestrial biota, with large numbers of native marine species occurring nowhere else in the world.

The numbers, identity, distribution and impacts of non-indigenous species in New Zealand's marine environments are poorly known. A recent review of existing records suggested that by 1998, at least 148 species had been deliberately or accidentally introduced to New Zealand's coastal waters, with around 90 % of these establishing permanent populations (Cranfield *et al*. 1998). To manage the risk from these and other non-indigenous species, better information is needed on the current diversity and distribution of species present within New Zealand.

BIOLOGICAL BASELINE SURVEYS FOR NON-INDIGENOUS MARINE SPECIES

In 1997, the International Maritime Organisation (IMO) released guidelines for ballast water management (Resolution A868-20) encouraging countries to undertake biological surveys of port environments for potentially harmful non-indigenous aquatic species. As part of its comprehensive five-year Biodiversity Strategy package on conservation, environment, fisheries, and biosecurity released in 2000, the New Zealand Government funded a national series of baseline surveys. These surveys aimed to determine the identity, prevalence and distribution of native, cryptogenic and non-indigenous species in New Zealand's major shipping ports and other high risk points of entry. The government department responsible for biosecurity in the marine environment at the time, the New Zealand Ministry of Fisheries (MFish), commissioned NIWA to undertake biological baseline surveys in 13 ports and three marinas that are first ports of entry for vessels entering New Zealand from overseas (Fig. 1). Marine biosecurity functions are now vested in Biosecurity New Zealand.

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[1] Biosecurity is the management of risks posed by introduced species to environmental, economic, social, and cultural values.

Figure 1: Commercial shipping ports in New Zealand where baseline non-indigenous species surveys have been conducted. Group 1 ports surveyed in the summer of 2001/2002 are indicated in bold and group 2 ports surveyed in the summer of 2002/2003 are indicated in plain font. Marinas were also surveyed for NIS in Auckland, Whangarei and Opua in 2002/2003.

The port surveys have two principal objectives:

i. To provide a baseline assessment of native, non-indigenous and cryptogenic[2] species, and
ii. To determine the distribution and relative abundance of a limited number of target species in shipping ports and other high risk points of entry for non-indigenous marine species.

The surveys will form a baseline for future monitoring of new incursions by non-indigenous marine species in port environments nationwide, and will assist international risk profiling of problem species through the sharing of information with other shipping nations.

This report summarises the results of the Opua Marina survey and provides an inventory of species detected in the Marina. It identifies and categorises native, introduced ("non-indigenous") and cryptogenic species. Organisms that could not be identified to species level are also listed as species indeterminata.

[2] "Cryptogenic:" species are species whose geographic origins are uncertain (Carlton 1996).

DESCRIPTION OF THE OPUA MARINA

The Opua Marina (35°18'S, 174°07'E) on the east coast of the North Island is located on Waimangaroa Point in the southwest of the Bay of Islands (Fig. 2). The marina is linked to the main Bay of Islands via the Veronica Channel to the north-west. The Kawakawa River is to the immediate south and Waikare Inlet to the immediate east of the marina. The marina is 27 km from Cape Brett, the entrance to the Bay of Islands, and within close proximity to Russell and Paihia. The Opua Marina is a major hub for recreational vessels in the North Island (Inglis 2001). It is often the first port of entry for recreational vessels entering New Zealand.

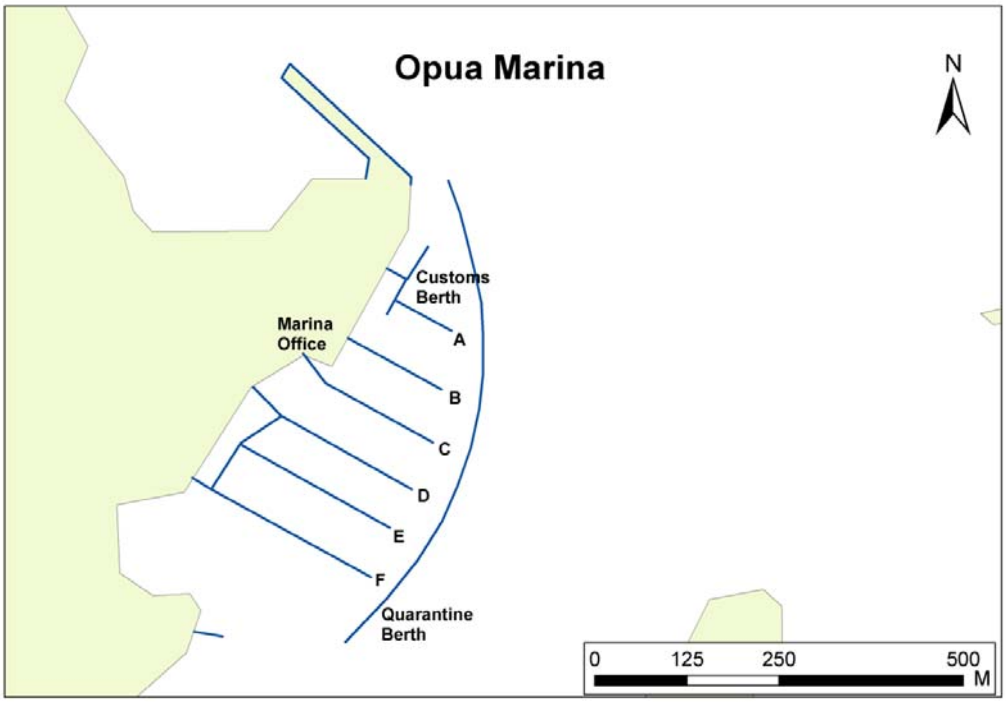

Figure 2: Opua Marina map.

MARINA OPERATION AND SHIPPING MOVEMENTS

Operational since 2000, the Opua Marina (parent company Far North Holdings Ltd) has 235 berths, ranging in size from 10.5 m to 27 m (Fig. 2), with floating concrete berths on H6 marine-grade pine pilings inside the marina and steel pilings on the breakwater. An additional 30 swing moorings plus several pile moorings are also available outside the marina breakwater (www.opuamarina.co.nz). Details of the berthing facilities available in the marina are provided in Table 1. There are numerous private swing moorings in the nearby bays, particularly in the Waikare Inlet, which can provide additional mooring for vessels waiting to enter the marina. Located adjacent to the marina southwards is a boatyard with slipway and floating berths which services and builds recreational vessels (www.ashbyboats.co.nz). A recent analyses of international shipping arrivals to Opua show that there was a total of 556 vessel visits during 2002/2003, with most of these (552 visits) being pleasure vessels. The other 4 visits were by larger commercial vessels to the Port of Opua (1 merchant, 3 passenger; Campbell 2004). The number of pleasure craft entering Opua Marina accounts for almost 70% of all international recreational craft visits to NZ, and is more than four times that of the next busiest location (Auckland: 132 pleasure vessels).

The original wharf at Opua (immediately to the northwest of the marina) was constructed in the early 1880's to load coal from Kawakawa, and continued this role until the late 1890's. In 1921 when the freezing works at Moerewa became operational, Opua developed into a significant meat export port although water depth restricted loading to the use of lighters. Dredging and wharf extension occurred in 1922, with further development in the 1950's. The last cargo vessel to use the wharf was in 1983, with passenger cruise ships using the wharf between 1983 and 1992. Customs and MAF were originally located at the wharf, but relocated to the new marina in 2000.

The Bay of Islands, in which the Opua Marina is situated, is a no-discharge area for vessels. Vessels are expected to comply with the Voluntary Controls on the Discharge of Ballast Water in New Zealand (www.fish.govt.nz/sustainability/biosecurity/); vessels are requested to exchange ballast water in mid-ocean (away from coastal influences) en route to New Zealand and discharge only the exchanged water while in port.

The quarantine and customs area within the Opua Marina is located on the northern half of the marina breakwater. During 2004, customs cleared approximately 480 vessels entering Opua Marina, with the majority arriving from the Pacific (Oliver Floerl, NIWA, *pers.comm*.)

In terms of future development, it is proposed to extend the marina southwards towards the Kawakawa River within the next 5 years, with extra berthing for 60-80 vessels up to 30 m in length (www.opuamarina.co.nz). Far North Holdings Ltd opened 162 m of marina-style facilities for smaller super yachts (10 berths up to 50 m) alongside the old Opua Wharf in 2004 and propose to further develop the old wharf, which is currently used by charter and fishing vessels, as a step towards the overall development of Opua as a servicing and support centre for visiting recreational boats. Indicators point to burgeoning recreational vessel traffic within the Bay of Islands.

PHYSICAL ENVIRONMENT OF OPUA MARINA

The marina is an artificial structure protected by a convex breakwater approximately 700 m in length with two entrances. This breakwater bounds the main Veronica Channel eastwards, which is only 350 m wide at its narrowest between Waimangaroa Point and Tapu Point. The smaller northern entrance of the marina is approximately 60 m wide, whilst the larger southwestern entrance is approximately 160 m wide. Minimum depth in the marina is 2 m at LWS. The marina seabed is composed mostly of sand. Tidal range varies between 1.6 and 2.0 m.

During its construction, the depth inside the marina was dredged down to a baseline of 2 m. No dredging inside the marina has been required since then, and the main channel adjacent to the marina is not dredged.

EXISTING BIOLOGICAL INFORMATION

There appears to be no published biological survey information available for Opua Marina and only limited information available on non-indigenous marine species in the Bay of Islands.

Morley and Hayward (1999) used benthic dredge sample to survey marine molluscs within the Bay of Islands. The area has the most diverse molluscan fauna of any area of similar size in New Zealand, with 551 species (389 gastropods, 139 bivalves, 20 chitons, two scaphopods and one shelled cephalopod) recorded from intertidal to 60 m depths, estuarine to exposed oceanic, rocky shores to muddy seafloor. The high diversity is a result of the wide range of habitats present and the area's location within the warm waters of the Aupourian Province (east coast of the northern North Island). Among the molluscs recorded were five non-indigenous species: the bivalves *Crassostrea gigas*, *Limaria orientalis*, *Musculista senhousia*, and *Theora lubrica*, and a gastropod, *Microtralia occidentalis*.

Occasional reports of the presence of new or rare subtropical species are characteristic of the Bay of Islands, and this region of New Zealand in general (Morley and Hayward 1999, Francis *et al*. 1999). Influxes of tropical and subtropical species occur mostly during warm summers and periods when the East Auckland Current is brought close to the coastline. Many of these species do not persist for longer than a single generation and are often the result of single recruitment events (Francis *et al*. 1999).

The Bay of Islands is an important area of commercial bivalve (oyster) aquaculture, with the main species under culture in the bay being the non-indigenous Pacific oyster, *Crassostrea gigas*. The farming method is predominantly rack-culture whereby oysters are seeded onto structures erected at the optimum growing level on the lower intertidal shore. Some growing areas in the Bay of Islands have had increasing problems with water quality as the surrounding human population and use of marine environments in the Bay of Islands have grown. In 1976, one of the major growing areas, Waikare Inlet, was listed as a slightly polluted estuary system (McLay, 1976). In 2001 an outbreak of Norwalk-like virus (a virus that causes gastro-enteritis and which is spread through contaminated food or water) shut down production in Waikare Inlet and forced some farmers to abandon their leases.

Sites within the Bay of Islands are regularly surveyed for harmful algae and biotoxins associated with Neurotoxic Shellfish Poisoning (NSP), Paralytic Shellfish Poisoning (PSP), Amnesic Shellfish Poisoning (ASP) and Diarrhetic Shellfish Poisoning (DSP) toxins at levels that present a risk to human health (Hay *et al*. 2000).

Following a bloom of the toxic dinoflagellate *Gymnodinium catenatum* in 2000 on the west coast of the North Island, Taylor and MacKenzie (2001) undertook a national delimitation survey to determine the distribution of *G. catenatum* that included a series of sediment samples from Orongo Bay in the Bay of Islands. No evidence was found of resting cysts of this species at the site.

Survey methods

SURVEY METHOD DEVELOPMENT

The sampling methods used in this survey were based on the CSIRO: Centre for Research on Introduced Marine Pests (CRIMP) protocols developed for baseline port surveys in Australia (Hewitt and Martin 1996, 2001). CRIMP protocols have been adopted as a standard by the International Maritime Organisation’s Global Ballast Water Management Programme (GloBallast). Variations of these protocols are being applied to baseline port surveys in many other nations. A group of New Zealand marine scientists reviewed the CRIMP protocols and conducted a workshop in September 2001 to assess their feasibility for surveys in this country (Gust *et al.* 2001). A number of recommendations for modifications to the protocols ensued from the workshop and were implemented in surveys throughout New Zealand. The modifications were intended to ensure cost effective and efficient collection of baseline species data for New Zealand ports and marinas. The modifications made to the CRIMP protocols and reasons for the changes are summarised in Table 2. Further details are provided in Gust *et al*. (2001).

Baseline survey protocols are intended to sample a variety of habitats within ports, including epibenthic fouling communities on hard substrata, soft-sediment communities, mobile invertebrates and fishes, and dinoflagellates. Below, we describe the methods and sampling effort used for the Opua Marina survey. The survey was undertaken between November 25th and 28th, 2002. Most sampling was concentrated on the recreational berths A-F. Additional sampling was also conducted around the marina breakwater. A summary of sampling effort within the marina is provided in Tables 3a,b.

DIVER OBSERVATIONS AND COLLECTIONS ON WHARF PILES

Fouling assemblages were sampled on four pilings at each site. Selected pilings were separated by 10 – 15 m and comprised four pilings on the outer face of the piers (Gust *et al*. 2001). On each piling, four quadrats (40 cm x 25 cm) were fixed to the outer surface of the pile at water depths of approximately -0.5 m, -1.5 m, -3.0 m and -7 m. A diver descended slowly down the outer surface of each pile and filmed a vertical transect from approximately high water to the base of the pile, using a digital video camera in an underwater housing. On reaching the sea floor, the diver then ascended slowly and captured high-resolution still images of each quadrat using the photo capture mechanism on the video camera. Because of limited visibility, four overlapping still images, each covering approximately ¼ of the area of the quadrat were taken for each quadrat. A second diver then removed fouling organisms from the piling by scraping the organisms inside each quadrat into a 1-mm mesh collection bag, attached to the base of the quadrat (Fig. 3). Once scraping was completed, the sample bag was sealed and returned to the laboratory for processing. The second diver also made a visual search of each piling for potential invasive species and collected samples of large conspicuous organisms not represented in quadrats. Opportunistic visual searches were also made of pontoons, breakwalls and rock facings within the commercial port area. Divers swam vertical profiles of the structures and collected specimens that could not be identified reliably in the field.

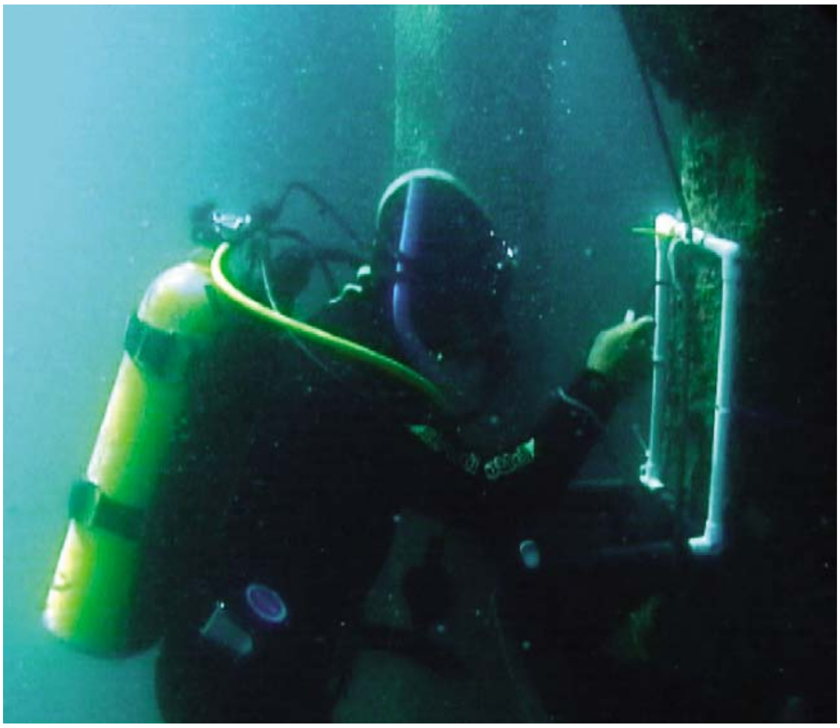

Figure 3: Diver sampling organisms on pier piles.

BENTHIC INFAUNA

Benthic infauna was sampled using a Shipek grab sampler deployed from a research vessel moored adjacent to the piers (Fig. 4), with samples collected from within 5 m of the pier edges. The Shipek grab removes a sediment sample of ~3 *l* and covers an area of approximately 0.04 m^2 on the seafloor to a depth of about 10 cm. It is designed to sample unconsolidated sediments ranging from fine muds and sands to hard-packed clays and small cobbles. Because of the strong torsion springs and single, rotating scoop action, the Shipek grab is generally more efficient at retaining samples intact than conventional VanVeen or Smith McIntyre grabs with double jaws (Fenwick *pers obs*). Three grab samples were taken at haphazard locations along each sampled pier. Sediment samples were washed through a 1-mm mesh sieve and animals retained on the sieve were returned to the field laboratory for sorting and preservation.

Figure 4: Shipek grab sampler: releasing benthic sample into bucket

EPIBENTHOS

Larger benthic organisms were sampled using an Ocklemann sled (hereafter referred to as a "sled"). The sled is approximately one meter long with an entrance width of ~0.7 m x 0.2 m. A short yoke of heavy chain connects the sled to a tow line (Fig. 5). The mouth of the sled partially digs into the sediment and collects organisms in the surface layers to a depth of a few centimetres. Runners on each side of the sled prevent it from sinking completely into the sediment so that shallow burrowing organisms and small, epibenthic fauna pass into the exposed mouth. Sediment and other material that enters the sled is passed through a mesh basket that retains organisms larger than about two mm. Sleds were towed for a standard time of two minutes at approximately two knots. During this time, the sled typically traversed between 80 – 100 m of seafloor before being retrieved. Two to three sled tows were completed adjacent to each sampled pier within the marina, and the entire contents were sorted.

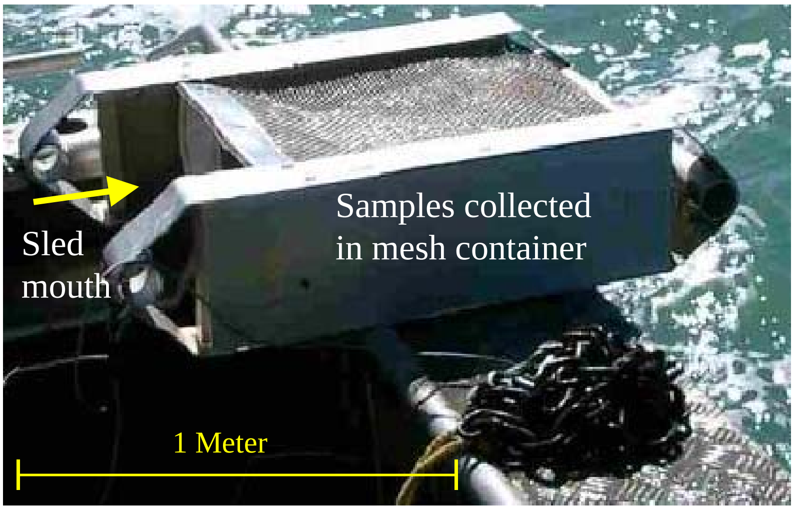

Figure 5: Benthic sled

SEDIMENT SAMPLING FOR CYST-FORMING SPECIES

A TFO gravity corer (hereafter referred to as a "javelin corer") was used to take small sediment cores for dinoflagellate cysts (Fig. 6). The corer consists of a 1 m long x 1 cm diameter hollow stainless steel shaft with a detachable 0.5 m long head (total length = 1.5 m). Directional fins on the shaft ensure that the javelin travels vertically through the water so that the point of the sampler makes first contact with the seafloor. The detachable tip of the javelin is weighted and tapered to ensure rapid penetration of unconsolidated sediments to a depth of 20 to 30 cm. A thin (1 cm diameter) sediment core is retained in a perspex tube within the hollow spearhead. In muddy sediments, the corer preserves the vertical structure of the sediments and fine flocculant material on the sediment surface more effectively than hand-held coring devices (Matsuoka and Fukuyo 2000). The javelin corer is deployed and retrieved from a small research vessel. Cyst sample sites were not constrained to the mooring areas sampled by pile scraping and trapping techniques. Sampling focused on high sedimentation areas within the marina and avoided areas subject to strong tidal flow. On retrieval, the perspex tube was removed from the spearhead and the top 5 cm of sediment retained for analysis. Sediment samples were kept on ice and refrigerated prior to culturing. Culture procedures generally followed those described by Hewitt and Martin (2001).

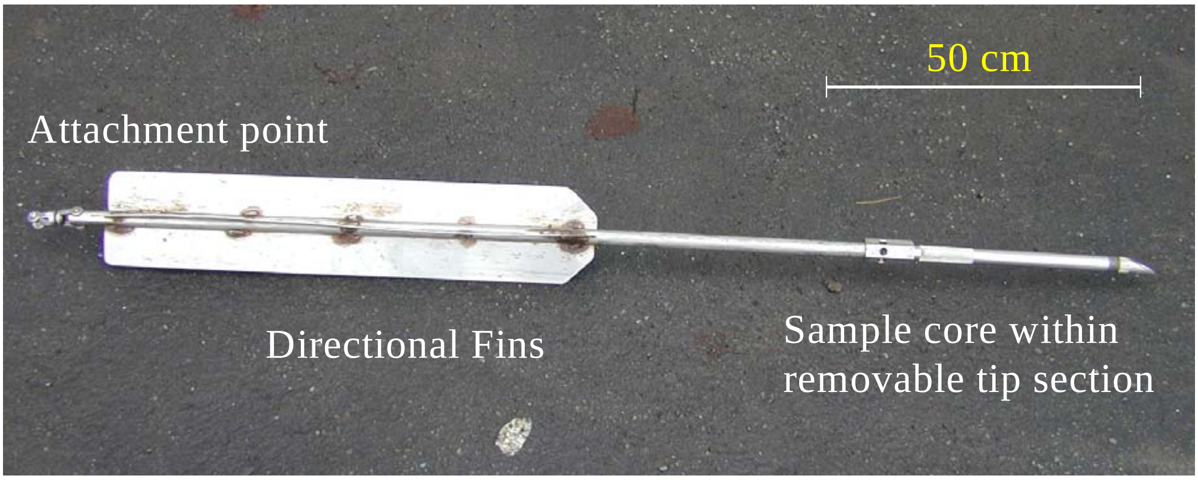

Figure 6: Javelin corer

MOBILE EPIBENTHOS

Benthic scavengers and fishes were sampled using a variety of baited trap designs described below.

Opera house fish traps

Opera house fish traps (1.2 m long x 0.8 m wide x 0.6 m high) were used to sample fishes and other bentho-pelagic scavengers (Fig. 7). These traps were covered in 1 cm^2 mesh netting and had entrances on each end consisting of 0.25 m long tunnels that tapered in diameter from 40 to 14 cm. The trap was baited with two dead pilchards (*Sardinops neopilchardus*) held in plastic mesh suspended in the centre of the trap. Two trap lines, each containing two opera house traps were set for a period of one hour at each site before retrieval. Previous studies have shown opera house traps to be more effective than other types of fish trap and that consistent catches are achieved with soak times of 20 to 50 minutes (Ferrell *et al.* 1994; Thrush *et al.* 2002).

Box traps

Fukui- designed box traps (63 cm x 42 cm x 20 cm) with a 1-cm mesh netting were used to sample mobile crabs and other small epibenthic scavengers (Fig. 7). A central mesh bait holder containing two dead pilchards was secured inside the trap. Organisms attracted to the bait enter the traps through slits in inward sloping panels at each end. Two trap lines, each containing two box traps, were set on the sea floor at each site and left to soak overnight before retrieval.

Starfish traps

Starfish traps designed by Whayman-Holdsworth were used to catch asteroids and other large benthic scavengers (Fig. 7). These are circular hoop traps with a basal diameter of 100 cm and an opening on the top of 60 cm diameter. The sides and bottom of the trap are covered with 26- mm mesh and a plastic, screw-top bait holder is secured in the centre of the trap entrance (Andrews *et al.* 1996). Each trap was baited with two dead pilchards. Two trap lines, each with two starfish traps were set on the sea floor at each site and left to soak overnight before retrieval.

Shrimp traps

Shrimp traps were used to sample small, mobile crustaceans. They consisted of a 15 cm plastic cylinder with a 5-cm diameter screw top lid in which a funnel had been fitted. The funnel had a 20-cm entrance that tapered in diameter to 1 cm. The entrance was covered with 1-cm plastic mesh to prevent larger animals from entering and becoming trapped in the funnel entrance. Each trap was baited with a single dead pilchard. Two trap lines, each containing two scavenger traps, were set on the sea floor at each site and left to soak overnight before retrieval.

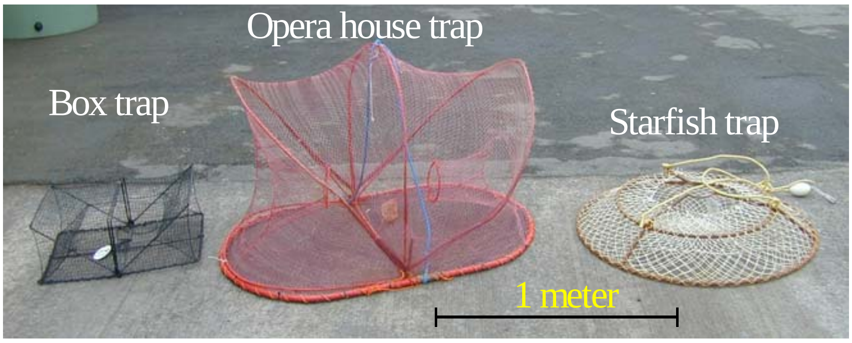

Figure 7: Trap types deployed in the marina.

SAMPLING EFFORT

A summary of sampling effort within the Opua Marina is provided in Tables 3 a,b. We particularly focused sampling effort on hard substrata, (such as pier piles), where invasive species are likely to be found (Hewitt and Martin 2001), and increased the number of quadrats sampled on each pile relative to the CRIMP protocols, as well as sampling both shaded and unshaded piles. The distribution of effort within the marina aimed to maximise spatial coverage and represent the diversity of active mooring sites within the area. Total sampling effort was constrained by the costs of processing and identifying specimens obtained during the survey.

The spatial distribution of sampling effort for each of the sample methods in the Opua Marina is indicated in the following figures: diver pile scrapings and javelin cyst coring (Fig. 8), benthic sledding and Shipek grab sampling (Fig. 9), box, starfish, shrimp and opera house fish trapping (Fig. 10). Sampling effort was varied between ports and marinas on the basis of risk assessments (Inglis 2001) to maximise the search efficiency for NIS nationwide. Sampling effort in each of the thirteen ports and three marinas surveyed over two summers is summarised in Table 3c.

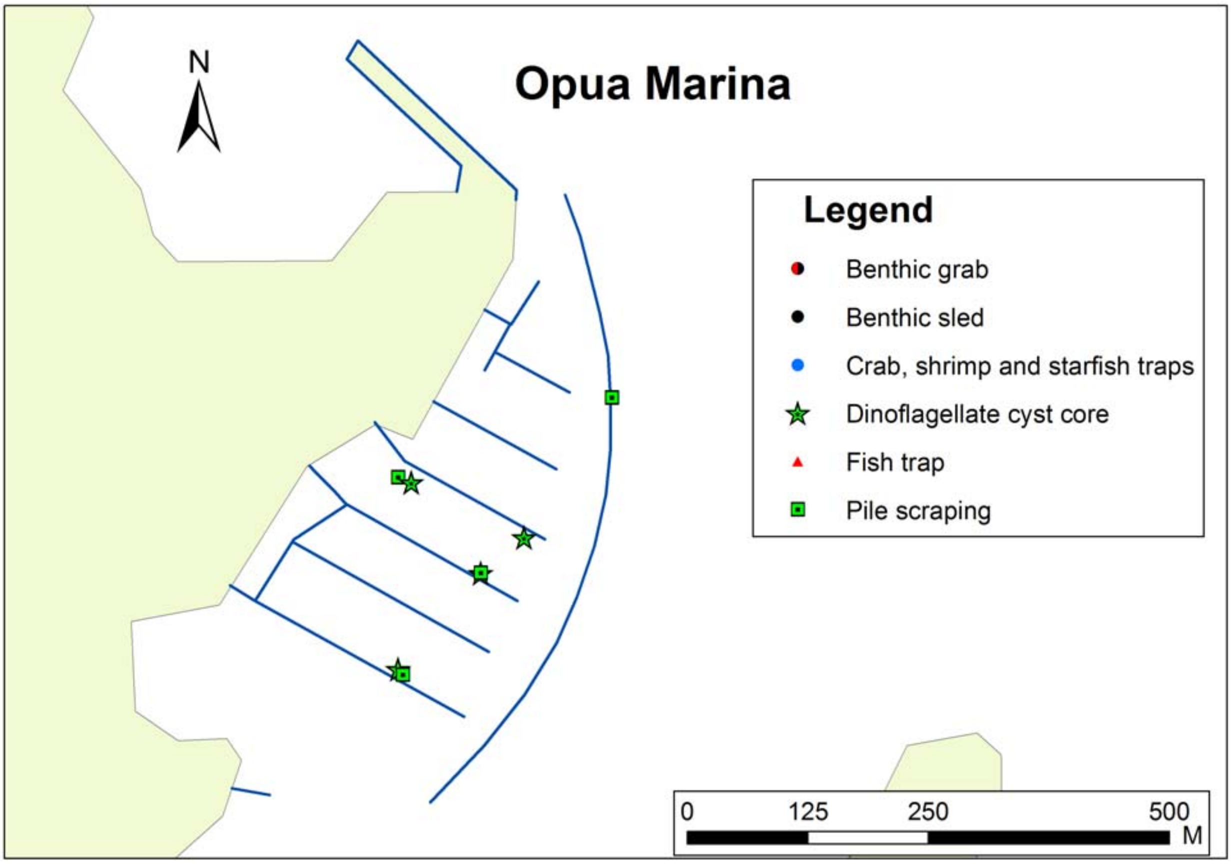

Figure 8: Diver pile scrape sites and dinoflagellate cyst coring sites

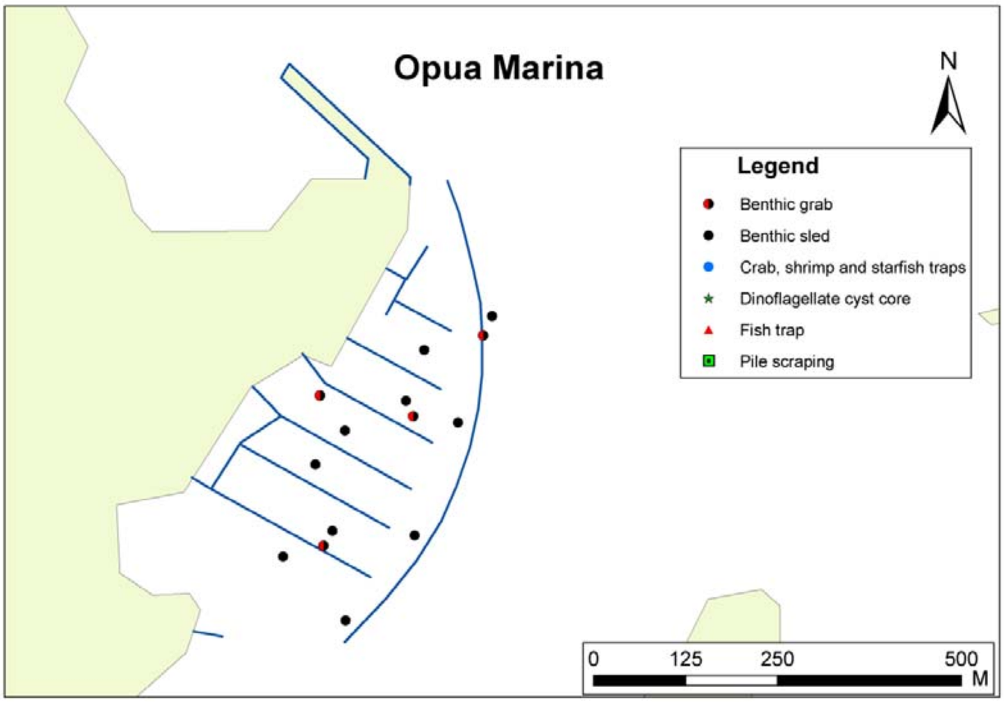

Figure 9: Benthic sled and Shipek benthic grab sites.

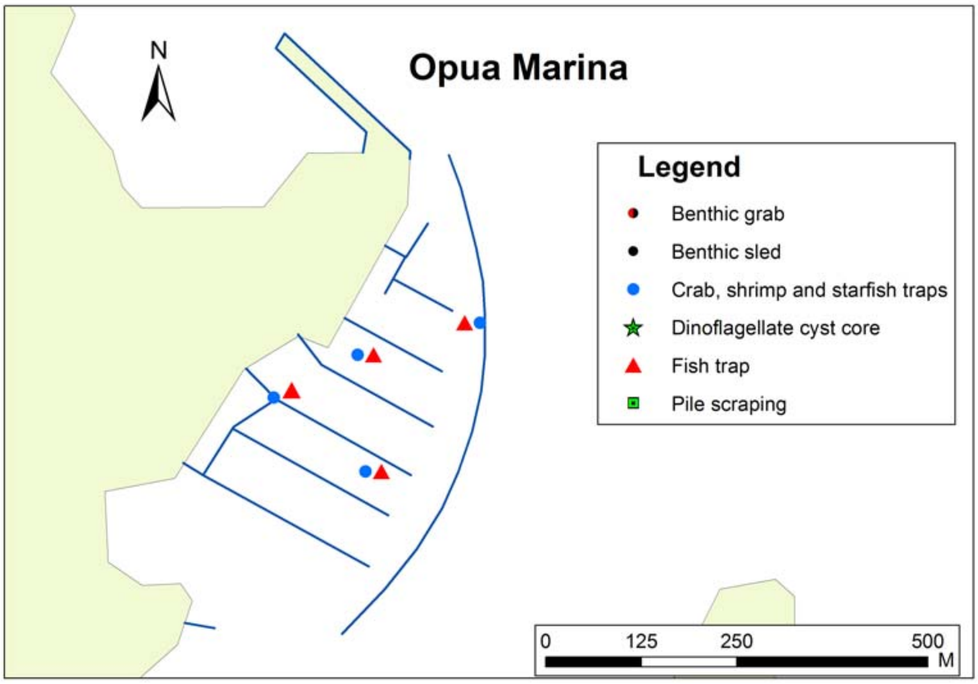

Figure 10: Sites trapped using box (crab), shrimp, starfish and opera house fish traps

SORTING AND IDENTIFYING SPECIMENS

Each sample collected in the diver pile scrapings, benthic sleds, box, starfish and shrimp traps, opera house fish traps, Shipek grabs and javelin cores was allocated a unique code on waterproof labels and transported to a nearby field laboratory where it was sorted by a team into broad taxonomic groups (e.g. ascidians, barnacles, sponges etc.). These groups were then preserved and individually labelled. Details of the preservation techniques varied for many of the major taxonomic groups collected, and the protocols adopted and preservative solutions used are indicated in Table 4. Specimens were subsequently sent to over 25 taxonomic experts (Appendix 1) for identification to species or lowest taxonomic unit (LTU). We also sought information from each taxonomist on the known biogeography of each species within New Zealand and overseas. Species lists compiled for each port were compared with the marine species listed on the New Zealand register of unwanted organisms under the Biosecurity Act 1993 (Table 5a) and the marine pest list produced by the Australian Ballast Water Management Advisory Council (Table 5b).

DEFINITIONS OF SPECIES CATEGORIES

Each species recovered during the survey was classified into one of four categories that reflected its known or suspected geographic origin. To do this we used the experience of taxonomic experts and reviewed published literature and unpublished reports to collate information on the species' biogeography.

Patterns of species distribution and diversity in the oceans are complex and still poorly understood (Warwick 1996). Worldwide, many species still remain undescribed or undiscovered and their biogeography is incomplete. These gaps in global marine taxonomy and biogeography make it difficult to reliably determine the true range and origin of many species. The four categories we used reflect this uncertainty. Species that were not demonstrably native or non-indigenous were classified as "cryptogenic" (sensu Carlton 1996). Cryptogenesis can arise because the species was spread globally by humans before scientific descriptions of marine flora and fauna began in earnest (i.e. historical introductions). Alternatively the species may have been discovered relatively recently and there is insufficient biogeographic information to determine its native range. We have used two categories of cryptogenesis to distinguish these different sources of uncertainty. In addition, a fifth category ("species indeterminata") was used for specimens that could not be identified to species-level. Formal definitions for each category are given below.

Native species

Native species are known to be endemic to the New Zealand biogeographical region and have not been introduced to coastal waters by human mediated transport.

Non-indigenous species (NIS)

Non-indigenous species (NIS) are known or suspected to have been introduced to New Zealand as a result of human activities. They were determined using a series of questions posed by Chapman and Carlton (1991, 1994), as exemplified by Cranfield *et al.* (1998).

1. Has the species suddenly appeared locally where it has not been found before?
2. Has the species spread subsequently?
3. Is the species' distribution associated with human mechanisms of dispersal?
4. Is the species associated with, or dependent on, other non-indigenous species?
5. Is the species prevalent in, or restricted to, new or artificial environments?
6. Is the species' distribution restricted compared to natives?

The worldwide distribution of the species was tested by a further three criteria:

7. Does the species have a disjunctive worldwide distribution?
8. Are dispersal mechanisms of the species inadequate to reach New Zealand, and is passive dispersal in ocean currents unlikely to bridge ocean gaps to reach New Zealand?

9. Is the species isolated from the genetically and morphologically most similar species elsewhere in the world?

In this report we distinguish two categories of NIS. "NIS" refers to non-indigenous species previously recorded from New Zealand waters, and "NIS (new)" refers to non-indigenous species first discovered in New Zealand waters during this project.

Cryptogenic species Category 1

Species previously recorded from New Zealand whose identity as either native or non-indigenous is ambiguous. In many cases this status may have resulted from their spread around the world in the era of sailing vessels prior to scientific survey (Chapman and Carlton 1991, Carlton 1992), such that it is no longer possible to determine their original native distribution. Also included in this category are newly described species that exhibited invasive behaviour in New Zealand (Criteria 1 and 2 above), but for which there are no known records outside the New Zealand region.

Cryptogenic species Category 2

Species that have recently been discovered but for which there is insufficient systematic of biogeographic information to determine whether New Zealand lies within their native range. This category includes previously undescribed species that are new to New Zealand and/or science.

Species indeterminata

Specimens that could not be reliably identified to species level. This group includes: (1) organisms that were damaged or juvenile and lacked morphological characteristics necessary for identification, and (2) taxa for which there is not sufficient taxonomic or systematic information available to allow identification to species level.

Survey results

A total of 122 species or higher taxa was identified from the Opua Marina survey. This collection consisted of 76 native (Table 6), 14 cryptogenic (Table 7), 12 non-indigenous species (Table 8) and 20 species indeterminata (Table 9, Fig. 15). The biota included a diverse array of organisms from 11 Phyla (Fig. 16). Five species from the Opua Marina had not previously been described from New Zealand waters. For general descriptions of the main groups of organisms (Phyla) encountered during this study refer to Appendix 2.

NATIVE SPECIES

A diverse array of native organisms was sampled during this survey (Fig. 12, Table 6). A total of 76 native species was identified which represents 62.3 % of all organisms identified from the marina. Native communities included highly diverse assemblages of annelids (21 species), molluscs (19 species), crustaceans (14 species), and vertebrates (fish) (7 species). A number of other less diverse phyla were also present in native communities within the marina (Fig. 12).

CRYPTOGENIC SPECIES

Fourteen cryptogenic species were discovered in the Opua Marina. Cryptogenic species represent 11.5 % of all species or higher taxa identified from the marina. The cryptogenic organisms identified included nine Category 1 and five Category 2 species as defined in Section 2.9 above. These organisms included three cnidarians (*Bougainvillia muscus*, *Clytia hemisphaerica*, *Phialella quadrata*), two crustaceans (*Balanus trigonus*, *Pilumnopeus serratifrons*), one mollusc (*Mytilus* sp.), three porifera (*Halichondria* n. sp. 4, *Haliclona* n. sp.

3, *Haliclona* n. sp. 9), one pyrrophycophyta (*Gymnodinium catenatum*) and four ascidian species (*Asterocarpa cerea*, *Corella eumyota*, *Styela plicata*, *Pyura* sp.; Table 7). Some of the Category 1 cryptogenic species (such as the ascidians *Astereocarpa cerea* and *Corella eumyota*) have been present in New Zealand for more than 100 years but have distributions outside New Zealand that suggest non-native origins (Cranfield *et al*. 1998).

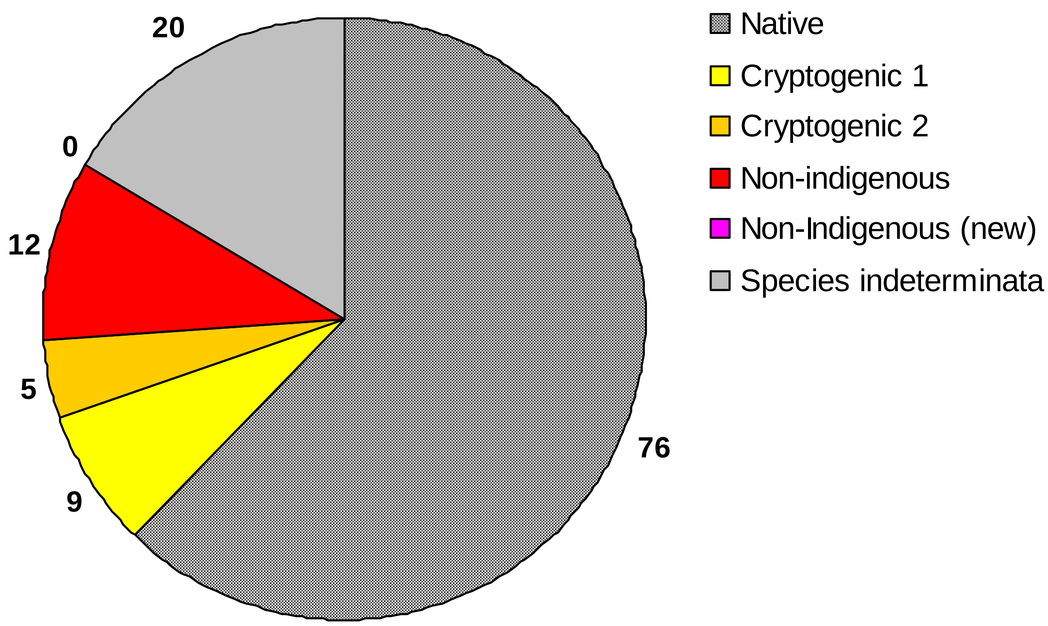

Figure 11: Diversity of marine species sampled in the Opua Marina. Values indicate the number of species in native, cryptogenic, non-indigenous and species indeterminata categories.

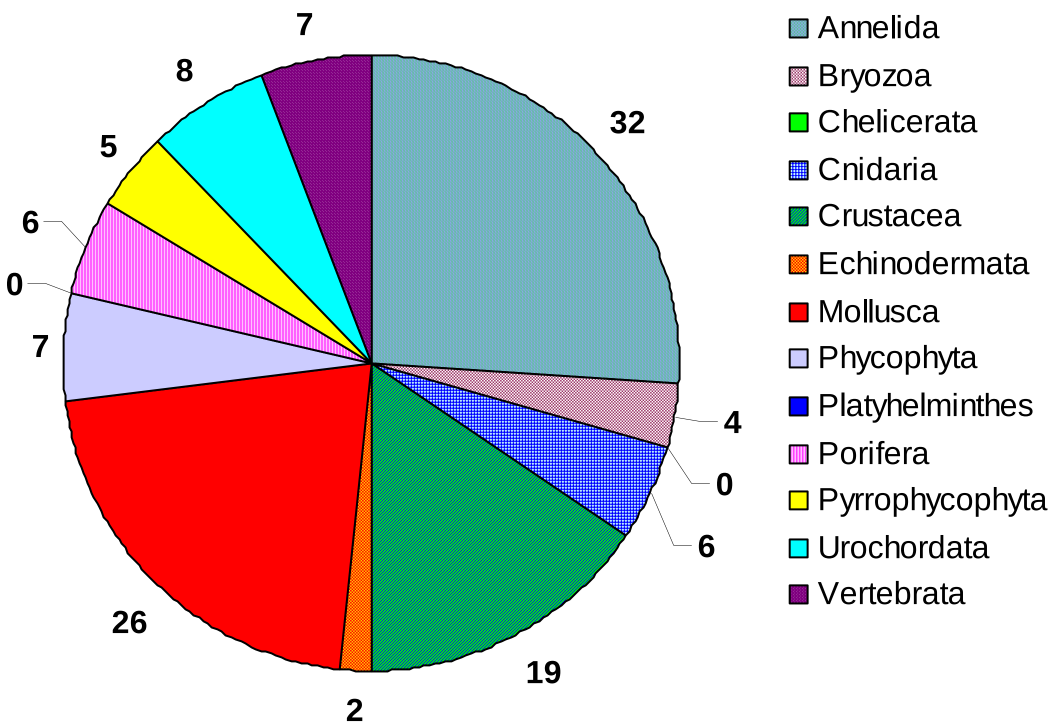

Figure 12: Marine Phyla sampled in the Opua Marina. Values indicate the number of species in each of the major taxonomic groups.

NON-INDIGENOUS SPECIES

Twelve non-indigenous marine species were recorded from the Opua Marina (Table 8). NIS represent 9.8 % of all identified species from this location. All were previously known from New Zealand waters. NIS included five molluscs, three bryozoans, and single representatives of the Annelida, Cnidaria, Crustacea and Phycophyta. A list of Chapman and Carlton's (1994) criteria (see Section 2.9.2) that were met by the non-indigenous species sampled in this survey is given in Appendix 3. Below we summarise available information on the biology of each of these species, providing images where available, and indicate what is known about their distribution, habitat preferences and impacts. This information was sourced from published literature, the taxonomists listed in Appendix 1 and from regional databases on non-indigenous marine species in Australia (National Introduced Marine Pest Information System; http://www.crimp.marine.csiro.au/nimpis) and the USA (National Exotic Marine and Estuarine Species Information System; http://invasions.si.edu/nemesis). Distribution maps for each NIS in the port are composites of multiple replicate samples. Where overlayed presence and absence symbols occur on the map, this indicates the NIS was found in at least one, but not all replicates at that GPS location. NIS are presented below by phyla in the same order as Table 8.

Polydora cornuta (Bosc, 1802)

No image available.

Polydora cornuta is a polychaete in the family Spionidae. It is native to the east-coast of the USA and has been introduced to California and Oregon, probably as a co-introduction with oyster aquaculture imports. *P. cornuta* lives in mud tubes attached to oysters and other bivalves, and is able to live in salinities as low as 5 ppt (Fuller and O'Connell 2005). It has been present in New Zealand since at least 1972 and has previously been recorded from Whangarei and Waitemata Harbours (Cranfield *et al*. 1998). In Opua Marina *P. cornuta* occurred in pile scrape samples taken from Berth D (Fig. 13).

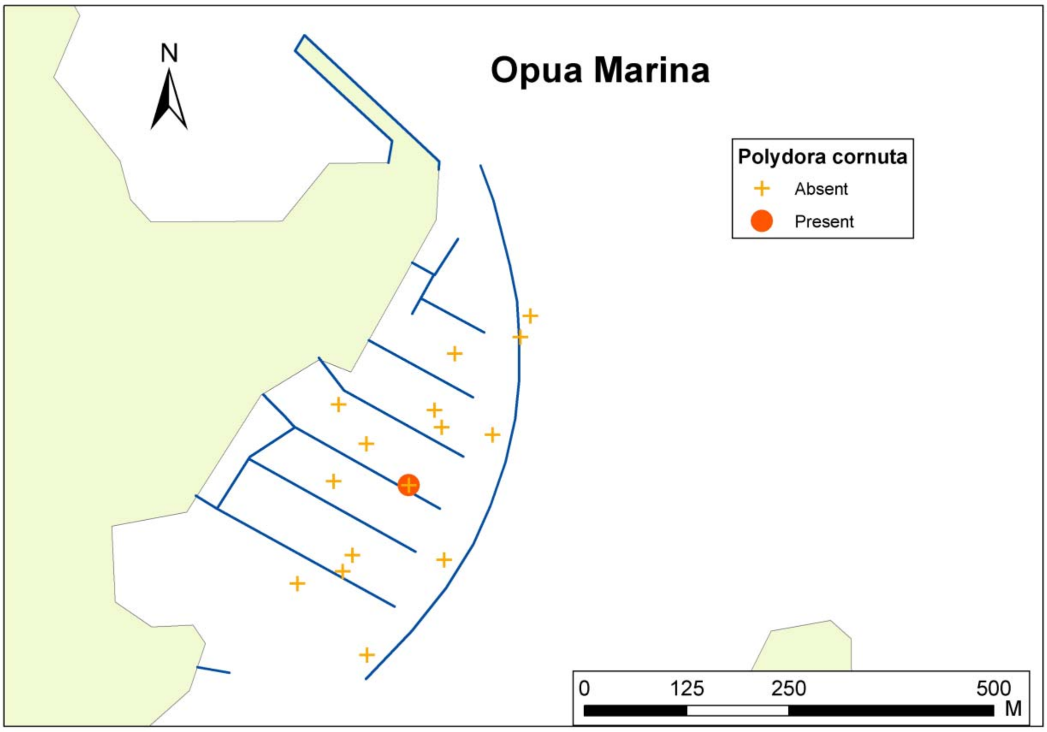

Figure 13: ***Polydora cornuta* distribution in Opua Marina**

***Bugula flabellata* (Thompson in Gray, 1847)**

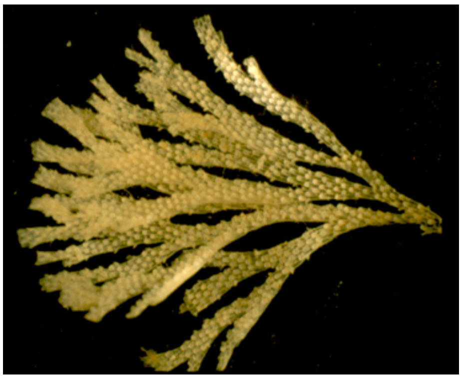

Image and information: NIMPIS (2002a)

Bugula flabellata is an erect bryozoan with broad, flat branches. It is a colonial organism and consists of numerous 'zooids' connected to one another. It is pale pink and can grow to about 4 cm high and attaches to hard surfaces such as rocks, pilings and pontoons or the shells of other marine organisms. It is often found growing with other erect bryozoan species such as *B. neritina* (see below) or growing on encrusting bryozoans. Vertical, shaded, sub-littoral rock surfaces also form substrata for this species. It has been recorded down to 35 m. *Bugula flabellata* is native to the British Isles and North Sea and has been introduced to Chile, Florida and the Caribbean and the north-east and west coasts of the USA, as well as Australia and New Zealand. It is cryptogenic on the Atlantic coasts of Spain, Portugal and France. *Bugula flabellata* is a major fouling bryozoan in ports and harbours, particularly on vessel hulls, pilings and pontoons and has also been reported from offshore oil platforms. There have been no recorded impacts from *B. flabellata.* During the current baseline surveys it was recorded from Opua Marina, Whangarei, Auckland, Tauranga, Napier, Taranaki, Wellington, Picton, Nelson, Lyttelton, Timaru, Dunedin and Bluff. In Opua Marina *B. flabellata* was recorded in pile scrape samples taken from the Quarantine berth (Fig. 14).

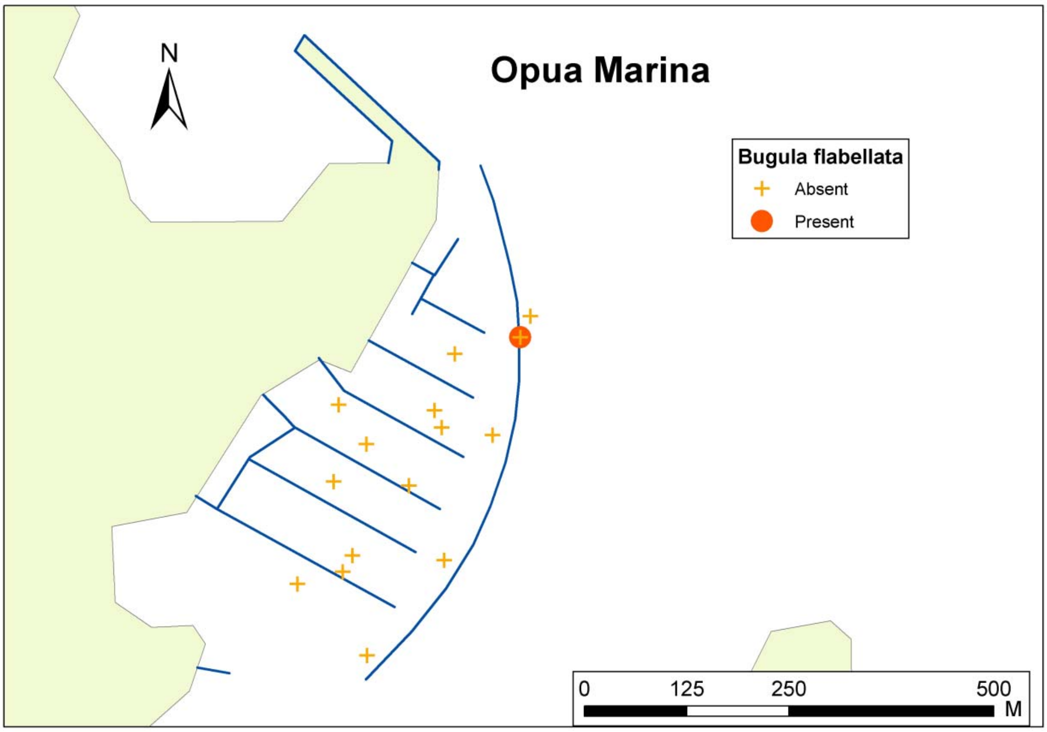

Figure 14: *Bugula flabellata* distribution in Opua Marina

Bugula neritina Linnaeus, 1758

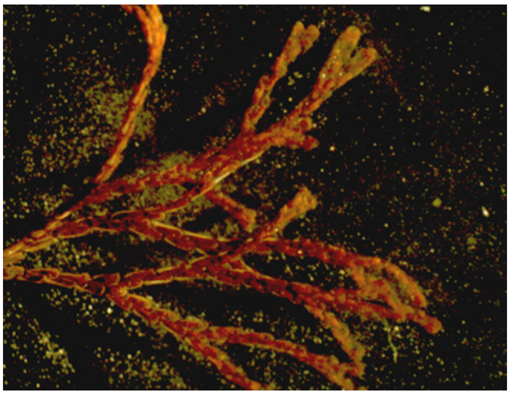

Image and information: NIMPIS (2002b)

Bugula neritina is an erect, bushy, red-purple-brown bryozoan. Branching is dichotomous (in series of two) and zooids alternate in two rows on the branches. Unlike all other species of *Bugula*, *B. neritina* has no avicularia (defensive structures) or spines, but there is a single pointed tip on the outer corner of zooids. Ovicells (reproductive structures) are large, globular and white in colour. They often appear in such high numbers that they resemble small snails or beads. *Bugula neritina* is native to the Mediterranean Sea. It has been introduced to most of North America, Hawaii, India, the Japan and China Seas, Australia and New Zealand. It is cryptogenic in the British Isles. *Bugula neritina* is one of the most abundant bryozoans in ports and harbours and an important member of the fouling community. The species colonises any available substratum and can form extensive monospecific growths. It grows well on pier piles, vessel hulls, buoys and similar submerged surfaces. It even grows heavily in ships' intake pipes and condenser chambers. In North America, *B. neritina* occurs on rocky reefs and seagrass leaves. In Australia, it occurs primarily on artificial substrata. *B. neritina* occurs in all New Zealand ports (Gordon and Matawari 1992). In Opua Marina it occurred in pile scrape samples taken from the Quarantine berth (Fig. 15).

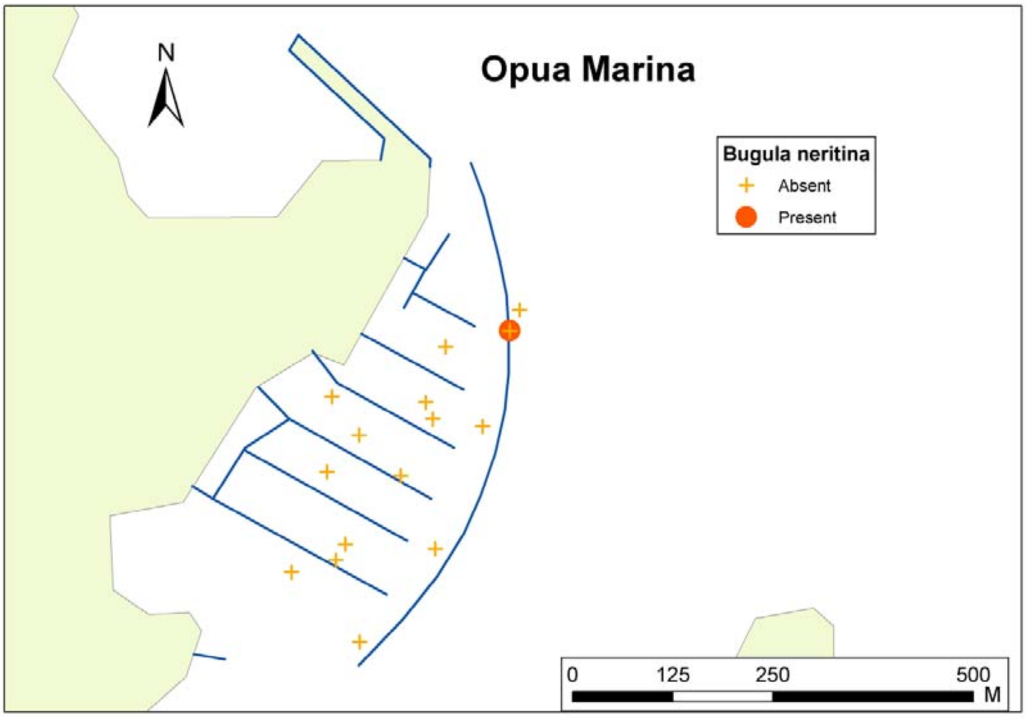

Figure 15: _Bugula neritina_ distribution in Opua Marina

Watersipora subtorquata (d'Orbigny, 1842)

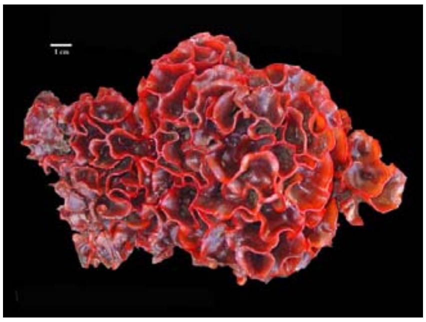

Image: California Academy of Sciences.
Information: Gordon and Matawari (1992)

Watersipora subtorquata is a loosely encrusting bryozoan capable of forming single or multiple layer colonies. The colonies are usually dark red-brown, with a black centre and a thin, bright red margin. The operculum is dark, with a darker mushroom shaped area centrally. *Watersipora subtorquata* has no spines, avicularia or ovicells. The native range of the species is unknown, but is thought to include the wider Caribbean and south Atlantic. The type specimen was described from Rio de Janeiro, Brazil (Gordon and Matawari 1992). It also occurs in the north-west Pacific, Torres Strait and north-eastern and southern Australia.

W. subtorquata is an important marine fouling species in ports and harbours. It occurs on vessel hulls, pilings and pontoons. This species can also be found attached to rocks and seaweeds. They form substantial colonies on these surfaces, typically around the low water mark. *Watersipora subtorquata* is also an abundant fouling organism and is resistant to a range of antifouling toxins. It can therefore spread rapidly on vessel hulls and provide an area for other species to settle onto which can adversely impact on vessel maintenance and speed, as fouling assemblages can build up on the hull.

W. subtorquata has been present in New Zealand since at least 1982 and is now present in most ports from Opua to Bluff (Gordon and Matawari 1992). In Opua Marina it occurred in pile scrape samples taken from Berths C, D, and the Quarantine Berth (Fig. 16).

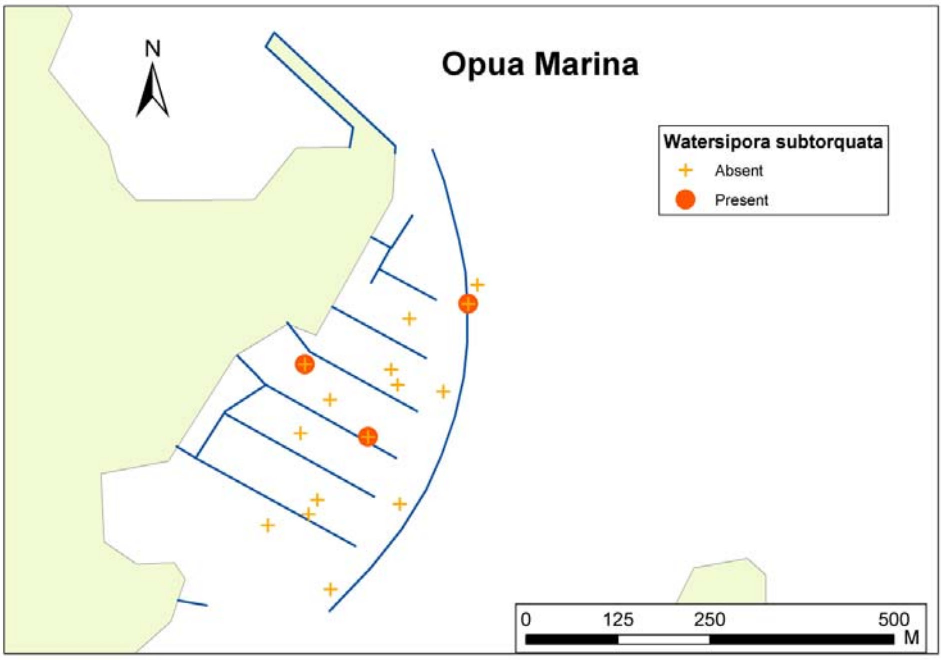

Figure 16: ***Watersipora subtorquata*** **distribution in Opua Marina**

***Obelia longissima* (Pallas, 1766)**

No image available.

Obelia longissima is a long, flexible hydroid (family Campanulariidae) with a prominent main stem and branches. It usually reaches up to 20 cm in length but may reach 35 cm. The main stem is long, reddish brown and unforked but may become forked in older colonies. *Obelia longissima* is found growing on algae and hard substrata. It is normally subtidal but can occasionally be found growing in intertidal rockpools and at extreme low water of spring tides. Subtidal colonies that become detached may continue to grow if washed into rockpools and entangled with other species such as mussels. It is a suspension feeder that feeds upon small zooplankton, small crustaceans, oligochaetes, insect larvae and probably detritus. *O. longissima* exhibits a typical leptolid life cycle consisting of a sessile colonial, vegetative hydroid stage, a free-living sexual medusoid stage, and a planula larval stage.

Obelia longissima has a near-cosmopolitan distribution. It was thought to be a predominantly cold water species, present in the north-east and north-west Pacific, north-east and north-west Atlantic, the Artic circle and the Black Sea, and, in the southern hemisphere, in Argentina, Chile, and New Zealand (Stepanjants 1998). However, numerous Indo-Pacific records may also be this species (Cornelius 1995). In New Zealand, *O. longissima* has previously been recorded from Christchurch and Dunedin (Watson, Hydrozoan Research Laboratory *pers. comm.*). During the port baseline surveys, it occurred in the Port of Auckland and in Opua Marina. In Opua Marina it occurred in pile scrape samples taken from the Quarantine Berth (Fig. 17).

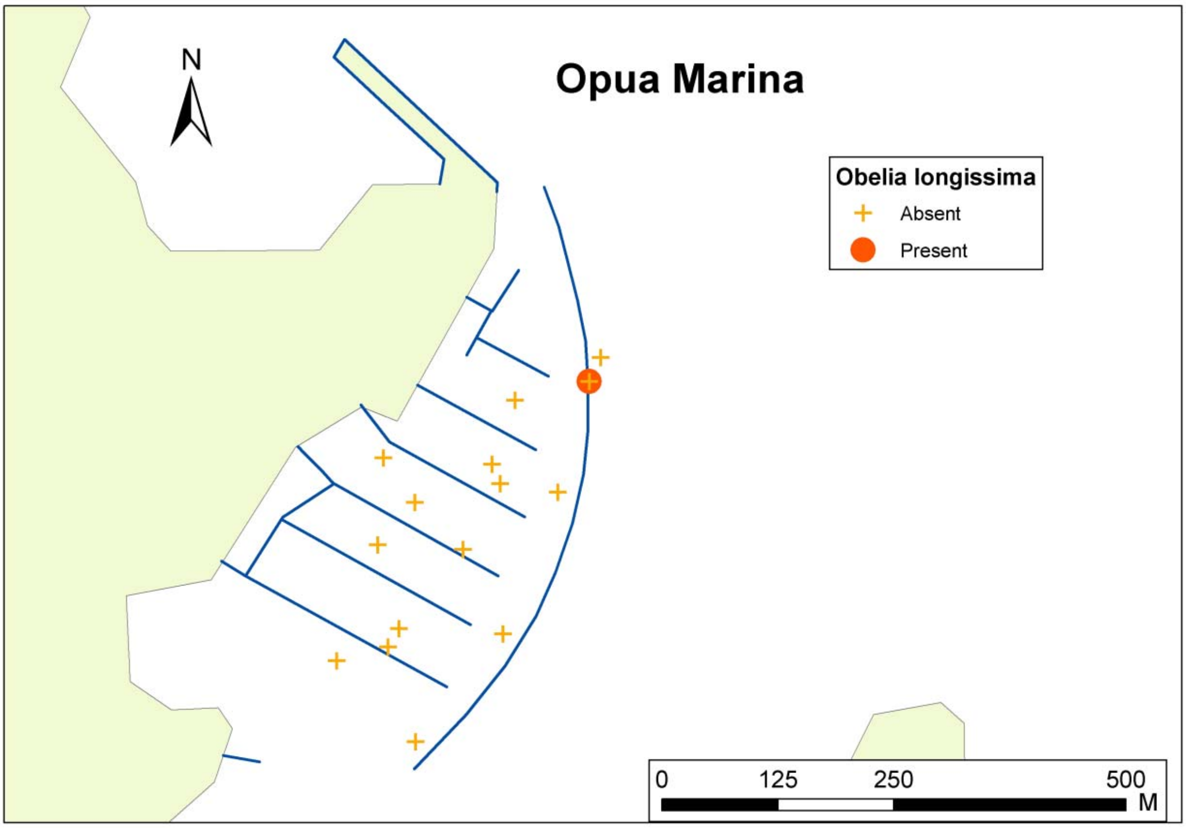

Figure 17: ***Obelia longissima* distribution in Opua Marina**

Apocorophium acutum (Chevreux, 1908)

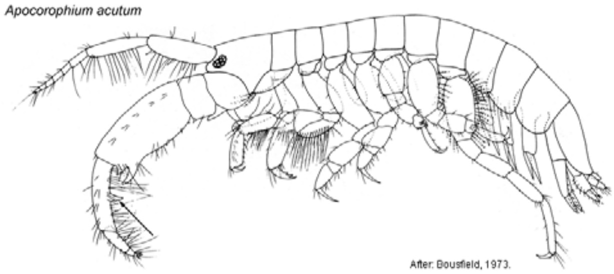

Image and information: Keys to the Northeast Atlantic and Mediterranean amphipods. [http://www.amphipoda.com/acutum.html]

Apocorophium acutum is a corophiid amphipod, known from the Atlantic Ocean (England, France, North America, Brazil, South Africa), Pacific Ocean (New Zealand) and the Mediterranean Sea. The exact native range of this species is not known, although the type specimen of this species was described from the southern Mediterranean. *Apocorophium acutum* inhabits marine sediments in estuarine mudflats and brackish water and fouling assemblages where it builds muddy tubes. It has no documented impacts. During the port baseline surveys *A. acutum* was recorded from the ports of Lyttelton, Tauranga and Timaru, and from Gulf Harbour and Opua Marinas. In Opua Marina it occurred in pile scrape samples taken from Berth D and from shrimp trap samples taken at Berth C (Fig. 18).

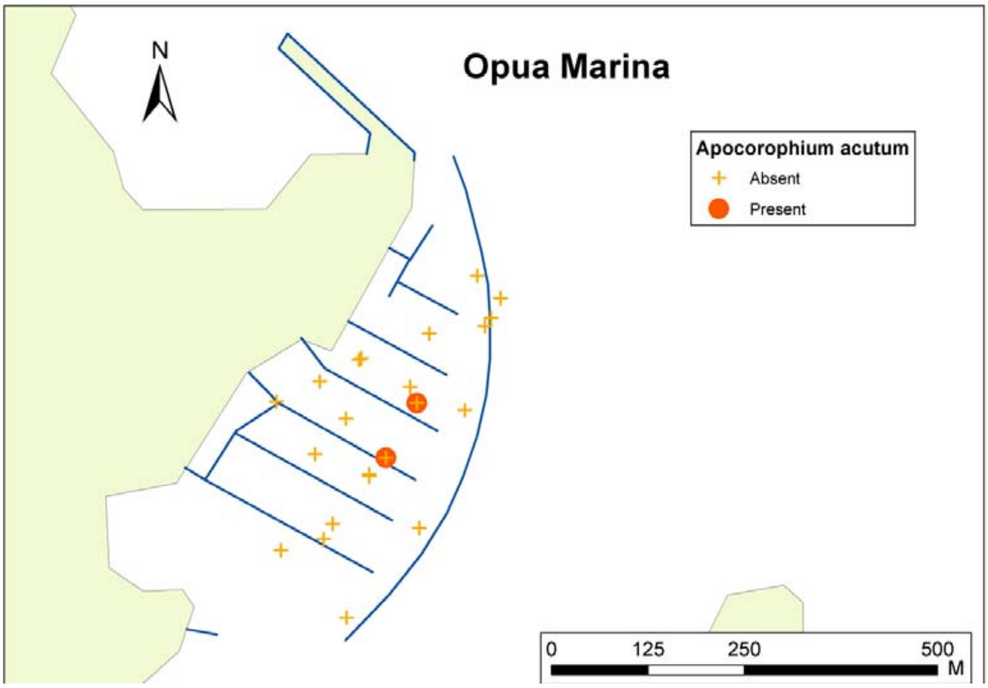

Figure 18: *Apocorophium acutum* distribution in Opua Marina

Musculista senhousia (Benson in Cantor, 1842)

Image and information: NIMPIS (2002d)

Musculista senhousia is a small mussel with a maximum length of around 30 mm. It has a smooth, thin shell that is olive green to brown, with dark radial lines or zigzag markings. A well-developed byssus is used to construct a cocoon which protects the shell. This cocoon is made up of byssal threads and sediment. *Musculista senhousia* burrows vertically down into the sand/mud leaving only its posterior end protruding, allowing its siphons access to the water to enable feeding. *Musculista senhousia* has been found from the intertidal to a depth of 20 m and on soft or hard substrata. It prefers to settle in groups on soft substrata, but is capable of fouling wharf pilings and man-made structures. When settled on hard substrata the mussel will not form a protective cocoon. It is a highly adaptive species, and is able to tolerate low salinities. *Musculista senhousia* can dominate benthic communities and potentially exclude native species. It settles in aggregations and is therefore able to reach high densities. The byssal mats formed by the mussel restrict the growth of some species of seagrass, increases sediment deposition and retention, and can thereby alter the abundance and composition of infaunal assemblages.

Musculista senhousia is native to the Japan and north China Seas. It has been introduced to the west coast of the USA, the Mediterranean, Australia and New Zealand. It is cryptogenic in the Red Sea, the eastern Indian Ocean, South China Sea, Indonesia and Papua New Guinea. It has been present in New Zealand since at least 1978 and has spread to a range of estuaries in north-east New Zealand, from the East Cape to Parengarenga Harbour. In the Opua Marina it occurred in pile scrape samples taken from C and D Berths and in benthic grab samples taken near D Berth (Fig. 19).

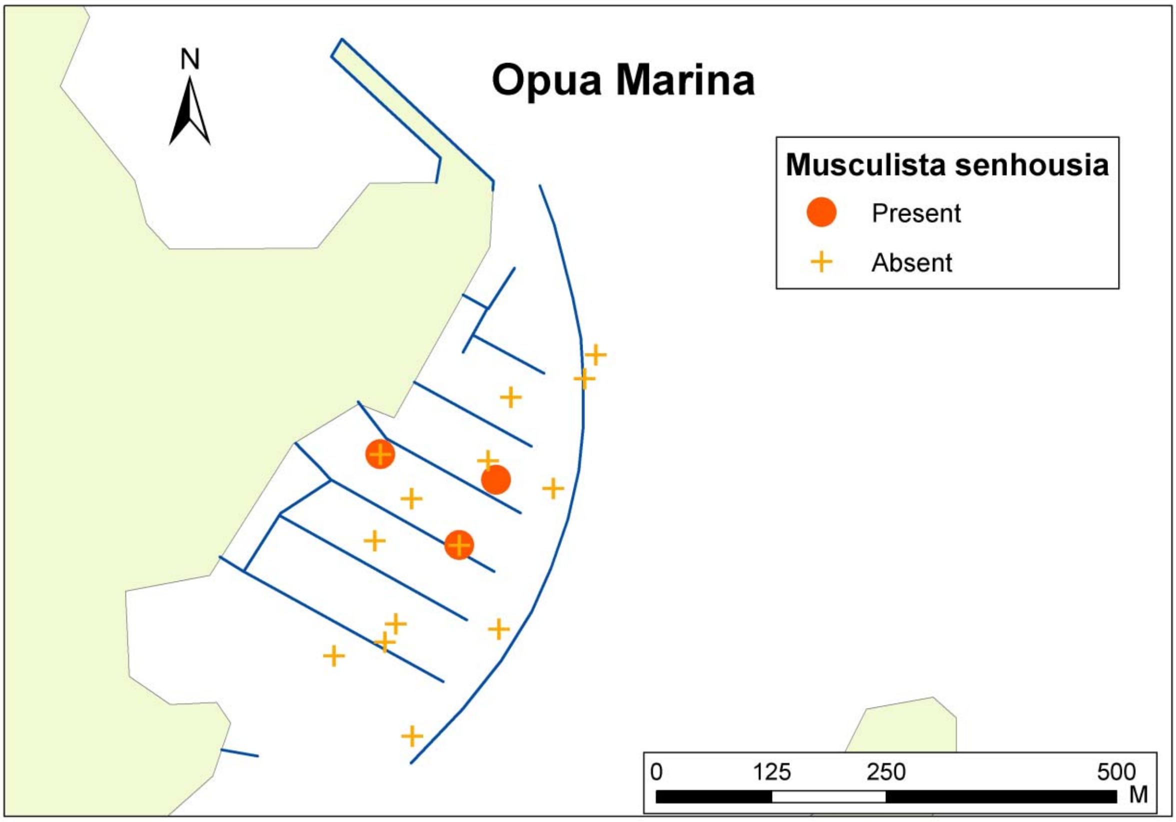

Figure 19: ***Musculista senhousia*** **distribution in Opua Marina**

***Crassostrea gigas* (Thunberg, 1793)**

Image and information: NIMPIS (2002c)

The Pacific oyster, *Crassostrea gigas*, is an important aquaculture species throughout the world, including New Zealand. It has a white elongated shell, with an average size of up to 150-200 mm. The two valves are solid, but unequal in size and shape. The left valve is slightly convex and the right valve is quite deep and cup shaped. One valve is usually entirely cemented to the substratum. The shells are sculpted with large, irregular, rounded, radial folds.

Crassostrea gigas is native to the Japan and China Seas and the northwest Pacific. It has been introduced to the west coast of both North and South America, the West African coast, the northeast Atlantic, the Mediterranean, Australia, New Zealand, Polynesia and Micronesia. It is cryptogenic in Alaska. *Crassostrea gigas* will attach to almost any hard surface in sheltered waters. Whilst they usually attach to rocks, the oysters can also be found in muddy or sandy areas. Oysters will also settle on adult oysters of the same or other species. They prefer sheltered waters in estuaries where they are found in the intertidal and shallow subtidal zones, to a depth of about 3 m. *Crassostrea gigas* settles in dense aggregations in the intertidal zone, resulting in the limitation of food and space available for other intertidal species.

C. gigas has been present in New Zealand since the early 1960s (Cranfield *et al*. 1998). Little is known about the impacts of this species in New Zealand, but it is now a dominant structural component of fouling assemblages and intertidal shorelines in northern harbours of New Zealand and the upper South Island. *C. gigas* is now the basis of New Zealand's oyster aquaculture industry, having displaced the native rock oyster, *Saccostrea glomerata*. *C. gigas* was recorded from Opua Marina, Whangarei Harbour, Gulf Harbour Marina, Auckland, Taranaki, Nelson and Dunedin during the port baseline surveys (Table 10). In Opua Marina it occurred in pile scrape samples taken from the C, D, and Quarantine berths and in benthic sled samples taken near B berth (Fig. 20).

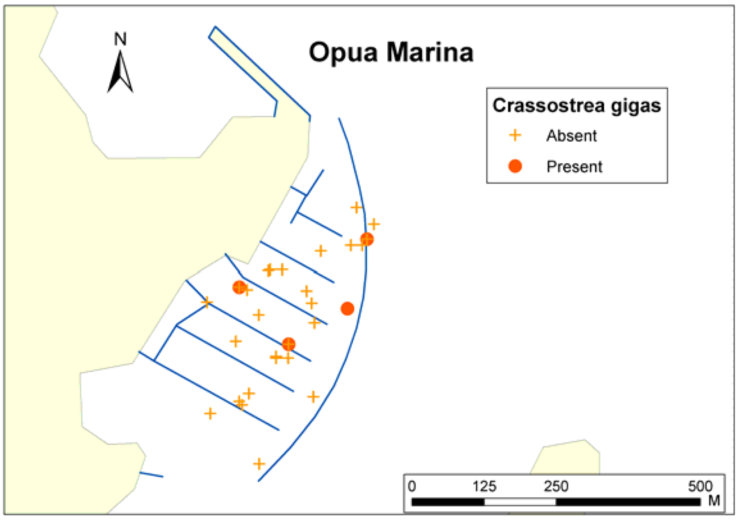

Figure 20: *Crassostrea gigas* distribution in Opua Marina

***Limaria orientalis* (Adams & Reeve, 1850)**

Image: www.femorale.com.

Limaria orientalis (file shell) is a bivalve in the family Limidae. It is known from Australia and the tropical Indo-Pacific. It was first recorded in New Zealand in 1972 from the Hauraki Gulf and Waitemata Harbour. It has since been recorded from the Bay of Islands and Coromandel (Cranfield *et al*. 1998), and is common in the Marlborough Sounds (Don Morrisey, NIWA, *pers. comm*.). *L. orientalis* can be a dominant member of benthic assemblages in muddy shell gravels (Hayward 1997). Its impacts in its introduced range are unknown. In Opua Marina it occurred in pile scrape samples taken from Berth D (Fig. 21).

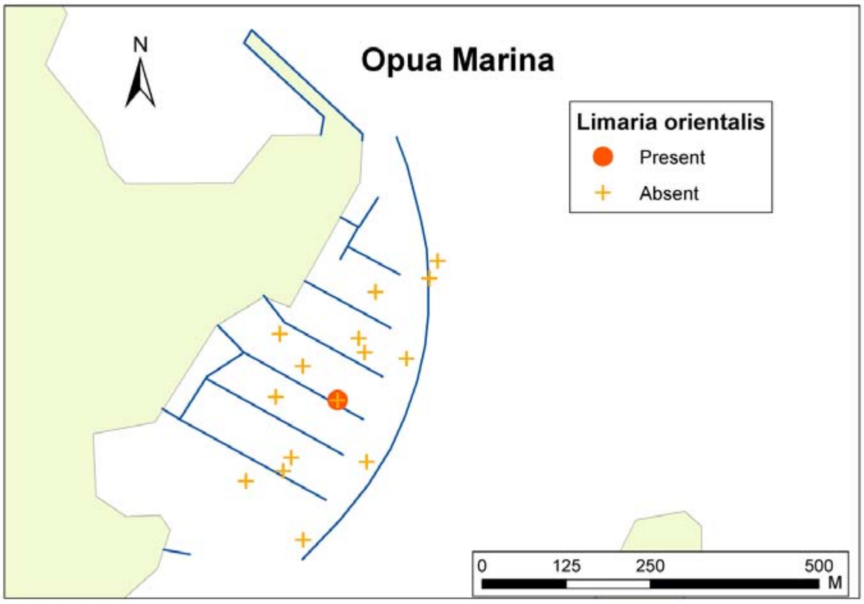

Figure 21: *Limaria orientalis* distribution in Opua Marina

***Theora lubrica* (Gould, 1861)**

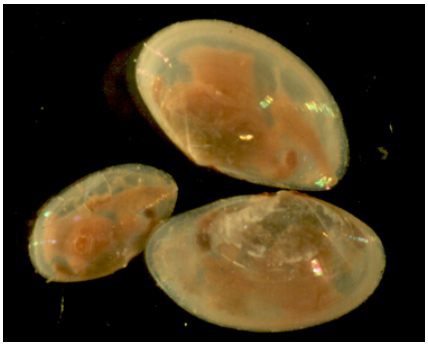

Image and information: NIMPIS (2002e)

Theora lubrica is a small bivalve with an almost transparent shell. The shell is very thin, elongated and has fine concentric ridges. *T. lubrica* grows to about 15 mm in size, and is characterised by a fine elongate rib extending obliquely across the internal surface of the shell. *Theora lubrica* is native to the Japan and China Seas. It has been introduced to the west coast of the USA, Australia and New Zealand. *Theora lubrica* typically lives in muddy sediments from the low tide mark to 50 m, however it has been found at 100 m. In many localities, *T. lubrica* is an indicator species for eutrophic and anoxic areas. *T. lubrica* has been present in New Zealand since at least 1971. It occurs in estuaries of the north-east coast of the North Island, including the Bay of Islands, Whangarei Harbour, Waitemata Harbour, Wellington and Pelorus Sound. During the port baseline surveys, it was recovered from Opua, Whangarei Port and Marina, Gulf Harbour Marina, Auckland, Gisborne, Napier, Taranaki, Wellington, Nelson, and Lyttelton. *T. lubrica* occurred throughout Opua Marina and was recorded in all 10 benthic sled samples taken within the marina, and in benthic grab samples taken near the C, D, and Quarantine berths (Fig. 22).

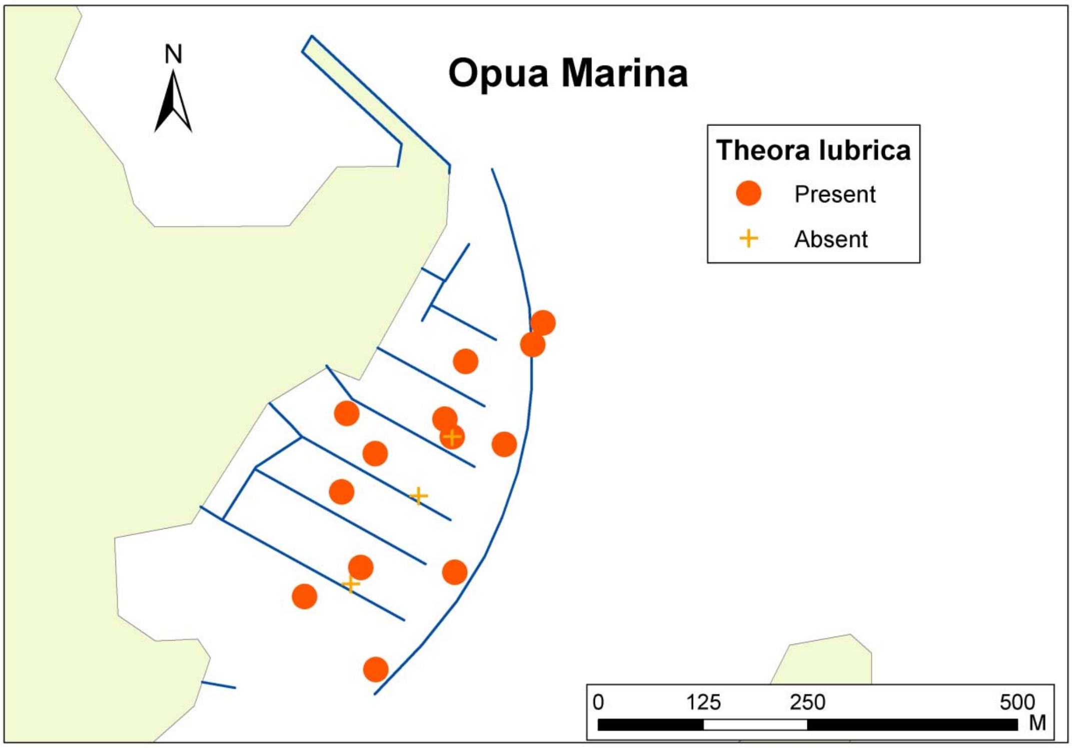

Figure 22: ***Theora lubrica* distribution in Opua Marina**

***Polycera hedgpethi* (Marcus, 1964)**

Image and information:
http://www.seaslugforum.net;
http://www.ciesm.org; Miller (2001)

Polycera hedgpethi is a small, polycerid nudibranch that commonly grows to 20 mm in length (max. 40 mm). It is distinguished by a small frontal veil bearing 4-6 white-tipped pointed processes, black or grey speckled body, with a rhinophore club with black and yellow banding. *P. hedgpethi* is native to the west coast of the USA and has been found in Australia, Japan, Mexico, the Mediterranean, New Zealand, South Africa, Spain, and West Africa. It has been known from New Zealand waters (east coast of North Island) since the 1970's (Cranfield *et al*. 1998). *Polycera hedgpethi* generally occurs on bryozoans, usually species of *Bugula*, which grow as fouling species on ropes, wharf pylons, fouling panels, pontoons and vessel hulls. They can also be found on natural substrata such as rocks, seagrasses and algae in the shallow subtidal to 10 m depth. Its association with major seaports, and common occurrence amongst ship hull biofouling, suggests a distribution from shipping rather than natural causes. It has no known impacts. In the Opua Marina, *P. hedgpethi* occurred in pile scrape samples taken from the Quarantine Berth (Fig. 23).

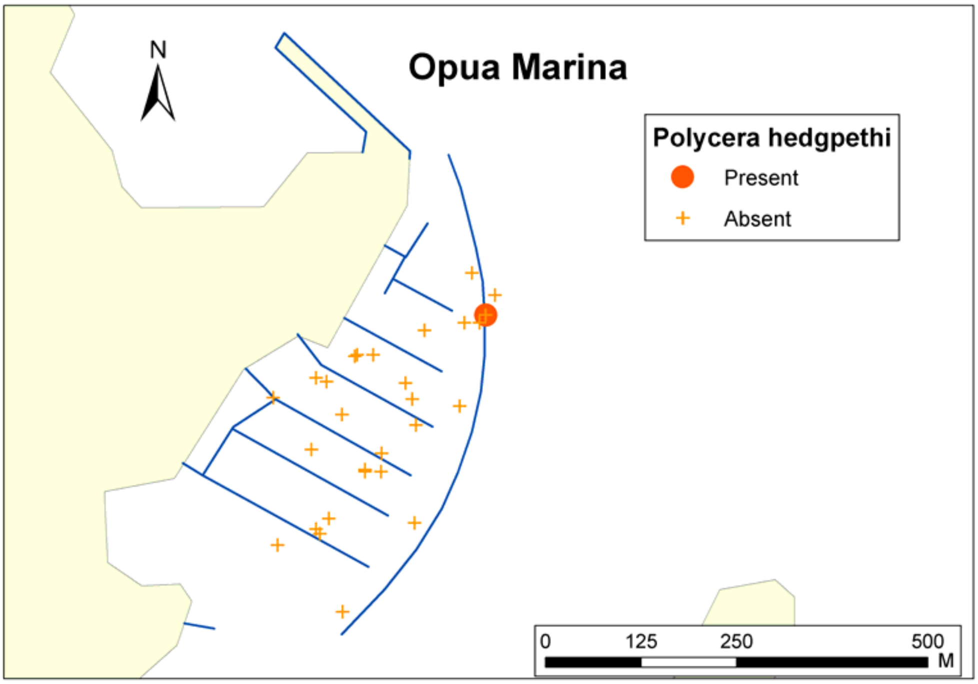

Figure 23: ***Polycera hedgpethi*** **distribution in Opua Marina**

Polysiphonia sertularioides **(Grateloup) J.Agardh**

Image: http://www.com.univ-mrs.fr/
Information: Adams (1994)

Polysiphonia sertularioides is a small filamentous red alga. Plants are delicate and tufted and grow up to 4 cm high. They have very slender stems and a holdfast of creeping stems. They are of a reddish brown colour and soft and flaccid texture. The type specimen for *P. sertularioides* was described from France, but although it is found throughout the

Mediterranean its native range is largely unknown. *P. sertularoides* has been recorded from the Caribbean, the Indian Ocean, French Polynesia and southern Australia (Guiry *et al*. 2005). It usually occurs on pebbles and twigs, and is epiphytic on various other seaweeds. It can be found in sheltered bays and tidal pools. The impacts of *P. sertularioides* are unknown. During the baseline port surveys, *P. sertularoides* was recorded from the port of Taranaki and Opua Marina. In Opua Marina it occurred in pile scrape samples taken from Berth C (Fig. 24).

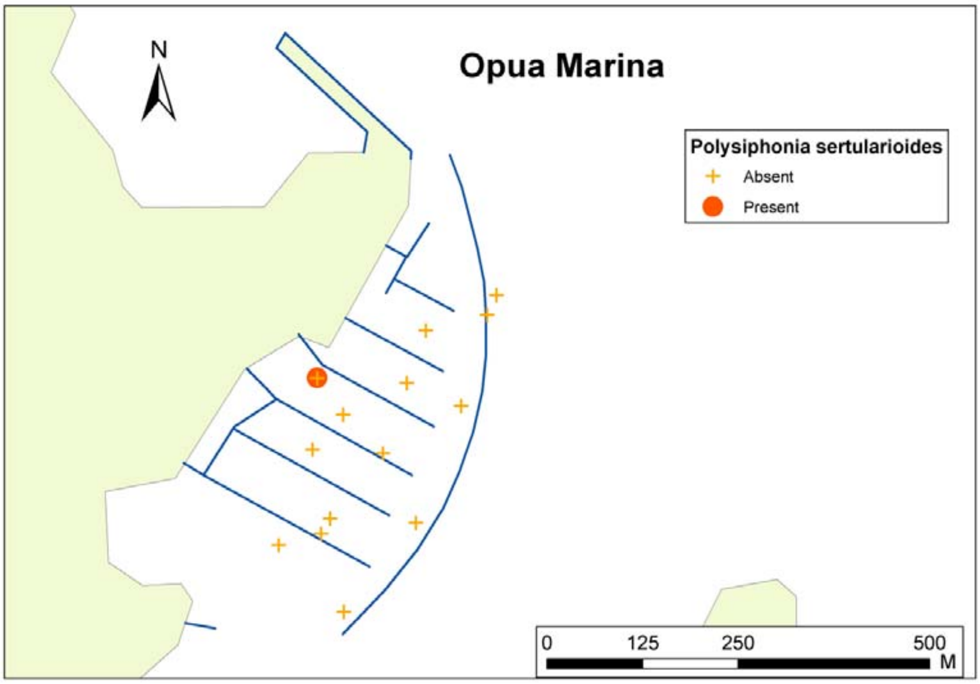

Figure 24: *Polysiphonia sertularoides* distribution in Opua Marina

SPECIES INDETERMINATA

Twenty organisms from the Opua Marina were classified as species indeterminata (Table 9). If each of these organisms is considered a species of unresolved identity, then together they represent 16.4 % of all species collected from this survey (Fig. 11). Species indeterminata from Opua Marina included 10 annelids, two cnidarians, two crustaceans, one mollusc and five phycophyta.

NOTIFIABLE AND UNWANTED SPECIES

Of the non-indigenous species identified from the Opua Marina, none are currently listed as unwanted species on the New Zealand register of unwanted organisms (Table 5a). Two non-indigenous species (the bivalves *Musculista senhousia* and *Crassostrea gigas*) and one cryptogenic species (the cryptogenic dinoflagellate *Gymnodinium catenatum*) are listed on the ABWMAC Australian list of pest species (Table 5b).

PREVIOUSLY UNDESCRIBED SPECIES IN NEW ZEALAND

Five species from the Opua Marina had not previously been recorded from New Zealand waters. These species are classified as Category 2 cryptogenic species in Table 7. The previously undescribed cryptogenic species included three porifera (*Halichondria* n. sp. 4, *Haliclona* n. sp. 3, *Haliclona* n. sp. 9), one bivalve mollusc (*Mytilus* sp.) and one ascidian (*Pyura* sp.). The sponges and the ascidian do not match existing species descriptions from New Zealand or overseas and may be new to science.

The mytilid bivalve is outside the known range of *Mytilus galloprovincialis* in New Zealand and has a slightly different morphology, showing more resemblance to *M. edulis* (B. Marshall, Museum of NZ Te Papa, *pers. comm*.). However, hybridization among members of the *M. edulis* complex makes the taxonomy of this group confused. Gardner (2004) has recently completed a morphometric analysis of *Mytilus* from throughout New Zealand that included both extant populations and shells taken from fossils and middens. He found that mussels from the Bay of Islands had more affinity with *M. edulis* than *M. galloprovincialis*, but fossil and midden mussels more closely aligned with *M. galloprovincialis*. More detailed genetic analysis of the mussels from the Bay of Islands is warranted to determine their true identity.

CYST-FORMING SPECIES

Four species of native dinoflagellate cysts were collected during this survey; they are indicated as members of the Pyrrophycophyta in Table 6. One cryptogenic dinoflagellate species (*Gymnodinium catenatum*) was also collected from the marina (Table 7), and is listed on the ABWMAC Australian list of pest species. Toxins produced by the motile form of *G. catenatum* can cause Paralytic Shellfish Poisoning (PSP) and are a significant public health problem. Blooms of *G. catenatum* can cause problems for aquaculture and recreational harvesting of shellfish.

POSSIBLE VECTORS FOR THE INTRODUCTION OF NON-INDIGENOUS SPECIES TO THE MARINA

The non-indigenous species located in the marina are thought to have arrived in New Zealand via international shipping. Table 8 indicates the possible vectors for the introduction of each NIS into the marina. Likely vectors of introduction are largely derived from Cranfield *et al*. (1998) and indicate that approximately 8 % (one of the 12 NIS) probably arrived via ballast water, 59 % probably were introduced to New Zealand waters via hull fouling, and 33 % could have arrived via either of these mechanisms.

COMPARISON WITH OTHER PORTS

Sixteen locations (13 ports and three marinas) were surveyed during the summers of 2001/2002 and 2002/2003 (Fig. 1). The total number of species identified in these surveys varied from 336 in the Port of Wellington to 56 in Whangarei Town Basin Marina (Fig. 25a). The number of species recorded in each location reflects sampling effort (Table 3c) and local patterns of marine biodiversity within the ports and marinas. Sampling effort alone (expressed as the total number of registered samples in each port), accounted for significant proportions of variation in the numbers of native (linear regression; $F_{1,14}$ = 33.14, P< 0.001, R^2 = 0.703), Cryptogenic 1 ($F_{1,14}$ = 5.94, P = 0.029, R^2 = 0.298) and Cryptogenic 2 ($F_{1,14}$ = 7.37, P = 0.017, R^2 = 0.345) species recorded in each location. However differences in sampling effort did not explain differences in the numbers of NIS in each port or marina ($F_{1,14}$ = 0.77, P = 0.394, R^2 = 0.052). After adjusting for sampling effort, Opua Marina had a slightly smaller than average number of NIS, relative to the other ports and marinas surveyed, and an average diversity of native, Cryptogenic 1 and Cryptogenic 2 species (Fig 26). Largest numbers of NIS were reported from the ports of Lyttelton and Whangarei, but significantly more Cryptogenic 1 species were recorded in Whangarei Port than in other surveyed locations (Fig 26c, Studentised residual = 3.87).

Native organisms represented over 60 % of the species diversity sampled in each surveyed location, with a minimum contribution of 61.0 % in the Port of Lyttelton and a maximum of 68.5 % in Picton (Fig. 25b). Species indeterminata organisms represented between 10.6 % and 25.6 % of the sampled diversity in each location. Non-indigenous and category 1 and 2 cryptogenic species were present in each port and marina, although their relative contributions differed between locations (Fig. 25b). Non-indigenous species represented between 3.6 % (Bluff) and 16.1 % (Whangarei Marina) of all species identified. NIS comprised 9.8 % of the total sampled diversity in the Opua Marina (Fig. 25b), ranking it 3rd highest in percentage composition of NIS from the sixteen locations surveyed.

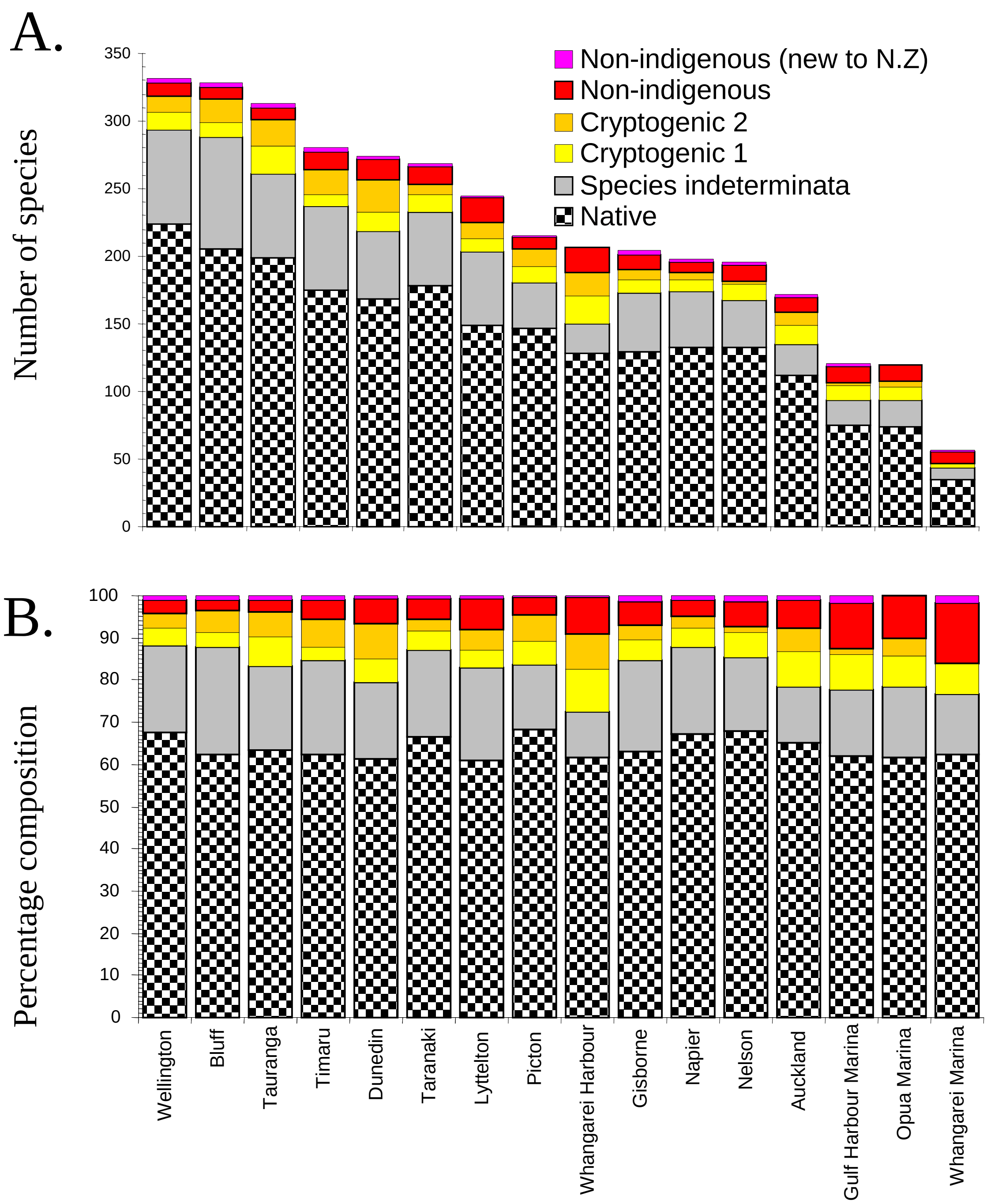

Figure 25: **Differences in (a) the number of species, and (b) the relative proportions of non-indigenous, cryptogenic, species indeterminata and native categories among the sixteen locations sampled over the summers of 2001 – 2002, and 2002-2003. Locations are presented in order of decreasing species diversity sampled.**

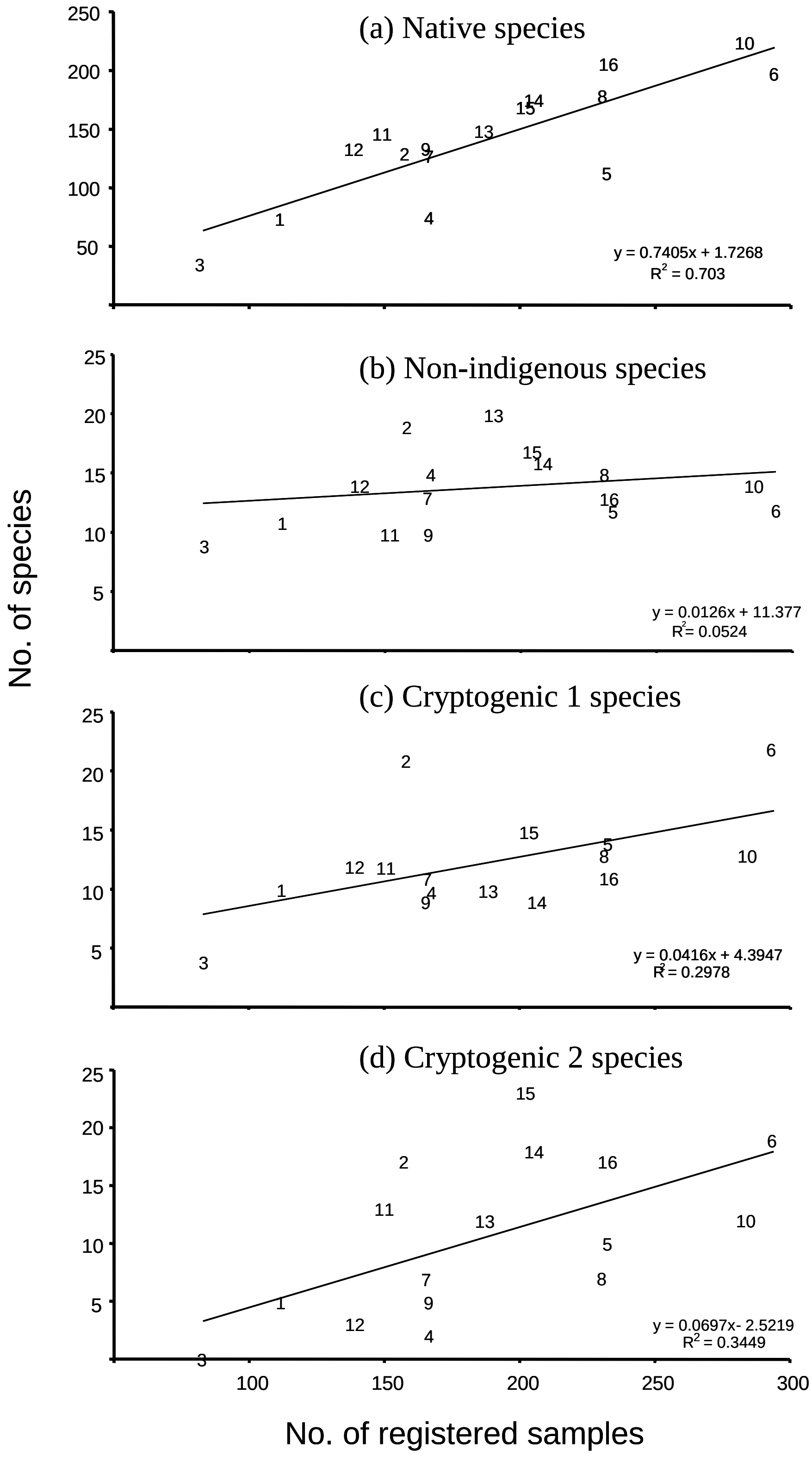

Figure 26: Linear regression equations relating numbers of species detected to sample effort at the 16 locations surveyed nation-wide. Location codes are as follows; 1 = Opua Marina, 2 = Whangarei Port, 3 = Whangarei Marina, 4 = Gulf Harbour Marina, 5 = Auckland Port, 6 = Tauranga Port, 7 = Gisborne Port, 8 = Taranaki Port, 9 = Napier Port, 10 = Wellington Port, 11 = Picton Port, 12 = Nelson Port, 13 = Lyttelton Port, 14 = Timaru Port, 15 = Dunedin Port, 16 = Bluff Port

Assessment of the risk of new introductions to the marina

Many NIS introduced to New Zealand ports, through hull fouling, ships' sea chests, or ballast water discharge, do not survive to establish self-sustaining local populations. Those that do, often come from coastlines that have similar marine environments to New Zealand. For example, approximately 80% of the marine NIS known to be present within New Zealand are native to temperate coastlines of Europe, the north -west Pacific, and southern Australia (Cranfield *et al*. 1998).

Commercial shipping arrivals in Opua Marina are uncommon when compared to other ports around New Zealand, and in 2004 these visits were limited to three cruise liners and one merchant ship (Campbell, 2004). The Bay of Islands has a 'no discharge' policy in place, so the risk of new introductions through ballast is minimal.

Pleasure boating is a very popular activity in New Zealand, and there are more than 30 marinas nationwide that offer mooring facilities to sailing yachts and cabin cruisers of up to 50m in length. New Zealand is also a popular destination for international yachts. These yachts arrive throughout the year, but predominantly (>90 % of all annual arrivals) between October and December. The Opua Marina is known for its high traffic of recreational pleasure craft. The marina has mooring space for 319 vessels and, on average, 70 % of this space is occupied at all times (Floerl, unpublished data). Each year, approximately 70 % of all international yacht arrivals enter New Zealand through Opua Marina (New Zealand Customs Service, personal communication). In 1998 – 2003, Opua received between 272 and 559 international yacht arrivals each year. Pleasure craft visiting the marina from overseas predominantly arrive from Fiji (35 %), Tonga (33 %), New Caledonia (16 %) and Australia (8 %) (NIWA, unpublished data). Recreational vessels from these regions, in particular from temperate or sub-tropical locations, present an on-going risk of introduction of new NIS to Opua Marina.

Assessment of translocation risk for non-indigenous species found in the marina

In addition to international arrivals, approximately 500 New Zealand boats visit Opua each year. Vessels departing from the Opua Marina travel to a wide range of locations around both of New Zealand's main islands. For example, a sample of 207 international yachts that had arrived in Opua from overseas in 2003 subsequently visited more than 70 locations around New Zealand's coastline (NIWA, unpublished data). Movements of yachts between Opua and other locations have the potential to spread introduced fouling organisms.

Generally, vessels departing from Opua Marina after having spent time at berth are likely to pose a risk of spreading established NIS to other marinas and ports within New Zealand where they do not currently occur. The risk of translocation of fouling species is highest for slow-moving vessels and vessels that have long residence times in port. In Opua Marina, recreational craft that are laid up for significant periods of time pose a particular risk for the spread of these species.

Management of existing non-indigenous species in the marina

Seven of the 12 NIS detected in this survey, were recorded from only a single sample location within the marina. Since the baseline surveys are not intended to provide a detailed description of the distribution and abundance of each species in the ports and marinas, it is unclear how widespread each of these species is in Opua Marina. All of the NIS recorded from Opua have been present in New Zealand for more than 20 years and most have been recorded previously from this region. It is likely, therefore, that their distribution in the Bay of

Islands is not limited to the marina environment. Further surveys, targeting these species, are necessary to determine the true extent of their population in the marina and in other ports around New Zealand.

For most marine NIS eradication by physical removal or chemical treatment is not yet a cost-effective option. Many of the species recorded in Opua Marina (particularly *Theora lubrica*) are widespread and local population controls are unlikely to be effective. Management should be directed toward preventing spread of species established in Opua Marina to locations where they do not presently occur. This may be particularly relevant to potentially harmful species that currently have restricted geographic distributions within New Zealand (e.g. *Musculista senhousia*, *Gymnodinium catenatum*). Such management will require better understanding of the frequency of movements by vessels from Opua Marina to other domestic and international locations and improved procedures for hull maintenance by vessels leaving this marina.

Prevention of new introductions

Interception of unwanted species transported by shipping is best achieved offshore, through control and treatment of ships destined for Opua Marina from high-risk locations elsewhere in New Zealand or overseas. Under the Biosecurity Act 1993, the New Zealand Government has developed an Import Health Standard for ballast water that requires large ships to exchange foreign coastal ballast water with oceanic water prior to entering New Zealand, unless exempted on safety grounds. This procedure ("ballast exchange") does not remove all risk, but does reduce the abundance and diversity of coastal species that may be discharged with ballast. Ballast exchange requirements do not currently apply to ballast water that is taken up domestically. Globally, shipping nations are moving toward implementing the International Convention for the Control and Management of Ships Ballast Water & Sediments that was recently adopted by the International Maritime Organisation (IMO). By 2016 all merchant vessels will be required to meet discharge standards for ballast water that are stipulated within the agreement.

Options are currently lacking, however, for effective in-situ treatment of biofouling on vessel hulls and sea-chests. Biosecurity New Zealand has recently embarked on a national survey of hull fouling on vessels entering New Zealand from overseas (including private yachts and launches). The study will characterise risks from this pathway (including high risk source regions and vessel types) and identify predictors of risk that may be used to manage problem vessels. Vessel owners can reduce the risk of transporting NIS in hull fouling or internal piping through regular maintenance and antifouling of their vessels.

Overseas studies have suggested that changes in trade routes can herald an influx of new NIS from regions that have not traditionally had major shipping links with the country or port (Carlton 1987). The growing number of baseline port surveys internationally and an associated increase in published literature on marine NIS means that information is becoming available that will allow more robust risk assessments to be carried out for new shipping routes. Similar assessments could be conducted on the principal sources of international yachts entering marinas of first entry from overseas. The assessment would allow potential problem species to be identified and appropriate management and monitoring requirements to be put in place.

Conclusions and recommendations

The national biological baseline surveys have significantly increased our understanding of the identity, prevalence and distribution of introduced species in New Zealand's shipping ports.

They represent a first step towards a comprehensive assessment of the risks posed to native coastal marine ecosystems from non-indigenous marine species. Although measures are being taken by the New Zealand government to reduce the rate of new incursions, foreign species are likely to continue being introduced to New Zealand waters by shipping, especially considering the lack of management options for hull fouling introductions. There is a need for continued monitoring of marine NIS in port environments to allow for (1) early detection and control of harmful or potentially harmful non-indigenous species, (2) to provide on-going evaluation of the efficacy of management activities, and (3) to allow trading partners to be notified of species that may be potentially harmful. Baseline inventories, like this one, facilitate the second and third of these two purposes. They become outdated when new introductions occur and, therefore, should be repeated on a regular basis to ensure they remain current. Hewitt and Martin (2001) recommend an interval of three to five years between repeat surveys.

The predominance of hull fouling as a likely introduction vector for NIS encountered in the Opua Marina (probably responsible for over 90% of the NIS introductions) is consistent with previous findings from a range of overseas locations. For instance, Hewitt *et al.* (1999) attributed the introduction of 77 % of the 99 NIS encountered in Port Phillip Bay (Australia) to hull fouling, and only 20 % to ballast water. Similarly, 61 % of the 348 marine and brackish water NIS established in the Hawaiian Islands are thought to have arrived on ships' hulls, but only 5 % in ballast water (Eldredge and Carlton 2002). However, ballast water is thought to be responsible for the introduction of 30 % of the 212 marine NIS established in San Francisco Bay (USA), compared to 34 % for hull fouling (Cohen and Carlton 1995). The high percentages of NIS thought to have been introduced by hull fouling in Australasia may reflect the fact that hull fouling has a far longer history (~200 years) as an introduction vector than ballast water (~40 years) (Hewitt *et al.* 1999). However, the fact that some of New Zealand and Australia's most recent marine NIS introductions (e.g. *Undaria pinnatifida*, *Codium fragile sp. tomentosoides*) have been facilitated by hull fouling suggests that it has remained an important transport mechanism (Cranfield *et al.* 1998; Hewitt *et al.* 1999).

Non-indigenous marine species can have a range of adverse impacts through interactions with native organisms. For instance, NIS can cause ecological impacts through competition, predator-prey interactions, hybridisation, parasitism or toxicity and can modify the physical environment through altering habitat structure (Ruiz *et al* 1999; Ricciardi 2001). Assessing the impact of a NIS in a given location ideally requires information on a range of factors, including the mechanism of their impact and their local abundance and distribution (Parker *et al.* 1999). To predict or quantify NIS impacts over larger areas or longer time scales requires additional information on the species' seasonality, population size and mechanisms of dispersal (Mack *et al* 2000). Further studies may be warranted to establish the abundance and potential impacts of the non-indigenous species encountered in this marina to determine if management actions are necessary or possible.

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Tables

Table 1: Berthage facilities in the Opua Marina.

Berth	Purpose	Construction	Length of Berth (m)	Depth (m below chart datum)
A	Recreational	Concrete berths/wood pilings	125	2.0
B	Recreational	Concrete berths/wood pilings	150	2.0
C	Recreational	Concrete berths/wood pilings	200	2.0
D	Recreational	Concrete berths/wood pilings	200	2.0
E	Recreational	Concrete berths/wood pilings	240	2.0
F	Recreational	Concrete berths/wood pilings	250	2.0

Table 2: Comparison of survey methods used in this study with the CRIMP protocols (Hewitt and Martin 2001), indicating modifications made to the protocols following recommendations from a workshop of New Zealand scientists. Full details of the workshop recommendations can be found in Gust *et al.* (2001).

	CRIMP Protocol		NIWA Method		
Taxa sampled	Survey method	Sample procedure	Survey method	Sample procedure	Notes
Dinoflagellate cysts	Small hand core	Cores taken by divers from locations where sediment deposition occurs	TFO Gravity core ("javelin" core)	Cores taken from locations where sediment deposition occurs	Use of the javelin core eliminated the need to expose divers to unnecessary hazards (poor visibility, snags, boat movements, repetitive dives > 10 m). It is a method recommended by the WESTPAC/IOC Harmful Algal Bloom project for dinoflagellate cyst collection (Matsuoka and Fukuyo 2000)
Benthic infauna	Large core	3 cores close to (0 m) and 3 cores away (50 m) from each berth	Shipek benthic grab	3 cores within 10 m of each sampled berth and at sites in the port basin	Use of the benthic grab eliminated need to expose divers to unnecessary hazards (poor visibility, snags, boat movements, repetitive dives > 10 m).
Dinoflagellates	20um plankton net	Horizontal and vertical net tows	Not sampled	Not sampled	Plankton assemblages spatially and temporally variable, time-consuming and difficult to identify to species. Workshop recommended using resources to sample other taxa more comprehensively
Zooplankton and/ phytoplankton	100 um plankton net	Vertical net tow	Not sampled	Not sampled	Plankton assemblages spatially and temporally variable, time-consuming and difficult to identify to species. Workshop recommended using resources to sample other taxa more comprehensively
Crab/shrimp	Baited traps	3 traps of each kind left overnight at each site	Baited traps	4 traps (2 line x 2 traps) of each kind left overnight at each site	
Macrobiota	Qualitative visual survey	Visual searches of wharves & breakwaters for target species	Qualitative visual survey	Visual searches of wharves & breakwaters for target species	
Sedentary / encrusting biota	Quadrat scraping	0.10 m2 quadrats sampled at -0.5 m, -3.0 m and -7.0 m on 3 outer piles per berth	Quadrat scraping	0.10 m2 quadrats sampled at -0.5 m, -1.5 m, -3.0 m and -7 m on 2 inner and 2 outer piles per berth	Workshop recommended extra quadrat in high diversity algal zone (-1.5 m) and to sample inner pilings for shade tolerant species

	CRIMP Protocol		NIWA Method		
Taxa sampled	Survey method	Sample procedure	Survey method	Sample procedure	Notes
Sedentary / encrusting biota	Video / photo transect	Video transect of pile/rockwall facing. Still images taken of the three 0.10 m2 quadrats	Video / photo transect	Video transect of pile/rockwall facing. Still images taken of the four 0.10 m2 quadrats	
Mobile epifauna	Beam trawl or benthic sled	1 x 100 m or timed trawl at each site	Benthic sled	2 x 100 m (or 2 min.) tows at each site	
Fish	Poison station	Divers & snorkelers collect fish from poison stations	Opera house fish traps	4 traps (2 lines x 2 traps) left for min. 1 hr at each site	Poor capture rates anticipated from poison stations because of low visibility in NZ ports. Some poisons also an OS&H risk to personnel and may require resource consent.
Fish/mobile epifauna	Beach seine	25 m seine haul on sand or mud flat sites	Opera house fish traps / Whayman Holdsworth starfish traps	4 traps (2 lines x 2 traps) of left at each site (Whayman Holdworth starfish traps left overnight)	Few NZ ports have suitable intertidal areas to beach seine.

Table 3a: Summary of the Opua marina sampling effort.

Sample method	Number of shipping berths sampled	Number of replicate samples taken
Benthic Sled Tows	(NB [1])	10
Benthic Grab (Shipek)	4	12
Box traps	4	12
Diver quadrat scraping	4	46
Opera house fish traps	4	8
Starfish traps	4	8
Shrimp traps	4	8
Javelin cores	N/A	8

(NB [1]) Sled tows taken between jetties.

Table 3b: Pile scraping sampling effort in the Port of Opua. Number of replicate quadrats scraped on Outer (unshaded) and Inner (shaded) pier piles at four depths. Pile materials scraped are indicated.

Sample Depth (M)	Outer Piles	Inner Piles
0.5	4 steel, 12 wood	0 (NB [2])
1.5	4 steel, 12 wood	0
3.5	4 steel, 8 wood	0
7	2 steel	0

(NB [2]) All piles unshaded in this marina due to construction layout.

Table 3c: Summary of sampling effort in Ports and Marinas surveyed during the austral summers of 2001-2002 (shown in bold type), and 2002-2003 (shown in plain type). The number of shipping berths sampled is indicated, along with the total numbers of samples taken (in brackets).

Survey Location	Benthic sled tows	Benthic grab	Box traps	Diver quadrat scraping	Opera house traps	Starfish traps	Shrimp traps	Javelin cores
Port of Lyttelton	5 (10)	5 (15)	6 (20)	5 (77)	5 (20)	6 (20)	6 (19)	(8)
Port of Nelson	4 (8)	1 (2) *	4 (16)	4 (55)	4 (16)	4 (16)	4 (16)	(8)
Port of Picton	3 (6)	*	3 (18)	3 (53)	3 (16)	3 (24)	3 (24)	(6)
Port of Taranaki	6 (12)	6 (21)	7 (25)	4 (66)	6 (24)	6 (24)	6 (24)	(14)
Port of Tauranga	6 (18)	6 (28)	8 (32)	6 (107)	6 (25)	7 (28)	7 (28)	(8)
Port of Timaru	6 (12)	4 (14)	5 (20)	4 (58)	5 (20)	5 (20)	5 (20)	(8)
Port of Wellington	7 (13)	6 (18)	7 (28)	6 (98)	7 (34)	7 (28)	7 (28)	(6)
Port of Auckland	6 (12)	6 (18)	6 (24)	6 (101)	6 (24)	6 (24)	5 (20)	(10)
Port of Bluff	6 (21)	7 (21)	7 (29)	5 (75)	6 (24)	7 (28)	7 (24)	(12)
Dunedin Harbour	5 (10)	5 (15)	5 (20)	5 (75)	5 (20)	5 (20)	5 (18)	(9)
Port of Gisborne	5 (10)	6 (18)	5 (20)	4 (50)	5 (20)	5 (20)	5 (20)	(8)
Gulf Harbour Marina	(17)	4 (12)	4 (16)	4 (66)	4 (16)	4 (16)	4 (16)	(8)
Port of Napier	5 (10)	5 (15)	5 (18)	4 (59)	5 (20)	5 (18)	5 (18)	(8)
Opua Marina	(10)	4 (12)	4 (12)	4 (46)	4 (8)	4 (8)	4 (8)	(8)
Whangarei Marina	3 (6)	2 (6)	2 (8)	4 (33)	2 (8)	2 (8)	2 (8)	(6)
Whangarei Harbour	4 (9)	4 (12)	4 (16)	4 (65)	4 (16)	4 (16)	4 (16)	(7)

*Shipek grab malfunctioned in the Ports of Nelson and Picton

Table 4: Preservatives used for the major taxonomic groups of organisms collected during the port survey. [1] indicates photographs were taken before preservation, and [2] indicates they were relaxed in magnesium chloride or menthol prior to preservation.

5 % Formalin solution	10 % Formalin solution	70 % Ethanol solution	Air dried
Phycophyta	Asteroidea	Alcyonacea [2]	Bryozoa
	Brachiopoda	Ascidiacea [1, 2]	
	Crustacea (large)	Crustacea (small)	
	Ctenophora [1]	Holothuria [1, 2]	
	Echinoidea	Mollusca (with shell)	
	Hydrozoa	Mollusca [1, 2] (without shell)	
	Nudibranchia [1]	Platyhelminthes [1]	
	Ophiuroidea	Porifera [1]	
	Polychaeta	Zoantharia [1, 2]	
	Scleractinia		
	Scyphozoa [1, 2]		
	Vertebrata [1] (pisces)		

Table 5a: Marine pest species listed on the New Zealand register of unwanted organisms under the Biosecurity Act 1993.

Phylum	Class/Order	Genus and Species
Annelida	Polychaeta	*Sabella spallanzanii*
Arthropoda	Decapoda	*Carcinus maenas*
Arthropoda	Decapoda	*Eriocheir sinensis*
Echinodermata	Asteroidea	*Asterias amurensis*
Mollusca	Bivalvia	*Potamocorbula amurensis*
Phycophyta	Chlorophyta	*Caulerpa taxifolia*
Phycophyta	Phaeophyceae	*Undaria pinnatifida*

Table 5b: Marine pest species listed on the Australian Ballast Water Management Advisory Council's (ABWMAC) schedule of non-indigenous pest species.

Phylum	Class/Order	Genus and Species
Annelida	Polychaeta	*Sabella spallanzanii*
Arthropoda	Decapoda	*Carcinus maenas*
Echinodermata	Asteroidea	*Asterias amurensis*
Mollusca	Bivalvia	*Corbula gibba*
Mollusca	Bivalvia	*Crassostrea gigas*
Mollusca	Bivalvia	*Musculista senhousia*
Phycophyta	Dinophyceae	*Alexandrium catenella*
Phycophyta	Dinophyceae	*Alexandrium minutum*
Phycophyta	Dinophyceae	*Alexandrium tamarense*
Phycophyta	Dinophyceae	*Gymnodinium catenatum*

Table 6: Native species recorded from the Opua Marina survey.

Phylum, Class	Order	Family	Genus and species
Annelida			
Polychaeta	Eunicida	Dorvilleidae	*Dorvillea australiensis*
Polychaeta	Eunicida	Lumbrineridae	*Abyssoninoe galatheae*
Polychaeta	Eunicida	Lumbrineridae	*Lumbrineris sphaerocephala*
Polychaeta	Eunicida	Onuphidae	*Onuphis aucklandensis*
Polychaeta	Phyllodocida	Glyceridae	*Glycera lamelliformis*
Polychaeta	Phyllodocida	Hesionidae	*Ophiodromus angustifrons*
Polychaeta	Phyllodocida	Nereididae	*Neanthes kerguelensis*
Polychaeta	Phyllodocida	Nereididae	*Perinereis vallata*
Polychaeta	Phyllodocida	Polynoidae	*Harmothoe macrolepidota*
Polychaeta	Phyllodocida	Polynoidae	*Lepidonotus polychromus*
Polychaeta	Phyllodocida	Sigalionidae	*Labiosthenolepis laevis*
Polychaeta	Sabellida	Sabellidae	*Megalomma suspiciens*
Polychaeta	Scolecida	Opheliidae	*Armandia maculata*
Polychaeta	Scolecida	Orbiniidae	*Phylo novazealandiae*
Polychaeta	Terebellida	Cirratulidae	*Protocirrineris nuchalis*
Polychaeta	Terebellida	Flabelligeridae	*Flabelligera affinis*
Polychaeta	Terebellida	Pectinariidae	*Pectinaria australis*
Polychaeta	Terebellida	Terebellidae	*Amaeana antipoda*
Polychaeta	Terebellida	Terebellidae	*Nicolea armilla*
Polychaeta	Terebellida	Terebellidae	*Pseudopista rostrata*
Polychaeta	Terebellida	Terebellidae	*Streblosoma toddae*
Bryozoa			
Gymnolaemata	Cheilostomata	Candidae	*Caberea rostrata*
Crustacea			
Cirripedia	Thoracica	Balanidae	*Austrominius modestus*
Malacostraca	Amphipoda	Melitidae	*Melita awa*
Malacostraca	Amphipoda	Phoxocephalidae	*Torridoharpinia hurleyi*
Malacostraca	Anomura	Porcellanidae	*Petrolisthes novaezelandiae*
Malacostraca	Brachyura	Hymenosomatidae	*Halicarcinus "muddy"*
Malacostraca	Brachyura	Hymenosomatidae	*Halicarcinus cookii*
Malacostraca	Brachyura	Hymenosomatidae	*Halicarcinus varius*
Malacostraca	Brachyura	Hymenosomatidae	*Neohymenicus pubescens*
Malacostraca	Brachyura	Majidae	*Notomithrax minor*
Malacostraca	Brachyura	Ocypodidae	*Macrophthalmus hirtipes*
Malacostraca	Brachyura	Pinnotheridae	*Pinnotheres atrinocola*
Malacostraca	Caridea	Crangonidae	*Pontophilus australis*
Malacostraca	Caridea	Palemonidae	*Periclimenes yaldwyni*
Malacostraca	Isopoda	Cirolanidae	*Natatolana narica*
Echinodermata			
Asteroidea	Valvatida	Asterinidae	*Patiriella regularis*
Echinoidea	Spatangoida	Loveniidae	*Echinocardium cordatum*
Mollusca			

Phylum, Class	Order	Family	Genus and species
Bivalvia	Myoida	Hiatellidae	*Hiatella arctica*
Bivalvia	Mytiloida	Mytilidae	*Modiolarca impacta*
Bivalvia	Mytiloida	Mytilidae	*Perna canaliculus*
Bivalvia	Mytiloida	Mytilidae	*Xenostrobus pulex*
Bivalvia	Mytiloida	Mytilidae	*Xenostrobus securis*
Bivalvia	Ostreoida	Anomiidae	*Pododesmus zelandicus*
Bivalvia	Ostreoida	Ostreidae	*Ostrea chilensis*
Bivalvia	Pterioida	Anomiidae	*Anomia trigonopsis*
Bivalvia	Pterioida	Pectinidae	*Talochlamys zelandiae*
Bivalvia	Veneroida	Mactridae	*Zenatia acinaces*
Bivalvia	Veneroida	Veneridae	*Dosinia lambata*
Bivalvia	Veneroida	Veneridae	*Irus reflexus*
Gastropoda	Cephalaspidea	Philinidae	*Philine auriformis*
Gastropoda	Littorinimorpha	Calyptraeidae	*Maoricrypta costata*
Gastropoda	Littorinimorpha	Calyptraeidae	*Sigapatella tenuis*
Gastropoda	Littorinimorpha	Struthiolariidae	*Struthiolaria papulosa*
Gastropoda	Neogastropoda	Buccinidae	*Cominella adspersa*
Gastropoda	Neogastropoda	Buccinidae	*Cominella glandiformis*
Gastropoda	Notaspidea	Pleurobranchidae	*Pleurobranchaea maculata*
Phycophyta			
Cladophorophyceae	Cladophorales	Cladophoraceae	*Rhizoclonium implexum*
Porifera			
Demospongiae	Haplosclerida	Chalinidae	*Adocia cf. parietalioides*
Demospongiae	Haplosclerida	Chalinidae	*Adocia cf. venustina*
Demospongiae	Haplosclerida	Chalinidae	*Haliclona cf. punctata*
Pyrrophycophyta			
Dinophyceae	Peridiniales	Gonyaulacaceae	*Gonyaulax spinifera*
Dinophyceae	Peridiniales	Peridiniaceae	*Protoperidinium conicum cf. conicoides*
Dinophyceae	Peridiniales	Peridiniaceae	*Protoperidinium sp.*
Dinophyceae	Peridiniales	Peridiniaceae	*Scrippsiella trochoidea*
Urochordata			
Ascidiacea	Aplousobranchia	Polyclinidae	*Aplidium adamsi*
Ascidiacea	Stolidobranchia	Pyuridae	*Microcosmus australis*
Ascidiacea	Stolidobranchia	Pyuridae	*Pyura subuculata*
Ascidiacea	Stolidobranchia	Styelidae	*Cnemidocarpa otagoensis*
Vertebrata			
Actinopterygii	Anguilliformes	Congridae	*Conger wilsoni*
Actinopterygii	Mugiliformes	Mugilidae	*Aldrichetta forsteri*
Actinopterygii	Perciformes	Arripidae	*Arripis trutta*
Actinopterygii	Perciformes	Gobiidae	*Favonigobius lentigenosus*
Actinopterygii	Perciformes	Labridae	*Notolabrus celidotus*
Actinopterygii	Perciformes	Sparidae	*Pagrus auratus*
Actinopterygii	Pleuronectiformes	Pleuronectidae	*Peltorhamphus latus*

Table 7: Cryptogenic marine species recorded from the Opua Marina survey. Category 1 cryptogenic species (C1); Category 2 cryptogenic species (C2). Refer to section 2.9 for definitions.

Phylum, Class	Order	Family	Genus and species	
Cnidaria				
Hydrozoa	Hydroida	Bougainvilliidae	*Bougainvillia muscus*	C1
Hydrozoa	Hydroida	Campanulariidae	*Clytia hemisphaerica*	C1
Hydrozoa	Hydroida	Campanulinidae	*Phialella quadrata*	C1
Crustacea				
Cirripedia	Thoracica	Balanidae	*Balanus trigonus*	C1
Malacostraca	Brachyura	Xanthidae	*Pilumnopeus serratifrons*	C1
Mollusca				
Bivalvia	Mytiloida	Mytilidae	*Mytilus sp.*	C2
Porifera				
Demospongiae	Halichondrida	Halichondriidae	*Halichondria n. sp. 4*	C2
Demospongiae	Haplosclerida	Chalinidae	*Haliclona n. sp. 3*	C2
Demospongiae	Haplosclerida	Chalinidae	*Haliclona n. sp. 9*	C2
Pyrrophycophyta				
Dinophyceae	Gymnodiniales	Gymnodiniacea	*Gymnodinium catenatum*	C1
Urochordata				
Ascidiacea	Phlebobranchia	Rhodosomatidae	*Corella eumyota*	C1
Ascidiacea	Stolidobranchia	Pyuridae	*Pyura sp.*	C2
Ascidiacea	Stolidobranchia	Styelidae	*Asterocarpa cerea*	C1
Ascidiacea	Stolidobranchia	Styelidae	*Styela plicata*	C1

Table 8: Non-indigenous marine species recorded from the Opua Marina survey. Likely vectors of introduction are largely derived from Cranfield *et al*. (1998), where H = Hull fouling and B = Ballast water transport. Novel NIS not listed in Cranfield *et al*. (1998) or previously encountered by taxonomic experts in New Zealand waters are marked as New Records (NR). For these species and others for which information is scarce, we provide dates of first detection rather than probable dates of introduction.

Phylum, Class	Order	Family	Genus and species	Probable means of introduction	Date of introduction or detection (d)
Annelida					
Polychaeta	Spionida	Spionidae	*Polydora cornuta*	H or B	Pre-1972
Bryozoa					
Gymnolaemata	Cheilostomata	Bugulidae	*Bugula flabellata*	H	Pre-1948
Gymnolaemata	Cheilostomata	Bugulidae	*Bugula neritina*	H	1949
Gymnolaemata	Cheilostomata	Watersiporidae	*Watersipora subtorquata*	H or B	Pre-1982
Cnidaria					
Hydrozoa	Hydroida	Campanulariidae	*Obelia longissima*	H	Pre-1928
Crustacea					
Malacostraca	Amphipoda	Corophiidae	*Apocorophium acutum*	H	Pre-1921
Mollusca					
Bivalvia	Mytiloida	Mytilidae	*Musculista senhousia*	H or B	1978
Bivalvia	Ostreoida	Ostreidae	*Crassostrea gigas*	H	1961
Bivalvia	Pterioida	Limidae	*Limaria orientalis*	H or B	Pre-1972
Bivalvia	Veneroida	Semelidae	*Theora lubrica*	B	1971
Gastropoda	Nudibranchia	Polyceridae	*Polycera hedgpethi*	H	1970s
Phycophyta					
Rhodophyceae	Ceramiales	Rhodomelaceae	*Polysiphonia sertularioides*	H	Pre-1938

Table 9: Species indeterminata recorded from the Opua Marina survey. This group includes: (1) organisms that were damaged or juvenile and lacked cruical morphological characteristics, and (2) taxa for which there is not sufficient taxonomic or systematic information available to allow positive identification to species level.

Phylum, Class	Order	Family	Genus and species
Annelida			
Polychaeta	Phyllodocida	Glyceridae	*Glycera Indet*
Polychaeta	Phyllodocida	Nereididae	*Platynereis Platynereis_australis_group*
Polychaeta	Phyllodocida	Phyllodocidae	*Mystides Mystides-B*
Polychaeta	Phyllodocida	Phyllodocidae	*Phyllodocidae-unknown Phyllodocidae-01*
Polychaeta	Sabellida	Sabellidae	*Branchiomma Branchiomma-A*
Polychaeta	Scolecida	Maldanidae	*Asychis Asychis-B*
Polychaeta	Scolecida	Orbiniidae	*Orbiniidae Indet*
Polychaeta	Spionida	Spionidae	*Paraprionospio Paraprionospio-A [pinnata]*
Polychaeta	Terebellida	Terebellidae	*Terebellidae Indet*
Polychaeta	Terebellida	Trichobranchidae	*Terebellides Indet*
Cnidaria			
Hydrozoa	Hydroida	Tubulariidae	*Ectopleura? sp.*
Scyphozoa			*Scyphozoa sp.*
Crustacea			
Malacostraca	Brachyura	Majidae	*Notomithrax sp.*
Malacostraca	Isopoda	Cirolanidae	*Natatolana sp.*
Mollusca			
Gastropoda			*Gastropoda sp.*
Phycophyta			
Cladophorophyceae	Cladophorales	Cladophoraceae	*Chaetomorpha sp.*
Phaeophyceae	Sphacelariales	Sphacelariaceae	*Sphacelaria sp.*
Rhodophyceae	Ceramiales	Rhodomelaceae	*Polysiphonia sp.*
Rhodophyceae	Plocamiales	Plocamiaceae	*Plocamium sp.*
Ulvophyceae	Ulvales	Ulvaceae	*Enteromorpha sp.*

Table 10: Non-indigenous marine organisms recorded from the Opua Marina survey and the techniques used to capture each species. Species distributions are indicated throughout the marina and in other locations surveyed in this project around New Zealand.

Non-indigenous species	Capture technique in Opua Marina	Locations detected in Opua Marina	Detected in other locations surveyed in ZBS2000_04
Polydora cornuta	Pile scrape	Berth D See Fig 13	Whangarei Marina
Bugula flabellata	Pile scrape	Quarantine Berth See Fig 14	Auckland, Bluff, Dunedin, Lyttleton, Napier, Nelson, Picton, Taranaki, Tauranga, Timaru, Whangarei Harbour, Wellington
Bugula neritina	Pile scrape	Quarantine Berth See Fig 15	Auckland, Dunedin, Gisborne, Gulf Harbour Marina, Lyttleton, Napier, Taranaki, Tauranga, Timaru, Whangarei Harbour, Whangarei Marina
Watersipora subtorquata	Pile scrape	Berth C; Berth D; Quarantine Berth See Fig 16	Bluff, Dunedin, Gisborne, Gulf Harbour Marina, Lyttleton, Napier, Nelson, Picton, Taranaki, Tauranga, Timaru, Whangarei Harbour, Wellington
Obelia longissima	Pile scrape	Quarantine Berth See Fig 17	Auckland, Whangarei Harbour
Apocorophium acutum	Pile scrape, Shrimp trap	Berth C; Berth D See Fig 18	Dunedin, Gulf Harbour Marina, Lyttleton, Tauranga, Timaru
Musculista senhousia	Pile scrape, Benthic grab	Berth C; Berth D See Fig 19	Whangarei Marina
Crassostrea gigas	Pile scrape, Benthic sled	Berth C; Berth D; Quarantine Berth See Fig 20	Auckland, Dunedin, Gulf Harbour Marina, Nelson, Taranaki, Whangarei Harbour
Limaria orientalis	Pile scrape	Berth D See Fig 21	Gulf Harbour Marina
Theora lubrica	Benthic sled, Benthic grab	Berths A-F; Quarantine Berth See Fig 22	Auckland, Gisborne, Gulf Harbour Marina, Lyttleton, Napier, Nelson, Taranaki, Whangarei Harbour, Whangarei Marina, Wellington
Polycera hedgpethi	Pile scrape	Quarantine Berth See Fig 23	Gisborne
Polysiphonia sertularioides	Pile scrape	Berth C See Fig 24	Taranaki

Appendices

Appendix 1: Specialists engaged to identify specimens obtained from the New Zealand Port surveys.

Phylum	Class	Specialist	Institution
Annelida	Polychaeta	Geoff Read, Jeff Forman	NIWA Greta Point
Bryozoa	Gymnolaemata	Dennis Gordon	NIWA Greta Point
Chelicerata	Pycnogonida	David Staples	Melbourne Museum, Victoria, Australia
Cnidaria	Anthozoa	Adorian Ardelean	West University of Timisoara, Timisoara, 1900, Romania
Cnidaria	Hydrozoa	Jan Watson	Hydrozoan Research Laboratory, Clifton Springs, Victoria, Australia
Crustacea	Amphipoda	Graham Fenwick	NIWA Christchurch
Crustacea	Cirripedia	Graham Fenwick, Isla Fitridge John Buckeridge[1]	NIWA Christchurch and [1]Auckland University of Technology
Crustacea	Decapoda	Colin McLay[1] Graham Fenwick, Nick Gust	[1]University of Canterbury and NIWA Christchurch
Crustacea	Isopoda	Niel Bruce	NIWA Greta Point
Crustacea	Mysidacea	Fukuoka Kouki	National Science Museum, Tokyo
Echinodermata	Asteroidea	Don McKnight	NIWA Greta Point
Echinodermata	Echinoidea	Don McKnight	NIWA Greta Point
Echinodermata	Holothuroidea	Niki Davey	NIWA Nelson
Echinodermata	Ophiuroidea	Don McKnight, Helen Rottman	NIWA Greta Point
Echiura	Echiuroidea	Geoff Read	NIWA Greta Point
Mollusca	Bivalvia. Cephalopoda, Gastropoda, Polyplacophora	Bruce Marshall	Museum of NZ Te Papa Tongarewa
Nemertea	Anopla, Enopla	Geoff Read	NIWA Greta Point
Phycophyta	Phaeophyceae, Rhodophyceae, Ulvophyceae	Wendy Nelson, Kate Neill	NIWA Greta Point
Platyhelminthes	Turbellaria	Sean Handley	NIWA Nelson
Porifera	Demospongiae, Calcarea	Michelle Kelly-Shanks	NIWA Auckland
Priapula	Priapulidae	Geoff Read	NIWA Greta Point
Pyrrophycophyta	Dinophyceae	Hoe Chang, Rob Stewart	NIWA Greta Point
Urochordata	Ascidiacea	Mike Page, Anna Bradley Patricia Kott[1]	NIWA Nelson and [1]Queensland Museum
Vertebrata	Osteichthyes	Clive Roberts, Andrew Stewart	Museum of NZ Te Papa Tongarewa

Appendix 2: Generic descriptions of representative groups of the main marine phyla collected during sampling.

Phylum Annelida

Polychaetes: The polychaetes are the largest group of marine worms and are closely related to the earthworms and leeches found on land. Polychaetes are widely distributed in the marine environment and are commonly found under stones and rocks, buried in the sediment or attached to submerged natural and artificial surfaces including rocks, pilings, ropes and the shells or carapaces of other species. All polychaete worms have visible legs or bristles. Many species live in tubes secreted by the body or assembled from debris and sediments, while others are free-living. Depending on species, polychaetes feed by filtering small food particles from the water or by preying upon smaller creatures.

Phylum Bryozoa

Bryozoans: This group of organisms is also referred to as 'moss animals' or 'lace corals'. Bryozoans are sessile and live attached to submerged natural and artificial surfaces including rocks, pilings, ropes and the shells or carapaces of other species. They are all colonial, with individual colonies consisting of hundreds of individual 'zooids'. Bryozoans can have encrusting growth forms that are sheet-like and approximately 1 mm thick, or can form erect or branching structures several centimetres high. Bryozoans feed by filtering small food particles from the water column, and colonies grow by producing additional zooids.

Phylum Chelicerata

Pycnogonids: The pycnogonids, or sea spiders, are a group within the Arthropoda, and closely related to land spiders. They are commonly encountered living among sponges, hydroids and bryozoans on the seafloor. They range in size from a few mm to many cm and superficially resemble spiders found on land.

Phylum Cnidaria

Hydroids: Hydroids can easily be mistaken for erect and branching bryozoans. They are also sessile organisms that live attached to submerged natural and artificial surfaces including rocks, pilings, ropes and the shells or carapaces of other species. All hydroids are colonial, with individual colonies consisting of hundreds of individual 'polyps'. Like bryozoans, they feed by filtering small food particles from the water column.

Phylum Crustacea

Crustaceans: The crustaceans represent one of the sea's most diverse groups of organisms, well known examples include shrimps, crabs and lobsters. Most crustaceans are motile (capable of movement) although there are also a variety of sessile species (e.g. barnacles). All crustaceans are protected by an external carapace, and most can be recognised by having two pairs of antennae.

Phylum Echinodermata

Echinoderms: This phylum contains a range of predominantly motile organisms – sea stars, brittle stars, sea urchins, sea cucumbers, sand dollars, feather stars and sea lilies. Echinoderms feed by filtering small food particles from the water column or by extracting food particles from sediment grains or rock surfaces.

Phylum Mollusca

Molluscs: The molluscs are a highly diverse group of marine animals characterised by the presence of an external or internal shell. This phyla includes the bivalves (organisms with hinged shells e.g. mussels, oysters, etc), gastropods (marine snails, e.g. winkles, limpets, topshells), chitons, sea slugs and sea hares, as well as the cephalopods (squid, cuttlefish and octopus).

Phylum Phycophyta

Algae: These are the marine plants. Several types were encountered during our survey. Large *macroalgae* were sampled that live attached to submerged natural and artificial surfaces including rocks, pilings, ropes and the shells or carapaces of other species. These include the green algae (Ulvophyceae), red algae (Rhodophyceae) and brown algae (Phaecophyceae). We also encountered microscopic algal species called *dinoflagellates* (phylum Pyrrophycophyta), single-celled algae that live in the water column or within the sediments.

Phylum Porifera

Sponges: Sponges are very simple colonial organisms that live attached to submerged natural and artificial surfaces including rocks, pilings, ropes and the shells or carapaces of other species. They vary greatly in colour and shape, and include sheet-like encrusting forms, branching forms and tubular forms. Sponge surfaces have thousands of small pores to through which water is drawn into the colony, where small food particles are filtered out before the water is again expelled through one or several other holes.

Phylum Pyrrophycophyta

Dinoflagellates: Dinoflagellates are a large group of unicellular algae common in marine plankton. About half of all dinoflagellates are capable of photosynthesis and some are symbionts, living inside organisms such as jellyfish and corals. Some dinoflagellates are phosphorescent and can be responsible for the phosphorescence visible at night in the sea. The phenomenon known as red tide occurs when the rapid reproduction of certain dinoflagellate species results in large brownish red algal blooms. Some dinoflagellates are highly toxic and can kill fish and shellfish, or poison humans that eat these infected organisms.

Phylum Urochordata

Ascidians: This group of organisms is sometimes referred to as ‘sea squirts’. Adult ascidians are sessile (permanently attached to the substrate) organisms that live on submerged natural and artificial surfaces including rocks, pilings, ropes and the shells or carapaces of other species. Ascidians can occur as individuals (solitary ascidians) or merged together into colonies (colonial ascidians). They are soft-bodied and have a rubbery or jelly-like outer coating (test). They feed by pumping water into the body through an inhalant siphon. Inside the body, food particles are filtered out of the water, which is then expelled through an exhalant siphon. Ascidians reproduce via swimming larvae (ascidian tadpoles) that retain a notochord, which explains why these animals are included in the phylum Chordata along with vertebrates.

Phylum Vertebrata

Fishes: Fishes are an extremely diverse group of the verterbrates familiar to most people. Approximately 200 families of fish are represented in New Zealand waters ranging from tropical and subtropical groups in the north to subantarctic groups in the south. Fishes can be classified according to their depth preferences. Fish that live on or near the sea floor are considered demersal while those living in the upper water column are termed pelagics.

Appendix 3: List of Chapman and Carlton's (1994) nine criteria (C1 – C9) for assigning non-indigenous species status that were met by the non-indigenous species sampled in the Opua Marina.

Criteria that apply to each species are indicated by (+). Cranfield *et al*'s (1998) analysis was used for species previously known from New Zealand waters. For non-indigenous species that were first detected during the present study, criteria were assigned using advice from the taxonomists that identified them. Refer to footnote for a full description of C1 – C9.

Phylum and species	C1	C2	C3	C4	C5	C6	C7	C8	C9
Annelida									
Polydora cornuta	+	+	+		+	+		+	
Bryozoa									
Bugula flabellata	+	+	+		+	+	+	+	+
Bugula neritina	+				+	+	+	+	+
Watersipora subtorquata	+	+	+		+	+	+	+	+
Cnidaria									
Obelia longissima	+	+	+						+
Crustacea									
Apocorophium acutum			+			+		+	+
Mollusca									
Musculista senhousia	+	+	+			+	+	+	+
Crassostrea gigas	+	+	+			+	+	+	+
Limaria orientalis	+	+	+			+	+	+	+
Theora lubrica	+	+			+	+	+	+	+
Polycera hedgpethi	+	+	+	+		+			
Phycophyta									
Polysiphonia sertularioides	+	+				+	+	+	+

Criterion 1: Has the species suddenly appeared locally where it has not been found before?
Criterion 2: Has the species spread subsequently?
Criterion 3: Is the species' distribution associated with human mechanisms of dispersal?
Criterion 4: Is the species associated with, or dependent on, other introduced species?
Criterion 5: Is the species prevalent in, or restricted to, new or artificial environments?
Criterion 6: Is the species' distribution restricted compared to natives?
Criterion 7: Does the species have a disjunct worldwide distribution?
Criterion 8: Are dispersal mechanisms of the species inadequate to reach New Zealand, and is passive dispersal in ocean currents unlikely to bridge ocean gaps to reach New Zealand?
Criterion 9: Is the species isolated from the genetically and morphologically most similar species elsewhere in the world?

Appendix 4. Geographic locations of the sample sites in Opua Marina

Site	Eastings	Northings	NZ Latitude	NZ Longitude	Survey Method	No. of sample units
BETWEEN B – C	2612791	6653320	-35.31682	174.12156	BSLD	1
BETWEEN C – D	2612708	6653279	-35.31720	174.12065	BSLD	1
BETWEEN CUSTOMS – B	2612816	6653389	-35.31619	174.12182	BSLD	1
BETWEEN D – E	2612668	6653233	-35.31762	174.12022	BSLD	1
BETWEEN E – F	2612691	6653143	-35.31842	174.12049	BSLD	1
C3	2612674	6653327	-35.31677	174.12027	BGRB	3
C3	2612729	6653358	-35.31648	174.12087	CRBTP	3
C3	2612688	6653322	-35.31681	174.12043	CYST	2
C3	2612749	6653358	-35.31648	174.12109	FSHTP	2
C3	2612674	6653327	-35.31677	174.12027	PSC	12
C3	2612726	6653356	-35.31650	174.12083	SHRTP	2
C3	2612726	6653356	-35.31650	174.12083	STFTP	2
C37	2612805	6653265	-35.31731	174.12172	CYST	2
CUSTOMS END OF QUARANTINE	2612908	6653435	-35.31576	174.12283	BSLD	1
D44	2612801	6653299	-35.31700	174.12167	BGRB	3
D44	2612619	6653302	-35.31700	174.11967	CRBTP	3
D44	2612760	6653228	-35.31765	174.12123	CYST	2
D44	261781	6653299	-32.61376	150.40893	FSHTP	2
D44	2612760	6653228	-35.31765	174.12123	PSC	12
D44	2612801	6653299	-35.31700	174.12167	SHRTP	2
D44	2612801	6653299	-35.31700	174.12167	STFTP	2
END OF B – C	2612862	6653290	-35.31708	174.12234	BSLD	1
END OF D – F	2612803	6653137	-35.31846	174.12172	BSLD	1
F END OF QUARANTINE	2612709	6653021	-35.31952	174.12070	BSLD	1
F20	2612679	6653123	-35.31861	174.12036	BGRB	3
F20	2612739	6653204	-35.31787	174.12100	CRBTP	3
F20	2612674	6653129	-35.31855	174.12030	CYST	2
F20	2612759	6653204	-35.31786	174.12122	FSHTP	2
F20	2612679	6653123	-35.31861	174.12036	PSC	8
F20	2612739	6653208	-35.31783	174.12100	SHRTP	2
F20	2612739	6653208	-35.31783	174.12100	STFTP	2
OUTSIDE OF F	2612624	6653108	-35.31875	174.11975	BSLD	1
QUARANTINE	2612896	6653409	-35.31600	174.12270	BGRB	3
QUARANTINE	2612888	6653400	-35.31608	174.12262	CRBTP	3
QUARANTINE	2612868	6653400	-35.31609	174.12239	FSHTP	2
QUARANTINE	2612896	6653409	-35.31600	174.12270	PSC	14
QUARANTINE	2612879	6653465	-35.31550	174.12250	SHRTP	2
QUARANTINE	2612879	6653465	-35.31550	174.12250	STFTP	2

*Survey methods: PSC = pile scrape, BSLD = benthic sled, BGRB = benthic grab, CYST = dinoflagellate cyst core, CRBTP = crab trap, FSHTP = fish trap, STFTP = starfish trap, SHRTP = shrimp trap.

Appendix 5a. Results from the diver collections and pile scrapings

					Site code	C3												D44												F20							
					Pile replicate	1			2			3			4			1			2			3			4			1		2		3		4	
Class	Orders	Family	Genus	Species	*Status																																
classes	orders	family	genus	species	status	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	1	2	1	2	1	2
Anthozoa	Actiniaria	Diadumenidae	*Diadumene*	*neozelandica*	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anthozoa	Actiniaria		*Acontiaira*	*sp.*	SI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anthozoa	Actiniaria		*Actiniaira*	*sp.*	SI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ascidiacea	Aplousobranchia	Polyclinidae	*Aplidium*	*adamsi*	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ascidiacea	Phlebobranchia	Rhodosomatidae	*Corella*	*eumyota*	C1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Ascidiacea	Stolidobranchia	Pyuridae	*Pyura*	*sp.*	C2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Ascidiacea	Stolidobranchia	Pyuridae	*Microcosmus*	*australis*	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ascidiacea	Stolidobranchia	Pyuridae	*Pyura*	*subuculata*	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ascidiacea	Stolidobranchia	Styelidae	*Asterocarpa*	*cerea*	C1	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1	0	1	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0
Ascidiacea	Stolidobranchia	Styelidae	*Styela*	*plicata*	C1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ascidiacea	Stolidobranchia	Styelidae	*Cnemidocarpa*	*otagoensis*	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bivalvia	Myoida	Hiatellidae	*Hiatella*	*arctica*	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bivalvia	Mytiloida	Mytilidae	*Perna*	*canaliculus*	N	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0
Bivalvia	Mytiloida	Mytilidae	*Mytilus*	*sp.*	C2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	0	0
Bivalvia	Mytiloida	Mytilidae	*Xenostrobus*	*pulex*	N	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	1	0	0	0	1
Bivalvia	Mytiloida	Mytilidae	*Modiolarca*	*impacta*	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bivalvia	Mytiloida	Mytilidae	*Musculista*	*senhousia*	A	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Bivalvia	Mytiloida	Mytilidae	*Xenostrobus*	*securis*	N	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bivalvia	Ostreoida	Anomiidae	*Pododesmus*	*zelandicus*	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bivalvia	Ostreoida	Ostreidae	*Crassostrea*	*gigas*	A	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	1	0	0	1	1	0	0	0	0	0	0	0	0
Bivalvia	Ostreoida	Ostreidae	*Ostrea*	*chilensis*	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bivalvia	Pterioida	Anomiidae	*Anomia*	*trigonopsis*	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bivalvia	Pterioida	Limidae	*Limaria*	*orientalis*	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Bivalvia	Pterioida	Pectinidae	*Talochlamys*	*zelandiae*	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bivalvia	Veneroida	Veneridae	*Irus*	*reflexus*	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	1	1	0	0	0	0	0	0	0	0
Cladophorophyceae	Cladophorales	Cladophoraceae	*Rhizoclonium*	*implexum*	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
Cladophorophyceae	Cladophorales	Cladophoraceae	*Chaetomorpha*	*sp.*	SI	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crustacea	Anomura	Porcellanidae	*Petrolisthes*	*novaezelandiae*	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crustacea	Brachyura	Hymenosomatidae	*Halicarcinus*	*varius*	N	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Crustacea	Brachyura	Hymenosomatidae	*Halicarcinus*	*cookii*	N	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Crustacea	Brachyura	Hymenosomatidae	*Neohymenicus*	*pubescens*	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crustacea	Brachyura	Majidae	*Notomithrax*	*minor*	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crustacea	Brachyura	Pinnotheridae	*Pinnotheres*	*atrinocola*	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crustacea	Brachyura	Xanthidae	*Pilumnopeus*	*serratifrons*	C1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crustacea	Caridea	Palemonidae	*Periclimenes*	*yaldwyni*	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crustacea	Thoracica	Balanidae	*Austrominius*	*modestus*	N	1	1	1	1	0	1	1	1	1	1	1	0	0	0	0	1	0	0	0	1	0	1	1	0	1	1	1	1	1	1	1	1
Crustacea	Thoracica	Balanidae	*Balanus*	*trigonus*	C1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	1	1	0	1	0	1	1	0	0	0	0	0	0	0	0
Demospongiae	Haplosclerida	Chalinidae	*Haliclona*	*cf. punctata*	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Demospongiae	Haplosclerida	Chalinidae	*Adocia*	*cf. parietalioides*	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Demospongiae	Haplosclerida	Chalinidae	*Adocia*	*cf. venustina*	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gastropoda	Littorinimorpha	Calyptraeidae	*Maoricrypta*	*costata*	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gastropoda	Littorinimorpha	Calyptraeidae	*Sigapatella*	*tenuis*	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gastropoda	Notaspidea	Pleurobranchidae	*Pleurobranchaea*	*maculata*	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gastropoda	Nudibranchia	Polyceridae	*Polycera*	*hedgpathi*	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gymnolaemata	Cheilostomata	Bugulidae	*Bugula*	*neritina*	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gymnolaemata	Cheilostomata	Bugulidae	*Bugula*	*flabellata*	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gymnolaemata	Cheilostomata	Candidae	*Caberea*	*rostrata*	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gymnolaemata	Cheilostomata	Watersiporidae	*Watersipora*	*subtorquata*	A	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Hydrozoa	Hydroida	Bougainvilliidae	*Bougainvillia*	*muscus*	C1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrozoa	Hydroida	Campanulariidae	*Clytia*	*hemisphaerica*	C1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrozoa	Hydroida	Campanulariidae	*Obelia*	*longissima*	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrozoa	Hydroida	Campanulinidae	*Phialella*	*quadrata*	C1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrozoa	Hydroida	Tubulariidae	*Ectopleura?*	*sp.*	SI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Malacostraca	Amphipoda	Corophiidae	*Apocorophium*	*acutum*	A	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0

*Status: A = non-indigenous (highlighted by shading), C1 = cryptogenic category 1, C2 = cryptogenic category 2, N = native, SI = species indeterminata. See text for details.

Appendix 5a. Results from the diver collections and pile scrapings

					Site code	C3												D44												F20							
					Pile replicate	1			2			3			4			1			2			3			4			1		2		3		4	
Class	Orders	Family	Genus	Species	*Status																																
Phaeophyceae	Sphacelariales	Sphacelariaceae	*Sphacelaria*	*sp*	SI	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polychaeta	Eunicida	Dorvilleidae	*Dorvillea*	*australiensis*	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polychaeta	Eunicida	Lumbrineridae	*Lumbrineris*	*sphaerocephala*	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polychaeta	Phyllodocida	Hesionidae	*Ophiodromus*	*angustifrons*	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polychaeta	Phyllodocida	Nereididae	*Neanthes*	*kerguelensis*	N	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	1	0	0	1	1	0	1	1	0	0	0	0	0	0	0	0
Polychaeta	Phyllodocida	Nereididae	*Perinereis*	*vallata*	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polychaeta	Phyllodocida	Nereididae	*Platynereis*	*Platynereis_australis_group*	SI	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polychaeta	Phyllodocida	Phyllodocidae	*Mystides*	*Mystides-B*	SI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polychaeta	Phyllodocida	Phyllodocidae	*Phyllodocidae-unknown*	*Phyllodocidae-01*	SI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polychaeta	Phyllodocida	Polynoidae	*Harmothoe*	*macrolepidota*	N	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Polychaeta	Phyllodocida	Polynoidae	*Lepidonotus*	*polychromus*	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0
Polychaeta	Sabellida	Sabellidae	*Branchiomma*	*Branchiomma-A*	SI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polychaeta	Sabellida	Sabellidae	*Megalomma*	*suspiciens*	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Polychaeta	Scolecida	Opheliidae	*Armandia*	*maculata*	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Polychaeta	Scolecida	Orbiniidae	*Orbiniidae*	*Indet*	SI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Polychaeta	Spionida	Spionidae	*Polydora*	*cornuta*	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Polychaeta	Terebellida	Cirratulidae	*Protocirrineris*	*nuchalis*	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polychaeta	Terebellida	Flabelligeridae	*Flabelligera*	*affinis*	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polychaeta	Terebellida	Terebellidae	*Pseudopista*	*rostrata*	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Polychaeta	Terebellida	Terebellidae	*Streblosoma*	*toddae*	N	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polychaeta	Terebellida	Terebellidae	*Nicolea*	*armilla*	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polychaeta	Terebellida	Terebellidae	*Terebellidae*	*Indet*	SI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhodophyceae	Ceramiales	Rhodomelaceae	*Polysiphonia*	*sertularioides*	A	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhodophyceae	Ceramiales	Rhodomelaceae	*Polysiphonia*	*sp.*	SI	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhodophyceae	Plocamiales	Plocamiaceae	*Plocamium*	*sp.*	SI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Ulvophyceae	Ulvales	Ulvaceae	*Enteromorpha*	*sp.*	SI	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0

*Status: A = non-indigenous (highlighted by shading), C1 = cryptogenic category 1, C2 = cryptogenic category 2, N = native, SI = species indeterminata. See text for details.

Appendix 5a. Results from the diver collections and pile scrapings

					Site code	QUARANTINE													
					Pile replicate	1			2				3			4			
Class	Orders	Family	Genus	Species	*Status														
classes	orders	family	genus	species	status	1	2	3	1	2	3	4	1	2	3	1	2	3	4
Anthozoa	Actiniaria	Diadumenidae	*Diadumene*	*neozelandica*	N	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Anthozoa	Actiniaria		*Acontiaira*	*sp.*	SI	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Anthozoa	Actiniaria		*Actiniaira*	*sp.*	SI	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Ascidiacea	Aplousobranchia	Polyclinidae	*Aplidium*	*adamsi*	N	1	0	0	0	1	1	0	0	0	0	0	1	0	1
Ascidiacea	Phlebobranchia	Rhodosomatidae	*Corella*	*eumyota*	C1	1	0	1	0	1	0	1	1	1	1	0	0	1	0
Ascidiacea	Stolidobranchia	Pyuridae	*Pyura*	*sp.*	C2	1	0	0	0	1	0	0	0	0	0	0	1	0	0
Ascidiacea	Stolidobranchia	Pyuridae	*Microcosmus*	*australis*	N	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Ascidiacea	Stolidobranchia	Pyuridae	*Pyura*	*subuculata*	N	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Ascidiacea	Stolidobranchia	Styelidae	*Asterocarpa*	*cerea*	C1	1	1	1	0	1	1	1	0	1	1	0	1	1	1
Ascidiacea	Stolidobranchia	Styelidae	*Styela*	*plicata*	C1	0	0	1	0	0	0	0	0	0	0	0	1	0	1
Ascidiacea	Stolidobranchia	Styelidae	*Cnemidocarpa*	*otagoensis*	N	0	1	0	0	0	0	0	0	0	0	0	0	1	0
Bivalvia	Myoida	Hiatellidae	*Hiatella*	*arctica*	N	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Bivalvia	Mytiloida	Mytilidae	*Perna*	*canaliculus*	N	1	1	1	0	1	0	0	0	1	1	0	1	0	0
Bivalvia	Mytiloida	Mytilidae	*Mytilus*	*sp.*	C2	0	1	0	0	1	1	0	0	1	0	1	1	0	0
Bivalvia	Mytiloida	Mytilidae	*Xenostrobus*	*pulex*	N	0	0	0	1	0	0	0	0	0	0	1	0	0	0
Bivalvia	Mytiloida	Mytilidae	*Modiolarca*	*impacta*	N	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Bivalvia	Mytiloida	Mytilidae	*Musculista*	*senhousia*	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bivalvia	Mytiloida	Mytilidae	*Xenostrobus*	*securis*	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bivalvia	Ostreoida	Anomiidae	*Pododesmus*	*zelandicus*	N	0	1	1	0	0	0	1	0	1	0	0	0	0	0
Bivalvia	Ostreoida	Ostreidae	*Crassostrea*	*gigas*	A	1	1	1	0	0	0	0	1	1	0	0	0	1	1
Bivalvia	Ostreoida	Ostreidae	*Ostrea*	*chilensis*	N	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Bivalvia	Pterioida	Anomiidae	*Anomia*	*trigonopsis*	N	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Bivalvia	Pterioida	Limidae	*Limaria*	*orientalis*	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bivalvia	Pterioida	Pectinidae	*Talochlamys*	*zelandiae*	N	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Bivalvia	Veneroida	Veneridae	*Irus*	*reflexus*	N	0	0	1	0	0	1	0	0	0	1	0	1	0	0
Cladophorophyceae	Cladophorales	Cladophoraceae	*Rhizoclonium*	*implexum*	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cladophorophyceae	Cladophorales	Cladophoraceae	*Chaetomorpha*	*sp.*	SI	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crustacea	Anomura	Porcellanidae	*Petrolisthes*	*novaezelandiae*	N	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Crustacea	Brachyura	Hymenosomatidae	*Halicarcinus*	*varius*	N	0	1	1	1	1	0	1	1	0	1	0	0	0	1
Crustacea	Brachyura	Hymenosomatidae	*Halicarcinus*	*cookii*	N	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Crustacea	Brachyura	Hymenosomatidae	*Neohymenicus*	*pubescens*	N	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Crustacea	Brachyura	Majidae	*Notomithrax*	*minor*	N	0	1	1	0	1	0	0	0	1	1	0	0	0	1
Crustacea	Brachyura	Pinnotheridae	*Pinnotheres*	*atrinocola*	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crustacea	Brachyura	Xanthidae	*Pilumnopeus*	*serratifrons*	C1	1	1	1	0	0	1	0	0	0	0	0	1	0	1
Crustacea	Caridea	Palemonidae	*Periclimenes*	*yaldwyni*	N	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Crustacea	Thoracica	Balanidae	*Austrominius*	*modestus*	N	0	0	0	1	0	0	0	1	0	0	1	0	0	0
Crustacea	Thoracica	Balanidae	*Balanus*	*trigonus*	C1	1	1	1	0	1	0	1	1	1	1	0	1	0	1
Demospongiae	Haplosclerida	Chalinidae	*Haliclona*	*cf. punctata*	N	0	1	0	0	0	0	0	0	0	1	0	0	0	0
Demospongiae	Haplosclerida	Chalinidae	*Adocia*	*cf. parietalioides*	N	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Demospongiae	Haplosclerida	Chalinidae	*Adocia*	*cf. venustina*	N	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Gastropoda	Littorinimorpha	Calyptraeidae	*Maoricrypta*	*costata*	N	0	0	1	1	0	0	0	0	1	0	0	0	0	0
Gastropoda	Littorinimorpha	Calyptraeidae	*Sigapatella*	*tenuis*	N	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Gastropoda	Notaspidea	Pleurobranchidae	*Pleurobranchaea*	*maculata*	N	0	1	1	0	0	0	0	0	0	1	0	1	0	1
Gastropoda	Nudibranchia	Polyceridae	*Polycera*	*hedgpathi*	A	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Gymnolaemata	Cheilostomata	Bugulidae	*Bugula*	*neritina*	A	0	1	1	0	1	1	0	1	1	1	0	0	1	1
Gymnolaemata	Cheilostomata	Bugulidae	*Bugula*	*flabellata*	A	0	0	1	0	0	1	1	0	0	1	0	0	1	1
Gymnolaemata	Cheilostomata	Candidae	*Caberea*	*rostrata*	N	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Gymnolaemata	Cheilostomata	Watersiporidae	*Watersipora*	*subtorquata*	A	1	0	0	1	1	1	0	1	1	0	0	1	1	0
Hydrozoa	Hydroida	Bougainvilliidae	*Bougainvillia*	*muscus*	C1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Hydrozoa	Hydroida	Campanulariidae	*Clytia*	*hemisphaerica*	C1	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Hydrozoa	Hydroida	Campanulariidae	*Obelia*	*longissima*	A	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Hydrozoa	Hydroida	Campanulinidae	*Phialella*	*quadrata*	C1	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Hydrozoa	Hydroida	Tubulariidae	*Ectopleura?*	*sp.*	SI	1	0	0	0	0	1	0	0	0	0	0	0	0	1
Malacostraca	Amphipoda	Corophiidae	*Apocorophium*	*acutum*	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0

*Status: A = non-indigenous (highlighted by shading), C1 = cryptogenic category 1, C2 = cryptogenic category 2, N = native, SI = species indeterminata. See text for details.

Appendix 5a. Results from the diver collections and pile scrapings

					Site code	QUARANTINE													
					Pile replicate	1			2				3			4			
Class	Orders	Family	Genus	Species	*Status														
Phaeophyceae	Sphacelariales	Sphacelariaceae	*Sphacelaria*	*sp*	SI	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polychaeta	Eunicida	Dorvilleidae	*Dorvillea*	*australiensis*	N	0	1	0	0	0	0	0	0	1	0	0	0	0	0
Polychaeta	Eunicida	Lumbrineridae	*Lumbrineris*	*sphaerocephala*	N	0	0	1	0	0	0	0	0	0	1	0	0	0	0
Polychaeta	Phyllodocida	Hesionidae	*Ophiodromus*	*angustifrons*	N	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Polychaeta	Phyllodocida	Nereididae	*Neanthes*	*kerguelensis*	N	1	0	1	0	1	1	1	1	1	1	1	1	1	0
Polychaeta	Phyllodocida	Nereididae	*Perinereis*	*vallata*	N	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Polychaeta	Phyllodocida	Nereididae	*Platynereis*	*Platynereis_australis_group*	SI	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polychaeta	Phyllodocida	Phyllodocidae	*Mystides*	*Mystides-B*	SI	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Polychaeta	Phyllodocida	Phyllodocidae	*Phyllodocidae-unknown*	*Phyllodocidae-01*	SI	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Polychaeta	Phyllodocida	Polynoidae	*Harmothoe*	*macrolepidota*	N	0	1	0	0	0	0	1	1	1	1	0	1	0	1
Polychaeta	Phyllodocida	Polynoidae	*Lepidonotus*	*polychromus*	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polychaeta	Sabellida	Sabellidae	*Branchiomma*	*Branchiomma-A*	SI	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Polychaeta	Sabellida	Sabellidae	*Megalomma*	*suspiciens*	N	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Polychaeta	Scolecida	Opheliidae	*Armandia*	*maculata*	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polychaeta	Scolecida	Orbiniidae	*Orbiniidae*	*Indet*	SI	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polychaeta	Spionida	Spionidae	*Polydora*	*cornuta*	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polychaeta	Terebellida	Cirratulidae	*Protocirrineris*	*nuchalis*	N	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Polychaeta	Terebellida	Flabelligeridae	*Flabelligera*	*affinis*	N	0	0	0	0	0	1	0	0	0	1	0	0	0	1
Polychaeta	Terebellida	Terebellidae	*Pseudopista*	*rostrata*	N	1	1	1	0	0	0	0	0	1	1	0	1	0	0
Polychaeta	Terebellida	Terebellidae	*Streblosoma*	*toddae*	N	0	1	1	0	0	0	0	1	1	1	0	1	0	1
Polychaeta	Terebellida	Terebellidae	*Nicolea*	*armilla*	N	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Polychaeta	Terebellida	Terebellidae	*Terebellidae*	*Indet*	SI	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhodophyceae	Ceramiales	Rhodomelaceae	*Polysiphonia*	*sertularioides*	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhodophyceae	Ceramiales	Rhodomelaceae	*Polysiphonia*	*sp.*	SI	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhodophyceae	Plocamiales	Plocamiaceae	*Plocamium*	*sp.*	SI	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ulvophyceae	Ulvales	Ulvaceae	*Enteromorpha*	*sp.*	SI	0	0	0	0	0	0	0	0	0	0	0	0	0	0

*Status: A = non-indigenous (highlighted by shading), C1 = cryptogenic category 1, C2 = cryptogenic category 2, N = native, SI = species indeterminata. See text for details.

Appendix 5b. Results from the benthic grab samples.

					Berth code	C3			D44			F20			QUARANTINE		
Class	Order	Family	Genus	Species	*Status	1	2	3	1	2	3	1	2	3	1	2	3
Ascidiacea	Stolidobranchia	Styelidae	*Asterocarpa*	*cerea*	C1	0	0	0	0	0	0	0	0	1	0	0	0
Bivalvia	Mytiloida	Mytilidae	*Musculista*	*senhousia*	A	0	0	0	1	0	0	0	0	0	0	0	0
Bivalvia	Mytiloida	Mytilidae	*Mytilus*	*sp.*	C2	0	0	0	1	0	0	0	0	0	0	0	0
Bivalvia	Veneroida	Mactridae	*Zenatia*	*acinaces*	N	1	0	0	0	0	0	0	0	0	0	0	0
Bivalvia	Veneroida	Semelidae	*Theora*	*lubrica*	A	1	1	1	0	1	1	0	0	0	1	1	1
Gastropoda	Cephalaspidea	Philinidae	*Philine*	*auriformis*	N	1	1	1	0	0	0	0	1	0	1	1	0
Malacostraca	Isopoda	Cirolanidae	*Natatolana*	*narica*	N	0	0	0	1	1	0	0	0	0	0	0	0
Polychaeta	Eunicida	Lumbrineridae	*Abyssoninoe*	*galatheae*	N	0	1	1	0	0	1	0	1	1	1	0	0
Polychaeta	Eunicida	Onuphidae	*Onuphis*	*aucklandensis*	N	0	0	1	1	0	0	0	0	1	0	1	0
Polychaeta	Phyllodocida	Glyceridae	*Glycera*	*Indet*	SI	0	1	0	0	0	0	0	0	0	0	0	0
Polychaeta	Phyllodocida	Glyceridae	*Glycera*	*lamelliformis*	N	0	0	0	0	0	1	0	0	0	0	0	0
Polychaeta	Phyllodocida	Sigalionidae	*Labiosthenolepis*	*laevis*	N	1	1	1	1	1	0	0	0	1	1	0	0
Polychaeta	Scolecida	Orbiniidae	*Phylo*	*novazealandiae*	N	0	1	0	1	1	1	0	0	0	0	0	0
Polychaeta	Scolecida	Orbiniidae	*Orbiniidae*	*Indet*	SI	0	0	1	0	0	0	0	0	0	0	0	0
Polychaeta	Spionida	Spionidae	*Paraprionospio*	*Paraprionospio-A [pinnata]*	SI	0	1	0	1	0	0	0	0	0	0	0	0
Polychaeta	Terebellida	Cirratulidae	*Protocirrineris*	*nuchalis*	N	0	0	1	0	0	0	0	0	0	0	0	0
Polychaeta	Terebellida	Terebellidae	*Amaeana*	*antipoda*	N	1	1	0	0	1	0	0	0	0	0	0	0

*Status: A = non-indigenous (highlighted by shading), N = native, C1 = cryptogenic category 1, C2 = cryptogenic category 2, SI = species indeterminata. See text for details.

Appendix 5c. Results from the benthic sled samples.

					Site code	BETWEEN B - C	BETWEEN C - D	BETWEEN CUSTOMS - B	BETWEEN D - E
Class	Order	Family	Genus	Species	*Status	1	1	1	1
Actinopterygii	Perciformes	Gobiidae	*Favonigobius*	*lentigenosus*	N	0	0	0	0
Actinopterygii	Pleuronectiformes	Pleuronectidae	*Peltorhamphus*	*latus*	N	0	0	1	0
Bivalvia	Mytiloida	Mytilidae	*Perna*	*canaliculus*	N	0	0	0	0
Bivalvia	Ostreoida	Ostreidae	*Crassostrea*	*gigas*	A	0	0	0	0
Bivalvia	Veneroida	Mactridae	*Zenatia*	*acinaces*	N	0	0	0	0
Bivalvia	Veneroida	Semelidae	*Theora*	*lubrica*	A	1	1	1	1
Bivalvia	Veneroida	Veneridae	*Dosinia*	*lambata*	N	0	0	0	0
Crustacea	Brachyura	Hymenosomatidae	*Halicarcinus*	*cookii*	N	0	0	0	1
Crustacea	Brachyura	Ocypodidae	*Macrophthalmus*	*hirtipes*	N	0	0	0	0
Crustacea	Caridea	Crangonidae	*Pontophilus*	*australis*	N	0	1	1	0
Crustacea	Caridea	Palemonidae	*Periclimenes*	*yaldwyni*	N	0	0	0	0
Echinoidea	Spatangoida	Loveniidae	*Echinocardium*	*cordatum*	N	0	0	1	0
Gastropoda	Cephalaspidea	Philinidae	*Philine*	*auriformis*	N	1	1	1	1
Gastropoda	Littorinimorpha	Struthiolariidae	*Struthiolaria*	*papulosa*	N	0	0	0	0
Malacostraca	Amphipoda	Phoxocephalidae	*Torridoharpinia*	*hurleyi*	N	0	0	1	0
Malacostraca	Isopoda	Cirolanidae	*Natatolana*	*narica*	N	0	0	0	0
Polychaeta	Eunicida	Lumbrineridae	*Abyssoninoe*	*galatheae*	N	1	0	1	1
Polychaeta	Eunicida	Onuphidae	*Onuphis*	*aucklandensis*	N	0	0	0	0
Polychaeta	Phyllodocida	Glyceridae	*Glycera*	*lamelliformis*	N	0	0	0	1
Polychaeta	Phyllodocida	Sigalionidae	*Labiosthenolepis*	*laevis*	N	1	1	1	1
Polychaeta	Scolecida	Maldanidae	*Asychis*	*Asychis-B*	SI	0	0	0	0
Polychaeta	Scolecida	Orbiniidae	*Phylo*	*novazealandiae*	N	0	0	0	0
Polychaeta	Spionida	Spionidae	*Paraprionospio*	*Paraprionospio-A [pinnata]*	SI	1	0	0	0
Polychaeta	Terebellida	Pectinariidae	*Pectinaria*	*australis*	N	0	0	0	0
Polychaeta	Terebellida	Terebellidae	*Amaeana*	*antipoda*	N	1	0	0	0
Polychaeta	Terebellida	Trichobranchidae	*Terebellides*	*Indet*	SI	0	0	0	0

*Status: A = non-indigenous (highlighted by shading), N = native, C! = cryptogenic category 1, C2 = cryptogenic category 2, SI = species indeterminata. See text for details.

Appendix 5c. Results from the benthic sled samples.

					Site code	BETWEEN E - F	CUSTOMS	END OF QUARANTINE	END OF B - C	END OF D - F
Class	Order	Family	Genus	Species	*Status		1	1	1	1
Actinopterygii	Perciformes	Gobiidae	*Favonigobius*	*lentigenosus*	N		0	0	0	0
Actinopterygii	Pleuronectiformes	Pleuronectidae	*Peltorhamphus*	*latus*	N		1	1	1	0
Bivalvia	Mytiloida	Mytilidae	*Perna*	*canaliculus*	N		0	0	1	0
Bivalvia	Ostreoida	Ostreidae	*Crassostrea*	*gigas*	A		0	0	1	0
Bivalvia	Veneroida	Mactridae	*Zenatia*	*acinaces*	N		0	0	0	0
Bivalvia	Veneroida	Semelidae	*Theora*	*lubrica*	A		1	1	1	1
Bivalvia	Veneroida	Veneridae	*Dosinia*	*lambata*	N		0	0	1	0
Crustacea	Brachyura	Hymenosomatidae	*Halicarcinus*	*cookii*	N		0	0	0	0
Crustacea	Brachyura	Ocypodidae	*Macrophthalmus*	*hirtipes*	N		0	0	0	0
Crustacea	Caridea	Crangonidae	*Pontophilus*	*australis*	N		1	1	0	0
Crustacea	Caridea	Palemonidae	*Periclimenes*	*yaldwyni*	N		1	0	0	0
Echinoidea	Spatangoida	Loveniidae	*Echinocardium*	*cordatum*	N		0	0	1	0
Gastropoda	Cephalaspidea	Philinidae	*Philine*	*auriformis*	N		1	1	1	1
Gastropoda	Littorinimorpha	Struthiolariidae	*Struthiolaria*	*papulosa*	N		0	0	1	0
Malacostraca	Amphipoda	Phoxocephalidae	*Torridoharpinia*	*hurleyi*	N		0	0	0	0
Malacostraca	Isopoda	Cirolanidae	*Natatolana*	*narica*	N		0	1	0	0
Polychaeta	Eunicida	Lumbrineridae	*Abyssoninoe*	*galatheae*	N		1	0	1	0
Polychaeta	Eunicida	Onuphidae	*Onuphis*	*aucklandensis*	N		0	0	1	0
Polychaeta	Phyllodocida	Glyceridae	*Glycera*	*lamelliformis*	N		0	1	0	0
Polychaeta	Phyllodocida	Sigalionidae	*Labiosthenolepis*	*laevis*	N		1	1	1	1
Polychaeta	Scolecida	Maldanidae	*Asychis*	*Asychis-B*	SI		0	0	0	0
Polychaeta	Scolecida	Orbiniidae	*Phylo*	*novazealandiae*	N		0	0	0	1
Polychaeta	Spionida	Spionidae	*Paraprionospio*	*Paraprionospio-A [pinnata]*	SI		0	0	0	0
Polychaeta	Terebellida	Pectinariidae	*Pectinaria*	*australis*	N		0	0	0	0
Polychaeta	Terebellida	Terebellidae	*Amaeana*	*antipoda*	N		0	0	0	1
Polychaeta	Terebellida	Trichobranchidae	*Terebellides*	*Indet*	SI		1	0	0	0

*Status: A = non-indigenous (highlighted by shading), N = native, C! = cryptogenic category 1, C2 = cryptogenic category 2, SI = species indeterminata. See text for details.

Appendix 5c. Results from the benthic sled samples.

					Site code	F END OF QUARANTINE	OUTSIDE OF F
Class	Order	Family	Genus	Species	*Status	1	1
Actinopterygii	Perciformes	Gobiidae	*Favonigobius*	*lentigenosus*	N	1	0
Actinopterygii	Pleuronectiformes	Pleuronectidae	*Peltorhamphus*	*latus*	N	0	0
Bivalvia	Mytiloida	Mytilidae	*Perna*	*canaliculus*	N	0	0
Bivalvia	Ostreoida	Ostreidae	*Crassostrea*	*gigas*	A	0	0
Bivalvia	Veneroida	Mactridae	*Zenatia*	*acinaces*	N	0	1
Bivalvia	Veneroida	Semelidae	*Theora*	*lubrica*	A	1	1
Bivalvia	Veneroida	Veneridae	*Dosinia*	*lambata*	N	0	0
Crustacea	Brachyura	Hymenosomatidae	*Halicarcinus*	*cookii*	N	0	0
Crustacea	Brachyura	Ocypodidae	*Macrophthalmus*	*hirtipes*	N	1	0
Crustacea	Caridea	Crangonidae	*Pontophilus*	*australis*	N	1	1
Crustacea	Caridea	Palemonidae	*Periclimenes*	*yaldwyni*	N	0	0
Echinoidea	Spatangoida	Loveniidae	*Echinocardium*	*cordatum*	N	0	0
Gastropoda	Cephalaspidea	Philinidae	*Philine*	*auriformis*	N	1	1
Gastropoda	Littorinimorpha	Struthiolariidae	*Struthiolaria*	*papulosa*	N	0	0
Malacostraca	Amphipoda	Phoxocephalidae	*Torridoharpinia*	*hurleyi*	N	0	0
Malacostraca	Isopoda	Cirolanidae	*Natatolana*	*narica*	N	0	1
Polychaeta	Eunicida	Lumbrineridae	*Abyssoninoe*	*galatheae*	N	0	0
Polychaeta	Eunicida	Onuphidae	*Onuphis*	*aucklandensis*	N	0	0
Polychaeta	Phyllodocida	Glyceridae	*Glycera*	*lamelliformis*	N	0	0
Polychaeta	Phyllodocida	Sigalionidae	*Labiosthenolepis*	*laevis*	N	1	1
Polychaeta	Scolecida	Maldanidae	*Asychis*	*Asychis-B*	SI	1	1
Polychaeta	Scolecida	Orbiniidae	*Phylo*	*novazealandiae*	N	0	0
Polychaeta	Spionida	Spionidae	*Paraprionospio*	*Paraprionospio-A [pinnata]*	SI	0	0
Polychaeta	Terebellida	Pectinariidae	*Pectinaria*	*australis*	N	1	0
Polychaeta	Terebellida	Terebellidae	*Amaeana*	*antipoda*	N	0	0
Polychaeta	Terebellida	Trichobranchidae	*Terebellides*	*Indet*	SI	0	0

*Status: A = non-indigenous (highlighted by shading), N = native, C! = cryptogenic category 1, C2 = cryptogenic category 2, SI = species indeterminata. See text for details.

Appendix 5d. Results from the dinoflagellate cyst core samples.

					Berth code	C3		C37		D44		F20	
Class	Order	Family	Genus	Species	*Status	1	2	1	2	1	2	1	2
Dinophyceae	Gymnodiniales	Gymnodiniacea	*Gymnodinium*	*catenatum*	C1	1	0	0	1	0	1	1	0
Dinophyceae	Peridiniales	Gonyaulacaceae	*Gonyaulax*	*spinifera*	N	0	1	0	0	0	0	0	0
Dinophyceae	Peridiniales	Peridiniaceae	*Protoperidinium*	*sp.*	N	0	1	0	1	1	0	0	1
Dinophyceae	Peridiniales	Peridiniaceae	*Protoperidinium conicum*	*cf. conicoides*	N	0	1	1	0	0	0	0	1
Dinophyceae	Peridiniales	Peridiniaceae	*Scrippsiella*	*trochoidea*	N	1	0	0	0	0	1	1	0

*Status: A = non-indigenous (highlighted by shading), N = native, C1 = cryptogenic category 1, C2 = cryptogenic category 2, SI = species indeterminata. See text for details.

Appendix 5e. Results from the fish trap samples.

					Berth code	C3		D44		F20		QUARANTINE	
					Line No.	1							
Class	Order	Family	Genus	Species	*Status	1	2	1	2	1	2	1	2
Actinopterygii	Mugiliformes	Mugilidae	*Aldrichetta*	*forsteri*	N	1	1	1	0	1	1	0	0
Actinopterygii	Perciformes	Arripidae	*Arripis*	*trutta*	N	0	0	1	0	0	0	0	0
Actinopterygii	Perciformes	Labridae	*Notolabrus*	*celidotus*	N	0	1	1	0	0	1	1	1
Actinopterygii	Perciformes	Sparidae	*Pagrus*	*auratus*	N	0	0	0	0	1	1	0	1

*Status: A = non-indigenous (highlighted by shading), N = native, C1 = cryptogenic category 1, C2 = cryptogenic category 2, SI = species indeterminata. See text for details.

Appendix 5f. Results from the crab trap samples.

				Berth code	C3			D44			F20			QUARANTINE		
				Line no.	1											
Class	Order	Family	Genus	Species	*Status	1	2	3	1	2	3	1	2	3	1	2	3
Actinopterygii	Anguilliformes	Congridae	*Conger*	*wilsoni*	N	0	0	0	0	0	0	0	0	1	0	0	0
Actinopterygii	Perciformes	Labridae	*Notolabrus*	*celidotus*	N	0	1	1	0	0	0	0	0	1	1	0	0
Crustacea	Brachyura	Majidae	*Notomithrax*	*minor*	N	0	0	0	0	0	0	1	0	0	0	0	0
Gastropoda	Neogastropoda	Buccinidae	*Cominella*	*adspersa*	N	0	1	1	0	0	0	0	0	0	0	0	0
Scyphozoa			*Scyphozoa*	*sp.*	SI	0	1	1	0	1	1	0	1	1	0	0	0

*Status: A = non-indigenous (highlighted by shading), N = native, C1 = cryptogenic category 1, C2 = cryptogenic category 2, SI = species indeterminata. See text for details.

Appendix 5g. Results from the starfish trap samples.

					Site code	C3		D44		F20		QUARANTINE	
					Line No.	1							
Class	Order	Family	Genus	Species	*Status	1	2	1	2	1	2	1	2
Asteroidea	Valvatida	Asterinidae	*Patiriella*	*regularis*	N	0	1	0	0	0	0	0	0
Crustacea	Brachyura	Majidae	*Notomithrax*	*sp.*	SI	0	0	0	0	0	0	1	0
Gastropoda	Neogastropoda	Buccinidae	*Cominella*	*adspersa*	N	0	1	0	0	0	0	0	0
Gastropoda	Neogastropoda	Buccinidae	*Cominella*	*glandiformis*	N	0	1	0	0	0	0	0	0

*Status: A = non-indigenous (highlighted by shading), N = native, C1 = cryptogenic category 1, C2 = cryptogenic category 2, SI = species indeterminata. See text for details.

Appendix 5h. Results from the shrimp trap samples.

				Berth code	C3		D44		F20		QUARANTINE	
				Line No.	1							
Class	Order	Family	Genus	Species	*Status	1	2	1	2	1	2	1	2
Gastropoda	Notaspidea	Pleurobranchidae	*Pleurobranchaea*	*maculata*	N	0	0	1	0	0	0	0	0
Malacostraca	Amphipoda	Corophiidae	*Apocorophium*	*acutum*	A	0	0	1	0	0	0	0	0
Malacostraca	Amphipoda	Melitidae	*Melita*	*awa*	N	0	0	1	0	0	0	0	0
Malacostraca	Isopoda	Cirolanidae	*Natatolana*	*sp.*	SI	1	1	0	0	0	0	1	1
Malacostraca	Isopoda	Cirolanidae	*Natatolana*	*narica*	N	0	0	1	0	0	0	0	0

*Status: A = non-indigenous (highlighted by shading), N = native, C1 = cryptogenic category 1, C2 = cryptogenic category 2, SI = species indeterminata. See text for details.

Addendum

After completing these reports we were advised of changes in the identification of one species. The ascidian *Cnemidocarpa sp*. refered to in this report as a new introduction to New Zealand has been revised to *Cnemidocarpa nisiotus* (status: native).