Kaipara Harbour & Marinas

Baseline survey for non-indigenous marine species (Research Project ZBS2005/19)

Biosecurity New Zealand Technical Paper No: 2019/07

Prepared for BNZ Post-clearance Directorate
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ISBN No: 978-1-98-857166-9
ISSN No: 2624-0203

June 2010

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Executive summary

- This report describes the results of the first port baseline survey of Kaipara Harbour, undertaken in September and October 2006. The survey provides an inventory of native, non indigenous and cryptogenic marine species within the fiord and surrounding coastal area and compares the biota with existing marine species records from the area.

- The survey is part of a nationwide investigation of native and non-native marine biodiversity in New Zealand's shipping ports and marinas of first entry for vessels 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. Some variations to these protocols were necessary for use in the marine environments of Kaipara Harbour.

- A wide range of sampling techniques was used to collect marine organisms from habitats within Kaipara Harbour. Fouling assemblages were scraped from hard substrata by divers, benthic assemblages were sampled using an anchor box dredge, large hand corer and diver visual transects, and a gravity corer or small hand corer was used to sample for dinoflagellate cysts. Phytoplankton and zooplankton were sampled with fine-meshed plankton nets. Mobile predators and scavengers were sampled using baited crab and shrimp traps, and fish were sampled with poison stations and beach seine netting. Beach wrack was surveyed on visual walks along selected shorelines. Sediment samples were also collected to analyse organic content and particle size.

- Sampling effort was distributed in Kaipara Harbour and surrounding coastal environments according to priorities identified by MAF Biosecurity New Zealand. In total, 22 sites were sampled during the survey.

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

- Prior to the baseline survey, a desktop review was conducted to compile an inventory of non-indigenous marine species that have been recorded previously from Kaipara Harbour and surrounding areas. Seven non-indigenous species (the molluscs *Musculista senhousia*, *Crassostrea gigas* and *Theora lubrica*, the bryozoan *Membraniporopsis tubigera* and the magnoliophytes *Spartina alterniflora*, S*partina anglica* and *Spartina* x *townsendi*) had been reported from within Kaipara Harbour. Four cryptogenic category one taxa (C1: those whose identity as native or non-indigenous is ambiguous) were also reported from within Kaipara Harbour.

- The baseline survey of Kaipara Harbour recorded a total of 389 species or higher taxa. The collection consisted of 274 native taxa, 10 non-indigenous species (NIS), nine cryptogenic category one taxa, 18 cryptogenic category two taxa (species that have recently been discovered but for which there is insufficient biogeographic or taxonomic information to determine the native provenance), and zooplankton (which were screened for target non-indigenous species but otherwise not identified), with the remaining 77 taxa being indeterminate (unable to be identified to species level).

- The ten species recorded in the survey known to be non-indigenous to New Zealand included the annelid *Dipolydora armata*, the crustaceans *Jassa slatteryi* and *Pyromaia tuberculata*, the bryozoans *Conopeum seurati*, *Anguinella palmata* and *Bowerbankia gracilis*, the molluscs *Musculista senhousia, Crassostrea gigas* and *Theora lubrica* and the sponge *Amphilectus fucorum*

- The nine cryptogenic category one taxa recorded from the initial baseline survey included the crustacean *Lysmata vittata*, the ascidian *Didemnum* sp., the cnidarian *Bougainvillia muscus*, the dinoflagellates *Gymnodinium catenatum*, *Alexandrium affine* and *Alexandrium catenella* and the sponges *Suberites* cf. *perfectus*, *Ciocalypta* cf. *pencillus* and *Callyspongia ramose*. All of these taxa are known to have established populations within New Zealand, but the occurrence of three of them in Kaipara Harbour represents an extension of the known range in New Zealand (*L. vittata, S.* cf. *perfectus* and *C.* cf. *pencillus*).

- The 19 NIS and C1 taxa were recorded from a total of only 72 of the 368 samples identified during the Kaipara Harbour survey, in water depths ranging from the intertidal zone to 28 m. the majority of these were anchor box dredges, pile scrapings and benthic sleds.

- Four taxa recorded from the initial port baseline survey of Kaipara Harbour are new records from New Zealand waters, and may be new to science. These are the sponges *Adocia* new sp. 10, *Haliclona* new sp. 21, *Eurypon* new sp. 1 and *Tedania* new sp. 5. All of these are considered to be cryptogenic category 2 taxa (C2), as there is insufficient information to determine whether New Zealand lies within their native range.

- None of the species recorded during the Kaipara Harbour survey or during the desktop review of existing species records are on the New Zealand register of unwanted organisms. However, two species are on the Australian CCIMPE Trigger List (the mollusc *Musculista senhousia* (NIS; recorded in both the survey and the desktop review) and the ascidian *Didemnum* sp. (C1; recorded only from the survey

- Four toxin-producing dinoflagellates were recorded during the Kaipara Harbour port baseline survey – the native species *Protoceratium reticulatum* and the C1 taxa *Alexandrium catenella, Gymnodinium catenatum* and *Alexandrium ostenfeldii*. One native, toxin-producing diatom, *Pseudo-nitzschia australis* was also recorded. Another two native diatoms recorded during the port survey, *Chaetoceros convolutes* and *Chaetoceros concavicornis* are considered harmful to fish due to its barbed setae, but are not directly toxic.

- There was only limited overlap in species composition between the desktop review of existing marine species records and the records from the port baseline survey. These differences can be attributed to variation in sampling effort and technique between surveys and to the differences in time-frame over which the records were accumulated (i.e. single snap-shot survey versus accumulation of historical records).

- Most non-indigenous and C1 taxa recorded during the Kaipara Harbour port survey or desktop review are likely to have been introduced to New Zealand accidentally by spread from other locations in New Zealand (including translocation by shipping).

- The councils in charge of Kaipara Harbour are implementing marine Biosecurity policies to protect the area from further invasion of NIS and C1 taxa, and from spread of those already present to other New Zealand locations.

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; Carlton 1999; AMOG Consulting 2002; Coutts *et al.* 2003). Transport by shipping has 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; Leppakoski *et al.* 2002).

Like many other coastal nations, New Zealand is just beginning to document the numbers, identity, distribution and impacts of non-indigenous species in its coastal waters. A review of existing records suggested that by 1998, at least 148 marine species had been recorded from New Zealand, with around 90 % of these establishing permanent populations (Cranfield *et al.* 1998). Since that review, at least another 41 non-indigenous species or suspected non-indigenous species (i.e. Cryptogenic category 1 – see “Definitions of Biosecurity Status”, below) have been recorded from New Zealand waters. 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. The purpose of these surveys is to:

- improve knowledge of potentially harmful species and of marine biodiversity in areas most at risk from harmful species,
- provide a baseline for monitoring the rate of new incursions by non-indigenous marine species in shipping ports, and
- assist international risk profiling of problem species through the sharing of information with other shipping nations (Hewitt and Martin 2001).

Worldwide, standardised port surveys have been completed in at least 37 Australian ports, at demonstration sites in China, Brasil, the Ukraine, Iran, South Africa, India, Kenya, and the Seychelles Islands, at six sites in the United Kingdom, and 10 sites throughout the Mediterranean (Raaymakers 2003).

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 port baseline surveys for non-indigenous marine species. 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 for vessels entering New Zealand from overseas.

Initial surveys were completed during the summers of 2001/2002 and 2002/2003 in 13 major shipping ports and three marinas of first entry for vessels entering New Zealand (

Figure 1). The surveys recorded more than 1300 species; 124 of which were known or suspected to have been introduced to New Zealand. At least 18 of the non-indigenous species were recorded for the first time in New Zealand in the port baseline surveys. In addition, 106 species that are potentially new to science were discovered. These 16 locations were subsequently resurveyed in the summers of 2004/05 and 2005/06 to establish changes in the number and identity of non-indigenous species present.

In 2005, MAF Biosecurity New Zealand extended the national port baseline surveys to a range of secondary, domestic and international ports and marinas within New Zealand to increase our knowledge of the non-indigenous marine species present in regional nodes for shipping. Biological baseline surveys were contracted for the following locations:

- Tahoroa Iron Sands Terminal
- Port of Onehunga (Manukau Harbour) & marinas
- Milford Sound
- Kaipara Harbour & marinas
- Golden Bay Marina (Takaka)
- Kaikoura / Port Underwood
- Stewart Island
- Chatham Islands

This report summarises the results of the first port baseline survey of the Kaipara Harbour and marinas and provides an inventory of species detected in the survey and in a review of existing biological records for the area. It identifies and categorises native, non-indigenous and cryptogenic taxa. Organisms that could not be identified to species level are also listed as indeterminate taxa.

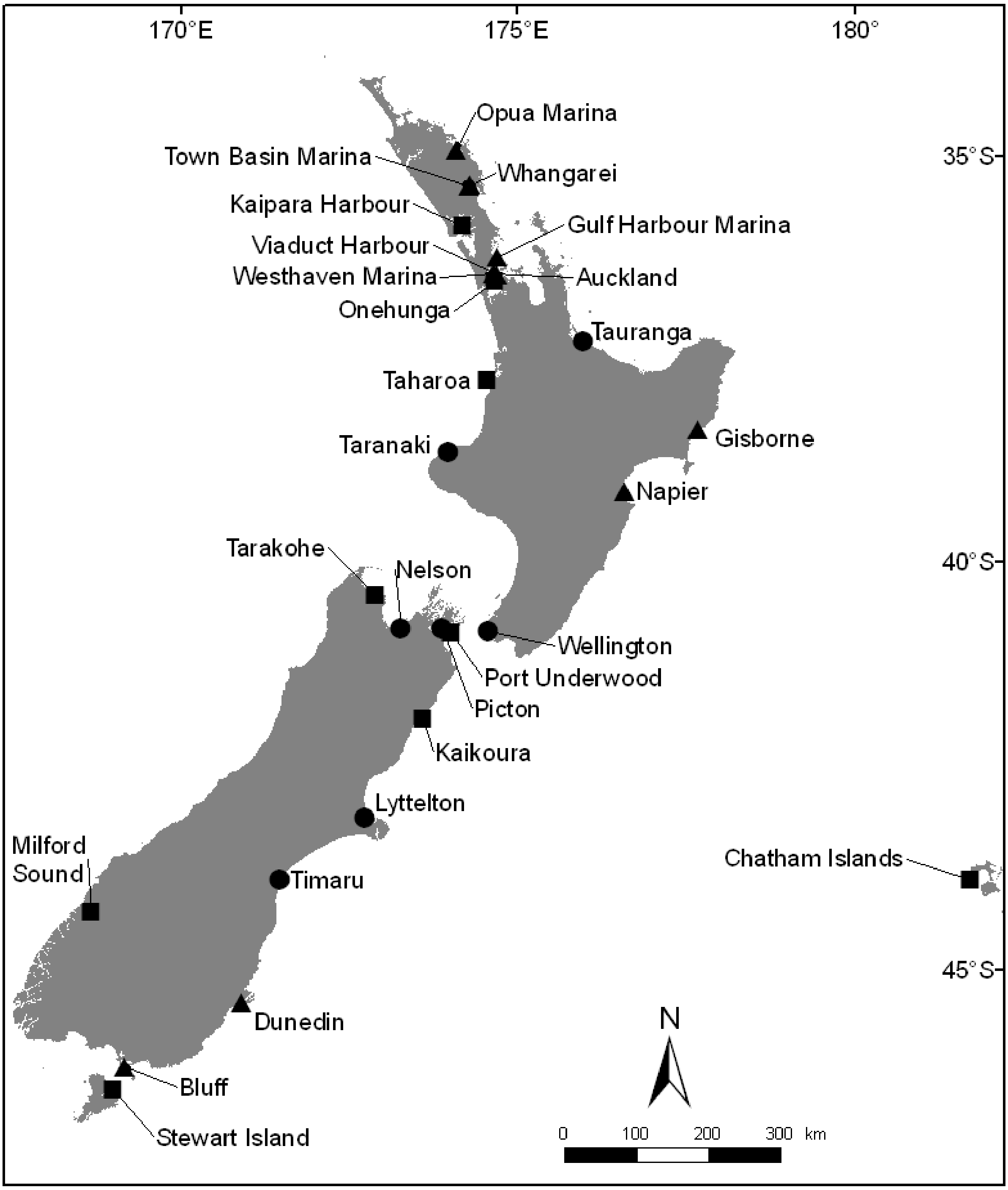

Figure 1: Commercial shipping ports in New Zealand where baseline non-indigenous species surveys have been conducted. Group 1 ports (circles) were surveyed in the summer of 2001/2002 and resurveyed in the summer of 2004/2005, Group 2 ports (triangles) were surveyed in the summer of 2002/2003 and resurveyed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

DESCRIPTION OF KAIPARA HARBOUR

General features

The Kaipara Harbour lies on the west coast of the North Island of New Zealand, near Auckland (
Figure 1, Figure 2). It is the largest inland coastal harbour in the southern hemisphere (Fish and Game New Zealand no date-b), with a shoreline over 3000 km long (Bardsley 1977) and a high spring tide surface area of 947 km^2 (Heath 1975). The Kaipara Harbour is very broad and shallow, with many tidal sandbanks, bays, tidal creeks, rivers, extensive mangrove and *Zostera* seagrass areas, and restricted intertidal and subtidal rocky habitats (Hewitt and Funnell 2005; Kaipara District Council 2005). The main rivers feeding the harbour are the Wairoa River in the north and the Kaipara River in the south. Large parts of the Kaipara Harbour have been drained to create farm land (Auckland Regional Council 2004).

The harbour has a very large tidal inlet approximately 7 km across at the narrowest point and over 50 m deep (Benson *et al.* 2003), allowing a spring tidal compartment (the volume of water entering the harbour on an incoming tide) of 1990 million m^3 (Heath 1975). The neap tidal range is 1.52 m and the spring tidal range is 2.68 m (Heath 1975). The shorelines, channels and shoals of the Kaipara Inlet system are highly mobile and dynamic (Benson *et al.* 2003), and the northern Kaipara Harbour can be very turbid as a result of sediment resuspension.

The northern part of the Kaipara Harbour is administered by Northland Regional Council, while the southern half is under the jurisdiction of the Auckland Regional Council. A restricted-access Defence area exists at South Kaipara Head (Auckland Regional Council 2004). Under the Regional Coastal Plan for Northland (Northland Regional Council 2004), the Outer Kaipara Harbour, comprising the entire Coastal Marine Area of the Wairoa River, including the entrance of the Otamatea arm and the entrance of that part of the Oruawharo River within the Northland Region, is a Marine 1 (Protection) Management Area (Northland Regional Council 2004). The rest of the Kaipara Harbour that is under Northland Regional Council jurisdiction is a Marine 2 (Conservation) Management Area, and contains numerous Marine 3 (Marine Farms) Management Areas. There is also a Marine 4 (Moorings) Management Area at Pahi (Northland Regional Council 2004). Under the Auckland Regional Coastal Plan, the Kaipara Harbour is an Area of Significant Conservation Value, and there are numerous areas throughout the harbour designated as Coastal Protection Area 1 and Coastal Protection Area 2, as well as Aquaculture Management Areas (Auckland Regional Council 2004).

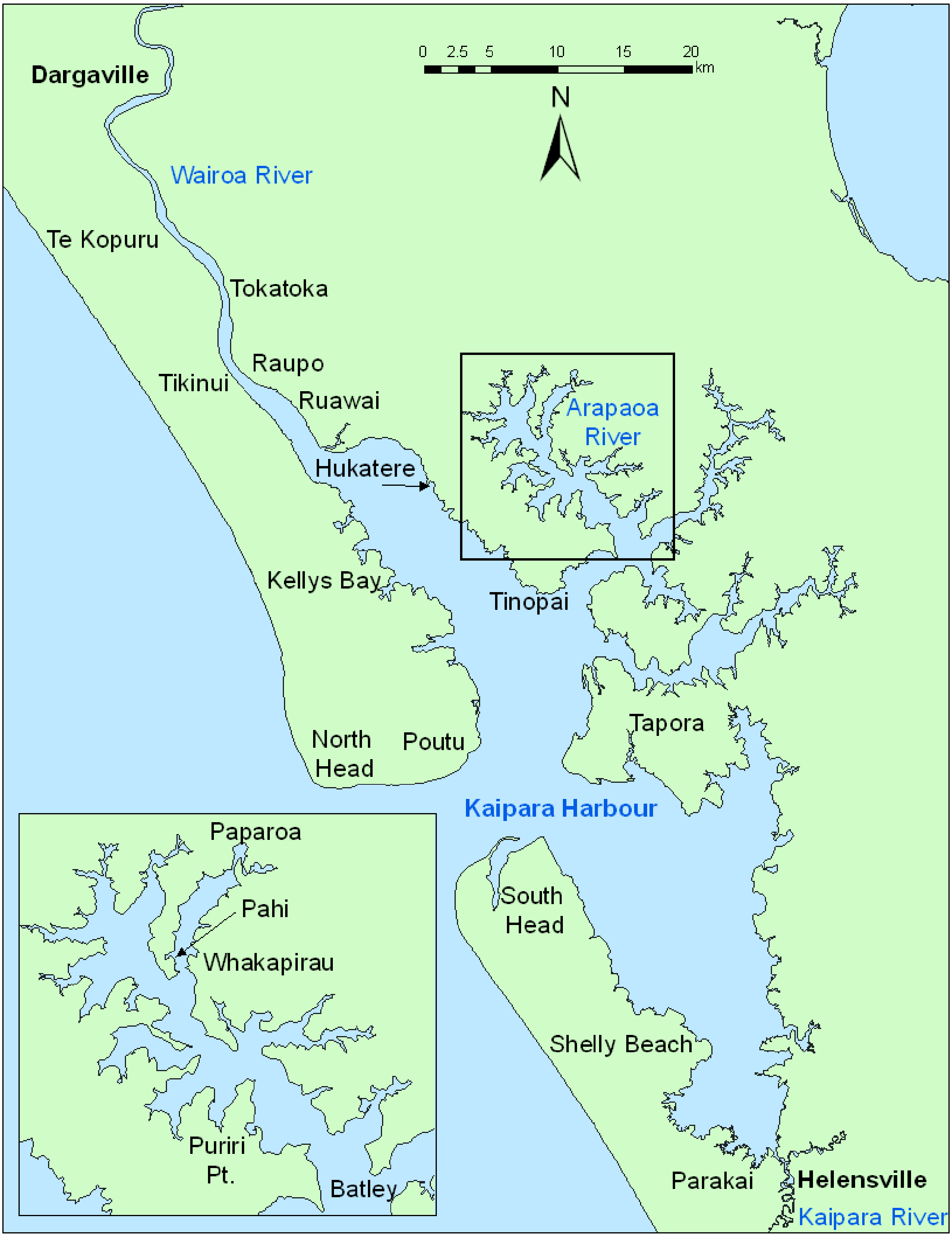

Figure 2: Map of the Kaipara Harbour, showing the major geographical features

Shipping and boating activities and facilities on the Kaipara Harbour

In the late 1800's the Kaipara Harbour was an active staging post for export of Kauri logs and gum. From 1884 to 1947 a port operated at the Kaipara Head lighthouse, with ships up to 90 tonnes transporting timber from Dargaville, Helensville, the northern Wairoa River and smaller settlements throughout the harbour (Bardsley 1977, Des Subritzky, West Coast and Kaipara Harbour Warden, pers. comm.). During this time the harbour also had an active ship-building industry, mostly on the Kaipara River in the south, Paparoa in the north (Kaipara District Council 2007), and with some work also at Pouto. Coal boats delivered coal to Dargaville until the 1940's, and a ferry used to operate between Raupo and Tikinui on the Wairoa River (Des Subritsky, West Coast and Kaipara Harbour Warden, pers. comm.).

There are now no commercial port facilities in Kaipara Harbour, due mostly to the shallow nature of the harbour and the treacherous bars and tides at its mouth. The wide expanse of the Kaipara Harbour, narrow navigation channels, large tidal range and wind fetch can make boating hazardous at times (there are around 150 shipwrecks in the area). Nonetheless, the harbour is popular with recreational boaters, fishers and hunters, and there are numerous boat ramps and a few small marinas located around the harbour. Some of the better-equipped facilities are described below, with information provided by Des Subritzky (West Coast and Kaipara Harbour Warden, pers. comm.).

The boating club in Dargaville has a wooden wharf approximately 30-40 m long with a floating pontoon, as well as a marina that can hold around 40 boats, and a concrete all-tide boat ramp. The Dargaville town wharf is of a similar size, also with a pontoon, for recreational boats. Helensville has a marina for around 40-50 boats and also has a good boat ramp. At Te Kopuru on the Wairoa River there is a marina for around 20 boats and a concrete jetty and wooden wharf which takes boats up to approximately 17 m long. The *Waikiri* patrol boat for the Northland Harbour Board was recently moored there for over one month whilst installing new channel lights and markers (Des Subritsky, West Coast and Kaipara Harbour Warden, pers. comm.). Mooring areas also exist at Tinopai, Pahi, Pahi Point, Puriri Point and Whakapirau (Northland Regional Council 2004). Other boat ramps around the Kaipara Harbour include those at Tokatoka, Raupo, Tikinui, Ruawai, Kelly's Bay, Tinopai, Whakapirau, Pahi and Shelly Beach. A more complete listing and description of boat ramps can be found on the websites of Fish and Game New Zealand (2007a,b).

Few yachts currently visit the Kaipara Harbour from other parts of New Zealand due to the potentially hazardous nature of the harbour. However, navigation markers and lights have recently been improved, which may results in an increase in yachting visitors (Des Subritsky, West Coast and Kaipara Harbour Warden, pers. comm.).

Several tourist cruise and fishing boats operate on the Harbour, including departures from Dargaville, Ruawai, Parakai and Shelly Beach (Dash Design 2007; Kaipara District Council 2007). Houseboats operate from Pahi (Kaipara District Council 2007).

Small numbers of commercial fishing launches around 40 feet long and fishing dories 6-8 m long operate in the harbour. Approximately eight operate in the Arapaoa River area, landing at Whakapirau, Pahi, Batley and Tinopai. Approximately another seven operate in the Northern Wairoa River, using wharfs at Ruawai (Christine Yardley, Secretary, Kaipara Harbour Sustainable Fisheries Management Study Group, pers. comm.).

Since June 2005, vessels entering New Zealand have been required to comply with the Import Health Standard for Ships' Ballast Water from All Countries (http://www.biosecurity.govt.nz/imports/non-organic/standards/ballastwater.htm). No ballast water is allowed to be discharged without the express permission of a MAF (Ministry of Agriculture and Forestry) inspector. To allow discharge, vessels Masters are responsible for providing the inspector with evidence of either: discharging ballast water at sea (200 nautical miles from the nearest land, and at least 200 m depth); demonstrating ballast water is fresh (2.5 ppt sodium chloride) or having the ballast water treated by a MAF approved treatment system. As the Kaipara Harbour does not receive international merchant vessels, it is believed that no ballast water is discharged in the Harbour, although in busier shipping days ships used to discharge ballast water near the Kaipara Heads (Des Subritsky, West Coast and Kaipara Harbour Warden, pers. comm.).

There is currently a proposal underway to install up to 200 submerged generators approximately three-quarters of a nautical mile directly off the Kaipara Head lighthouse, and a wind farm is being considered for the Pouto peninsula (Des Subritsky, West Coast and Kaipara Harbour Warden, pers. comm.).

Imports and exports

No international imports or exports are made to or from the Kaipara Harbour. However, the Kaipara Harbour is a source of sand for the Auckland construction industry, and finfish and shellfish for domestic markets.

Two commercial companies have permits to extract sand from the Kaipara Harbour inlet. Winstone Aggregates Ltd operates a 500 tonne capacity sand barge which docks at a purpose-built wharf on the Kaipara River (Fraser Thomas Ltd 2003). Mt Rex Shipping Ltd operates a 410 tonne capacity sand barge and an aggregates barge with a light displacement 318 tonnes and loaded displacement of 1,600 tonnes (Pryce 2005). The sands are used mostly to supply Auckland's construction industry. These two companies are permitted to extract a total 400,000 cubic metres per year, for five years, then increasing quantities after meeting further conditions (Auckland Regional Council 2004). Sand extraction is currently limited to the banks at shoals associated with flood tidal delta deposits in the tidal inlet. The sand is extracted by suction dredging in shallow waters 2 to 7 m deep. Volumes of sand stored in the dunes, beaches and seabed of the tidal inlet are several orders of magnitude greater than current volumes of sand extraction (Benson *et al.* 2003). A smaller sand extraction operation operates in the northern harbour, with the sand being transported by barge to a ramp at Kaihu Creek near Dargaville (Des Subritsky, West Coast and Kaipara Harbour Warden, pers. comm.).

There is also a gravel quarry near Hukatere. A barge transports the product to the Mt Rex Shipping Ltd facilities near Helensville (Des Subritsky, West Coast and Kaipara Harbour Warden, pers. comm.).

Kaipara Harbour has extensive areas of non-indigenous oyster (*Crassostrea gigas*) aquaculture, particularly in the Arapaoa (Pahi) and Whakaki arms of the northern Kaipara Harbour, and from South Head to Shelly Beach in the southern part of the Harbour (Auckland Regional Council 2004; Northland Regional Council 2004). However, economic burdens in recent years have caused many of these marine farms to close; for example, over approximately the last seven years the number of working leases has dropped from 11 to 2 in the Arapaoa River area (Christine Yardley, Secretary, Kaipara Harbour Sustainable Fisheries Management Study Group, pers. comm.). The invasive Asian date mussel, *Musculista senhousia*, has also encroached upon and smothered some leases, and there are concerns that difficulties in fattening the oysters may be due to competition for food with this invasive mussel, although this has not been formally investigated (Christine Yardley, Secretary, Kaipara Harbour Sustainable Fisheries Management Study Group, pers. comm.).

Catching of oyster spat also occurs, with spat caught in the Kaipara Harbour, including around the Batley area, being distributed to farms on the east coast and in the far north of the country (Northland Regional Council 2004). The Kaipara Harbour is the source of the majority of oyster-spat for the North Island industry (Handley 2002). At least one lease in the Kaipara Harbour also produces oysters to be transported to the east coast where they are fattened for sale

(Christine Yardley, Secretary, Kaipara Harbour Sustainable Fisheries Management Study Group, pers. comm.).

The Kaipara Harbour also supports a customary and recreational scallop (*Pecten novaezelandiae*) fishery, although this has been closed since 2005 due to a decline in scallop densites. There have been no formal studies on the causes of this decline, but suspected causes include severe rainfall events and predation by the eleven-armed seastar *Coscinasterias muricata*. The re-opening of the scallop fishery will be reconsidered after 27 November 2009 (Hon Jim Anderton, Minister of Fisheries, press release, 7 November 2008, 4:05 pm).

A strong customary fishery also exists for kingfish and gurnard, with the latter also starting to be targeted commercially (Christine Yardley, Secretary, Kaipara Harbour Sustainable Fisheries Management Study Group, pers. comm.). In the past, fishers operating from Ruawai have dredged for tuatua (*Amphidesma subtriangulatum*, a shellfish similar to the common pipi) in the area off Tapora (Des Subritsky, West Coast and Kaipara Harbour Warden, pers. comm.). The tuatua beds are of concern to local Maori, as young tuatua get sucked up in the sand dredges (Christine Yardley, Secretary, Kaipara Harbour Sustainable Fisheries Management Study Group, pers. comm.).

The Kaipara Harbour is also a major fish nursery for both estuarine-based species and species that move out to the open coast with increasing age and size, including snapper, trevally, red gurnard, sand and yellow-belly flounders; rig, school and hammerhead sharks; yellow-eyed mullet and anchovies. The Kaipara River, at the southern end of the harbour, is popular for duck-hunting (Fish and Game New Zealand 2007a).

The number of operating commercial fishers has a declined over recent years due to difficulties meeting market expectations of fish size (Christine Yardley, Secretary, Kaipara Harbour Sustainable Fisheries Management Study Group, pers. comm.). Species targeted are the yellow-belly flounder, rig and grey mullet (Hartill 2004). School shark and trevally were also commercially fished in the past but are no longer targeted, and commercial fishing for sand flounder has also reduced (Christine Yardley, Secretary, Kaipara Harbour Sustainable Fisheries Management Study Group, pers. comm.). Commercial fishers also operate longlines for dogfish for a short period around September / October each year in the Otamatea River area (Des Subritsky, West Coast and Kaipara Harbour Warden, pers. comm.).

EXISTING BIOLOGICAL INFORMATION

Ecologically, Kaipara Harbour is very important and contains extensive mangrove, eelgrass beds and salt marshes (Kirschberg 2007). Studies of various aspects of the marine communities in the Kaipara Harbour have been conducted in the past, but none have been focused specifically on inventorying the non-native species in the Harbour. The more relevant studies are summarised below, with particular attention paid to any non-native species reported.

Three invasive bivalves are established in the Kaipara Harbour. These are the Asian date mussel *Musculista senhousia*, the East Asian bivalve *Theora lubrica*, and the Pacific oyster *Crassostrea gigas* (Northland Regional Council 2004; Hewitt and Funnell 2005). The Kaipara Harbour is a major Pacific Oyster aquaculture area. *Crassostrea gigas* has reportedly covered hundreds of acres in the Kaipara Harbour, and when they die off the mud builds up very thickly (Des Subritsky, West Coast and Kaipara Harbour Warden, pers. comm.).

A study of the distribution of wood-boring molluscan shipworms (Bivalvia: Teredinidae) in New Zealand was conducted in the 1970's, by examining fixed wood and drift wood (McKoy 1980a). Five species were recorded, none of which are endemic to New Zealand. One of the five species, *Bankia australis*, was recorded in the northern Kaipara Harbour and appeared tolerable of very low salinities in the Wairoa River. *B. australis* is considered to be native in New Zealand and Australia. It is a tropical to temperate species, ranging in Australia from Gladstone to Hobart, with an isolate population also occurring in Rabaul, Papua New Guinea. The southern limit of its range in New Zealand, the Cook Strait Area, roughly corresponds with the southern limit in Australia (McKoy 1980a). The other four species recorded in New Zealand (*Bankia neztalia*, *Lyrodus pedicellatus*, *L. medilobatus* and *Nototeredo edax*) were not recorded from the Kaipara Harbour, but were recorded from elsewhere in the North Island. *Lyrodus medilobatus* was apparently transferred from the east coast of North Auckland to Kaipara Harbour through movement of oyster spat sticks between these areas, but the species does not appear to have established itself in the Kaipara (McKoy 1980a).

Predatory flatworms (Phylum Platyhelminthes) are a problem for bivalves in the Kaipara Harbour (Handley 2000). These flatworms can prey on important aquaculture species including the Pacific Oyster *Crassostrea gigas*, the green-lipped mussel *Perna canaliculus* and the scallop *Pecten novaezelandiae*. Provisional identifications of the two problematic flatworm species are *Enterogonia orbicularis* and a member of the family Planoceridae (Diggles *et al.* 2002). The Kaipara Harbour is the source of the majority of oyster-spat for the North Island industry (Handley 2002), and these two species have been recorded in most Pacific Oyster growing areas in the North Island that have sourced spat from the Kaipara Harbour in the past (Diggles *et al.* 2002). The native provenance of *E. orbicularis* is uncertain; Prudhoe (1982) noted that although the type material was originally recorded from the Chilean coast, a subsequent worker suggested there is evidence that the material was actually collected in New Zealand.

Cranfield *et al.* (1998) reviewed the published literature and classified 159 species as being adventive in New Zealand. Of these species, those recorded from the Kaipara Harbour were three species of estuarine cord grass in the genus *Spartina* and the barnacle *Balanus variegatus*[1]. In addition, numerous species were reported with distributions including locations on the west coast of the North Island, such as the sponge *Halichondria panicea*, recorded from New Plymouth; the bryozoans *Bowerbankia gracilis* and *Bugula stolonifera*, recorded from the New Plymouth area and *Zoobotryon verticillatum* recorded from the Manukau Harbour, the gastropods *Cuthona beta* and *C. perca*, recorded from the Auckland west coast; the gastropod *Cypraea caputserpentis*, recorded from an oil rig in Taranaki waters but believed not to be an established population; the nudibranch gastropod *Eubranchus agrius*, recorded from the north west and north east coasts of the North Island; the bivalve shipworms *Lyrodus pedicellatus* and *Nototeredo edax*, recorded from New Plymouth and Wanganui; the bivalve *Microtralia insularis*, recorded from Manukau Harbour; the barnacles *Balanus* cf. *flos* and *Platylepas hexastylos*, recorded from Piha Beach near Auckland; and the crabs *Dromia wilsoni*, recorded on the west coast of the North Island from Wanganui south to Tasman Bay and *Merocryptus lambriformis* recorded from the Taranaki Coast. Several other species were reported with less specific distributions that encompassed most parts of New Zealand or the North Island and therefore it may be inferred that they could potentially be found in Kaipara Harbour, including the sponges *Clathrina coriacea*, *Cliona celata*, *Dendya poterium*, *Hymeniacidon perleve*, *Leucosolenia botryoides*, *Sycon ciliata*, and *Tethya aurantium*; the hydroids *Amphisbetia operculata*, *Obelia longissima* and *Plumularia setacea*;

[1] *Balanus variegatus*, now known as *Amphibalanus variegatus*, is currently considered to be native to New Zealand, following recent re-examination of type specimens and revisions of the taxonomy. *A. variegatus* ranges from temperate Australia to the northern part of New Zealand (S. Ahyong, NIWA, pers. comm.).

the caryophylliid *Tethocyathus cylindraceus*; the bryozoans *Bugula flabellata* and *B. neritina*; the Pacific Oyster *Crassostrea gigas* (known from the Kaipara, Hewitt and Funnell 2005); the nudibranch gastropod *Okenia plana*; and the ascidian *Corella eumyota*.

Eade (1967) studied New Zealand Recent species of the foraminiferan families Islandiellidae and Cassidulinidae. He reported nineteen species, of which four occurred off the Kaipara Harbour at a sample depth of 684 m - *Cassidulina carinata*, *Evolvocassidulina orientalis*, *Globocassidulina minuta* and *G. canalisuturata*. These four species are all considered to be native in New Zealand (H. Grenfell, Geomarine Research, pers. comm.).

The Auckland Regional Council has recently purchased land for a Regional Park in south Kaipara near Kaipara Head and commissioned a series of resource assessment surveys to aid its planning for the park. These include coastal vegetation mapping in the southern Kaipara Harbour (Auckland Regional Council 2005) and a survey of benthic marine habitats and communities undertaken by NIWA (Hewitt and Funnell 2005). These studies have documented large intertidal and subtidal seagrass (*Zostera*) meadows on the Kakaraia and Omokoiti Flats and unusually diverse benthic assemblages with high diversity patches of sponges, suspension-feeding bivalves, filamentous seaweeds and a unique tube-worm dominated community (Hewitt and Funnell 2005).

The Papakanui Spit, on the south side of the harbour entrance, is a haul out area for New Zealand fur seals. Large Great White sharks, *Carcharodon carcharias*, are often encountered near the harbour entrance and channels. Orca and dolphins are also often seen in the harbour, including visits from the critically endangered Maui's dolphin (Kaipara Branch of the Royal Forest and Bird Protection Society of New Zealand Inc. 2006).

In anticipation of the scallop fishery re-opening, a survey was conducted through the Ministry of Fisheries on the scallop stock in the Kaipara Harbour. The preliminary report of this survey found that the scallop population in the Kaipara Harbour was largely restricted to two main beds at Shelley Beach and at Tinopai, that most scallops are of the minimum legal size (100mm) or larger. There were also limited numbers of juveniles, suggesting there has been no recent widespread recruitment (Ministry of Fisheries 2008).

Several areas around the Kaipara Harbour are important habitats for endemic and international migratory shorebirds and waders, including threatened species (Northland Regional Council 2004; Royal Forest and Bird Protection Society of New Zealand Inc. 2007). A campaign is currently underway by the Royal Forest and Bird Protection Society of New Zealand to have the Kaipara given Ramsar status as a coastal wetland of international importance (Royal Forest and Bird Protection Society of New Zealand Inc. 2007).

Baseline Survey Methods

REVIEW OF MARINE SPECIES RECORDS FROM KAIPARA HARBOUR

Prior to undertaking the Kaipara Harbour port baseline survey, we conducted a desktop review of biological records (including historical) of marine species previously recorded from Kaipara Harbour. We conducted this review by searching the Southwestern Pacific Regional OBIS Node (SW-PRON) database (NIWA 2008) and relevant published literature.

The SW_PRON database is a work in progress, comprising a growing number of datasets containing marine biodiversity data from the Southwestern Pacific region (NIWA 2008). At the time of our review (mid-2006) it contained two datasets – a “fish” dataset and a “bryozoan” dataset. The “fish” dataset contains mostly fish records as well as some invertebrate records that are derived from various trawl surveys conducted on behalf of New Zealand’s Ministry of Fisheries in the Southwest Pacific Ocean between 14/03/1961 and 07/07/2005. The “bryozoan” dataset contains bryozoan species presence data derived from various trips in and around the New Zealand Exclusive Economic Zone between 14/07/1874 and 19/04/2002. These datasets are available for public access on the SW-PRON website (NIWA 2008).

We compiled a list of all species records that we encountered from within or just outside of Kaipara Harbour, but focused particularly on obtaining a complete inventory of non-indigenous (NIS) and cryptogenic category 1 (C1) species. After compiling our initial species lists we sent the lists for each taxonomic group to relevant experts for them to review species names, reliability of the records and assign appropriate biosecurity status (see “Definitions of Biosecurity Status”, below). We also asked the experts to add any NIS or C1 species records that we had missed, and to provide information on the New Zealand and global distribution for the NIS and C1 species. The distribution information was then mapped and species information sheets prepared for each NIS and C1 species.

PORT BASELINE SURVEY OF KAIPARA HARBOUR AND MARINAS

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. We surveyed a variety of these habitat types at sites specified by MAF Biosecurity New Zealand within Kaipara Harbour in September and October 2006.

A variety of sampling techniques was used for the survey of Kaipara Harbour. These sampling methods, specified by MAF Biosecurity New Zealand in the tender documents, are derived from the CSIRO Centre for Research on Introduced Marine Pests (CRIMP) protocols developed for port baseline surveys in Australia (Hewitt and Martin 1996; Hewitt and Martin 2001). CRIMP protocols have been adopted as a standard by the International Maritime Organisation’s Global Ballast Water Management Programme (GloBallast). The methods include small cores for dinoflagellate cysts, large cores and box dredge samples for benthic invertebrates, 20 μm and 100μm plankton nets, crab and shrimp traps, qualitative visual searches, quadrat scraping, photo stills and video, poison stations, beach seines and beach walks (Appendix 1).

SAMPLING EFFORT

Sampling sites and the methods to be employed at each site were specified by MAF Biosecurity New Zealand. A summary of achieved sampling effort during the first baseline survey of the Kaipara Harbour and Marinas is provided in

Table **1**, and the spatial distribution for each of the sample methods is shown in Figure 11 to Figure 20. The exact geographic locations of sample sites are given in Appendix 2. Planned sampling that was not conducted, and the reasons for this, are given in Appendix 3.

Sampling at the Kaipara Harbour was conducted from the NIWA vessels *Haku* and *Maui* and the commercial fishing boat *R & R*. The fieldwork was split into three trips because of tidal cycles and weather conditions. The first trip, between 26-29th September 2006, sampled sites in the northern sector of Kaipara Harbour, whilst a second trip (9-12th October 2006) sampled sites in the southern Sector. The final trip on the 31st October finished off remaining phytoplankton samples from the northern sector. The samples and photographic/ video surveys were collated, sorted and stored by NIWA scientific staff on the day of collection.

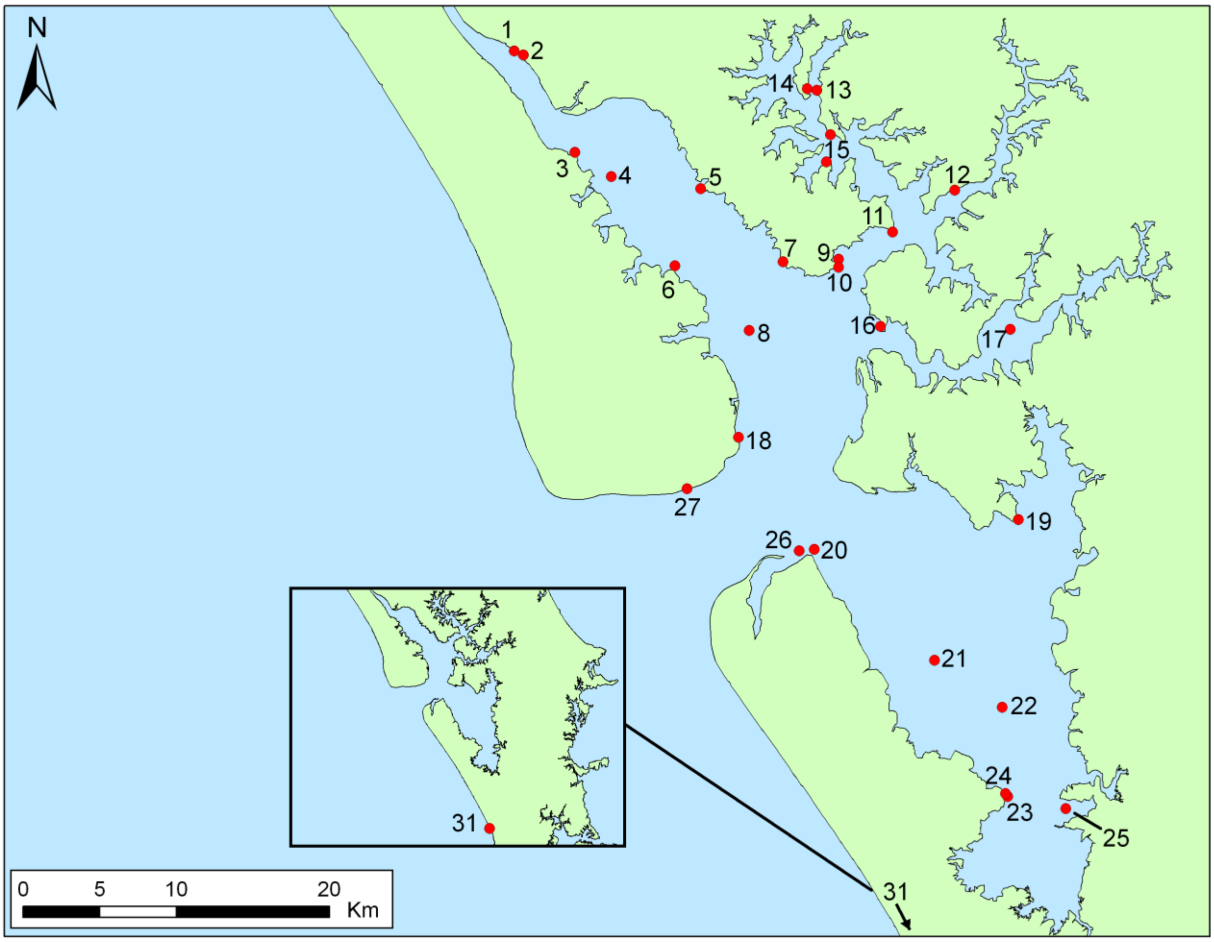

Figure 3: Sampling sites for the Kaipara Harbour survey.
Site numbers refer to site names as follows: 1: Ruawai Slipway; 2: Ruawai Landing; 3: Sail Point; 4: Middle Channel; 5: Pakaukau Point; 6: Matihe Point; 7: Bushy Point; 8: Five Fathom Channel; 9: Te Whau Point Slipway; 10: Mussel Rock; 11: The Funnel; 12: Te Hoanga Point; 13: Pahi Landing; 14: Pahi Slipway; 15: Kapua Point; 16: Motikumara Point; 17: Hargreaves Point; 18: Pouto Point; 19: Karaka Point; 20: Kaipara River 1; 21: Kaipara River 2; 22: Kaipara River 3; 23: Shelly Beach Slipway; 24: Shelly Beach Landing; 25: Ngapuke Creek; 26: Waionui Inlet; 27: Kaipara Head; 31: Rangitira Beach

FOULING COMMUNITIES

Fouling assemblages at piling and hard substrate sites were surveyed using photographic stills and video and quadrat scraping samples.

Divers recorded video transects continuously from the surface to 10 m depth (where possible). Following the video transects, quadrats (25 cm x 40 cm) were secured to the hard surfaces and still images were taken with a high-resolution digital camera. Four overlapping photographic stills were taken in each quadrat to cover the area. Once the first diver had obtained the photograhic images, a second diver then removed fouling organisms by scraping the organisms inside each quadrat into a 1 mm mesh collection bag, attached to the base of the quadrat. Once scraping was completed, the sample bag was sealed and returned to the boat for processing. The divers also made a visual search of the area for known harmful invasive species and collected samples of large conspicuous organisms not represented in quadrats.

The planned sampling design was for quadrats to be placed at depths of 0.5 m, 3.0 m and 7.0 m, but depths did not exceed 3.3 m at the planned sites, so only the 0.5 m and 3.0 m depth quadrats could be sampled. At site 9 (Te Whau Point Slipway), the maximum depth was 2.2 m, so quadrats were done at 0.5 m and either 2.2 m or 2.5 m depth. Sites 1 (Ruawai Slipway) and 23 (Shelly Beach Slipway) were in areas of extreme high current and close to zero visibilty. To enable sampling at these sites, photo stills, video and quadrat scrapings were taken above the water at low tide, when the wharf pilings were almost completely exposed (Figure 4).

A qualitative visual survey was also conducted at the concrete marker near site 22.

Figure 4: Research vessel *Haku* tied alongside the wharf at Ruawai Slipway, Site 1.

BENTHIC INFAUNA

Benthic infauna were collected by sieving sediment collected in an anchor box dredge (Figure 5). The anchor box dredge consists of a solid metal box (38 cm x 35 cm x 20.5 cm) that attaches to a long chain. The dredge is dropped from a boat or wharf to the seafloor where it sinks down into the sediment. It is then hauled back onto the boat and the retrieved sediment sieved to capture benthic infauna. This allowed sampling without requiring divers to negotiate the strong currents or very low visibility conditions at many of the Kaipara Harbour sites. At each site, triplicate samples were taken 50 m out from the pile and hard structure site (where applicable).

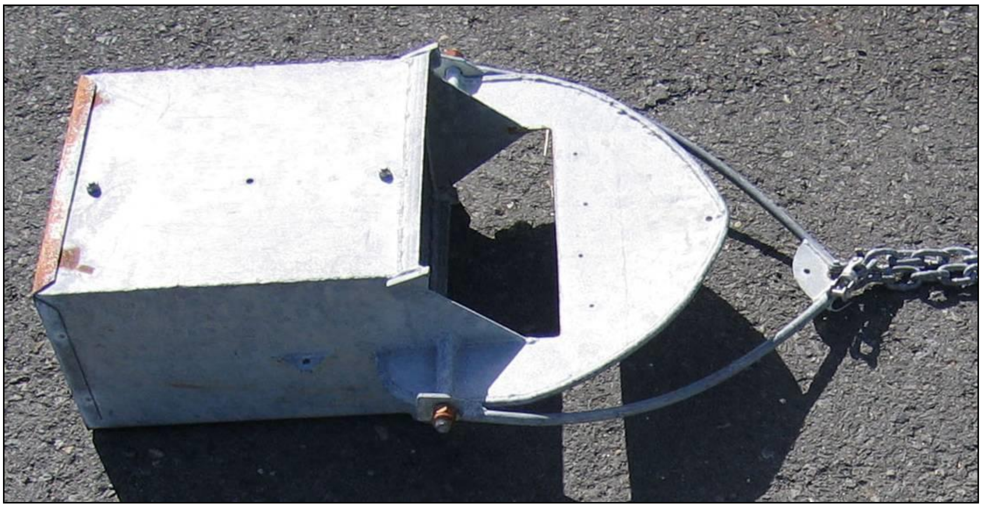

Figure 5: Anchor box dredge for sampling benthic infauna

DINOFLAGELLATE CYST-FORMING SPECIES

Triplicate samples were collected for dinoflagellate cysts at planned sites, with samples taken 50 m out from any hard structures (where applicable). At sites with suitable benthos, samples for dinoflagellate cysts were taken with a TFO gravity corer but for sites with coarse sand benthos, equivalent dinoflagellate cyst samples were extracted from the surface portion of the anchor box dredge sample. Sediment samples were kept on ice and refrigerated prior to dispatch to the specialist taxonomist.

The TFO gravity corer consists of a 1 m long x 1.5 cm diameter hollow stainless steel shaft with a detachable 0.5-m long head (total length = 1.5 m; Figure 6). Directional fins on the shaft ensure that the corer travels vertically through the water so that the point of the sampler makes first contact with the seafloor. The detachable tip of the corer is weighted and tapered to ensure rapid penetration of unconsolidated sediments to a depth of 20 to 30 cm. A thin (1.2 cm diameter) sediment core is retained in a perspex tube within the hollow spearhead. In muddy sediments, the corer effectively preserves the vertical structure of the sediments and fine flocculant material on the sediment surface. The TFO corer is deployed and retrieved from a small research vessel.

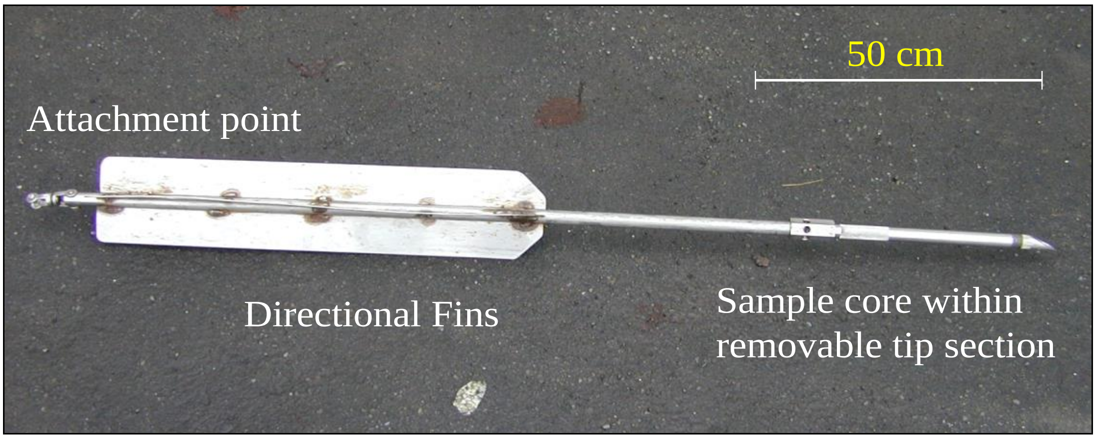

Figure 6: TFO gravity corer

DINOFLAGELLATES, PHYTOPLANKTON AND PLANKTON IN THE WATER COLUMN

A 100 μm net with a diameter of 70 cm (
Figure 7) was used to sample zooplankton in the water column. The net dropped vertically to approximately 1.5 metres from the substrate. Following the vertical drop the net was retrieved and carefully sprayed down to collect all the sample which was then placed in containers and preserved.

A 20 μm net with a diameter 25 cm (
Figure 7) was used to sample dinoflagellates and phytoplankton species. This net was towed behind the vessels at slow speed for 1 minute then retrieved, washed down and placed in sample containers. A subsample was separated and preserved in Lugols Iodine solution. Once logged, the live phytoplankton samples were driven to the nearest courier pick point (Kaiwaka in the north and Helensville in the south) for rapid dispatch to the taxonomist.

Figure 7: Zooplankton net commencing its vertical drop.

EPIBENTHOS

Larger benthic organisms were sampled using Ocklemann sled tows, box traps and shrimp traps.

Benthic sled tows

Ocklemann benthic sled tows were used to sample burrowing organisms and epibenthos instead of using diver visual surveys, due to very low visibility, depth, high currents and lack of hard substrate at the planned sites. The Ocklemann benthic sled (hereafter referred to as a "sled") is approximately one meter long with an entrance width of ~0.7 m and height of 0.2 m. A short yoke of heavy chain connects the sled to a tow line (Figure 8). 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 2 mm. Sleds were towed for a standard time of two minutes at approximately four knots. During this time, the sled typically traversed between 80-100 m of seafloor before being retrieved. A single tow was completed at each site, and the entire contents were sorted.

A visual survey was conducted in one location, at the concrete marker close to site 22. This marker was completely exposed on the sand bank at low tide.

Traps

Crab box traps (63 cm x 42 cm x 20 cm; Figure 9) with a 1.3 cm mesh netting were used to sample mobile crabs and other small epibenthic scavengers. 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 three box traps, were set on the sea floor at each site and left to soak overnight before retrieval.

Shrimp traps (Figure 9) were used to sample small, mobile crustaceans. They consist of a 15 cm plastic cylinder with a 5 cm diameter screw top lid in which a funnel is fitted. The funnel has a 20 cm entrance that tapered in diameter to 1 cm. The entrance is 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 three shrimp traps, were set on the sea floor at each site and left to soak overnight before retrieval.

At site 9, the target soak time of deploying in late afternoon and retrieving the next morning was achieved. However, due to large travel distances to retrieve the traps from the other sites, traps at sites 1, 13, 23 and 25 received an extended soak time of approximately 24 hours.

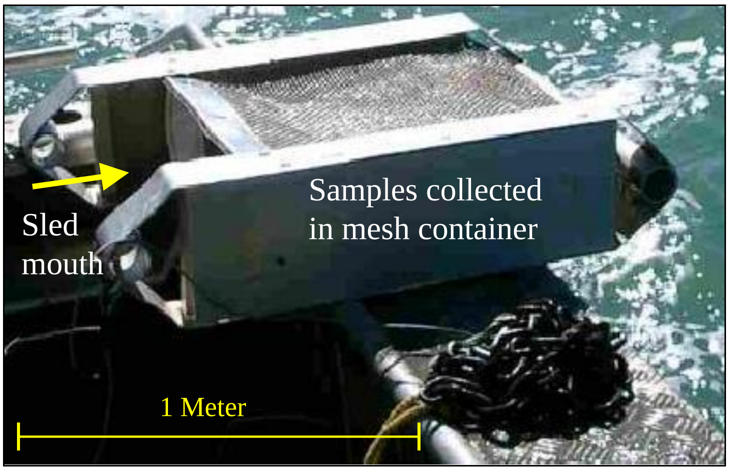

Figure 8: Ocklemann benthic sled for sampling epibenthos

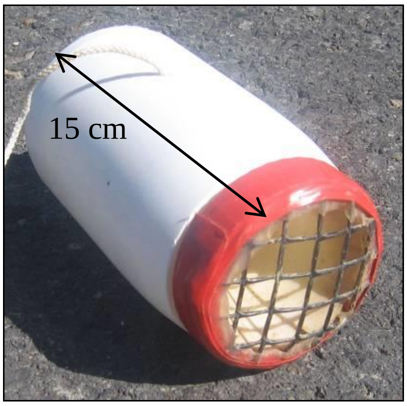

Figure 9: Crab box trap (left) and shrimp trap (right)

Fishes

Fishes were sampled using poison stations and beach seine netting.

Poison stations were sampled over hard substrates using clove oil. An area with suitable contours was selected and draped with a collection net. Clove oil was then applied to the area paying particular attention to potential hiding places for fish species. As the fish in the selected area became anesthetised they were collected using small aquarium dip nets and placed in a sealed bag. This was then returned to the charter boat for processing and labelling before being frozen. Fish sampling using poison stations in the Kaipara Harbour was difficult due to high current, but was attempted at sites 9, 13 and 26. Very poor visibility precluded poison station sampling at site 1.

Triplicate beach seines were used to sample fish species at estuaries and beaches (Figure 10). The seine net used was 11 m wide, had a headline height of around 1 m and a 4 m cod end of 9 mm mesh. The net was dragged from a suitable starting position onto the beach where the catch was bagged, labelled and placed on ice for freezing at the first opportunity.

Figure 10: A beach seine net being dragged out before hauling in

Beach wrack

Qualitative visual surveys of beach wrack were conducted at specified sites to collect crab exuviae, target macroalgae or other target organisms. Surveyors walked parallel to the water's edge 2 m from the shore, 5 m from the shore and 10 m from the shore. Collected organisms were bagged and labelled.

ENVIRONMENTAL DATA

Water temperature, salinity and sea state

Field measurements of water temperature and salinity were taken at each site. Turbidity measurements (measured as Secchi depth) were taken at each site using a 150 mm diameter Secchi disk. Observations were also made of daily sea state (Beaufort scale).

Sediment analysis

Two replicate sediment samples were taken for analysis of grain size and organic content from each site that was sampled for benthic infauna. A ~100 g wet weight sample was collected from each of two replicate anchor box dredge or large hand core samples at each site, and frozen prior to analysis. A ~30 g sub-sample was removed for analysis of organic content, while the remainder was used to determine the particle size distribution of the sample using a laser grain size analyser.

The organic content of the sediments was estimated using the common method of loss on ignition (LOI). For each sample, the wet sample was well mixed and a representative subsample (approximately 30 g) placed into a pre-weighed crucible. The sample was put into a 104 ^{o}C oven until completely dry. It was then transferred to a desiccator to cool before being weighed to the nearest 0.001 g. The sample was then ashed in a muffle furnace at 500 ^{o}C for four hours. When cool enough it was transferred to a desiccator to cool further before being weighed to the nearest 0.001 g. The difference between nett dry and nett ash-free dry weights was then calculated. This difference or weight loss, expressed as a percentage (LOI %), is closely correlated with the organic content (combustible carbon) of the sediment sample (Heiri *et al.* 2001).

The distribution of particle sizes at each port was measured using the standard procedures and equipment of nested sieves to sort the larger particles (down to 0.5 mm) and a laser grain size analyser to sort particles below this size, as follows: Samples were wet sieved using sieves of mesh sizes 8 mm, 5.6 mm, 4 mm, 2.8 mm, 2 mm, 1 mm and 0.5 mm.

1. Sediments retained on each sieve were dried and weighed.
2. The remaining fraction (< 0.5 mm) was prepared for laser analysis: the < 0.5 mm fraction was made up to 1 L in a cylinder fitted with an extraction tap. The sample was homogenised by continuous agitation with a plunger up and down in the cylinder for 20 seconds. With agitation continuing during extraction, approximately 100 ml was drawn off for drying and weighing and a second 100 ml was drawn off for laser particle analysis.
3. The first 100 ml was measured to obtain a percent of the whole sample, then dried, weighed and scaled up to 100 % to return the < 0.5 mm gross dry weight.
4. The laser analysis returns percent distributions of volume in any chosen size ranges. These percents are then applied to the < 0.5 mm gross dry weight.
5. Laser analysis was conducted using a Galai CIS-100 "time-of-transition" (TOT) stream-scanning laser particle sizer. Particles sized between 2 µm and 600 µm were measured by the laser particle sizer and classified into the standard Wentworth size

classes, with some extra divisions included in the pebble and fine silt categories (Table 2). Typically, 250,000 to 500,000 particles were counted per sample.

6. The fraction in each size category calculated by the laser analysis was then calculated as a percent of the total net dry weight.

SORTING AND IDENTIFICATION OF SPECIMENS

Each sample collected in the survey was allocated a unique code on waterproof labels and transported to the 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 3. Specimens were subsequently sent to approximately 20 taxonomic experts (Project Team above) 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 4) and the Australian Trigger List produced by the Consultative Committee on Introduced Marine Pest Emergencies (Table 5).

While not all zooplankton samples were identified, all were screened for target non-indigenous organisms (*Eriocheir* species, *Carcinus* species, echinoderm and ascidian larvae). Platyhelminthes, Sipuncula and nemerteans collected by any method were not identified due to NIWA being unable to secure the services of experts to examine these groups. These specimens were therefore classed as indeterminate taxa (see section "Definitions of Biosecurity Status").

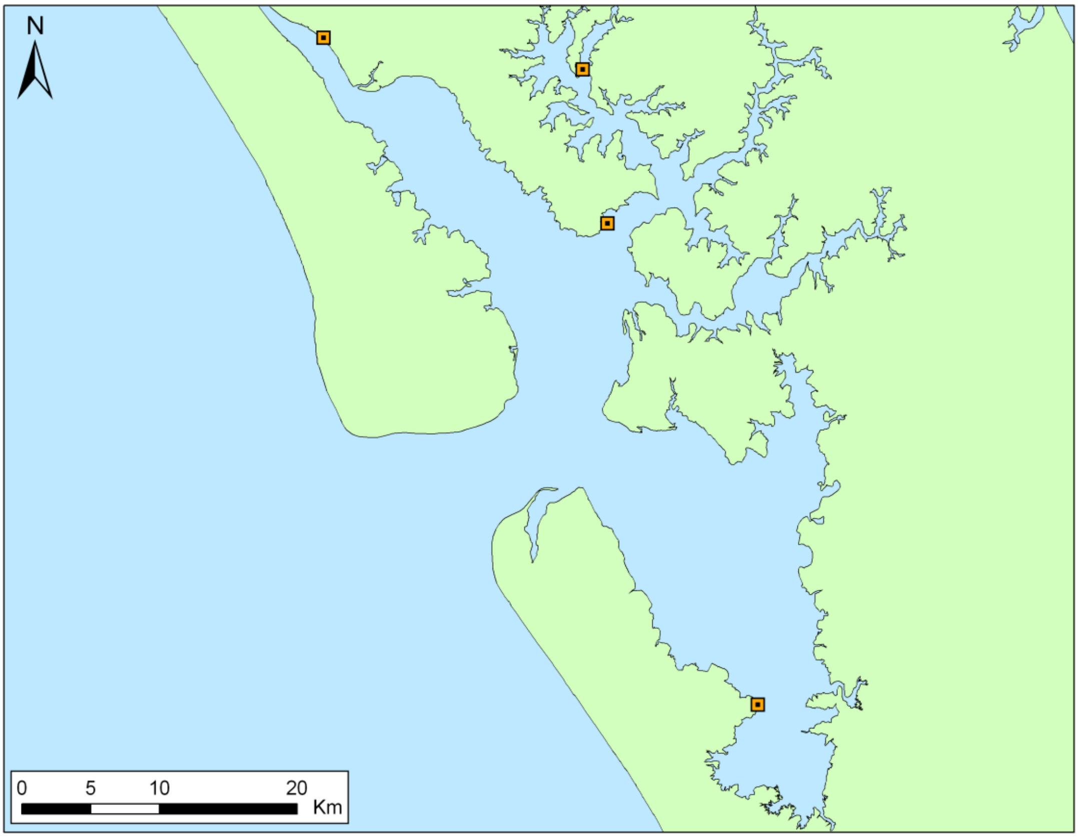

Figure 11: Fouling assemblage sites sampled by quadrat scraping, photographic stills and video, and qualitative visual surveys

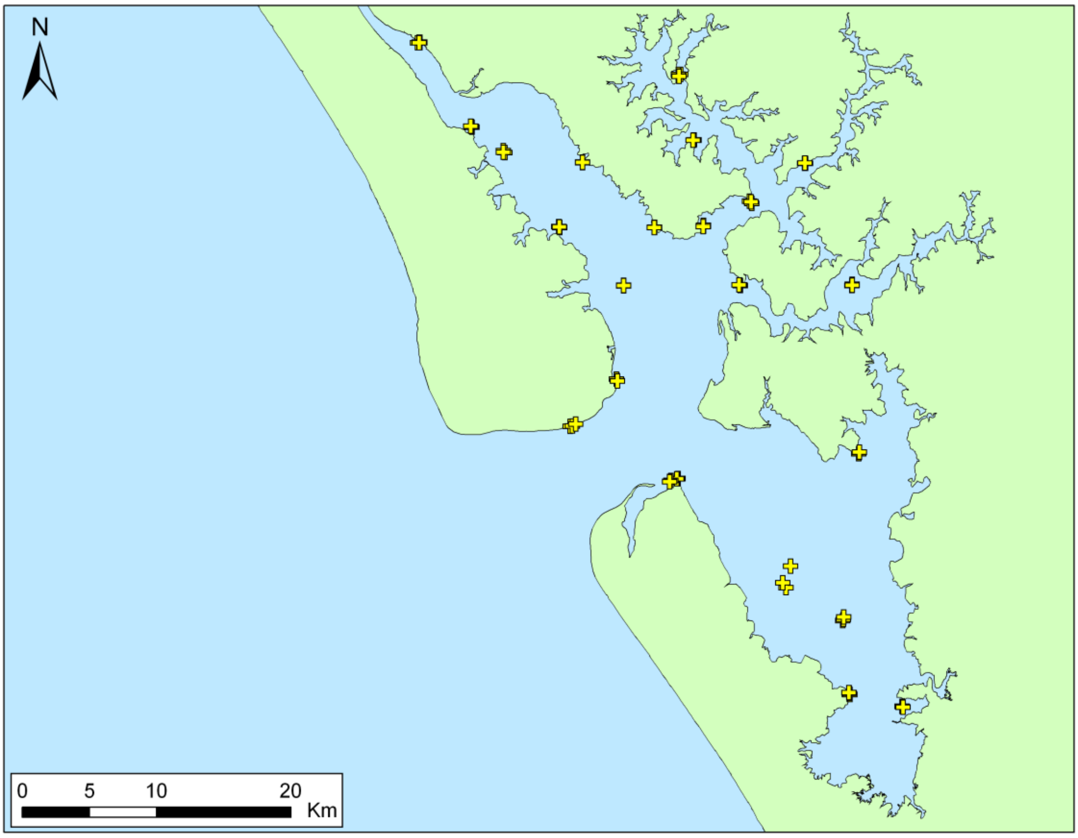

Figure 12: Benthic infauna sites sampled using anchor box dredge

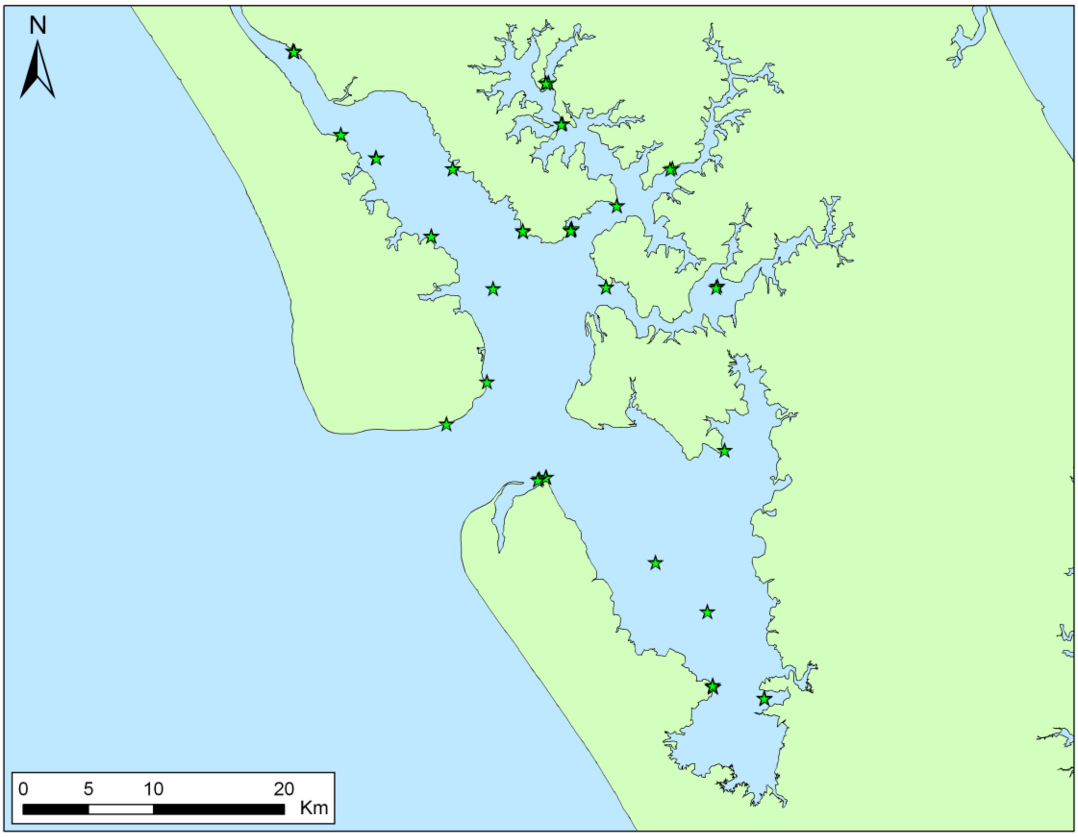

Figure 13: Cyst-forming dinoflagellate sample sites

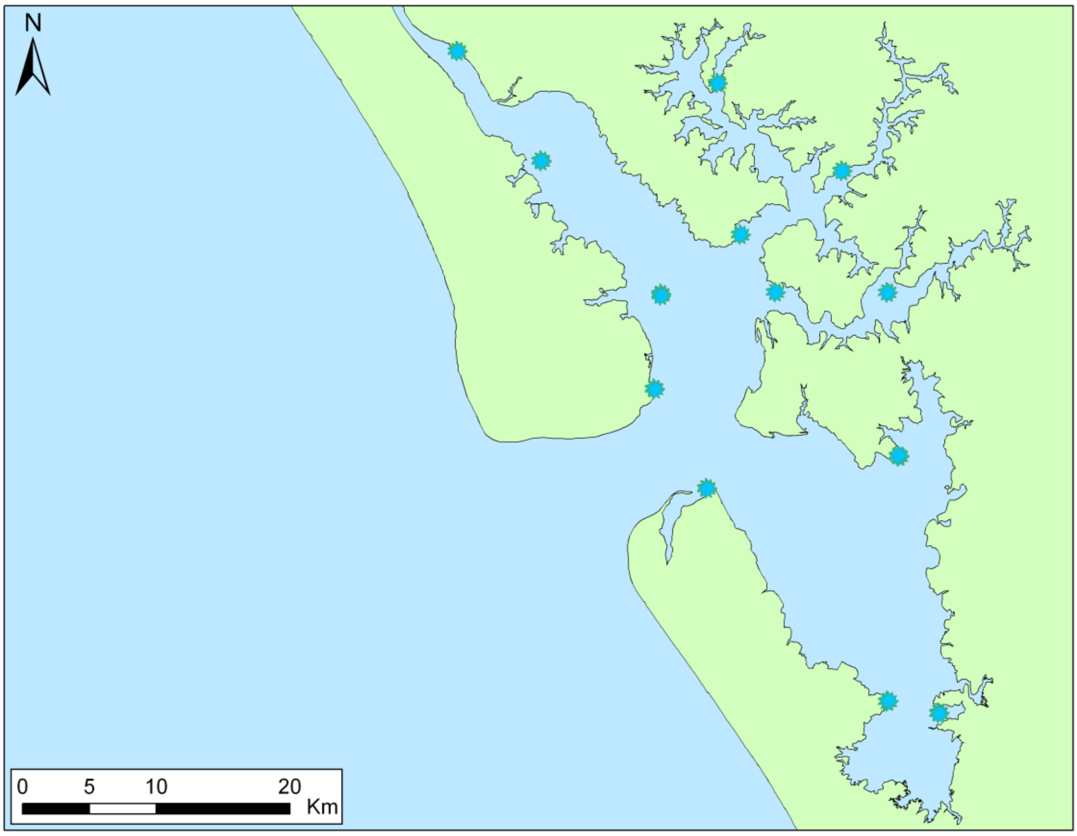

Figure 14: Plankton sampling sites using both 100 µm and 20 µm nets

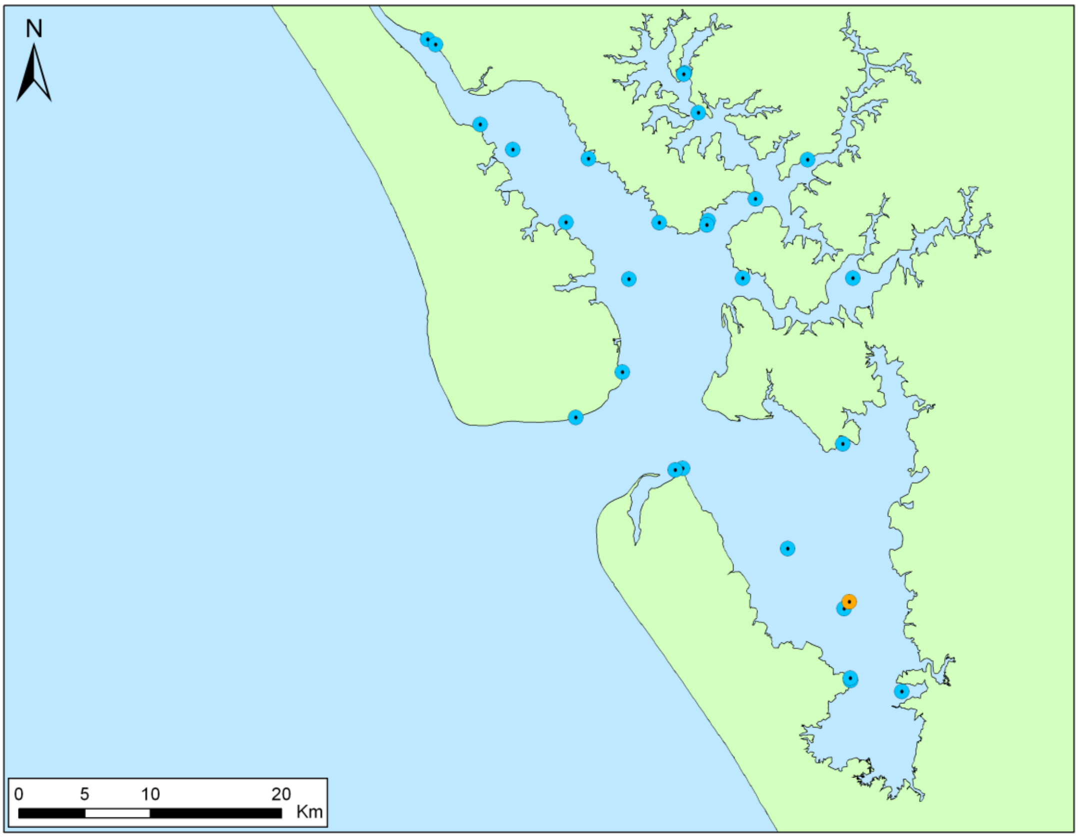

Figure 15: Epibenthos sites sampled using Ocklemann benthic sled (blue circles) and qualitative diver visual surveys (orange circles)

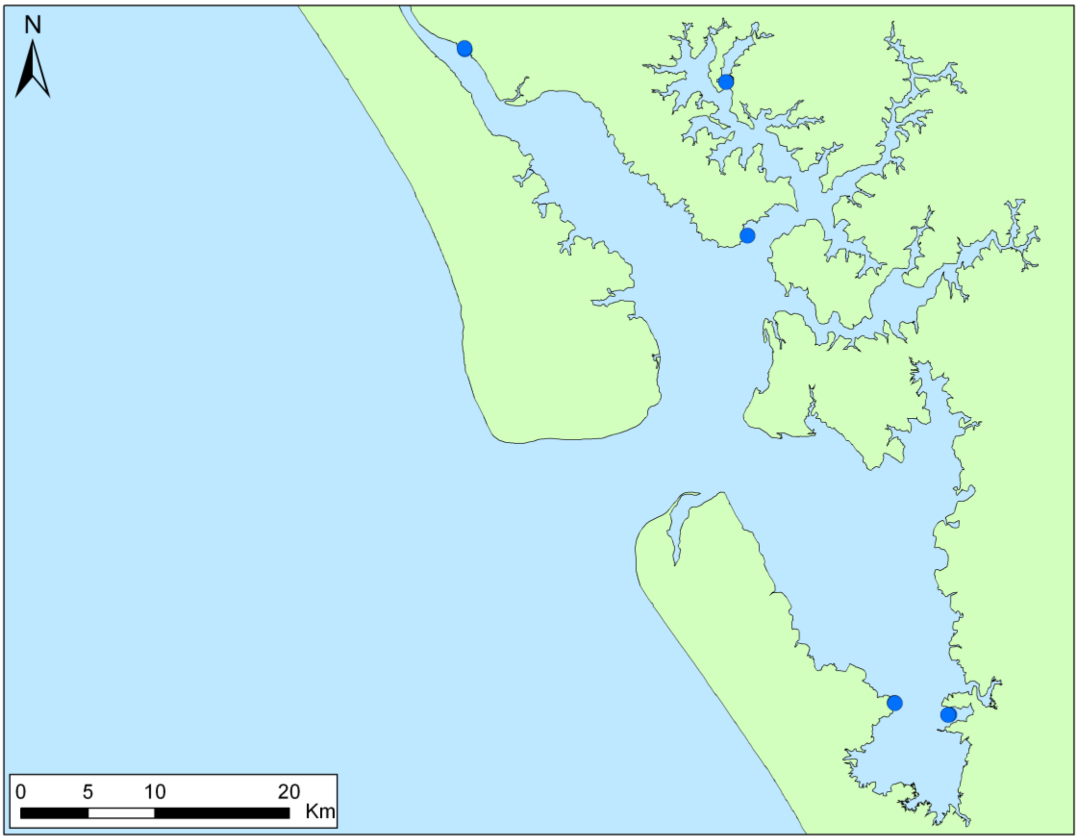

Figure 16: Epibenthos sites sampled using both box traps and shrimp traps

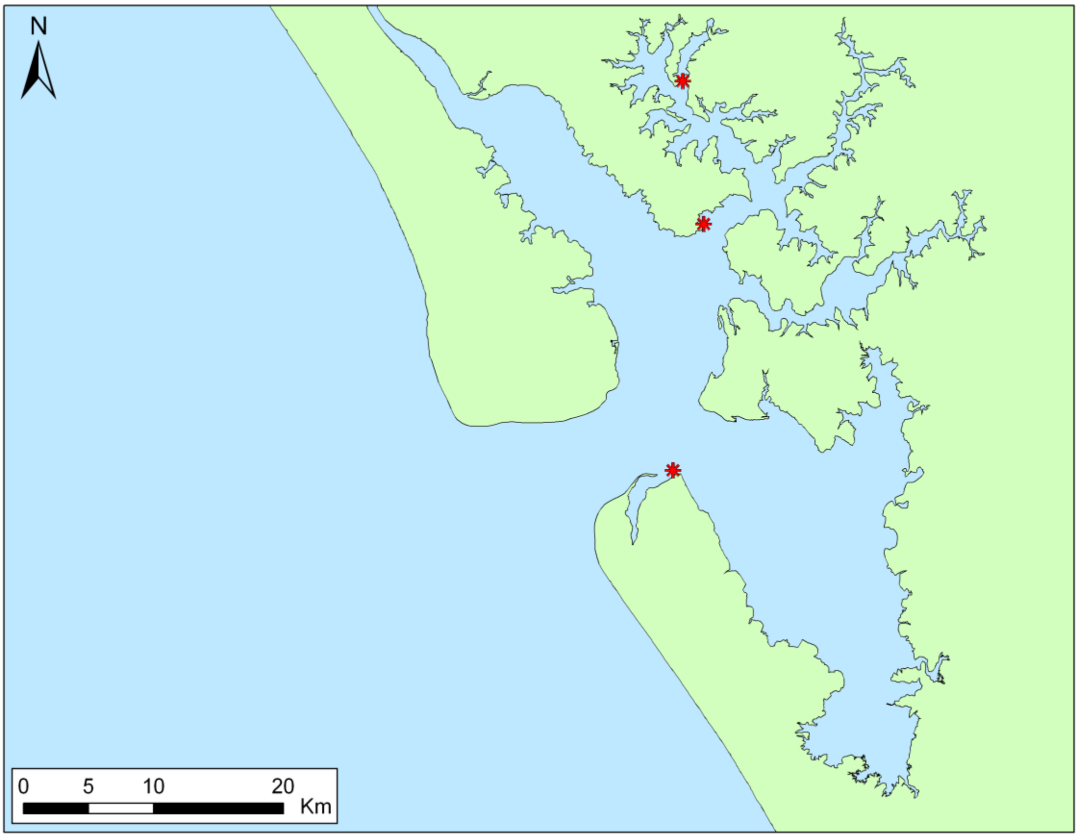

Figure 17: Fish sampling sites using poison stations

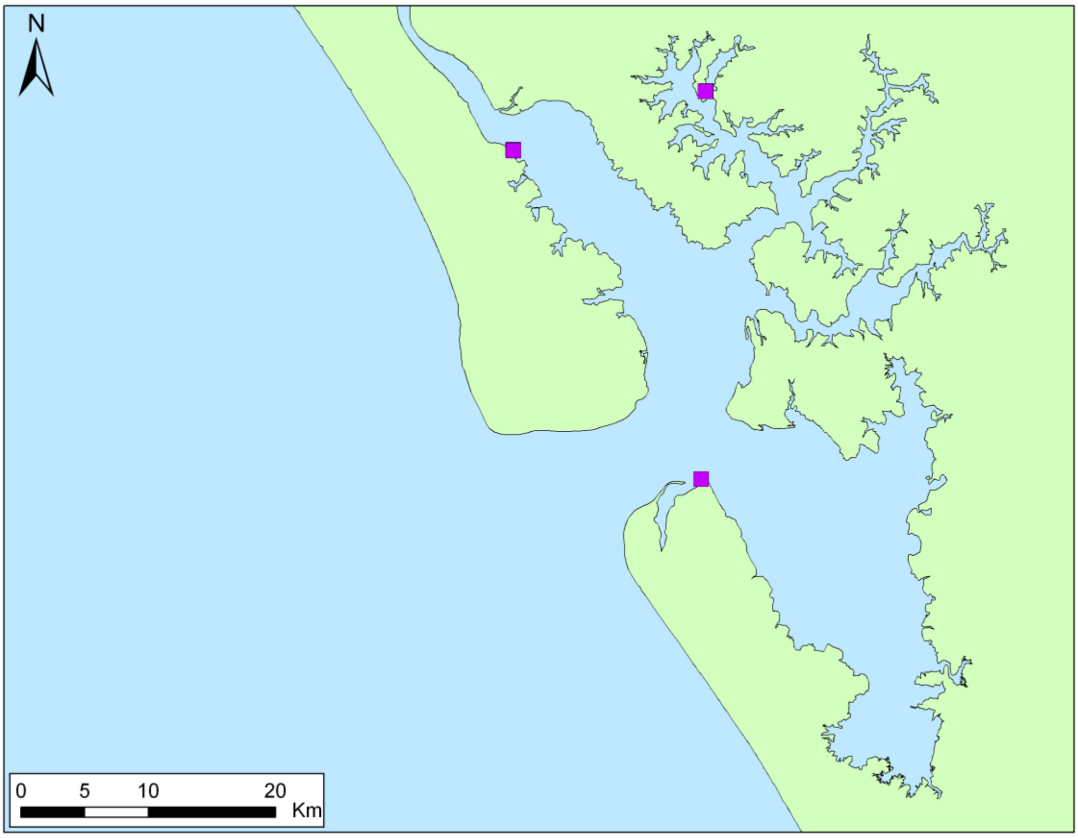

Figure 18: Fish sampling sites using beach seine netting

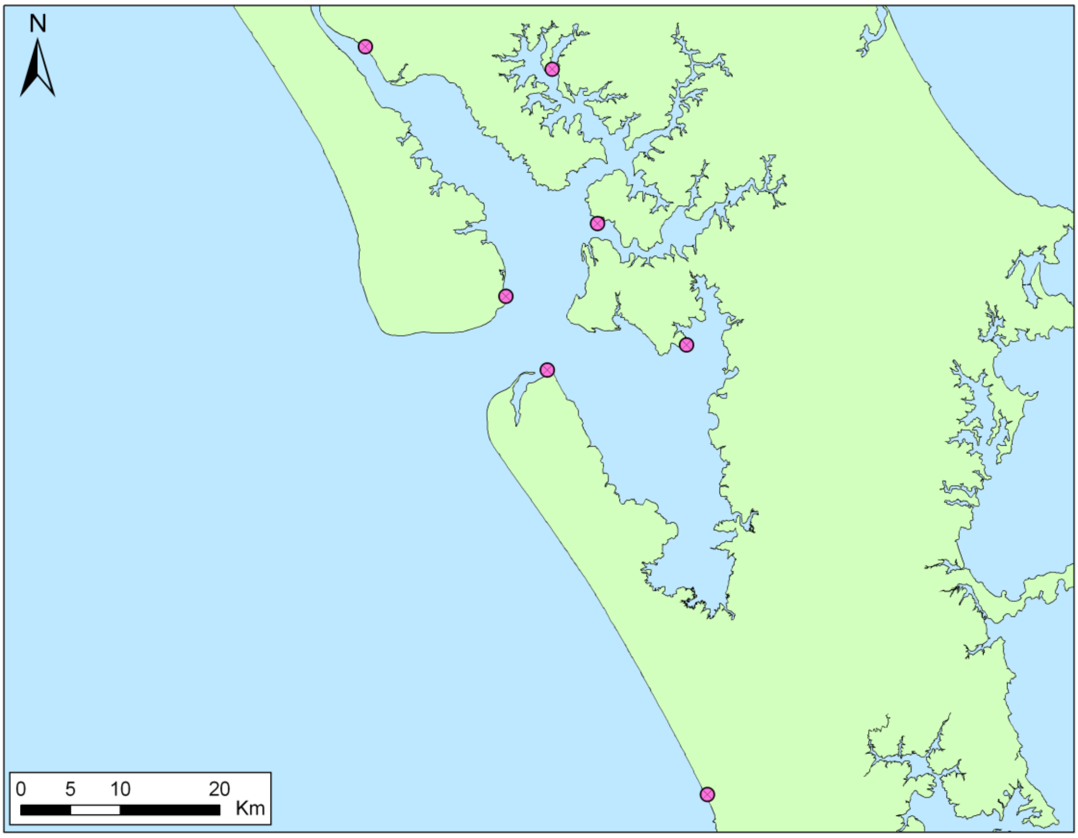

Figure 19: Beach wrack qualitative visual sampling sites

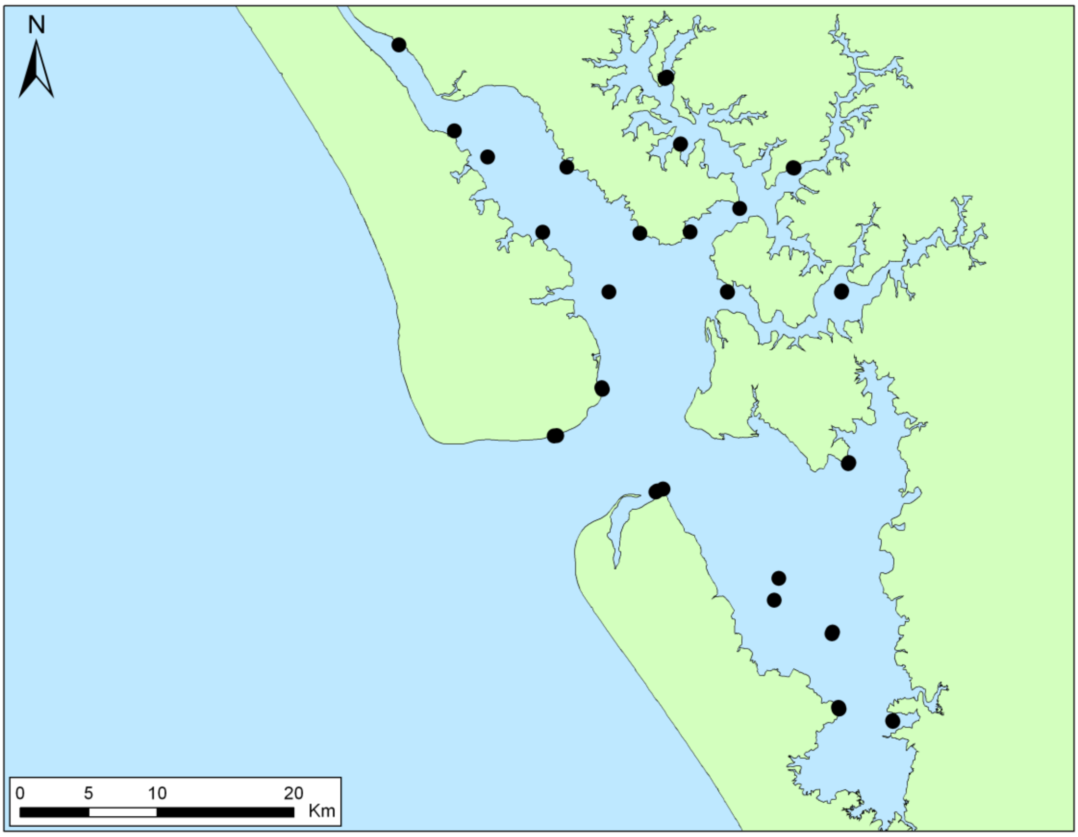

Figure 20: Sediment sampling sites

DEFINITIONS OF BIOSECURITY STATUS

Each species recovered during the survey was classified into one of five categories ("biosecurity status") 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 determine the true range and origin of many species reliably. The biosecurity status 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. A fifth biosecurity status ("indeterminate taxa") was used for specimens that could not be identified to species-level. Formal definitions for each biosecurity status are given below, and a full glossary is provided at the end of the report.

Native species

Native species occurred within the New Zealand biogeographical region historically 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 as a guide 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?

Cryptogenic category 1 taxa (C1)

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 category 2 taxa (C2)

Species that have recently been discovered but for which there is insufficient systematic or 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.

Indeterminate taxa

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.

PUBLIC AWARENESS PROGRAMME

A well-targeted public awareness programme is an important component of this project. Because the Kaipara Harbour is a relatively remote part of New Zealand with small local communities, a large field research team is highly visible and requires the support and infrastructure of the community. It is important, therefore, that the community clearly understand the motives for the survey and how they may contribute to a successful national outcome (i.e. greater biosecurity awareness and protection). The attachment of local communities to their surrounding marine environment can act to the advantage of biosecurity if local vigilance can be harnessed for on-going passive surveillance for marine pests. Developing a strong public awareness programme is, therefore, critical to the success of the project and to on-going protection of New Zealand's marine environment from unwanted marine organisms.

NIWA worked closely with Biosecurity NZ and relevant local and regional authorities to develop a public awareness programme for the survey. We made joint media releases to local media immediately before the survey began. These outlined the activities to be undertaken during the survey and encouraged any public reports or observations on potentially introduced species, including providing points of contact for reporting (Appendix 4). Where possible, any reports were followed up by the survey team while they were on location or immediately after the survey was completed. A log was kept of any such reports and the response to them.

Consideration of Maori interests is also an important part of the public awareness programme. In many parts of the country, including the Kaipara, Iwi hapu or whanau hold manamoana over local marine resources. It is important to establish appropriate lines of communication before the surveys to ensure the kaitiaki are aware of the survey's purpose and to seek their support for the sampling activities. NIWA's Maori Development Unit, Te Kuwaha o Taihoro Nukurangi, worked closely with Biosecurity NZ's Maori Strategic Unit team to identify appropriate hunga whakapa. Local Iwi contacted included Ngati Whatua, Ngati Wai, Te Uri o Hau and Pai rawa te korero Mauri.

Media releases for the Kaipara Harbour port survey were sent to the following organisations and stakeholders:

Media

- TV One News Auckland
- TV3 News Aukland
- New Zealand Press Association
- Rodney Times
- Nor-West News
- Whangarei Report
- Whangarei Leader
- NZ Herald
- Kaiwaka Bugle
- Local Matters (Warkworth)
- Northern Advocate

Stakeholders

- MFish Fisheries Officer, Auckland: Matt Cowan
- MFish Fisheries Officer, Whangarei: Darren Edwards
- Kaipara District Council: Stephen Foole
- Rodney District Council: David Thatcher
- Northland Regional Council, Harbour Master: Ian Nisbit
- Auckland Regional Council, Biosecurity Manager: Jack Craw
- Northland Regional Council, Biosecurity Team Leader: Matthew Hall
- Guardians of the Kaipara: Linda
- Department of Conservation, Auckland: Dan Breen
- Department of Conservation, Northland: Paul Buisson
- New Zealand Aquaculture Council: Callum McCallum

Following the media release, the following press coverage resulted:

- Northern Advocate: 'Sea pests sought', 9 October 2006, p.3.
- Nor-West News: 'Trawling the Kaipara for foreign invaders', 5 October 2006, p.2.
- Rodney Times: 'Marine pests put under pressure by biosecurity: Survey targets eight problem species', Jan Mathis-Collins, 26 September 2006, p.6.
- Nor-West News: 'Sea hunt on for invaders', 21 September 2006, p.7.
- Whangarei Report: 'Kaipara NIWA survey to check for marine pests', 21 September 2006, p.13.

Survey Results

REVIEW OF MARINE SPECIES RECORDS FROM KAIPARA HARBOUR

There were 115 taxa representing 10 phyla were recorded during the desktop review of existing marine species records from Kaipara Harbour and surrounding areas. These include 96 native taxa (Table 6), eight non-indigenous species (NIS; Table 7), four cryptogenic category 1 (C1) taxa (Table 8), two cryptogenic category 2 (C2) taxa (

Table 9) and six indeterminate taxa (Table 10). For general descriptions of the main groups of organisms recorded during this review, refer to Appendix 5. A list of Chapman and Carlton's (1994) criteria (see section "Definitions of Biosecurity Status") that were met by the NIS and C1 taxa is given in Table 11.

The 96 native taxa compiled in our review of existing marine species records from Kaipara Harbour are comprised of six phyla, dominated by fish (49 taxa) and protozoans (38 taxa), but also included annelids (three species), molluscs (three species), crustaceans (two species and one sponge (Table 6). It should be noted that whilst our review was thorough, achieving an exhaustive list of native species was not possible within the resources available to the study.

The eight non-indigenous species previously recorded from Kaipara Harbour (Table 7) include three molluscs (*Crassostrea gigas*, *Musculista senhousia* and *Theora lubrica*), three magnoliophytes (*Spartina alterniflora*, *Spartina anglica* and *Spartina* x *townsendi*) and one Bryozoan (*Membraniporopsis tubigera*). Available information on the ecology of each of these species, their global and New Zealand distributions, vectors and potential impacts are provided in Appendix 6.

None of the NIS recorded in the literature are on the New Zealand Register of Unwanted Organisms (

Table 4), but the Asian Date mussel, *Musculista senhousia* is listed as established in Australia but not widespread on the Australian CCIMPE Trigger List (Table 5). Three of non-indigenous molluscs recorded in the desktop review are on the Australian list of priority domestic pests (Hayes *et al.* 2005). In decending order of impact potential, these are: *Crassostrea gigas*, *Musculista senhousia* and *Theora lubrica*.

The four cryptogenic category 1 (C1) taxa previously recorded from Kaipara Harbour and surrounding areas (Table 8) comprised of two dinoflagellates (*Alexandrium ostenfeldii* and *Gymnodinium catenatum*), one mollusc (*Lyrodus mediolobatus*) and one platyhelminthes (*Enterogonia orbicularis*).

None of the C1 recorded in the literature are on the New Zealand Register of Unwanted Organisms (

Table 4) or on the Australian CCIMPE Trigger List (Table 5). However, the dinoflagellate *Gymnodinium catenatum* is listed as number one in impact potential on the Australian list of priority domestic pests (Hayes *et al.* 2005) due to its wide distribution and toxin production (see "S: Range extensions" below).

A single cryptogenic category 2 (C2) taxon was recorded in the desktop review; the sponge *Ciocalypta* new sp. 1 (cf *C. polymastia*).

The remaining six records in the desktop review were not identified to species level and are thus considered indeterminate (Table 10). These include three protozoans (*Cancris* sp., *Rosalina* sp. and *Saccammina* sp.), one fish (*Helicolenus* sp.), one magnoliophyte (*Zostera* sp.) and one platyhelminthes (*Planoceridae* Indet.).

PORT ENVIRONMENT

Twenty-eight different sites were sampled around the Kaipara Harbour (Figure 3, Table 12). Maximum recorded depths varied throughout the harbour without showing any clear spatial patterns. The shallowest maximum recorded depth was 3.7 m at Hargreaves Point, and the deepest was 28.8 m at Matihe Point (Table 12). Turbidity tended to be greatest at the more inner harbour and upriver sites, with secchi depths of less than 0.5 m at Karaka Point, Shelly Beach Landing, Ruawai Landing and Slipway, Shelly Beach Slipway, Ngapuke Creek and Middle Channel (Table 12). The lowest turbidity was recorded at northern outer harbour sites, with the clearest water at Kaipara Head (secchi depth of 3.52 m), followed by Poutu Point, Five Fathom Channel, Matihe Point and Mussel Rock, all having secchi depths of at least 2 m at the time of sampling (Table 12). Not surprisingly, salinity was lowest in the estuarine areas where rivers flow into the harbour, with the lowest salinity at Ruawai Slipway (15 ppt), followed by Ruawai Landing, Sail Point, Middle Channel, Kapua Point, Pahi Landing, Pahi Slipway, Te Hoanga Point, Hargreaves Point and Pakaukau Point, all with salinities below 30 ppt. Sites in the southern harbour had the highest salinity, with a maximum of 40 ppt recorded at Shelly Beach Slipway (Table 12). Water temperatures tended to be cooler at the outer harbour sites, with a minimum of 14.8 ^{o}C at Kaipara River 1, and tended to be warmer at the upper harbour sites, with a maximum of 18.5 ^{o}C recorded at Pahi Slipway (Table 12). Sea states during sampling ranged from 0 to 4 on the Beaufort Scale (ie. from less than 1 knot of wind up to 11-16 knots). However, this does not necessarily reflect usual conditions at the sites, as sampling could only be conducted during relatively calm conditions. For example, sampling at Pouto Point was conducted whilst the sea state was at Beaufort Scale 0, but this site can often be much rougher, with nearby sites such as Kaipara Head and Waionui Inlet being at Beaufort Scale 4 during sampling (Table 12).

The organic content of sediments in the Kaipara Harbour was low, with a mean LOI across all 50 analysed samples from 25 sites of 2.5 % ± 0.3 (
Figure 21). Organic content was generally higher at the upper harbour sites and lower in the outer harbour and around the heads. Loss on ignition results ranged from a minimum of 0.5 % ± 0.07 % at Waionui Inlet to a maximum of 5.68 % ± 0.04 at Hargreaves Point (
Figure 21).

Sediments at the sampling sites in Kaipara Harbour ranged in size from pebbles to silt, but were strongly dominated by fine sand-sized particles (representing an average of 51 % by volume of the sediment samples). The remainder of the particles were mostly medium and very fine sand (
Figure 22). There was little variation in particle sizes between sites.

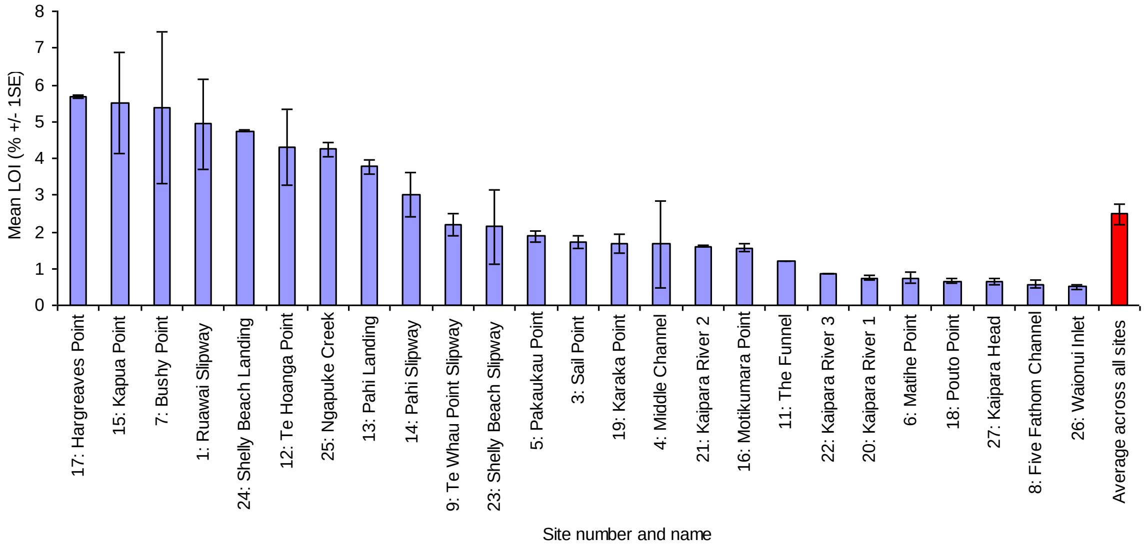

Figure 21: **Organic content as determined by loss on ignition analyses of sediments from 25 sites in the Kaipara Harbour (n=2 at each site).**

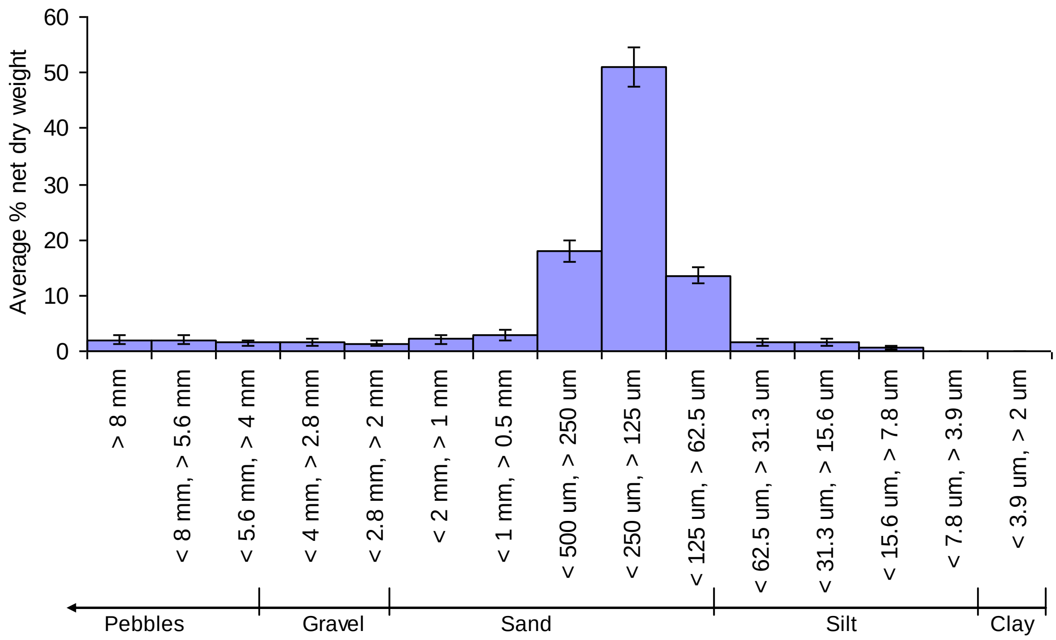

Figure 22: **Sediment particle size distribution averaged across 25 sites in Kaipara Harbour (n=1 sample per site).**

SPECIES RECORDED

A total of 389 species or higher taxa were identified from the survey of Kaipara Harbour. This collection consisted of 274 native Table 13), 10 non-indigenous species (Table 14), nine cryptogenic category 1 taxa (C1) (Table 15), 18 cryptogenic category 2 taxa (C2) (Table 16), 77 taxa being made up of indeterminate taxa (Table 17, Figure 23) and one zooplankton (which were screened for target non-indigenous species but not all samples were identified).

The biota in the resurvey included a diverse array of organisms from 17 phyla (Figure 24) as well as an unidentified zooplankton specimen and three speciemens that could not be described to Phylum, so are listed here as 'unidentified'. For general descriptions of the main groups of organisms (Phyla) encountered during this study refer to Appendix 5, and for detailed species lists collected using each method refer to Appendix 7.

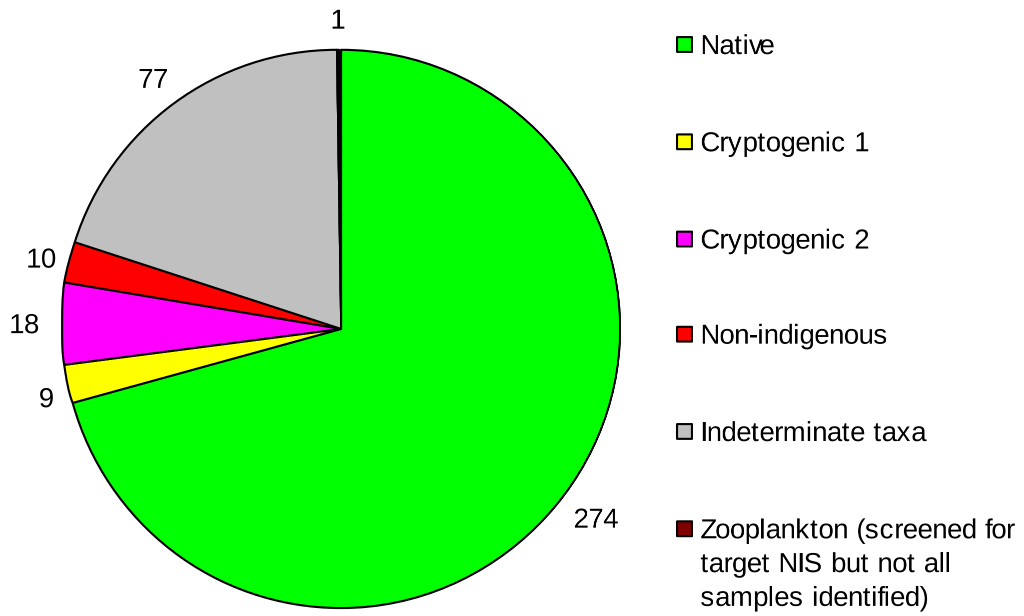

Figure 23: Diversity of marine species sampled in the Kaipara Harbour. Values indicate the number of taxa in each category.

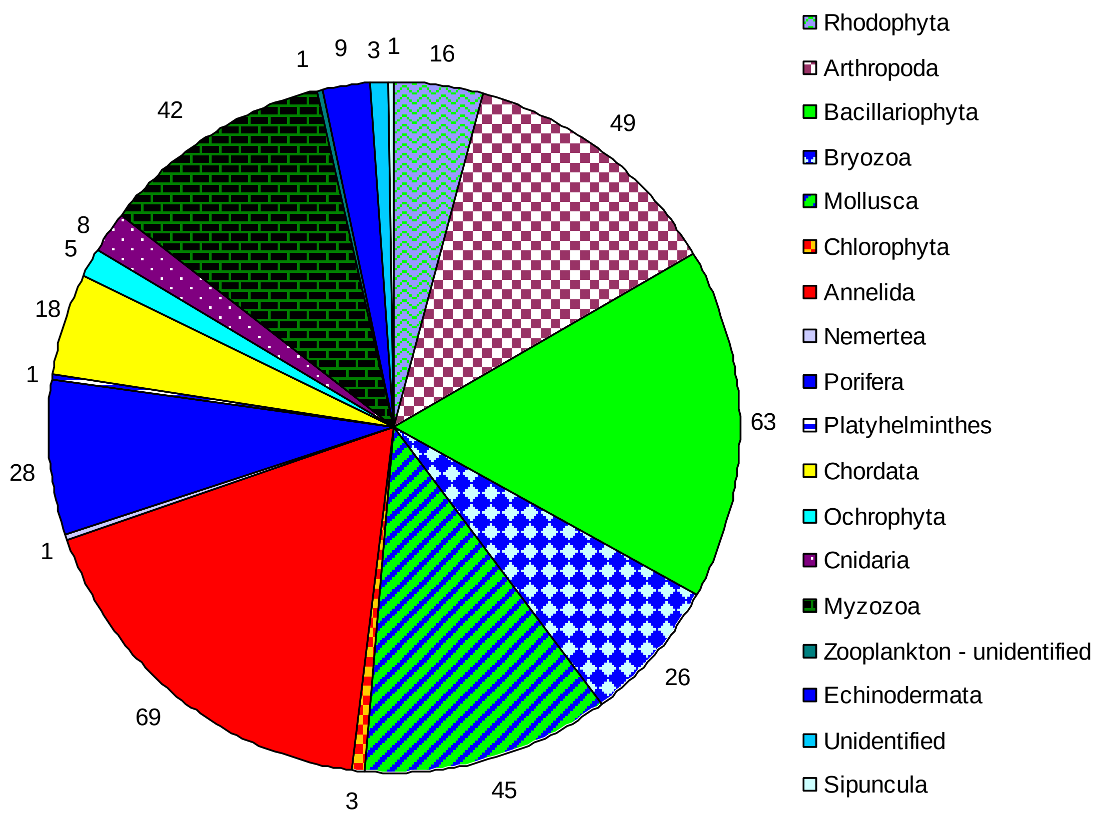

Figure 24: Phyla sampled in Kaipara Harbour. Values indicate the number of taxa in each of the major taxonomic groups.

Native species

The 274 native species recorded during the survey of Kaipara Harbour represented 70 % of all species identified from this location (Table 13) and included diverse assemblages of diatoms (46 species), annelids (44 species), arthropods (42 species), molluscs (39 species), dinoflagellates (29 species), bryozoans (19 species), fish (13 species), sponges (12 species), red algae (10 species), echinoderms (eight species), cnidarians (four species), brown algae (four species), ascidians (three species) and one Magnoliophyta (Table 13).

Non-indigenous species

The 10 non-indigenous species (NIS) recorded in the survey of the Kaipara Harbour included three bryozoans, three molluscs, two crustaceans, one annelid and one sponge (Table 14).

None of the NIS are new to New Zealand. Eight of the NIS are known to have been present in New Zealand for at least 30 years, while the remaining two; the amphipod *Jassa slatteryi* and the sponge *Amphilectus fucorum* have been present since 1990 and 2001, respectively. A list of Chapman and Carlton's (1994) criteria (see "Definitions of Biosecurity Status", above) that were met by the non-indigenous species sampled in this survey is given in Table 11.

Available information on the ecology of each NIS species, its global and New Zealand distribution, vectors and potential impacts is provided in Appendix 6. The local distributions as recorded during the port survey are mapped below for each species. These maps are composites of multiple replicate samples. Where overlayed presence and absence symbols occur on the map, this indicates that the species was found in at least one but not all replicates at that precise location.

Dipolydora armata (Langerhans, 1880)

Dipolydora armata occurred in one anchor box dredge sample taken at the Ruawai Slipway (Figure 25).

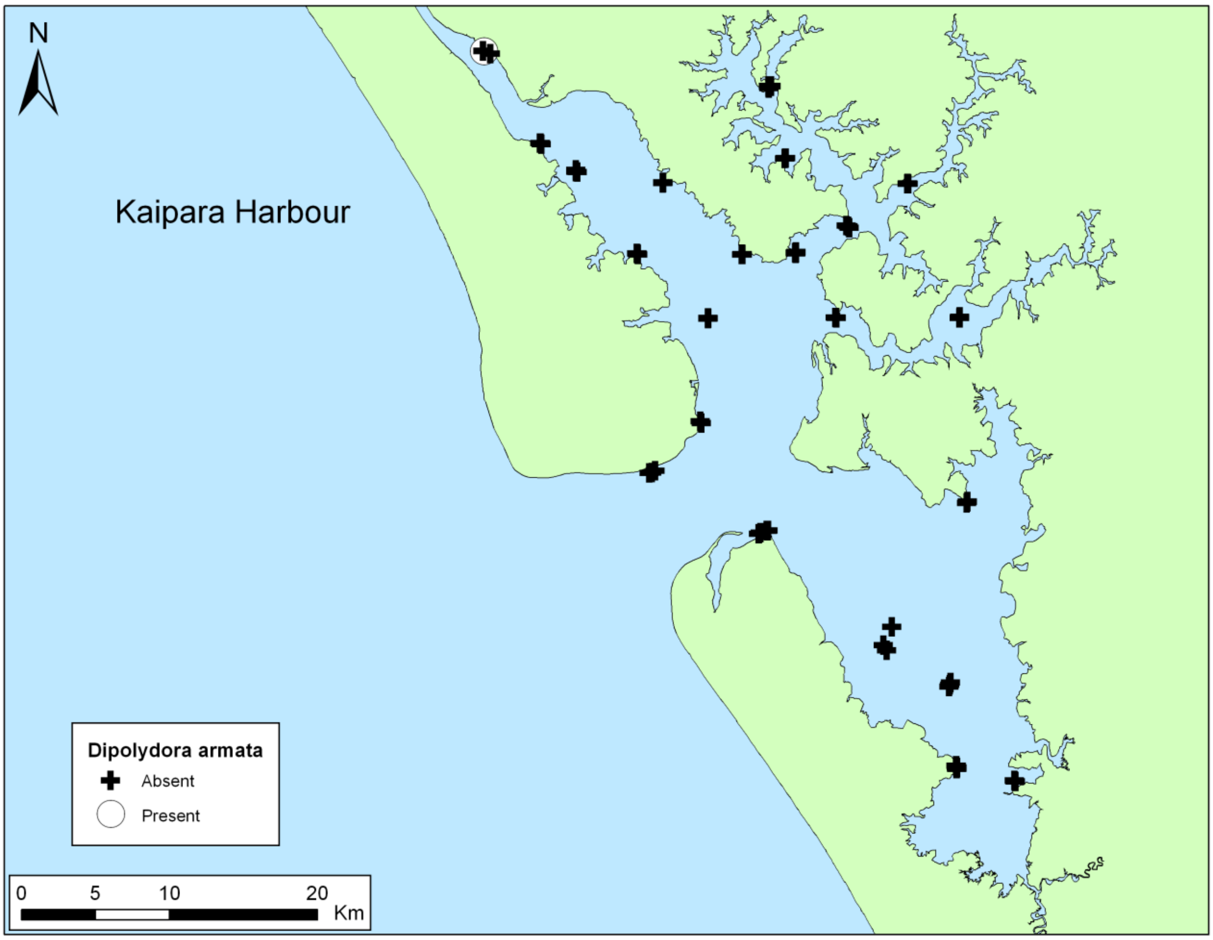

Figure 25: ***Dipolydora armata* distribution in the Kaipara Harbour survey**

Jassa slatteryi (Conlan, 1990)

Jassa slatteryi occurred in one anchor box dredge sample and one pile scrape sample at the Te Whau Point Slipway (

Figure 26).

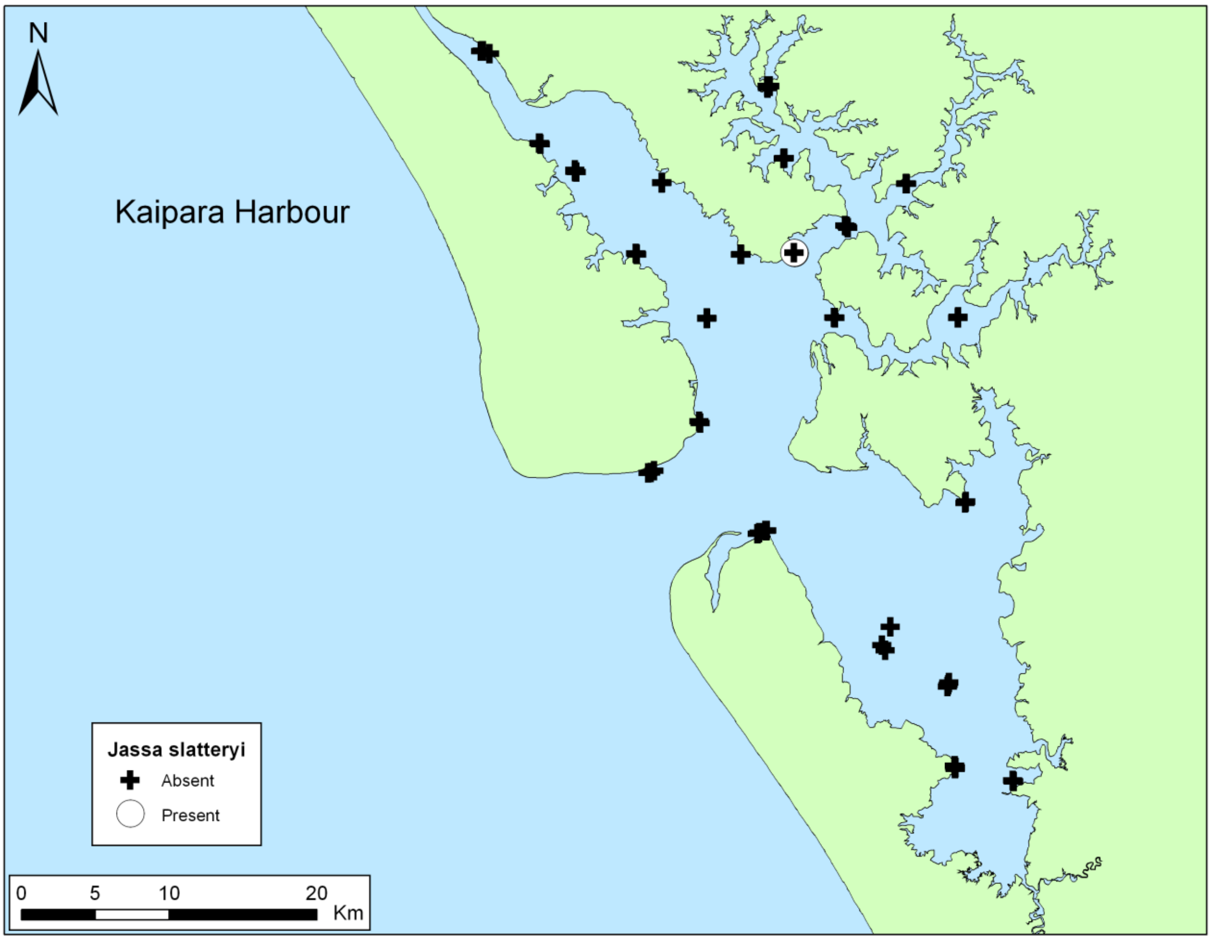

Figure 26: ***Jassa slatteryi*** **distribution in the Kaipara Harbour survey**

Pyromaia tuberculata **(Lockington, 1877)**

Pyromaia tuberculata occurred in four benthic sled samples at The Funnel, Kapua Point, Karaka Point and Kaipara River 3 (

Figure 27).

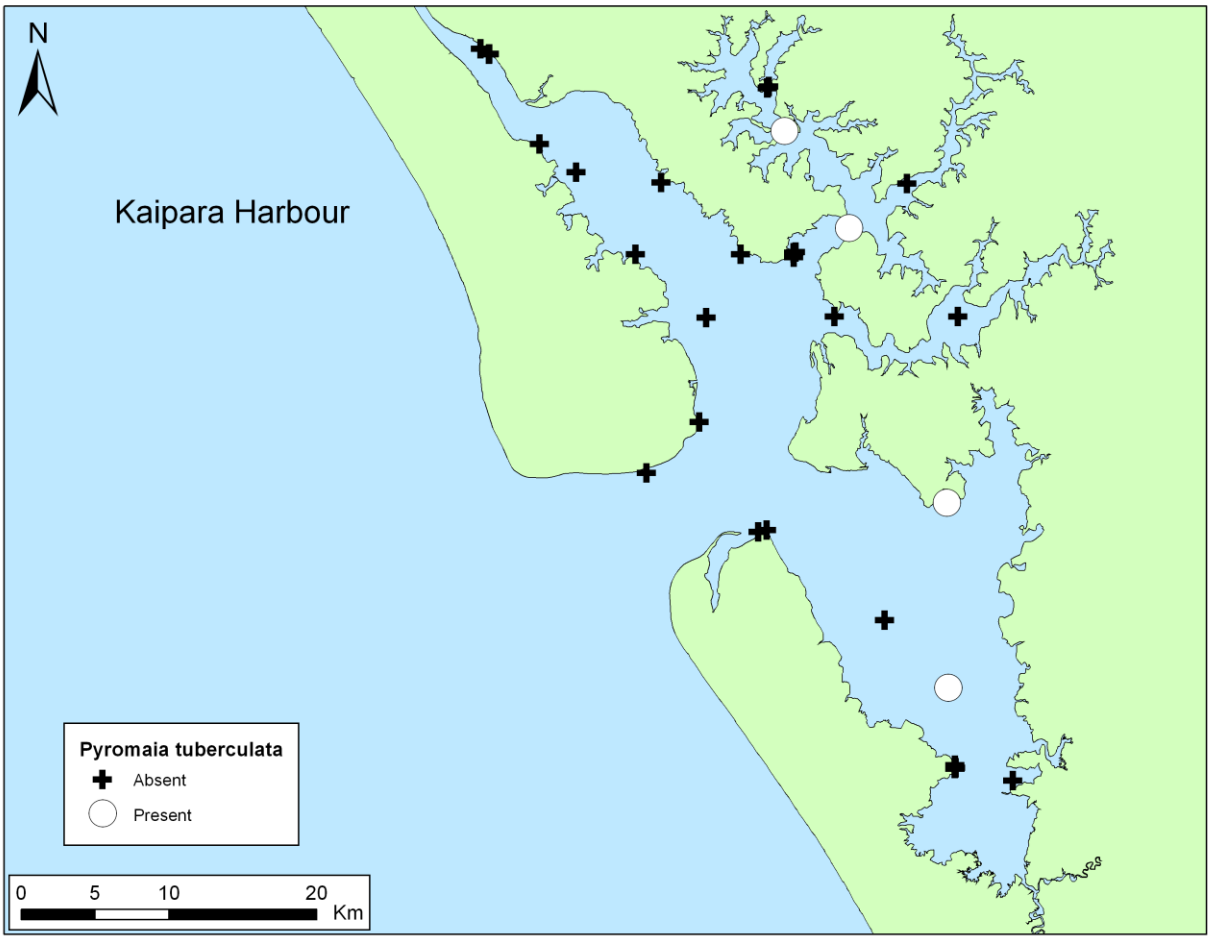

Figure 27: *Pyromaia tuberculata* distribution in the Kaipara Harbour survey

Conopeum seurati (Canu, 1928)

Conopeum seurati occurred in four samples; two anchor box dredge samples in Ruawai Slipway and Pahi Slipway and two pile scrape samples at Shelly Beach Slipway (

Figure 28).

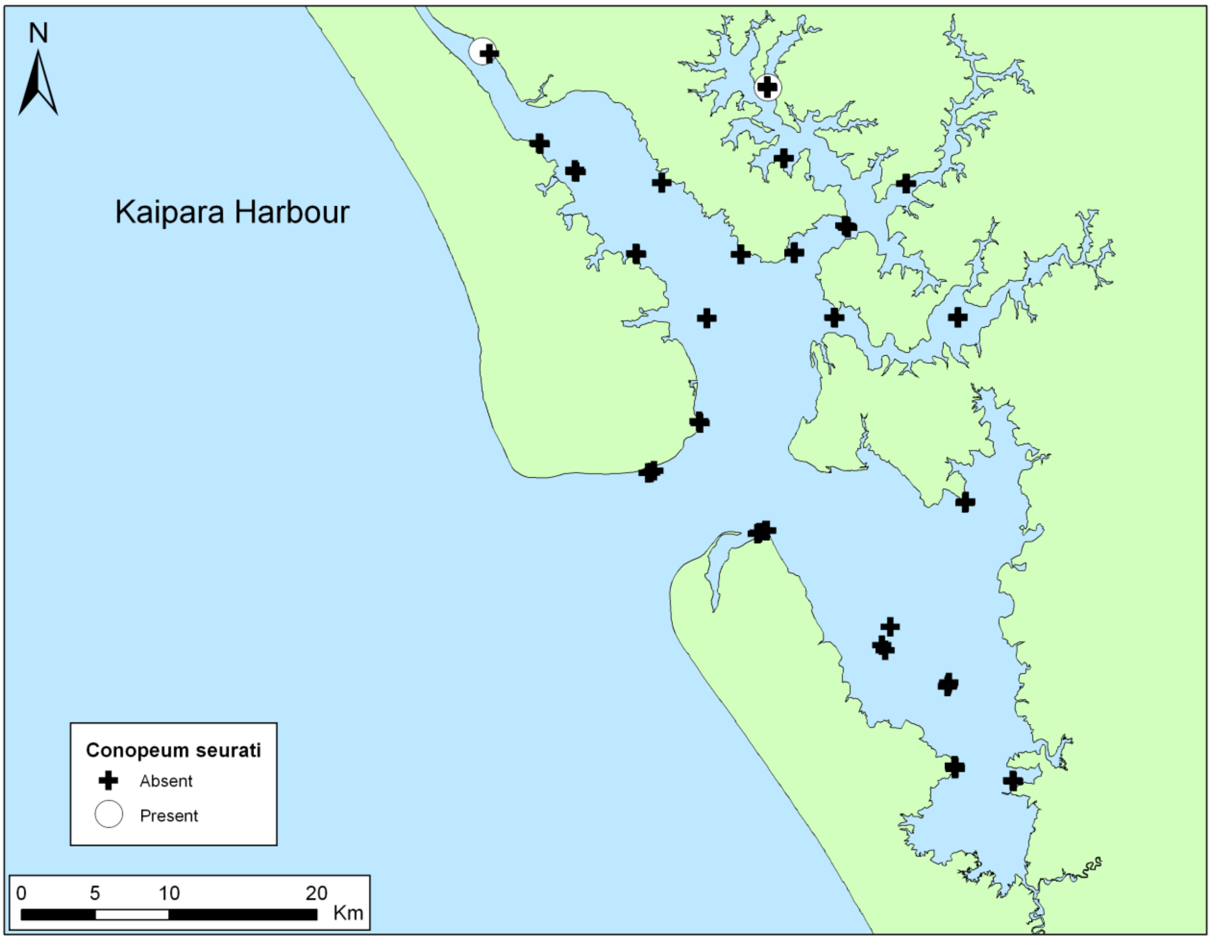

Figure 28: ***Conopeum seurati*** **distribution in the Kaipara Harbour survey**

Anguinella palmata (Van Beneden, 1845)

Anguinella palmata occurred in one benthic sled sample at Kapua Point (

Figure 29).

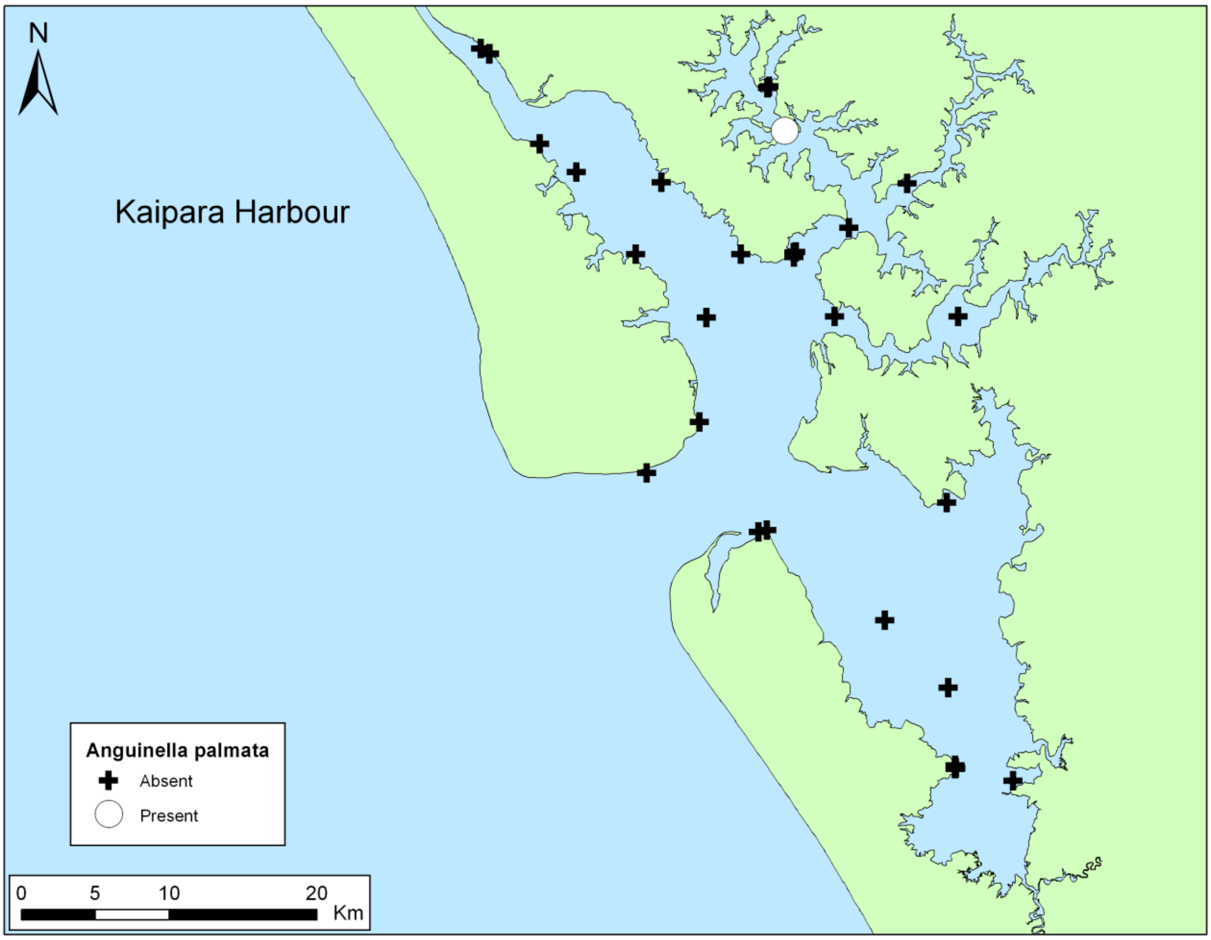

Figure 29: ***Anguinella palmata*** **distribution in the Kaipara Harbour survey**

Bowerbankia gracilis **(Leidy, 1855)**

Bowerbankia gracilis occurred in one anchor box dredge sample at Pahi Slipway (

Figure 30).

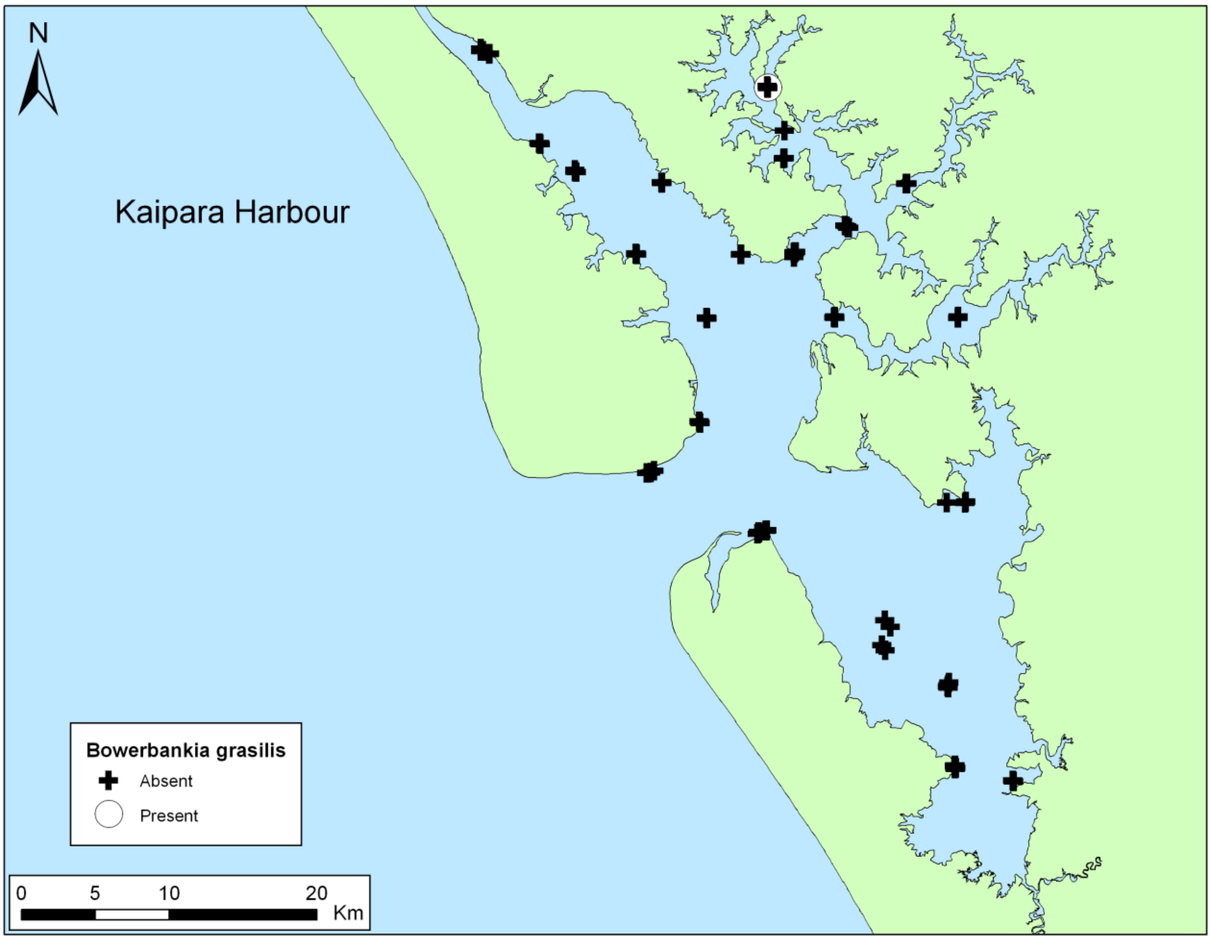

Figure 30: ***Bowerbankia gracilis*** **distribution in the Kaipara Harbour survey**

***Musculista senhousia* (Benson, 1842)**

Musculista senhousia occurred in 19 samples. Ten were anchor box dredge samples; three at Kapua Point, three at Bushy Point, two at Pakaukau Point and one at Hargreaves Point and Karaka Point (

Figure 31). Nine were benthic sled samples; one each at Ruawai Slipway, Pahi Landing, Pahi Slipway, Kapua Point, Motikumara Point, Sail Point, Middle Channel, Pakaukau Point and Bushy Point (

Figure 31).

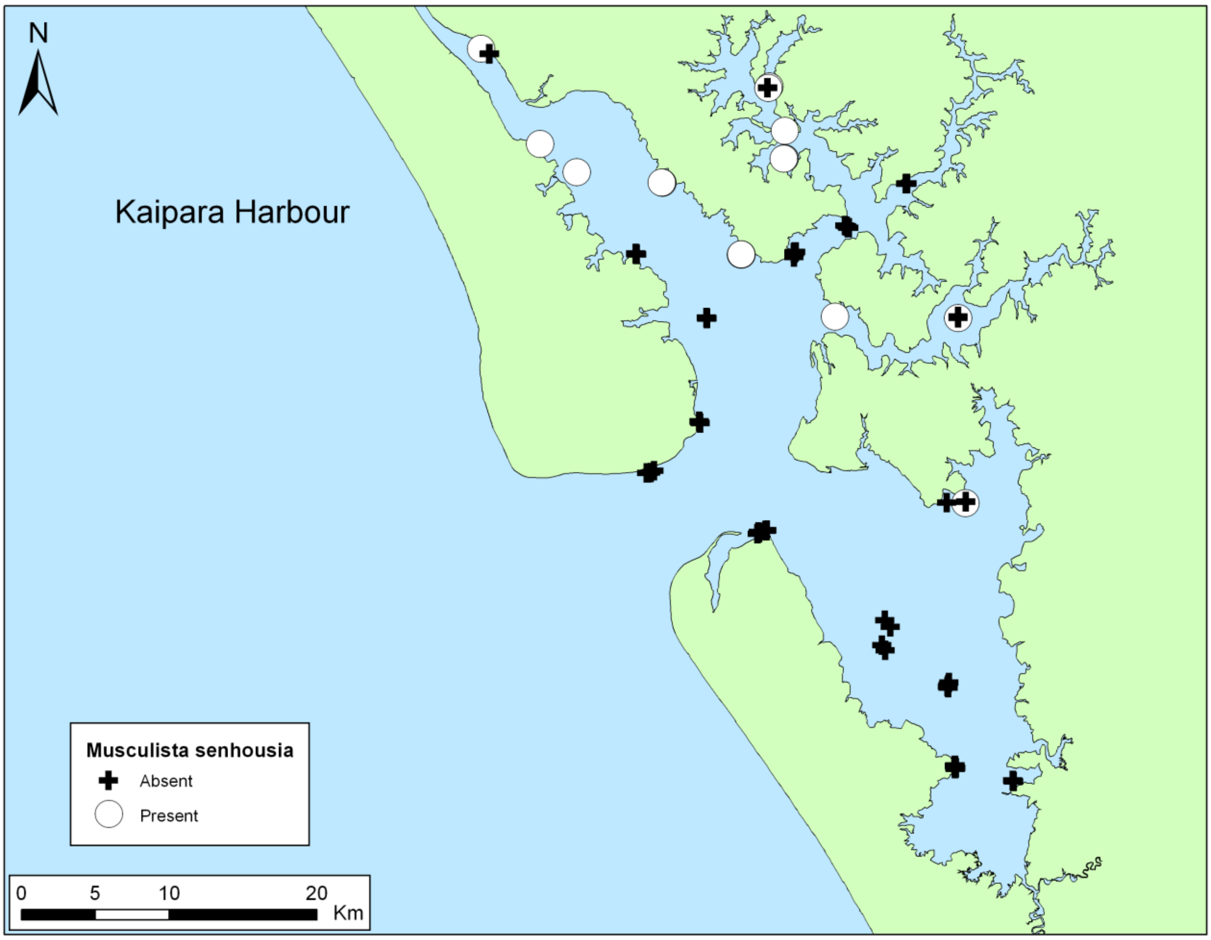

Figure 31: *Musculista senhousia* distribution in the Kaipara Harbour survey

Crassostrea gigas (Thunberg, 1793)

Crassostrea gigas occurred in 17 samples, 14 of which were pile scrape samples; nine at Shelly Beach Slipway and five at Pahi Slipway. Two were anchor box dredge samples found at Ruawai Slipway and Pahi Slipway, and one miscellaneous search at Te Whau Point Slipway (
Figure **32**).

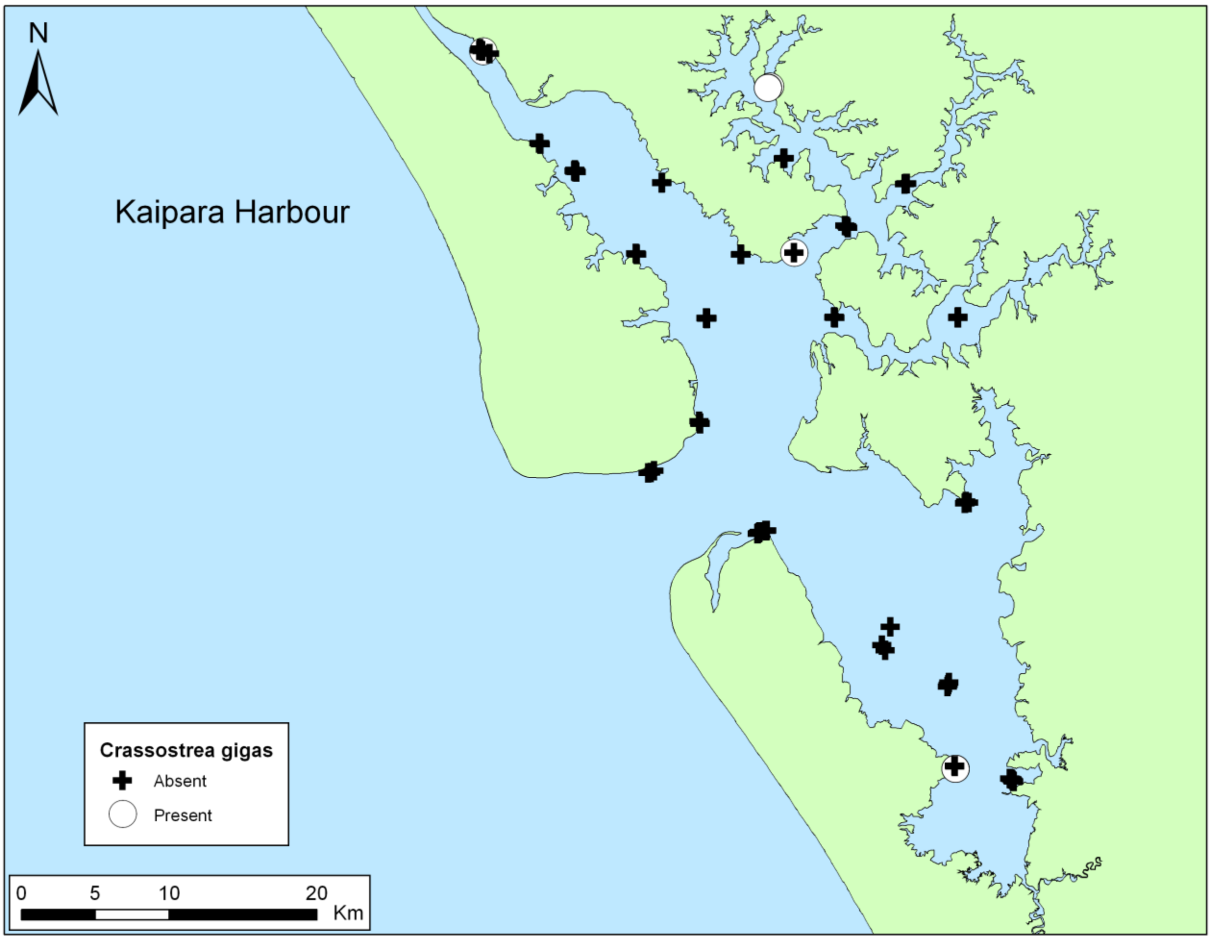

Figure 32: ***Crassostrea gigas* distribution in the Kaipara Harbour survey**

Theora lubrica (Gould, 1861.)

Theora lubrica occurred in 13 samples. Eight were anchor box dredge samples; three at Pakaukau Point, two at Hargreaves Point, and one at Shelly Beach Slipway, Shelly Beach Landing and Bushy Point. Five were benthic sled samples; one found at Te Hoanga Point, Hargreaves Point, Shelly Beach Landing, Pakaukau Point and Bushy Point (
Figure **32**).

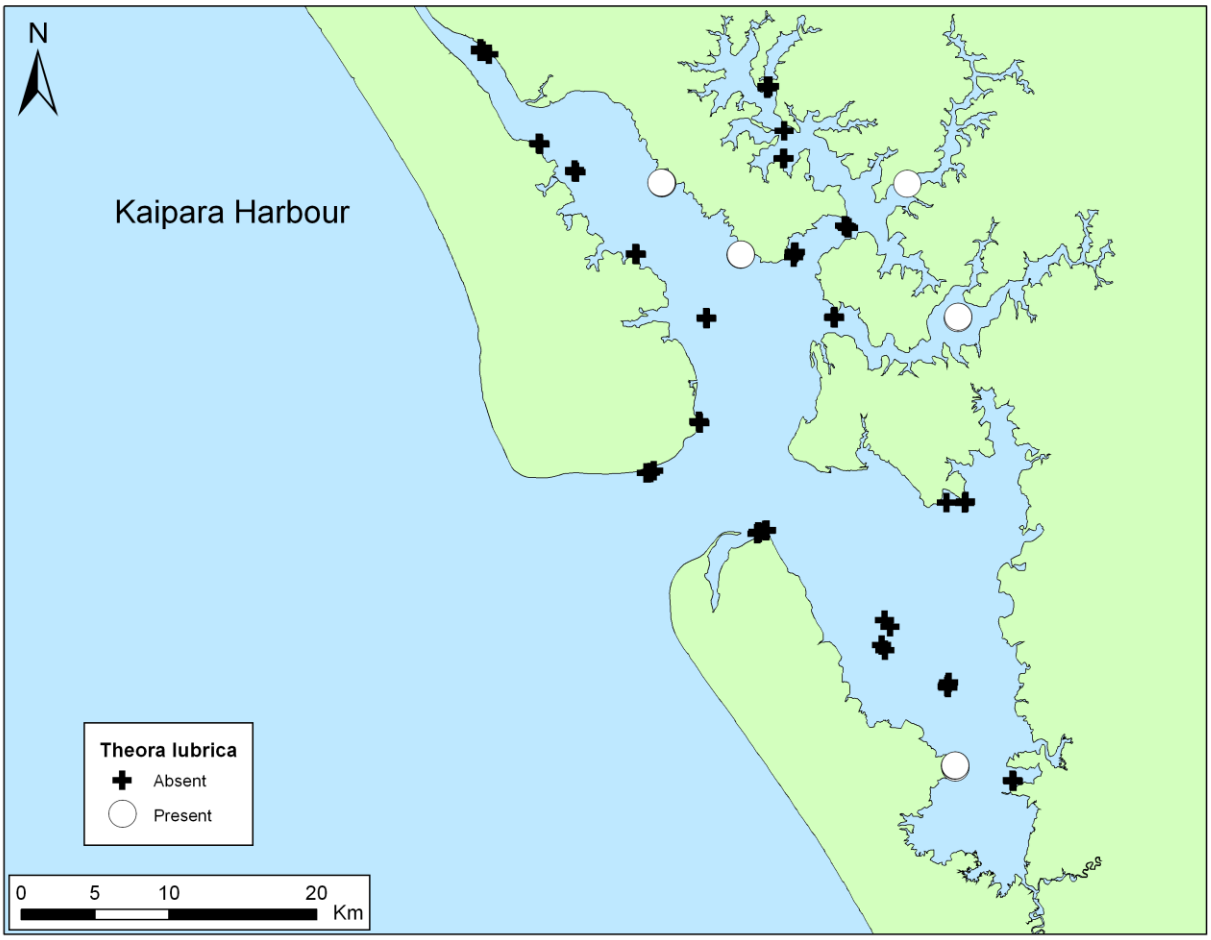

Figure 33: *Theora lubrica* **distribution in the Kaipara Harbour survey**

Amphilectus fucorum (Esper, 1794)

Amphilectus fucorum occurred in one anchor box dredge at Kaipara River 3 (
Figure **34**).

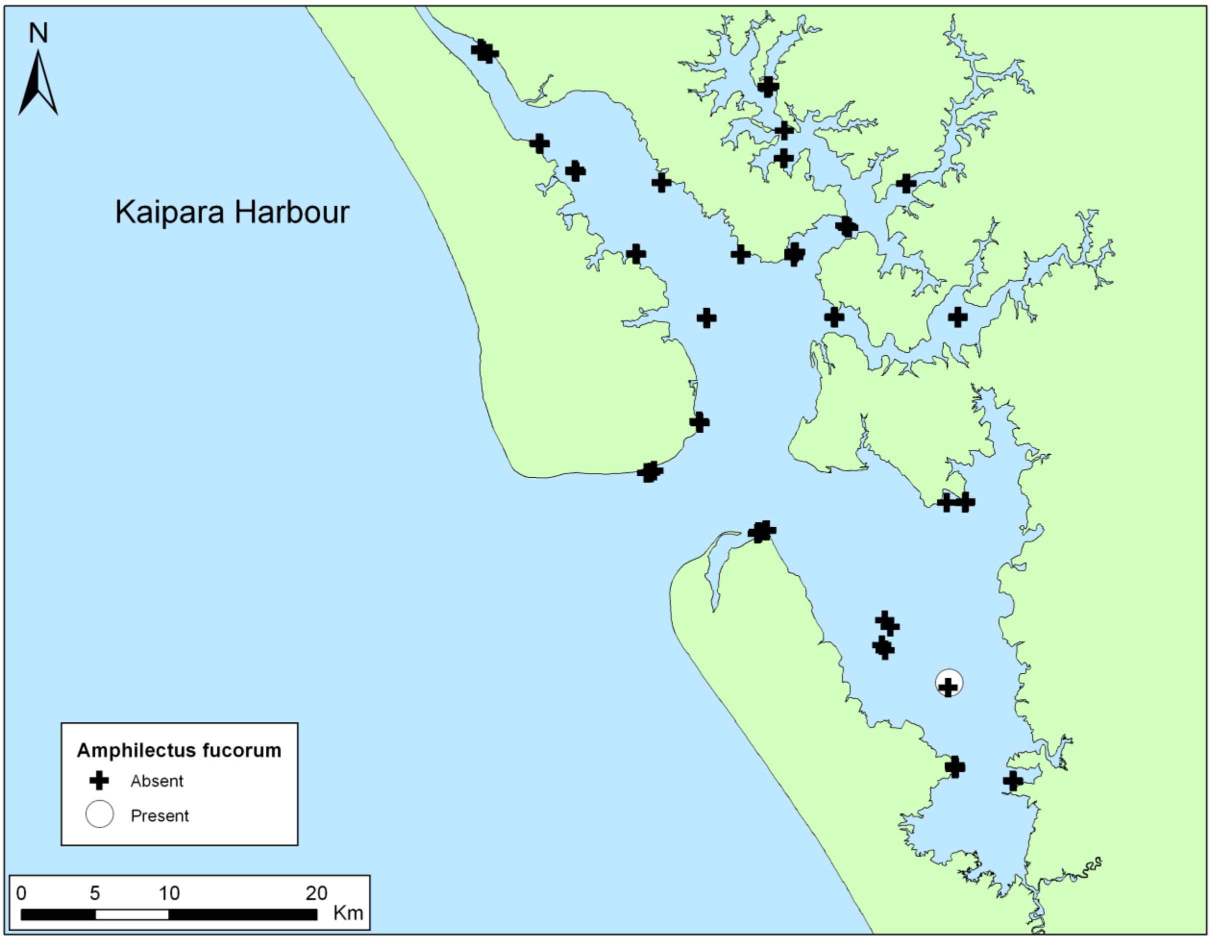

Figure 34: *Amphilectus fucorum* distribution in the Kaipara Harbour survey

Cryptogenic category one taxa (C1)

There were nine cryptogenic category one (C1) taxa recorded from the Kaipara Harbour survey, representing 2.3 % of all species or higher taxa recorded. These organisms included three sponges, three dinoflagellates, one crustacean, one ascidian and one cnidarian (Table 15). A list of Chapman and Carlton's (1994) criteria (see "Definitions of Biosecurity Status", above) that were met by the cryptogenic category one species recorded in this survey is given in Table 11.

One of the taxa included in the C1 category, *Didemnum* sp., encompasses a genus rather than an individual species, due to difficulties in identification of species within this genus. The genus *Didemnum* includes at least two species that have recently been reported from within New Zealand (*D. vexillum* and *D. incanum*) and two related, but distinct species from Europe (*D. lahillei*) and the north Atlantic (*D. vestum* sp. nov.) that have displayed invasive charactertistics (i.e. sudden appearance and rapid spread, Kott 2004b, 2004a). All can be dominant habitat modifiers. The taxonomy of the Didemnidae is complex and it is difficult to identify specimens to species level. The colonies do not display many distinguishing characters at either species or genus level and are comprised of very small, simplified zooids with few distinguishing characters (Kott 2004a). Six species have been described in New Zealand (Kott 2002) and 241 in Australia (Kott 2004a). Most are recent descriptions and, as a result, there are few experts who can distinguish the species reliably. All *Didemnum* specimens were therefore identified only to genus level, including *D. vexillum* which was recorded as a separate species in the literature review. We have reported these species collectively, as a species group (*Didemnum* sp.; Table 15).

None of the C1 taxa are new species records for New Zealand, and all are known from elsewhere in New Zealand. The presence of the sponges *Suberites* cf. *perfectus* and *Ciocalypta* cf. *pencillus* was highlighted by taxonimists as representing an extension to the known range of these organisms in New Zealand.

Available information on the ecology of each C1 species, it's global and New Zealand distribution, vectors and potential impacts is provided in Appendix 6. The local distributions as recorded during the port survey are mapped below for each species. These maps are composites of multiple replicate samples. Where overlayed presence and absence symbols occur on the map, this indicates that the species was found in at least one but not all replicates at that precise location.

Lysmata vittata (Stimpson, 1860)

Lysmata vittata occurred in one miscellaneous search at Te Whau Point Slipway (

Figure 35).

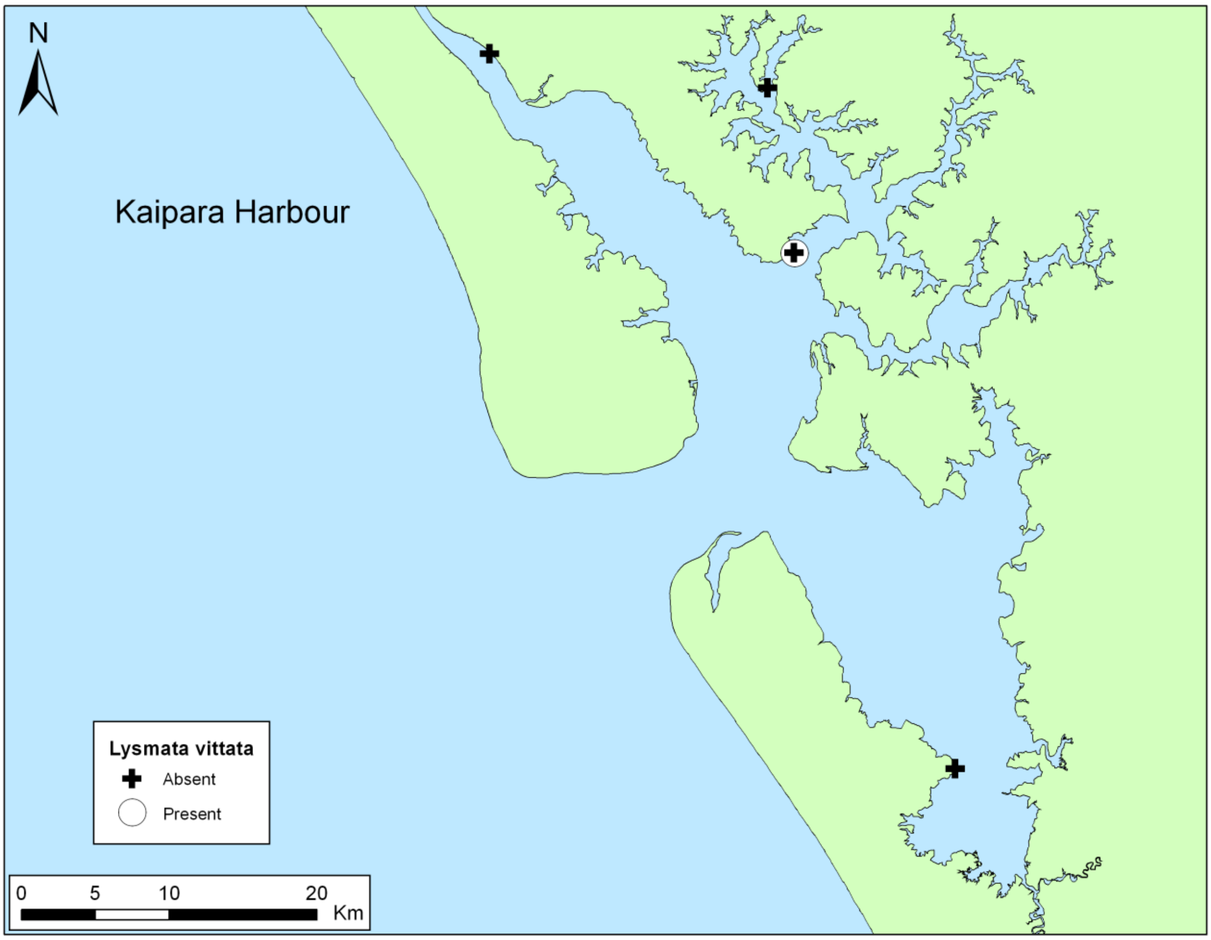

Figure 35: *Lysmata vittata* distribution in the Kaipara Harbour port survey

Didemnum sp.

Didemnum sp. occurred in five pile scrape samples; four at Te Whau Point Slipway and one at Pahi Slipway (

Figure 36).

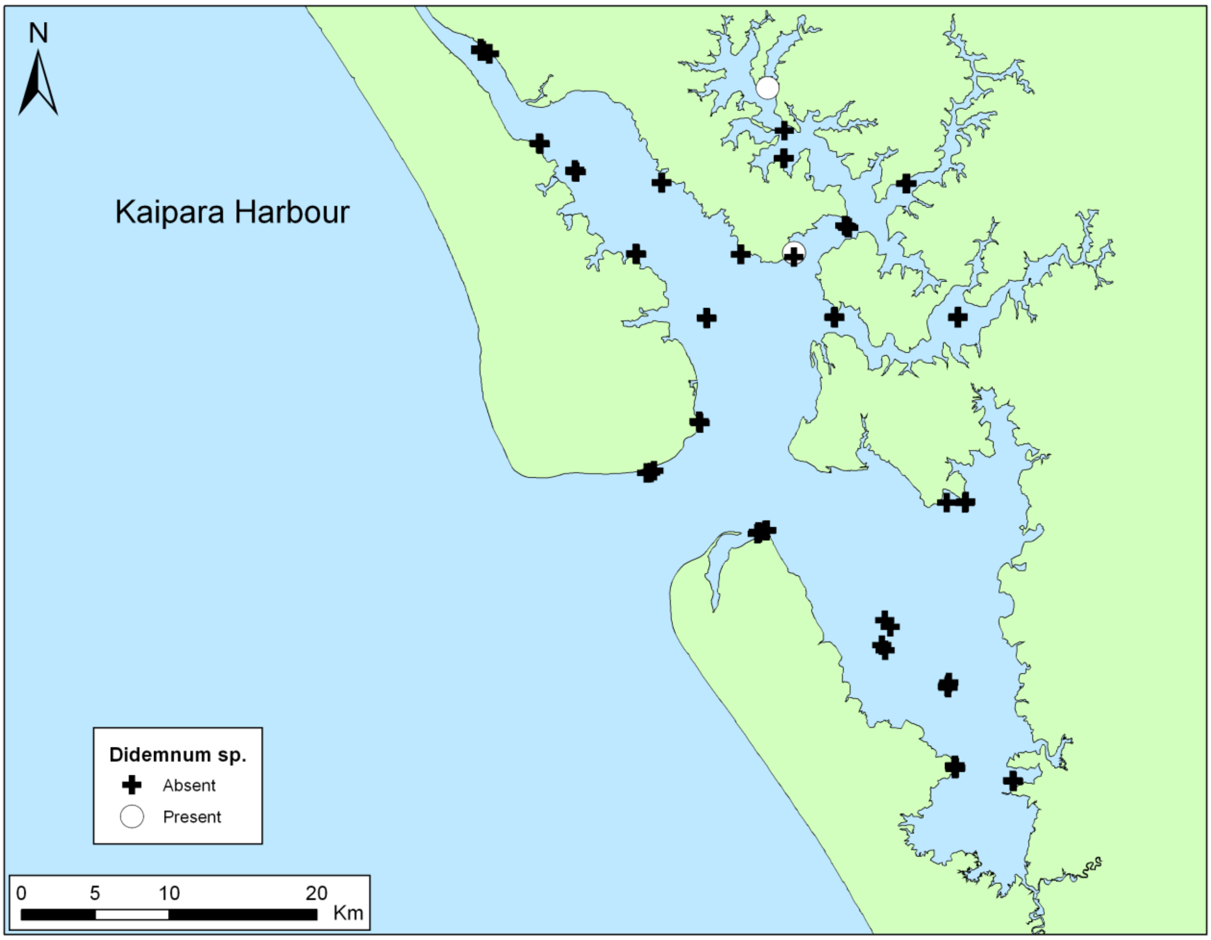

Figure 36: ***Didemnum sp.*** **distribution in the Kaipara Harbour port survey**

Bougainvillia muscus **(Van Beneden, 1844)**

Bougainvillia muscus (Van Beneden, 1844) occurred in four samples; three were anchor box dredge samples, two at Motikumara Point and one at Ruawai Slipway. One was a benthic sled sample at Pahi Slipway (

Figure 37).

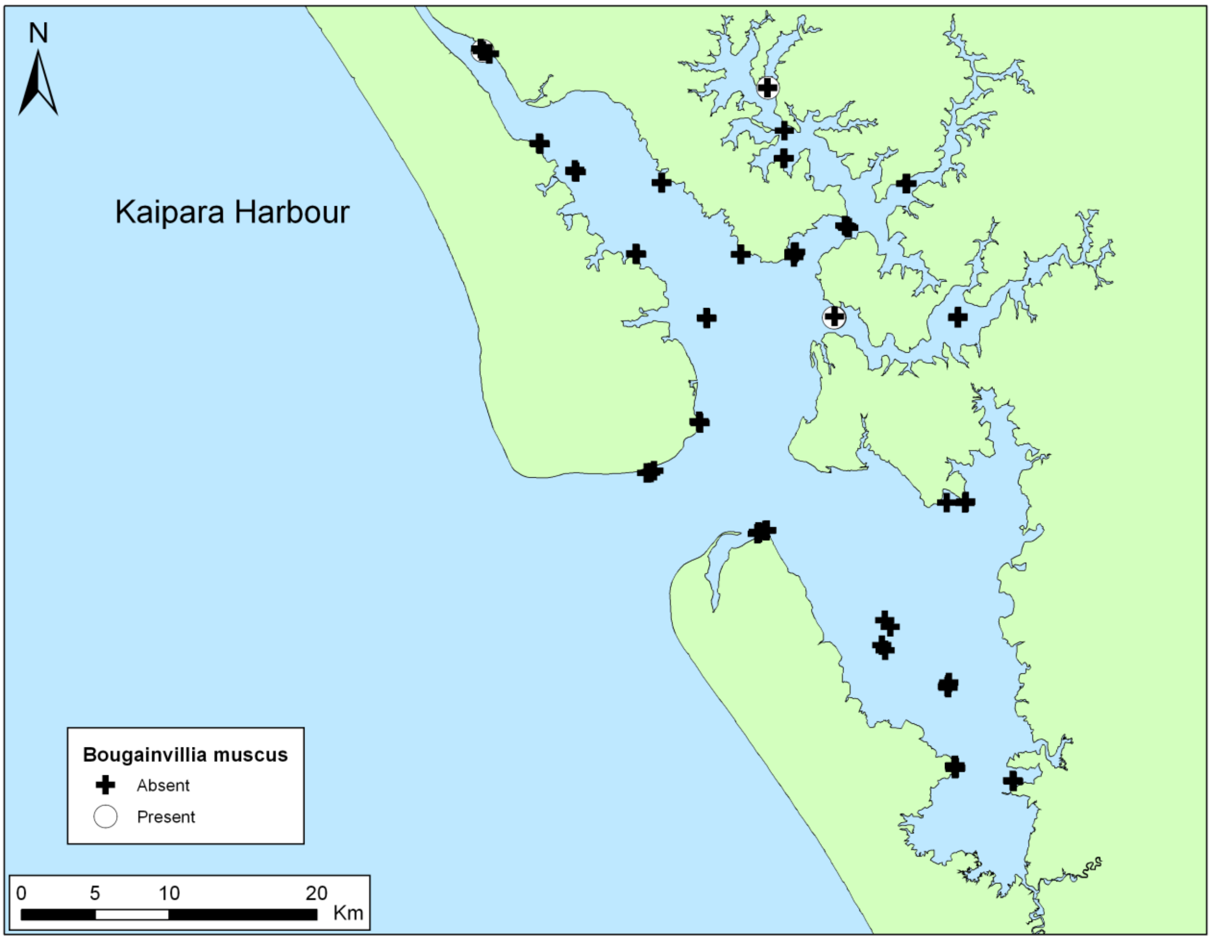

Figure 37: ***Bougainvillia muscus*** **distribution in the Kaipara Harbour port survey**

Gymnodinium catenatum (Graham, 1943)

Gymnodinium catenatum occurred in two cyst samples, one at Kapua Point and one at Ngapuke Creek (

Figure 38).

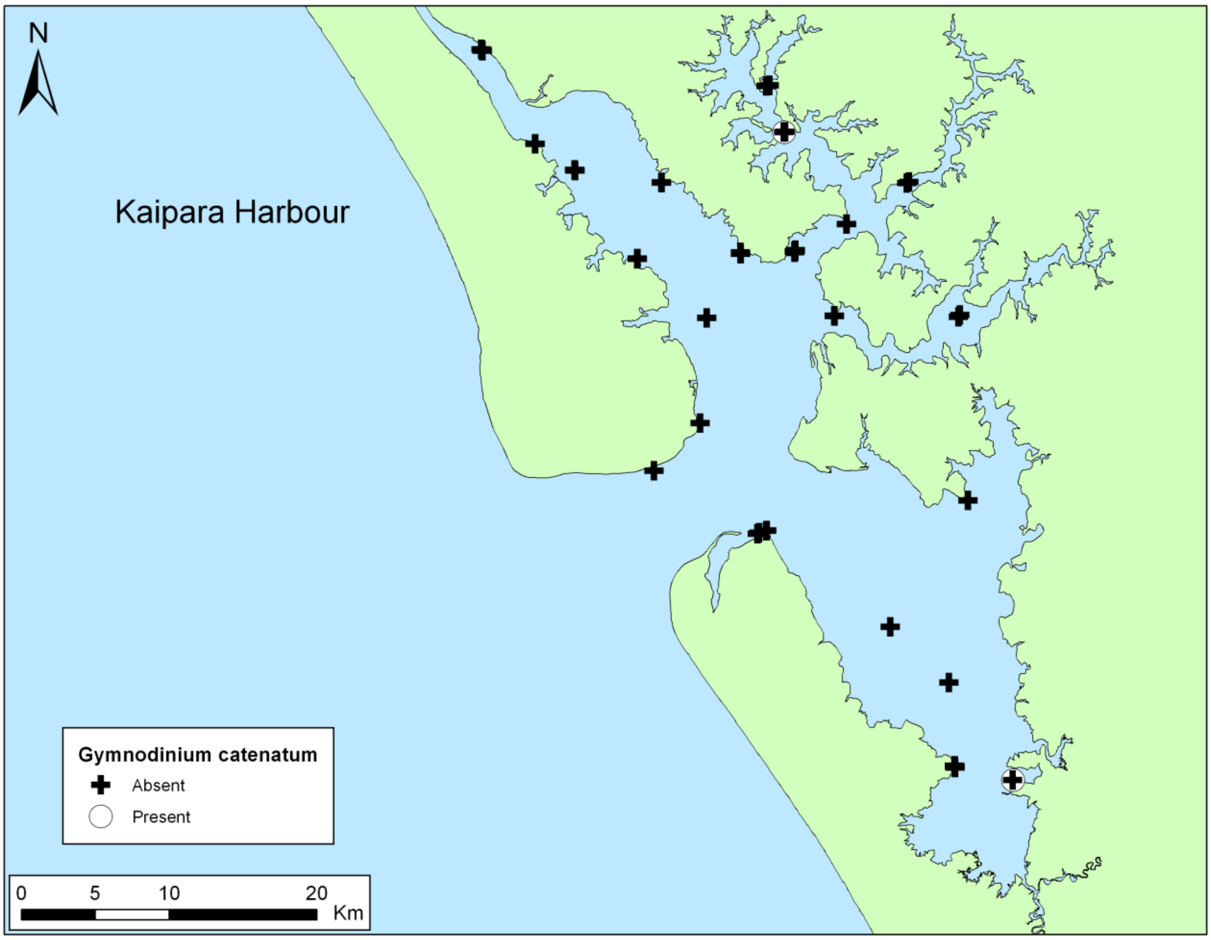

Figure 38: *Gymnodinium catenatum* distribution in the Kaipara Harbour port survey

Alexandrium affine (Inoue & Fukuyo 1985) E. Balech

Alexandrium affine occurred in two samples; a cyst sample at Middle Channel and a phytoplankton tow at Five Fathom Channel (
Figure 39).

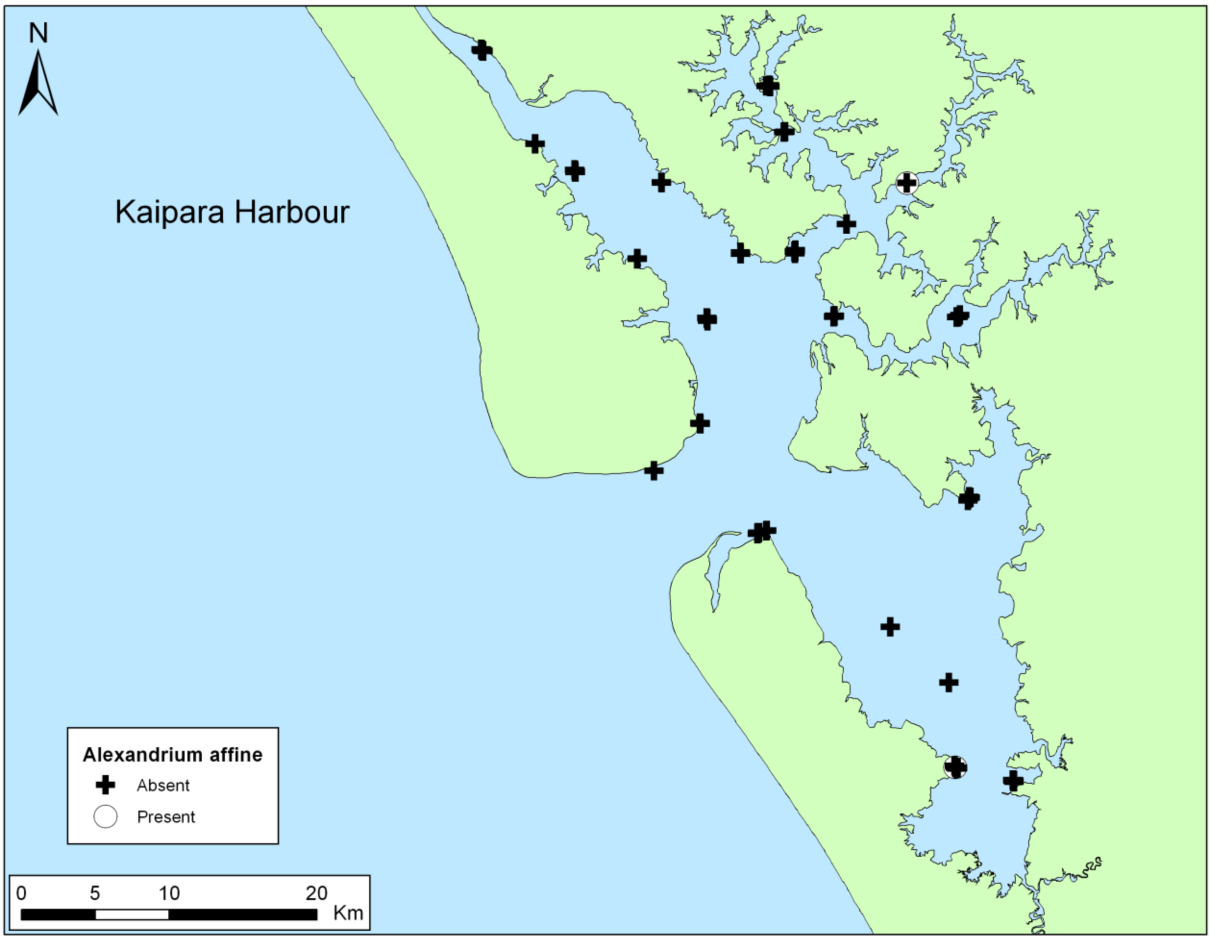

Figure 39: ***Alexandrium affine*** **distribution in the Kaipara Harbour port survey**

Alexandrium catenella (Whedon & Kofoid) E. Balech

Alexandrium catenella occurred in two samples; one cyst sample at Shelly Beach Slipway and one phytoplankton tow at Te Hoanga Point (

Figure 40).

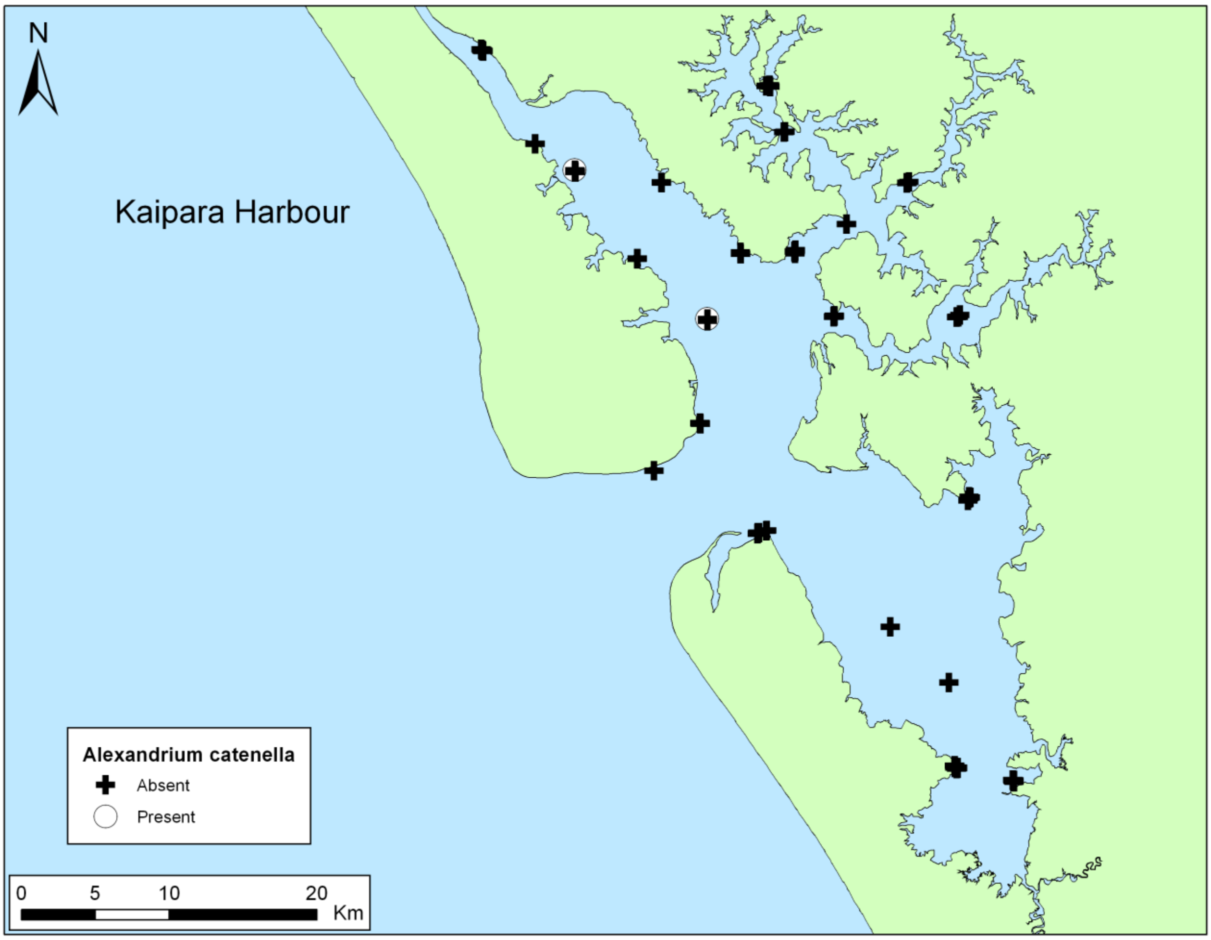

Figure 40: *Alexandrium catenella* distribution in the Kaipara Harbour port survey

Suberites cf. perfectus

Suberites cf. perfectus occurred in one anchor box dredge at Kaipara River 1 (
Figure 41).

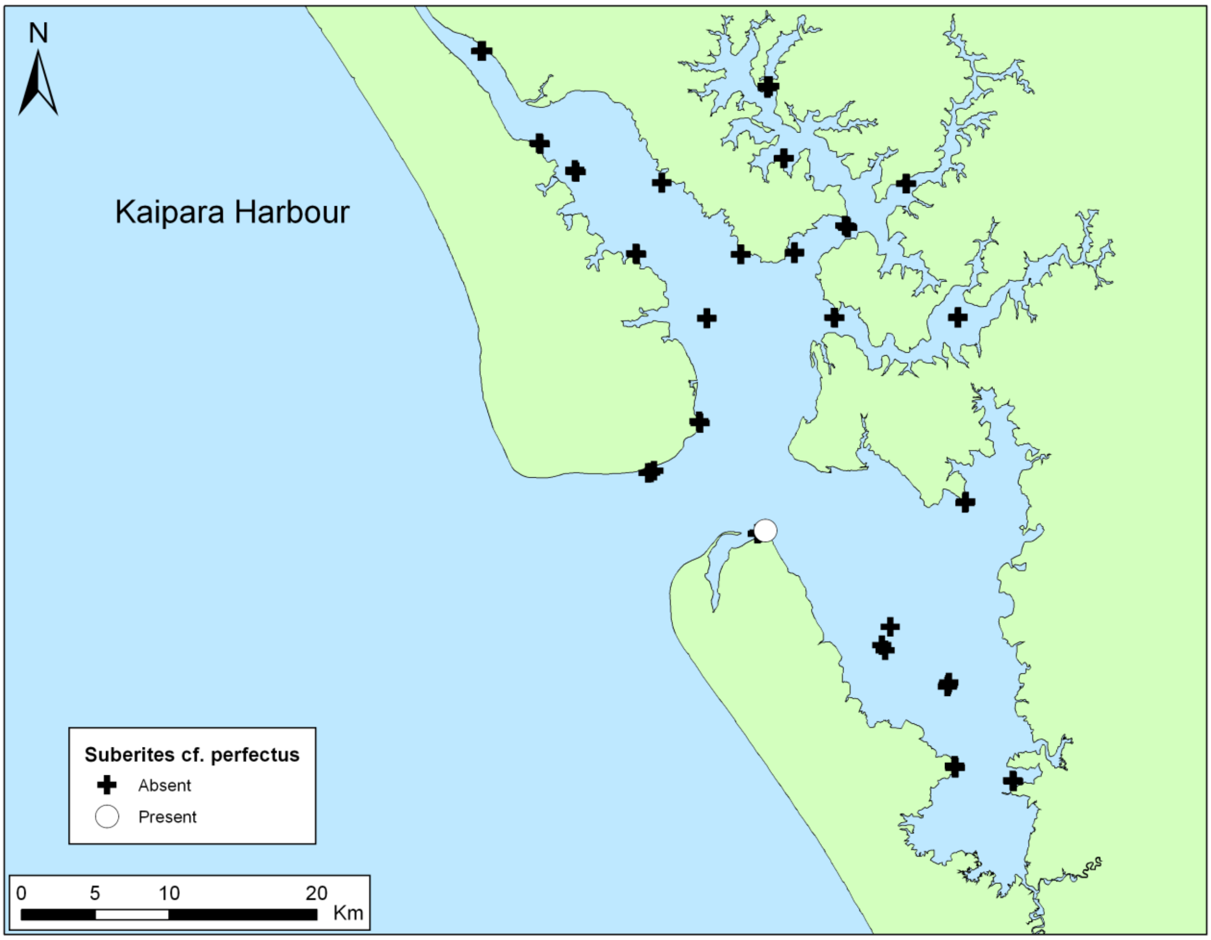

Figure 41: *Suberites cf. perfectus* distribution in the Kaipara Harbour port survey

Ciocalypta cf. *pencillus*

Ciocalypta cf. *pencillus* occurred in one anchor box dredge at Middle Channel (
Figure 42).

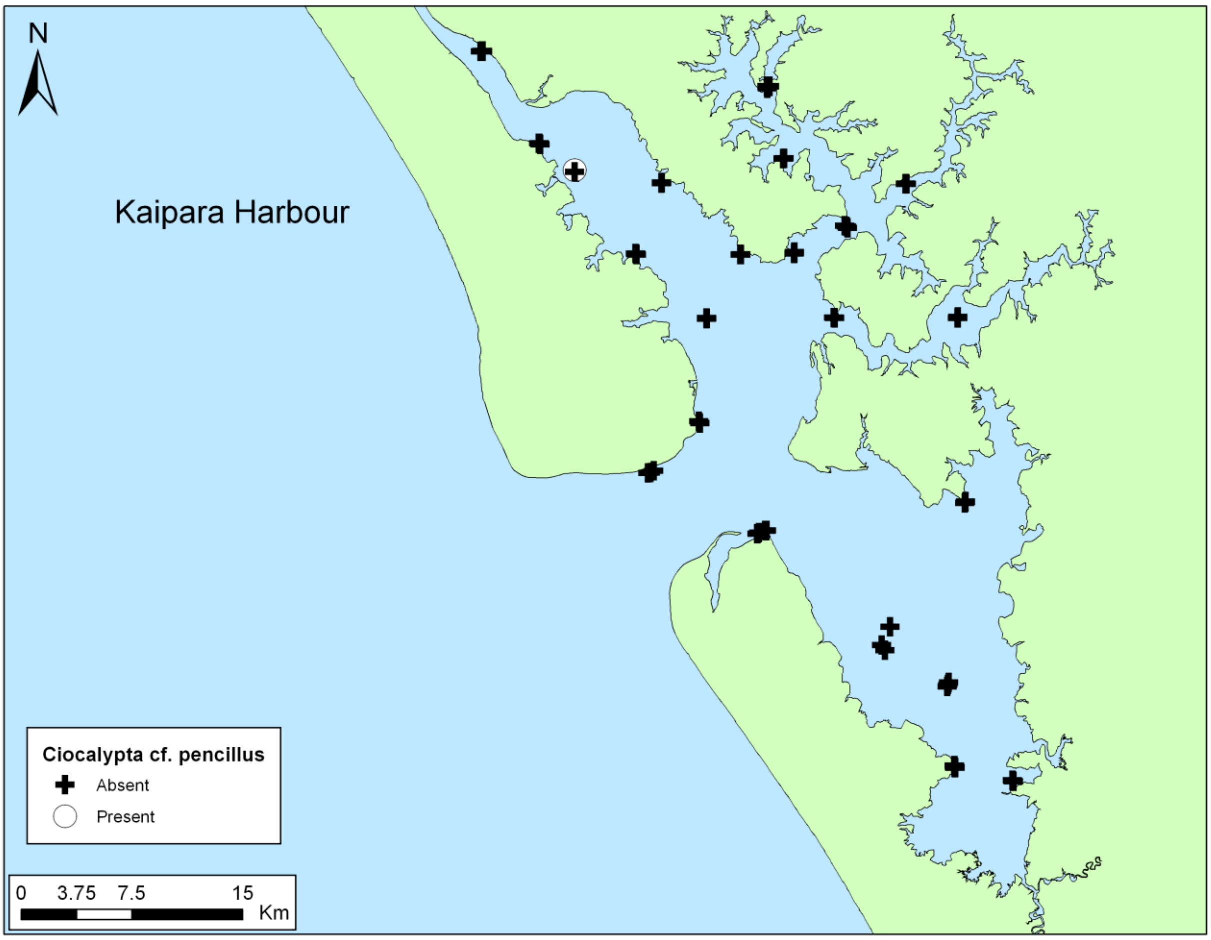

Figure 42: ***Ciocalypta* cf. *pencillus* distribution in the Kaipara Harbour port survey**

Callyspongia ramosa (Gray, 1843)

Callyspongia ramosa occurred in four samples; two beach wrack samples at Karaka Point, one benthic sled sample at Mussel Rock and one miscellaneous search sample at Te Whau Point Slipway (
Figure 43).

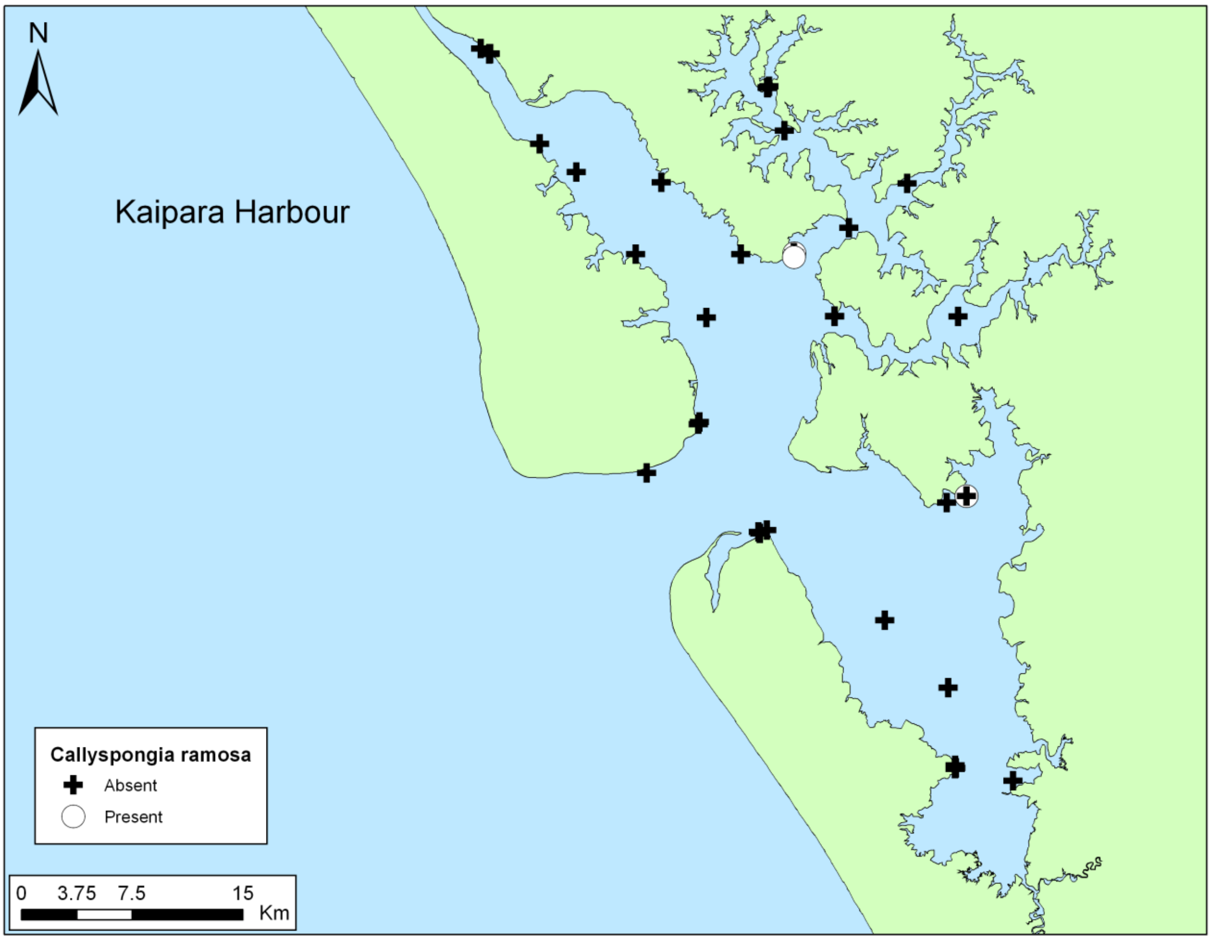

Figure 43: ***Callyspongia ramosa*** **distribution in the Kaipara Harbour port survey**

Cryptogenic category two taxa (C2)

During the survey of Kaipara Harbour, 18 cryptogenic category two (C2) taxa were recorded (Table 16), representing 4.6 % of the total number of taxa identified. These included 12 sponges and six annelid worms. These taxa are recently discovered new species, or might be new species, for which there is insufficient information to determine whether New Zealand lies within their native range. Four of the C2 taxa recorded in the Kaipara Harbour port survey records represent new records in New Zealand. These are; the sponges *Haliclona* new sp. 21, *Adocia* new sp. 10, *Eurypon* new sp. 1 and *Tedania* new sp. 5

Indeterminate taxa

During the Kaipara Harbour survey, 77 organisms were classified as indeterminate taxa. This represents 20 % of all determinations made from this survey (Figure 23). Indeterminate taxa from the Kaipara Harbour survey included 18 annelids, 17 diatoms, 10 dinoflagellates, six Rhodophyta, four arthropods, four bryozoans, three Chlorophyta, three cnidarians, three molluscs, one Ochrophyta, one ascidian, one echinoderm, one flatworm, one nemertean, one sipunculan and three organisms that were unable to be identified to phylum (Table 17).

Zooplankton

No target organisms (the Chinese mitten crab *Eriocheir sinensis* or other members of this genus, the European green crab *Carcinus maenas*, the northern Pacific seastar *Asterias amurensis* and the ascidian *Styela clava*) were identified from any of the zooplankton samples from Kaipara Harbour.

Notifiable and unwanted species

None of the species recorded from the Kaipara Harbour survey are currently listed on the New Zealand Register of Unwanted Organisms (Table 4).

The Australian Consultative Committee on Introduced Marine Pest Emergencies (CCIMPE) has recently endorsed a Trigger List (Table 5) of marine pest species (CCIMPE 2006). Five taxa on this Trigger List were recorded in the survey on Kaipara Harbour. Two taxa on this list are non-indigenous to New Zealand. Exotic invasive strains of the colonial ascidian *Didemnum* sp. are listed as trigger species still exotic to Australia. *Didemnum* sp. was recorded in the Kaipara Harbour port survey (see "Results:

Cryptogenic category one taxa (C1*)*", above). The non-indigenous mollusc *Musculista senhousia*, which was also found in the Kaipara Harbour port survey, is listed as established in Australia, but not widespread. The mollusc *Maoricolpus roseus* is also on this list, however it is considered native to New Zealand. The remaining three species, all diatoms; *Pseudo-nitzschia australis*, *Chaetoceros concavicornis* and *Chaetoceros convolutes* are listed as 'Holoplankton alert species' in Australia, which means that their presence should be notified, but an eradication response within Australia is highly unlikely. These diatoms are all considered native in New Zealand, due to their cosmopolitan oceanic distributions but are listed here as unwanted due to the toxins they produce (see "Range extensions" below).

Australia has also recently prepared an expanded list of priority marine pests that includes 53 non-indigenous species that have already established in Australia and 37 potential pests that have not yet reached its shores (Hayes *et al.* 2005). A similar watch list for New Zealand is currently being prepared by MAF Biosecurity NZ. Five of the 53 Australian priority domestic pests were recorded during the Kaipara Harbour port survey. These are listed in descending order of the impact potential ranking attributed to them by Hayes *et al.* (2005): *Gymnodinium catenatum, Crassostrea gigas, Musculista senhousia, Theora lubrica* and *Bougainvillia muscus.*

The three diatoms present in the survey of Kaipara Harbour and listed above on the CCIMPE Trigger List "Holoplankton alert species" (CCIMPE 2006) are also in the list of 37 priority international pests (ie. those not yet in Australia) identified by Hayes *et al.* (2005). These are listed in descending order of the impact potential ranking attributed to them by Hayes *et al.* (2005): *Pseudo-nitzschia australis, Chaetoceros convolutes* and *Chaetoceros concavicornis*.

Previously undescribed species in New Zealand

Four species recorded from the Kaipara Harbour port survey are new records from New Zealand waters, and all are C2 sponges; *Haliclona* new sp. 21, *Adocia* new sp. 10, *Eurypon* new sp. 1 and *Tedania* new sp. 5

Range extensions

Five taxa record from the Kaipara Harbour port survey was highlighted as representing an extension to the known range of the species in New Zealand. These were: the crustacean *Lysmata vittata* (C1; previously known from Viaduct Harbour and Westhaven Marina), the sponges *Suberites* cf. *perfectus* (C1; previously known from Great Barrier, Whangapoua, Major Island, Rangitoto Channel and Three Kings), *Ciocialypta* cf. *pencillus* (C1; previously known from the Hauraki Gulf, Colville Channel and Bay of Plenty) and *Ciocalypta colvilii* (Native; previously known from the Hauraki Gulf, Bay of Plenty and Little Barrier Island) and the red alga *Gracilaria* sp. Indet. (Indeterminate; previously known from Manukau Harbour and Orakei Basin (Waitamata Harbour)).

Cyst- and toxin-producing species

Cysts of 20 dinoflagellate taxa (Phylum Myzozoa) were collected during this survey of which nine of are considered native species (Table 13), three are C1 taxa (Table 15) and the remaining eight could not be identified and are therefore classed as indeterminate (Table 17). One native species, *Protoceratium reticulatum* and three C1 taxa, *Alexandrium catenella, Gymnodinium catenatum* and *Alexandrium ostenfeldii* are known to be produce toxins, as described below.

Of the organisms identified from the phytoplankton samples (85 different dinoflagellate and diatom taxa, 66 are considered native species (Table 13), and the remaining 19 are inderterminate (Table 17). Six of the native species (*Pseudo-nitzschia australis, Chaetoceros* *convolutes*, *Dinophysis acuminata*, *Dinophysis acuta*, *Dinophysis tripos* and *Chaetoceros concavicornis*) are known to be harmful (see below).

Protoceratium reticulatum, *D. acuta* and *D. tripos* are associated with Diarrhetic Shellfish Poisoning (DSP) events, but no blooms have been reported for *D. tripos* (Faust and Gulledge 2002).

Dinophysis acuminata is a toxic bloom-forming marine planktonic dinoflagellate that is also associated with Diarrhetic Shellfish Poisoning (DSP) events. The species is distributed widely in temperate waters and has been recorded from most parts of the New Zealand coast (Hay *et al.* 2000; Faust and Gulledge 2002 and references therein; New Zealand Food Safety Authority 2003). It is most abundant in the coastal northern Atlantic and Pacific, especially in eutrophic areas (Faust and Gulledge 2002 and references therein). Blooms have been reported from many parts of the world, including New Zealand (Faust and Gulledge 2002 and references therein; New Zealand Food Safety Authority 2003). *D. acuminata* can cause shellfish toxicity at very low cell concentrations, but weak or no toxicity has also sometimes been reported in the presence of dense blooms of this species (Faust and Gulledge 2002; Moestrup 2004 and references therein).

Alexandrium catenella, *Gymnodinium catenatum* and *Alexandrium ostenfeldii* are known to produce Paralytic Shellfish Poisoning (PSP) (Faust and Gulledge 2002). *G. catenatum* is the only gymnodinioid that is capable of producing PSP. Toxin profiles of different populations of *G. catenatum* show quite different toxin components. The Spanish strains tend to produce a high proportion of the low potency sulfocarbamoyl toxins, while strains in warmer waters from Singapore tend to produce highly potent carbamate gonyautoxin as dominant toxins (GTX1 and 4), with lesser amount of GTX2, GTX3, neosaxitoxin (neoSTX) and saxitoxin (STX).

Pseudo-nitzschia australis can produce a domoic acid, which causes Amnesic Shellfish Poisoning (ASP, New Zealand Food Safety Authority 2003). However, not all isolates of *P. australis* in New Zealand have been confirmed to produce domoic acid (Hay *et al.* 2000).

Another two native diatom species recorded from the phytoplankton samples, *Chaetoceros convolutus* and *C. concavicornis*, are also worth noting. Although no direct toxic effects are known for these two species, their barbed setae can become lodged in fish gills, causing death (Kraberg and Montagnes 2007).

Depth stratification trends

Analysis of depth stratification excludes zooplankton tows as each sample taken with this method involves sampling the entire water column.

Sampling effort was greatest in the top five metres of water and decreased steadily with greater depth (Figure 44). The proportion of native taxa recorded from different depth classes approximately reflected the sampling effort conducted in each depth class. Both the greatest proportion of samples (57 %) and the highest proportion of native taxa (59 %) was recorded between 0 m and 5 m depth. Despite the smaller sampling effort in the 5-10m depth class (23 % of samples), the greatest proportion of NIS and C1 taxa (74 %) were collected in this depth range.

Of the 19 NIS and C1 taxa analysed for depth stratification, 18 (95 %) were collected between 0 m and 10 m depth (11 (59 %) from the 0-5 m depth class alone and 14 (74 %) from the 5-10 m depth class alone; Table 18). The only taxon that was not collected in samples from 0 m to

10 m depth was the sponge Amphilectus fucorum, which was collected from a single anchor box dredge sample at a depth of 22 m. Of the 18 taxa collected in the top 10 m of water, 14 were not recorded from deeper samples, while *Theora lubrica*, *Musculista senhousia* and *Pyromaia tuberculata* were collected each from a single sample from greater depths and *Bougainvillia muscus* was collected from two samples at a greater depth. The sponge *Callyspongia ramosa* was found in two samples on shore but not at greater depths.

Of the 272 native taxa analysed for depth stratification, 238 (88 %) were recorded between 0 m and 10 m depth (201 (74 %) from the 0-5 m depth class alone and 103 (38 5) from the 5-10 m depth class alone; Table 19). The large proportion of taxa recorded in the 0-5 m depth class is due to the large number of samples that were recorded in phytoplankton tows (39 of a total of 368 (37 %) specimens collected), which were done at a depth of 0.5 m (see "

Baseline Survey Methods:"DINOFLAGELLATES, PHYTOPLANKTON AND PLANKTON IN THE WATER COLUMN", above). Only 27 of the 272 (10 %) native taxa were not collected between 0 and 10 m depth, but from deeper samples, and seven taxa were only recorded from samples taken in the intertidal. Ten taxa were only collected from the 10-15 m depth class, and all were only found in single samples. Ten taxa were collected only in the 15-20 m depth class, and all were found single samples except the bryozoan Akatopora circumsaepta which was found in two samples. Four taxa (the annelids *Lepidonotus jacksoni* and *Trypanosyllis zebra*, the mollusc *Dendrodoris citrina* and the cnidarian *Dictyocladium monilifer*) were only found in single samples deeper than 20 m.

The 19 NIS and C1 taxa collected during the Kaipara Harbour port survey occurred in 72 (20 %) of the 368 samples taken and in eight of the 13 different sampling methods (excluding zooplankton tows) (Table 18). Of the 85 NIS and C1 records, the majority were collected from anchor box dredges (31 records; 36 %), pile scrapings (22 records; 26 %) and benthic sleds (21 records; 25 %), predominantly at depths between 0 m and 10 m but ranging down to 28.4 m. The 11 records resulting from the other five methods were collected in samples from depths ranging from the intertidal (a beach wrack survey) to 8.6 m depth (cyst core). In contrast, of the 1592 native records collected from Kaipara Harbour, 28 % were collected from anchor box dredges, 11% from benthic sleds and only 9 % from pile scrapings (Table 19). This emphasises the range of NIS and C1 taxa in Kaipara harbour able to take advantage of a variety of habitats, including benthic dwellers and fouling organisms, and therefore the importance of sampling a range of habitats and depths.

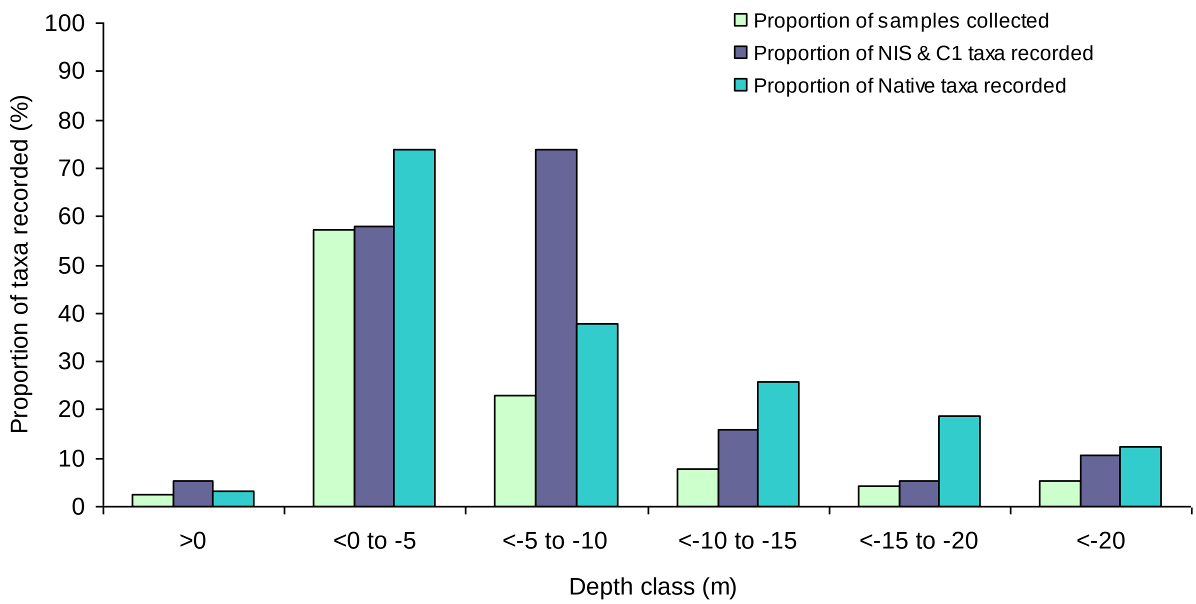

Figure 44: Proportion of taxa recorded from 5 m depth classes during the Kaipara Harbour port survey. The proportion of taxa sums to a total of >100% across depth classes, as some taxa were recorded from more than one depth class.

Possible vectors for the introduction of NIS and C1 taxa to the port

The possible vectors for the introduction of NIS and C1 taxa to New Zealand are indicated in Table 7 and Table 8 for taxa recorded during the desktop review of existing species records, and in Table 14 and Table 15 for taxa recorded during the Kaipara Harbour port survey. Likely vectors of introduction are largely derived from Hayes *et al.* (2005) and expert opinion (see Appendix 6 for definitions of vectors). Most of the NIS and C1 taxa recorded from

Kaipara Harbour during the port survey and review of existing species records are thought to have arrived in New Zealand via biofouling and international shipping.

The probable vectors for introduction to New Zealand that was cited for the greatest number of NIS and C1 taxa in Kaipara Harbour was accidental introduction by fouling on ships (S1) and accidental inroduction by ships ballast water (S3). Accidental introductions associated with fisheries operations (F1, F2 and F3) and human generated debris (D) were also cited for several taxa. The non-indigenous plants (Magnoliophyta) may have also been introduced through accidental or deliberate individual release (IR1, IR2). Some taxa can probably also take advantage of several other vectors to reach New Zealand (see Table 7, Table 15, Table 14 and Table 15).

Spread within New Zealand of the NIS and C1 taxa recorded from Kaipara Habour is also often likely to be via fouling of ships' hulls (S1) or associated with translocations of fish or shellfish (F2, F3). Natural translocation, via planktonic dispersal (N1) or long-distance movement of adults as detached plants (N3) may also be responsible for the spread of several of these taxa. The spread of some of these taxa throughout New Zealand is probably also assisted by several other vectors (see Table 7, Table 8, Table 14 and Table 15).
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COMPARISON BETWEEN DESKTOP REVIEW OF EXISTING RECORDS AND PORT BASELINE SURVEY RECORDS

There were 311 taxa (excluding indeterminate taxa and zooplankton that were only screened for target species) recorded during the port baseline survey of Kaipara Harbour, compared with 115 in the desktop review of existing species records from the area. This highlights both the paucity of biological research in Kaipara Harbour over the past century, and the effectiveness of the Kaipara Harbour baseline survey, which in a single survey recorded almost triple of the number of taxa that were recorded during the review of literature spanning many decades and projects (although the overlap in the actual taxa recorded was lower, as discussed below).

Of the 115 taxa recorded in the desktop review, 11 were subsequently recorded during the initial port baseline survey of Kaipara Harbour (seven native (Table 6), three NIS (Table 7) and one C1 (Table 8)). Similarly, 301 of the 311 taxa (97 %) that were identified in the port survey (excluding indeterminate taxa) were not recorded in the desktop review. The port baseline survey has therefore made a valuable contribution to the knowledge of the flora and fauna of the Kaipara Harbour area, apparently adding more than 300 taxa to those already known from the area.

The low overlap in the inventories compiled by these different methods is not unusual for surveys of this type (Ruiz and Hewitt 2002). Review of literature and museum records provides a broader spatial and temporal coverage of species from a region than a single field survey can, as such records have been obtained over time from a variety of survey methods and variable search effort. Because of this they do not provide a standardised baseline for comparison to other regions or surveys. All survey methods have inherent biases in the efficiency with which they sample different species. Thus, while the CRIMP protocols have been devised to ensure that a standardised methodology is used for baseline port surveys, the methods used do not sample all species efficiently. Thus, the two approaches used provide complementary inventories of the marine biota around Kaipara Harbour.

Five of the eight NIS and two of the four C1 taxa recorded during our desktop review were not recorded during the Kaipara Harbour port survey. The absence of these species from the

Kaipara Harbour port survey records could indicate that these taxa have gone locally extinct in the area since their discovery, or they may be present in densities low enough that they were not encountered during the port survey. More detailed delimitation surveys for these species would be needed to assess these possibilities.

Conversely, seven of the ten NIS and none of the C1 taxa recorded during the port survey were not recorded during the desktop review. The NIS were the annelid *Dipolydora armata*, the crustaceans *Jassa slatteryi* and *Pyromaia tuberculata*, the bryozoans *Conopeum seurati*, *Anguinella palmate* and *Bowerbankia gracilis* and the sponge *Amphilectus fucorum*. These speices are are small organisms that may have been overlooked in previous surveys, or may have been missed in our desktop review. Furthermore, *J. slatteryi* were first described less than two decades ago, so would only appear in more recent studies of the Kaipara Harbour amphipod fauna.

Assessment of the risk of new introductions to the harbour

Many non-indigenous species introduced to New Zealand ports by shipping 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 northwest Pacific, and southern Australia (Cranfield *et al.* 1998).

Although there are no international imports or exports made from Kaipara Harbour, the harbour is a source of sand for the Auckland construction industry and for domestic fisheries (see: Shipping and boating activities and facilities on the Kaipara Harbour, above). Therefore, ships regularly travel between Kaipara Harbour and Auckland or other northern locations.

As the Port of Auckland is an international port, and is known to contain various NIS and C1 taxa, particularly the recently recorded club-shaped ascidian *Styela clava* (Inglis, in press), which is on the New Zealand Register of Unwanted Species (Table 4), there is a potential risk that NIS from Auckland or other areas may be introduced to Kaipara Harbour via means shipping, particularly biofouling.

Assessment of translocation risk for introduced species found in the port

Many of the non-indigenous species found in the survey of Kaipara Harbour have been recorded in other locations throughout New Zealand (see Appendix 6), however, they are not universally present throughout the area. Although there is comparatively little shipping traffic between Kaipara Harbour and other parts of New Zealand, Kaipara Harbour is regularly visited by tourist cruise ships, fishing boats and houseboats originating from and returning to Dargaville, Ruawai, Parakai, Shelly Beach, and Pahi (see "Shipping and boating activities and facilities on the Kaipara Harbour", above). Kaipara Harbour is also the source of the majority of oyster-spat for the North Island industry (Handley 2002). This movement of vessels to and around the harbour, and the transportation of water with oyster-spat increase the risk of translocating NIS and C1 taxa around the port and to other New Zealand locations.

Some dense areas of the invasive Asian date mussel *Musculista senhousia* have been found within Aquaculture Management Areas in the southern part of Kaipara Harbour (Hewitt and Funnell 2005). Transporting aquaculture equipment from these areas to other parts of the harbour or country may therefore potentially transfer this invasive mussel. The invasive East Asian bivalve *Theora lubrica* is also present in Kaipara Harbour and could potentially be transported in the same way.

However, in general the densities of the NIS and C1 taxa in Kaipara Harbour appear to be very low. Only three of the eight NIS previously recorded from Kaipara Harbour were recorded during the port survey, despite sampling suitable habitats. The 10 NIS found in the harbour were recorded from a total of only 64 of the 2386 samples identified during the Kaipara Harbour survey. Of the 10 NIS recorded, only three were found in more than four samples (*Crassostrea gigas*, found in 18 samples, *Musculista senhousia* found in 19 samples and *Theora lubrica*, found in 13 samples). Four NIS occurred in just a single sample during the survey. These were the sponge *Amphilectus fucorum* (found in an anchor box dredge at Kaipara River 3), the bryozoans *Anguinella palmata* (found in a benthic sled at Kapua Point) and *Bowerbankia gracilis* (found in an anchor box dredge at Pahi Slipway) and the annelid *Dipolydora armata* (found in an anchor box dredge at Ruawai Slipway).

None of these species were recorded in the literature of the area but three have been recorded in New Zealand for at least 40 years (*A. fucorum* is thought to have arrived in 2001) indicating that either this is a new incursion into Kaipara Harbour from elsewhere in New Zealand, or that the environment in Kaipara Harbour is not suitable for the prolification of these species and population density in the area is low.

Of the four C1 taxa recorded in the literature, only one was found in the survey (the dinoflagellate *Gymnodinium catenatum*). The nine C1 taxa that were recorded during the survey, were found in a total of only 22 of the 2386 samples identified during the Port Kaipara Harbour survey. Three C1 taxa occurred in just a single sample during the survey. These were the crustacean *Lysmata vittata* (found in a miscellaneous search at Te Whau Point Slipway) and the sponges *Suberites* cf. *perfectus* (found in an anchor box dredge at Kaipara River 1) and *Ciocalypta* cf. *pencillus* (found in an anchor box dredge at Middle Channel).

Although none of these taxa were recorded in the literature, *L. vittata* is thought to have arrived in 2006 and the Kaipara Harbour survey is the first known occurrence of

S. cf. *perfectus* and *C.* cf. *pencillus*, indicating that the taxa would be absent in any literature published prior to 2006.

Although the NIS and C1 taxa recorded from both the survey and literature of Kaipara Harbour appear to have relatively widespread distributions throughout New Zealand (see species information sheets for NIS, Appendix 6), there is still a risk that these species could be spread from Kaipara Harbour to other locations where they are not yet present.

Management of existing non-indigenous species in the port

Kaipara Harbour is of significant conservation value with many areas of the coast under protection and an important mussel aquaculture area (Auckland Regional Council 2004). The prevention or reduction of impacts from non-indigenous species is therefore a high priority.

Control of Kaipara Harbour is split between the Auckland Regional Council (ARC) in the southern half and the Northland Regional Council (NRC) in the northern half. Thus management of marine biosecurity differs within the harbour. According to Kirschberg (2007) four invasive plant pests pose the greatest threat to the coastal environment of Kaipara Harbour - spartina, saltwater paspalum, Manchurian wild rice and sharp rush. According to the ASR study findings, spartina present on mudflats near Oyster Point at the southern edge of the Harbour and is spreading. As eradication of this pest requires significant resources, both councils have taken different approaches to its management. The ARC has taken a targeted control approach, while the NRC has taken a 'control through eradication' approach (Kirschberg 2007).

Under the Local Government Act 2002, Regional and District Councils are required to develop a Long Term Council Community Plan (LTCCPs). The LTCCPs set out the policy projects and activities for the next ten years (2006-2016) for each of the Councils (Kirschberg 2007).

The Kaipara LTCCP includes:

- Administer Biodiversity Funds for financial assistance to stakeholders to assist in protection and enhancement of Kaipara's environment.
- Stormwater infiltration to be addressed to minimise wastewater overflows and improve treatment standards.
- Implementation of Reserves and Open Spaces Strategy.
- Establish and administer a Heritage Fund for financial assistance to stakeholders to assist in protection and enhancement (Kirschberg 2007).

The Auckland LTCCP includes:

- The Policy will continue to be developed to refine rules in its Regional Policy: Coastal and policy to support possible variations to the Regional Policy: Coastal for aquaculture, coastal occupation charging, and mangrove management.
- 2007-15: Monitoring of marine ecology and water quality parameters to continue.
- 2007-10: Policy to improve integrated management of Kaipara Harbour coastal environment.
- Work with the regional community to raise awareness, advocate for, conservation of natural treasures.
- Protect and enhance significant habitats and endangered species in regional parks.
- Continue pest management work across the region in accordance with Regional Pest Management Strategy.
- Implement biodiversity advocacy and conservation programme
- Continue habitat restoration and species management programmes on regional parks.
- Controlling and eradicating targeted invasive plant species such as spartina and rhamnus, to prevent significant adverse effects on ecosystems.
- Implementation of comprehensive plant pest control programme in targeted areas on the regional parks estate (Kirschberg 2007).

The Northland LTCCP includes:

- Prioritise and develop management plans for specific harbour or coastal areas and/or communities.
- Maintain and where necessary, improve stormwater quality management, in conjunction with district councils.
- Maintain and where necessary improve coastal water quality at bathing sites and marine farming areas in conjunction with district councils, Northland Health, industry and the Ministry for the Environment.
- Integrate regional and district planning provisions to ensure a consistent approach in coastal management strategies.
- Work with district councils to improve on-shore facilities adjacent to mooring areas.
- Develop and implement a Biosecurity Emergency Action Plan for Northland together with Biosecurity New Zealand, Ministry of Agriculture and Forestry, Department of Conservation, Ministry of Health, and Ministry of Fisheries.
- Develop and implement a plan to identify and protect Northland land with high biodiversity values, together with landowners, relevant government agencies and the district councils.
- Prepare strategies to eradicate or control pest organisms that threaten indigenous biodiversity and agricultural values, together with relevant government agencies.
- Encourage innovative community and residential planning for coastal developments.
- Support organisations providing incentives that recognise responsible environmental behaviour. Recreational and leisure opportunities (2007-2009).
- Support and encourage secured access to appropriate parts of the coastline, marine and natural environment for the purposes of recreation in conjunction with district councils and the Department of Conservation.
- Support the continued development of recreational infrastructure in the natural environment such as boat-launching ramps, toilets, walking tracks in conjunction with district councils and the Department of Conservation.
- Continue to support and encourage secured access to the coastline, marine and natural environment for the purposes of recreation in conjunction with district councils and the Department of Conservation.
- Continue to support the continued development of recreational infrastructure in the natural environment such as boat-ramps, toilets, walking tracks etc in conjunction with district councils and the Department of Conservation (Kirschberg 2007).

Due to the logistical and/ or technical difficulties associated with eradication of the potentially high impact NIS and C1 taxa in and near Kaipara Harbour, it is recommended that management activity be directed toward mitigating the spread of these organisms to locations where they do not presently occur. Such management will require more detailed delimitation surveys of their distribution within Kaipara Harbour, and of the location and frequency of movements of potential vectors that might spread them to other locations.

Prevention of new introductions

Interception of unwanted species transported by shipping is best achieved offshore, through control and treatment of ships and boats destined for Kaipara Harbour 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 uptaken 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 and sea-chests. Biosecurity New Zealand has recently embarked on a national survey of hull fouling on vessels entering New Zealand from overseas. 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. Shipping companies and vessel owners can reduce the risk of transporting NIS in hull fouling or sea chests through regular maintenance and antifouling of their vessels. Until effective risk mitigation options are developed, it is recommended that local authorities and port companies assess the risk of activities such as in-water cleaning of vessel hulls and sea-chests. These activities can increase the likelihood of non-indigenous fouling species being released and potentially becoming established within the port. They should be discouraged where the risk is considered unacceptable. Slow moving barges or vessels that are laid up in overseas ports for long periods before travelling to New Zealand can carry large densities of non-indigenous marine organisms with them. Cleaning and maintenance of these vessels should be encouraged by port authorities and shipping companies prior to their departure for New Zealand waters.

Studies of historical patterns of invasion 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; Hayden *et al.* in review). 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. We recommend that port companies consider undertaking such assessments for their ports when new import or export markets are forecast to develop. The assessment would allow potential problem species to be identified and appropriate management and monitoring requirements to be put in place.

Conclusions and recommendations for monitoring and resurveying

The national biological baseline surveys have significantly increased our understanding of the identity, prevalence and distribution of introduced and native species in New Zealand's shipping ports and marinas. 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 to be introduced to New Zealand waters by shipping. There is a need for continued monitoring of non-indigenous marine species 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.

The baseline survey of Kaipara Harbour recorded 389 species or higher taxa including 10 non-indigenous species and nine cryptogenic category 1 taxa. Excluding the 77 indeterminate records and the one collective zooplankton taxon, 301 of the 311 (97 %) taxa recorded in the survey did not occur in our desktop review of existing marine species records from Kaipara Harbour, and may be new records for the area. The initial port baseline survey has highlighted the diversity of the Kaipara Harbour marine assemblage, with results indicating that it has few NIS and C1 taxa, and even fewer that are likely to be of significant impact to the native environment.

Despite the large number of species detected, the large area of habitat available for marine organisms and the logistic difficulties of sampling in environments like Kaipara Harbour means that detection probabilities are likely to be comparatively low for species with low prevalence, even when species-specific survey methods are used (Inglis 2003; Inglis *et al.* 2003; Hayes *et al.* 2005; Gust *et al.* 2006; Inglis *et al.* 2006). In generalised pest surveys, such as the port baseline surveys, this problem is compounded by the high cost of identifying all specimens (native and non-indigenous), which constrains the total number of samples that can be taken (Inglis 2003). A consequence is that a high proportion of comparatively rare species will remain undetected by any single survey. This problem is not limited to non-indigenous species; 32 % of native species recorded in the Kaipara Harbour port survey occurred in just a single sample. Nor is it unique to marine assemblages. These results reflect the spatial and temporal variability that are features of marine biological assemblages (Morrisey *et al.* 1992a, 1992b) and the difficulties that are involved in characterising diversity within hyper-diverse assemblages (Gray 2000; Gotelli and Colwell 2001; Longino *et al.* 2002).

Nevertheless, the baseline surveys continue to reveal new records of non-indigenous species in New Zealand ports and, with repetition, the cumulative number of undetected species should decline over time. This type of sequential analysis of occupancy and detection probability requires a series of three (or more) surveys, which should allow more accurate estimates of the rate of new incursions and extinctions (MacKenzie *et al.* 2004). Hewitt and Martin (2001) recommend repeating the baseline surveys on a regular basis to ensure they remain current. It may also be prudent to repeat at least components of a survey over a shorter time frame to achieve better estimates of occupancy without the confounding effects of temporal variation and new incursions.

The baseline survey provides a starting point for further investigations of the distribution, abundance and ecology of the species described within Kaipara Harbour and for monitoring the rate of new incursions by NIS and C1 taxa over time. Non-indigenous marine species can have a range of adverse impacts through interactions with native organisms. These include competition with native species, predator-prey interactions, hybridisation, parasitism or toxicity and modification of the physical environment (Ruiz *et al.* 1999; Ricciardi 2001). Assessing the impact of NIS and C1 taxa discovered 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 their 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).

Acknowledgements

We thank the Kaipara Harbour authorities for access to their facilities and assistance during the survey, and Des Subritsky (West Coast and Kaipara Harbour Warden) for harbour information. We also thank the field team and taxonomists listed in the project team above.

Glossary

Term	Definition	Terms with the same or similar meaning
Biosecurity	The *Biosecurity Strategy for New Zealand* defines Biosecurity as the exclusion, eradication or effective management of risks posed by pests and diseases to the economy, environment and human health.	
Biosecurity status	A determination of the known or suspected geographic origin of a species or higher taxon. Categories of biosecurity status used in this report are *native, non-indigenous, cryptogenic* (category 1 or category 2), and *indeterminate*.	
Chief Technical Officer†	A person appointed as a Chief Technical Officer under section 101 of the Biosecurity Act 1993	
Cryptogenic taxa	Species that are neither clearly indigenous nor non-indigenous.	
Endemic	An organism restricted to a specified region or locality.	
Environment†	(a) Ecosystems and their constituent parts, including people and their communities; and (b) All natural and physical resources; and (c) Amenity values; and (d) The aesthetic, cultural, economic, and social conditions that affect or are affected by any matter referred to in paragraphs (a) to (c) of this definition	
Established	A non-indigenous organism that has formed self-sustaining populations within the new area of introduction, but is not necessarily an invasive species.	Naturalised
Generalised pest survey	A survey to identify and inventory the range of non-indigenous species present in an area	Blitz survey
Introduction	Direct or indirect movement by a human agency of an organism across a major geographical barrier to a region or locality that is beyond its natural distribution potential.	Translocation (*usually applied to secondary movement of the organism within a new region*)
Indeterminate taxa	Specimens that could not be identified to species level reliably because they were damaged, incomplete or immature, or because there was insufficient taxonomic or systematic information to allow identification to species level.	*(referred to as "Indeterminate taxa" in previous NZ port survey reports)*
Harmful organism	Organisms considered harmful to the environment, where "*environment*" has the broad definition described above.	Noxious, Pest
Invasive species	A *non-indigenous species* that has established in a new area and is expanding its range	
Indigenous species	An organism occurring within its natural past or present range and dispersal potential (organisms whose dispersal potential is independent of human intervention).	Native
Non-indigenous species	Any organism (including its seeds, eggs, spores, or other biological material capable of propagating that species) occurring outside its natural past or present range and dispersal potential (organisms whose dispersal is caused by human action).	Adventive Alien, Allochthonous, Exotic, Introduced, Non-native
Pathway	Used interchangeably with *vector*, but can also include the purpose (the reason why a species is moved), and route (the geographic corridor) by which a species is moved from one point to another (Carlton 2001).	Vector
Pest†	(1) A non-indigenous organism that is considered harmful to the environment, where "*environment*" has the broad definition described above. (2) An organism specified as a pest in a pest management strategy that has been approved under Part V of Biosecurity Act 1993.	
Prevalence	The ratio of the number of recorded occurrences of a species relative to the total number of observations.	
Species richness	The number of species present in an area.	
Species composition	The types or identities of species present in a sample, site, or region.	

Term	Definition	Terms with the same or similar meaning
Species density	The number of species per unit area.	
Targeted pest survey	A survey to determine characteristics of a particular pest population	
Unwanted organism†	Any organism that a *Chief Technical Officer* believes is capable or potentially capable of causing unwanted harm to any natural resources	
Vector	The physical means by which a species is transported	Pathway

†Terms defined by the New Zealand *Biosecurity Act 1993*

Sources for definitions of commonly used biosecurity terms include: Biosecurity Council (2003), Carlton (2001), Cohen and Carlton (1998), Colautii and MacIsaac (2004), Falk-Petersen *et al.* (2006), Gotelli and Colwell (2001), Gray (2000) and Occhipinti-Ambrogi and Galil (2004).

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Tables

Table 1: Number of replicate samples taken for each sampling method at each site in the baseline survey of Kaipara Harbour. Exact geographic locations of survey sites are provided in Appendix 2.

Site #	Site name	Quadrat scraping	Photo stills and video	Anchor box dredge	Sediment samples	Cyst samples	Zoo-plankton net	Phyto-plankton net	Qualitative diver visual surveys	Benthic sled	Crab trap	Shrimp trap	Poison stations	Beach seine net	Beach wrack walk	Miscell-aneous sampling	Total (excl. photo & video)
1	Ruawai Slipway	4	4	6	2	6	3	3		1	6	6					**37**
2	Ruawai Landing									1					3		**4**
3	Sail Point			3	2	3				1				3*			**12**
4	Middle Channel			3	2	3	3	3		1							**15**
5	Pakaukau Point			3	2	3				1							**9**
6	Matihe Point			3	2	3				1							**9**
7	Bushy Point			3	2	3				1							**9**
8	Five Fathon Channel			3	2	3	3	3		1							**15**
9	Te Whau Point Slipway	7	3	6	2	6	3	3		1	6	6	1			1[#]	**42**
10	Mussel Rock									1							**1**
11	The Funnel			3	2	3				1							**9**
12	Te Hoanga Point			3	2	3	3	3		1							**15**
13	Pahi Landing			3	2	3	3	3		1	6	6	1				**28**
14	Pahi Slipway	12	12	6	2	6				1				3	1		**31**
15	Kapua Point			3	2	3				1							**9**
16	Motikumara Point			3	2	3	3	3		1					3		**18**
17	Hargreaves Point			3	2	3	3	3		1							**15**
18	Pouto Point			3	2	3	3	3		1					3		**18**
19	Karaka Point			3	2	3	3	3		1					3		**18**
20	Kaipara River 1			3	2	3				1							**9**
21	Kaipara River 2			3	2	3				1							**9**

Site #	Site name	Quadrat scraping	Photo stills and video	Anchor box dredge	Sediment samples	Cyst samples	Zoo-plankton net	Phyto-plankton net	Qualitative diver visual surveys	Benthic sled	Crab trap	Shrimp trap	Poison stations	Beach seine net	Beach wrack walk	Miscell-aneous sampling	Total (excl. photo & video)
22	Kaipara River 3			3	2	3			1	1							**10**
23	Shelly Beach Slipway	12	12	6	2	6	3	3		1	6	6					**45**
24	Shelly Beach Landing			3	2	3				1							**9**
25	Ngapuke Creek			3	2	3	3	3		1	6	6					**27**
26	Waionui Inlet			3	2	3	3	3		1			1	3	3		**22**
27	Kaipara Head			3	2	3				1							**9**
31	Rangitira Beach														3		**3**
Total		**35**	**31**	**87**	**50**	**87**	**39**	**39**	**1**	**27**	**30**	**30**	**3**	**9**	**19**	**1**	**457**

* The beach seine netting at Sail Point was originally planned for Ruawai Landing, but could not be done at that site due to extensive mangroves impeding the dragging of the net.
[#] The miscellaneous sample was taken from a tangled fishing line attached to the benthic sled chain.

Table 2. Particle size classes used in grain size analyses of sediment samples from the baseline port surveys.

Particle size class	Method	Wentworth Size Class
> 8 mm	Sieve	~ Small pebbles (Wentworth division describes pebbles as 4 mm to 64 mm)
< 8 mm to > 5.6mm	Sieve	
< 5.6 mm to > 4 mm	Sieve	
< 4 mm to > 2.8 mm	Sieve	Gravel
< 2.8 mm to > 2 mm	Sieve	
< 2 mm to > 1 mm	Sieve	Very coarse sand
< 1 mm to > 0.5 mm	Sieve	Coarse sand
< 500 µm to > 250 µm	Laser analysis	Medium sand
< 250 µm to > 125 µm	Laser analysis	Fine sand
< 125 µm to > 62.5 µm	Laser analysis	Very fine sand
< 62.5 µm to > 31.3 µm	Laser analysis	Coarse silt
< 31.3 µm to > 15.6 µm	Laser analysis	Fine silt
< 15.6 µm to > 7.8 µm	Laser analysis	
< 7.8 µm to > 3.9 µm	Laser analysis	
< 3.9 µm to > 2 µm	Laser analysis	Clay

Table 3: Preservatives used for the major taxonomic groups of organisms collected during the port survey.

5 % Formalin solution	10 % Formalin solution	70 % Ethanol solution	80 % Ethanol solution	100 % Ethanol solution	Press instead of preserving
Algae (except *Codium* and *Ulva*)	Ascidiacea (colonial) [1, 2]	Alcyonacea [2]	Ascidiacea (solitary) [1]	Bryozoa	*Ulva* [4]
	Asteroidea	Crustacea (small)			
	Echinoidea	Holothuria [1, 2]			
	Ophiuroidea	Zoantharia [1, 2]			
	Brachiopoda	Porifera [1]			
	Crustacea (large)	Mollusca (with shell)			
	Ctenophora [1]	Mollusca [1, 2] (without shell)			
	Scyphozoa [1, 2]	Platyhelminthes [1, 3]			
	Hydrozoa	*Codium* [4]			
	Actiniaria & Corallimorpharia[1, 2]				
	Scleractinia				
	Nudibranchia [1]				
	Polychaeta				
	Actinopterygii & Elasmobranchii [1]				

[1] photographs were taken before preservation
[2] relaxed in menthol prior to preservation
[3] a formalin fix was carried out before final preservation took place
[4] a sub-sample was retained in silica gel beads for DNA analysis

Table 4: 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*
Urochordata	Ascidiacea	*Styela clava*[1]

[1]*Styela clava* was added to the list of unwanted organisms in 2005, following its discovery in Auckland Harbour

Table 5: Consultative Committee on Introduced Marine Pest Emergencies (CCIMPE) Trigger List (Endorsed by the National Introduced Marine Pest Coordinating Group, 2006).

	Scientific Name/s	Common Name/s
Species Still Exotic to Australia		
1 *	Eriocheir *spp.*	Chinese Mitten Crab
2	Hemigrapsus sanguineus	Japanese/Asian Shore Crab
3	Crepidula fornicata	American Slipper Limpet
4 *	Mytilopsis sallei	Black Striped Mussel
5	Perna viridis	Asian Green Mussel
6	Perna perna	Brown Mussel
7 *	Corbula (Potamocorbula) amurensis	Asian Clam, Brackish-Water Corbula
8 *	Rapana venosa (syn Rapana thomasiana)	Rapa Whelk
9 *	Mnemiopsis leidyi	Comb Jelly
10 *	Caulerpa taxifolia (exotic strains only)	Green Macroalga
11	Didemnum spp. (exotic invasive strains only)	Colonial Sea Squirt
12 *	Sargassum muticum	Asian Seaweed
13	Neogobius melanostomus (marine/estuarine incursions only)	Round Goby
14	Marenzelleria spp. (invasive species and marine/estuarine incursions only)	Red Gilled Mudworm
15	Balanus improvisus	Barnacle
16	Siganus rivulatus	Marbled Spinefoot, Rabbit Fish
17	Mya arenaria	Soft Shell Clam
18	Ensis directus	Jack-Knife Clam
19	Hemigrapsus takanoi/penicillatus	Pacific Crab
20	Charybdis japonica	Lady Crab
Species Established in Australia, but not Widespread		
21 *	Asterias amurensis	Northern Pacific Seastar
22	Carcinus maenas	European Green Crab
23	Varicorbula gibba	European Clam
24 *	Musculista senhousia	Asian Bag Mussel, Asian Date Mussel
25	Sabella spallanzanii	European Fan Worm
26 *	Undaria pinnatifida	Japanese Seaweed
27 *	Codium fragile spp. tomentosoides	Green Macroalga
28	Grateloupia turuturu	Red Macroalga
29	Maoricolpus roseus	New Zealand Screwshell
Holoplankton Alert Species * For notification purposes, eradication response from CCIMPE is highly unlikely		
30 *	Pfiesteria piscicida	Toxic Dinoflagellate
31	Pseudo-nitzschia seriata	Pennate Diatom
32	Dinophysis norvegica	Toxic Dinoflagellate
33	Alexandrium monilatum	Toxic Dinoflagellate
34	Chaetoceros concavicornis	Centric Diatom
35	Chaetoceros convolutus	Centric Diatom

***** Species on Interim CCIMPE Trigger List

Table 6: Native taxa recorded during the desktop review of existing marine species records from Kaipara Harbour and nearby areas. Also indicated is whether the taxon was subsequently recorded from the Kaipara baseline survey (this report).

Phylum, Class	Order	Family	Taxon name	Name as given in literature record[1]	Reference	Nearby Records	Recorded in port survey?
Annelida							
Polychaeta	Phyllodocida	Polynoidae	*Lepidonotus polychromus*		(Knox 1956)		Yes
Polychaeta	Phyllodocida	Syllidae	*Odontosyllis psammochroma*		Augener 1924, In (Glasby and Read 1998)		
Polychaeta	Sabellida	Sabellariidae	*Neosabellaria kaiparaensis*	*Sabellaria kaiparaensis*	Augener 1926, In (Glasby and Read 1998)		Yes
Arthropoda							
Malacostraca	Decapoda	Palinuridae	*Jasus edwardsi*	*Jasus edwardsii*	(NIWA 2008)		
Maxillopoda	Sessilia	Balanidae	*Amphibalanus variegatus*	*Balanus variegatus*	Foster (1978), Dromgoole & Foster (1983)		Yes
Chordata							
Actinopterygii	Aulopiformes	Chlorophthalmidae	*Chlorophthalmus nigripinnis*		(NIWA 2008)		
Actinopterygii	Clupeiformes	Clupeidae	*Sardinops neopilchardus*		(NIWA 2008)		
Actinopterygii	Clupeiformes	Engraulidae	*Engraulis australis*		(NIWA 2008)		Yes
Actinopterygii	Gadiformes	Merlucciidae	*Macruronus novaezelandiae*		MBIS, Stonehouse 1964		
Actinopterygii	Gadiformes	Moridae	*Auchenoceros punctatus*		(NIWA 2008)		
Actinopterygii	Gadiformes	Moridae	*Pseudophycis bachus*		(NIWA 2008)		
Actinopterygii	Mugiliformes	Mugilidae	*Aldrichetta forsteri*		(NIWA 2008)		Yes
Actinopterygii	Ophidiiformes	Ophidiidae	*Genypterus blacodes*		(NIWA 2008)		
Actinopterygii	Perciformes	Arripidae	*Arripis trutta*		(NIWA 2008)		
Actinopterygii	Perciformes	Carangidae	*Pseudocaranx dentex*		(NIWA 2008)		

Phylum, Class	Order	Family	Taxon name	Name as given in literature record[1]	Reference	Nearby Records	Recorded in port survey?
Actinopterygii	Perciformes	Carangidae	*Seriola lalandi*		(NIWA 2008)		
Actinopterygii	Perciformes	Carangidae	*Trachurus declivis*		(NIWA 2008)		
Actinopterygii	Perciformes	Carangidae	*Trachurus novaezelandiae*		(NIWA 2008)		
Actinopterygii	Perciformes	Centrolophidae	*Seriolella brama*		(NIWA 2008)		
Actinopterygii	Perciformes	Cheilodactylidae	*Nemadactylus macropterus*		(NIWA 2008)		
Actinopterygii	Perciformes	Gempylidae	*Thyrsites atun*		(NIWA 2008)		
Actinopterygii	Perciformes	Kyphosidae	*Scorpis violaceus*		(NIWA 2008)		
Actinopterygii	Perciformes	Leptoscopidae	*Leptoscopus macropygus*		(NIWA 2008)		
Actinopterygii	Perciformes	Scombridae	*Scomber australasicus*		(NIWA 2008)		
Actinopterygii	Perciformes	Sparidae	*Pagrus auratus*		(NIWA 2008)		
Actinopterygii	Perciformes	Trichiuridae	*Lepidopus caudatus*		(NIWA 2008)		
Actinopterygii	Perciformes	Uranoscopidae	*Genyagnus monopterygius*		(NIWA 2008)		
Actinopterygii	Perciformes	Uranoscopidae	*Kathetostoma giganteum*		(NIWA 2008)		
Actinopterygii	Perciformes	Uranoscopidae	*Xenocephalus armatus*		(NIWA 2008)		
Actinopterygii	Pleuronectiformes	Bothidae	*Arnoglossus scapha*		(NIWA 2008)		
Actinopterygii	Pleuronectiformes	Bothidae	*Lophonectes gallus*		(NIWA 2008)		
Actinopterygii	Pleuronectiformes	Pleuronectidae	*Colistium guntheri*		(NIWA 2008)		
Actinopterygii	Pleuronectiformes	Pleuronectidae	*Colistium nudipinnis*		(NIWA 2008)		
Actinopterygii	Pleuronectiformes	Pleuronectidae	*Pelotretis flavilatus*		(NIWA 2008)		
Actinopterygii	Pleuronectiformes	Pleuronectidae	*Peltorhamphus novaezeelandiae*		(NIWA 2008)		
Actinopterygii	Pleuronectiformes	Pleuronectidae	*Rhombosolea plebeia*		(NIWA 2008)		Yes
Actinopterygii	Scorpaeniformes	Triglidae	*Chelidonichthys kumu*		(NIWA 2008)		
Actinopterygii	Scorpaeniformes	Triglidae	*Pterygotrigla picta*		(NIWA 2008)		
Actinopterygii	Syngnathiformes	Centriscidae	*Macrorhamphosus scolopax*		(NIWA 2008)		
Actinopterygii	Tetradontiformes	Monocanthidae	*Parika scaber*		(NIWA 2008)		
Actinopterygii	Tetraodontiformes	Diodontidae	*Allomycterus jaculiferus*		(NIWA 2008)		
Actinopterygii	Zeiformes	Zeidae	*Zeus faber*		(NIWA 2008)		
Elasmobranchii	Carcharhiniformes	Scyliorhinidae	*Cephaloscyllium isabellum*		(NIWA 2008)		
Elasmobranchii	Carcharhiniformes	Sphyrnidae	*Sphyrna zygaena*		(NIWA 2008)		
Elasmobranchii	Carcharhiniformes	Triakidae	*Galeorhinus galeus*		(NIWA 2008)		
Elasmobranchii	Carcharhiniformes	Triakidae	*Lepidotrigla brachyoptera*		(NIWA 2008)		

Phylum, Class	Order	Family	Taxon name	Name as given in literature record[1]	Reference	Nearby Records	Recorded in port survey?
Elasmobranchii	Carcharhiniformes	Triakidae	*Mustelus lenticulatus*		(NIWA 2008)		
Elasmobranchii	Rajiformes	Dasyatidae	*Dasyatis brevicaudata*		(NIWA 2008)		
Elasmobranchii	Rajiformes	Dasyatidae	*Dasyatis thetidis*		(NIWA 2008)		
Elasmobranchii	Rajiformes	Myliobatidae	*Myliobatis tenuicaudatus*		(NIWA 2008)		
Elasmobranchii	Rajiformes	Rajidae	*Dipturus innominatus*		(NIWA 2008)		
Elasmobranchii	Rajiformes		*Dipturus nasutus*		(NIWA 2008)		
Elasmobranchii	Squaliformes	Squalidae	*Squalus acanthias*		(NIWA 2008)		
Elasmobranchii	Squaliformes	Squalidae	*Squalus mitsukurii*		(NIWA 2008)		
Mollusca							
Bivalvia	Myoida	Teredinidae	*Bankia australis*		(McKoy 1975, 1980a)		
Bivalvia	Pterioida	Pectinidae	*Pecten novaezelandiae*		(Hewitt and Funnell 2005)		Yes
Cephalopoda	Teuthida	Loliginidae	*Sepioteuthis australis*		(NIWA 2008)		
Porifera							
Demospongiae	Haplosclerida	Chalinidae	*Haliclona fragilis*		(Bergquist and Warne 1980)		
Protozoa							
Granuloreticulosea	Foraminiferida	Bolivinidae	*Bolivina neocompacta*		(Hayward *et al.* 1999)		
Granuloreticulosea	Foraminiferida	Buliminidae	*Bulimina elongata*		(Hayward *et al.* 1999)		
Granuloreticulosea	Foraminiferida	Cassidulinidae	*Cassidulina carinata*		(Eade 1967)		
Granuloreticulosea	Foraminiferida	Cassidulinidae	*Evolvocassidulina orientalis*		(Eade 1967)		
Granuloreticulosea	Foraminiferida	Cassidulinidae	*Globocassidulina canalisuturata*		(Eade 1967)		
Granuloreticulosea	Foraminiferida	Cassidulinidae	*Globocassidulina minuta*		(Eade 1967)		
Granuloreticulosea	Foraminiferida	Cibicididae	*Cibicides dispars*	*Cibicides marlboroughensis*	(Kustanowich 1964; Hayward *et al.* 1999)		

Phylum, Class	Order	Family	Taxon name	Name as given in literature record[1]	Reference	Nearby Records	Recorded in port survey?
Granuloreticulosea	Foraminiferida	Cornuspiridae	*Cornuspira involvens*		Hayward *et al.* 1999		
Granuloreticulosea	Foraminiferida	Ellipsolagenidae	*Fissurina lucida*		Hayward *et al.* 1999		
Granuloreticulosea	Foraminiferida	Elphidiidae	*Elphidium advenum*		Hayward *et al.* 1999		
Granuloreticulosea	Foraminiferida	Elphidiidae	*Elphidium charlottense*		Hayward *et al.* 1999		
Granuloreticulosea	Foraminiferida	Elphidiidae	*Elphidium excavatum s.l.*		Hayward *et al.* 1999		
Granuloreticulosea	Foraminiferida	Elphidiidae	*Elphidium gunteri*		Hayward *et al.* 1999		
Granuloreticulosea	Foraminiferida	Elphidiidae	*Haynesina depressula*		Hayward *et al.* 1999		
Granuloreticulosea	Foraminiferida	Glabratellidae	*Pileolina zelandica*		Hayward *et al.* 1999		
Granuloreticulosea	Foraminiferida	Globigerinidae	*Globigerina falconensis*		Hayward *et al.* 1999		
Granuloreticulosea	Foraminiferida	Globigerinidae	*Globigerina quinqueloba*		(Kustanowich 1964; Hayward *et al.* 1999)		
Granuloreticulosea	Foraminiferida	Haplophragmoididae	*Hapophragmoides jeffreysi*		Hayward *et al.* 1999		
Granuloreticulosea	Foraminiferida	Haplophragmoididae	*Hapophragmoides wilberti*		Hayward *et al.* 1999		
Granuloreticulosea	Foraminiferida	Helenididae	*Helenina andersoni*		Hayward *et al.* 1999		
Granuloreticulosea	Foraminiferida	Hormosinidae	*Scherochorella moniliforme*		Hayward *et al.* 1999		
Granuloreticulosea	Foraminiferida	Miliolidae	*Quinqueculina seminula*		Hayward *et al.* 1999		
Granuloreticulosea	Foraminiferida	Nonionidae	*Nonionellina flemingi*		Hayward *et al.* 1999		
Granuloreticulosea	Foraminiferida	Nonionidae	*Nonionoides turgida*		Hayward *et al.* 1999		
Granuloreticulosea	Foraminiferida	Nonionidae	*Zeaflorilus parri*		Hayward *et al.* 1999		
Granuloreticulosea	Foraminiferida	Polysaccamminidae	*Polysaccammina ipohaina*		Hayward *et al.* 1999		
Granuloreticulosea	Foraminiferida	Rotaliidae	*Ammonia aoteana*		Hayward *et al.* 1999		
Granuloreticulosea	Foraminiferida	Rotaliidae	*Ammonia pustulosa*		Hayward *et al.* 1999		
Granuloreticulosea	Foraminiferida	Rzehakinidae	*Miliammina fusca*		Hayward *et al.* 1999		
Granuloreticulosea	Foraminiferida	Rzehakinidae	*Miliammina obliqua*		Hayward *et al.* 1999		
Granuloreticulosea	Foraminiferida	Saccamminidae	*Pseudothurammina limnetis*		Hayward *et al.* 1999		
Granuloreticulosea	Foraminiferida	Stainforthiidae	*Spiroloxostoma glabra*		Hayward *et al.* 1999		
Granuloreticulosea	Foraminiferida	Textulariidae	*Textularia earlandi*		Hayward *et al.* 1999		
Granuloreticulosea	Foraminiferida	Trochamminidae	*Trochammina bartrami*		Hayward *et al.* 1999		
Granuloreticulosea	Foraminiferida	Trochamminidae	*Trochammina inflata*		Hayward *et al.* 1999		
Granuloreticulosea	Foraminiferida	Trochamminidae	*Trochammina sorosa*		Hayward *et al.* 1999		
Granuloreticulosea	Foraminiferida	Uvigerinidae	*Trifarina angulosa*		Hugh Grenfell, pers. comm.		

Phylum, Class	Order	Family	Taxon name	Name as given in literature record[1]	Reference	Nearby Records	Recorded in port survey?
Granuloreticulosea	Foraminiferida	Vaginulinidae	*Lenticulina rotulatus*	*Robulus* cf. *rotulatus*	(Kustanowich 1964)		

[1] If the taxon name given in the cited literature record has since been synonymised, this column contains the name as it was given in the literature record. The column to the left ("Taxon name") contains the current valid name.

Table 7: Non-indigenous species recorded during the desktop review of existing marine species records from Kaipara Harbour. Also indicated are the probable means of introduction to New Zealand (see Appendix 6), the date of introduction or detection (d) in New Zealand, and whether the NIS were recorded in the literature were subsequently recorded in the Kaipara Harbour baseline survey (this report).

Phylum, Class	Order	Family	Taxon name	Name as given in literature record[1]	Reference	Date of introduction, or detection (d)	Probable means of introduction to NZ	Probable means of spread within NZ	Recorded in port survey?
Mollusca									
Bivalvia	Mytiloida	Mytilidae	*Musculista senhousia*		(Hewitt and Funnell 2005)	1978	F2, S1, S3	D, F1, F2, NB	Yes
Bivalvia	Pterioida	Ostreidae	*Crassostrea gigas*		(Dinamani 1971)	1961	F1, F2, F3, S1	D, F1, F2, F3	Yes
Bivalvia	Veneroida	Semelidae	*Theora lubrica*		Hewitt & Funnell 2005	1971	S3	N1, RE, S1, S5	Yes
Bryozoa									
Gymnolaemata	Cheilostomata	Electridae	*Membraniporopsis tubigera*	*Membranipora* sp. *Kaipara* Hbr EF	(Gordon *et al.* 2006; NIWA 2008)	2001	no data	no data	
Magnoliophyta									
Liliopsida	Cyperales	Poaceae	*Spartina alterniflora*		(Partridge 1987)	1953	D, IR1, IR2, NB	D, F3, IR1, IR2	
Liliopsida	Cyperales	Poaceae	*Spartina anglica*		(Partridge 1987)	1924	D, IR1, IR2, NB	D, F3, IR1, IR2	
Liliopsida	Cyperales	Poaceae	*Spartina* x *townsendi*		(Partridge 1987)	1913	D, IR1, IR2, NB	D, F3, IR1, IR2	

Table 8: Cryptogenic category one (C1) taxa recorded during the desktop review of existing marine species records from Kaipara Harbour and nearby areas. Also indicated are the probable means of introduction to New Zealand (see Appendix 6), the date of introduction or detection (d) in New Zealand, and whether the taxon was subsequently recorded in the Kaipara Harbour baseline survey (this report).

Phylum, Class	Order	Family	Taxon name	Reference	Nearby Records	Date of introduction, or detection (d)	Probable means of introduction to NZ	Probable means of spread within NZ	Recorded in port survey?
Mollusca									
Bivalvia	Myoida	Teredinidae	*Lyrodus mediolobatus*	(McKoy 1980b)		no data	S1, S3	N2, S1	
Myzozoa									
Dinophyceae	Gymnodiniales	Gymnodiniaceae	*Gymnodinium catenatum*	(Taylor and MacKenzie 2001)		2000	F2, N1, S3	F2, N1, S1	Yes
Dinophyceae	Peridiniales	Gonyaulacaceae	*Alexandrium ostenfeldii*	(MacKenzie *et al.* 1996)	Entrance to Kaipara Harbour	1992	F2, N1, S3	F2, N1, S1	
Platyhelminthes									
Turbellaria	Polycladida	Stylochidae	*Enterogonia orbicularis*	(Diggles *et al.* 2002)		no data			

Table 9: Cryptogenic category two (C2) taxa recorded during the desktop review of existing marine species records from Kaipara Harbour and nearby areas. Also indicated are the probable means of introduction to New Zealand (see Appendix 6), the date of introduction or detection (d) in New Zealand, and whether the taxon was subsequently recorded in the Kaipara Harbour baseline survey (this report).

Phylum, Class	Order	Family	Taxon name	Reference	Probable means of introduction to NZ	Date of introduction, or detection (d)	Recorded in port survey?
Porifera							
Demospongiae	Halichondrida	Halichondriidae	*Ciocalypta* new sp. 1 (cf *C. polymastia*)	(Bergquist 1970)	no data	no data	

Table 10: Indeterminate taxa recorded during the desktop review of existing marine species records from Kaipara Harbour. Also indicated is whether the taxon was subsequently recorded in the Kaipara Harbour baseline survey (this report).

Phylum, Class	Order	Family	Taxon name	Reference	Probable means of introduction to NZ	Date of introduction, or detection (d)	Recorded in port survey?
Chordata							
Actinopterygii	Scorpaeniformes	Sebastidae	*Helicolenus* sp.	(NIWA 2008)	no data	no data	
Magnoliophyta							
Liliopsida	Najadales	Zosteraceae	*Zostera* sp.	(Hewitt and Funnell 2005)	no data	no data	
Platyhelminthes							
Turbellaria	Polycladida	Planoceridae	Planoceridae Indet.	(Diggles *et al.* 2002)	no data	no data	
Protozoa							
Granuloreticulosea	Foraminiferida	Bagginidae	*Cancris* sp.	(Hayward *et al.* 1999)	no data	no data	
Granuloreticulosea	Foraminiferida	Rosalinidae	*Rosalina* sp.	(Kustanowich 1964; Hayward *et al.* 1999)	no data	no data	
Granuloreticulosea	Foraminiferida	Saccamminidae	*Saccammina* sp.	(Hayward *et al.* 1999)	no data	no data	

Table 11: The Chapman and Carlton (1994) criteria (C1 – C9) for each NIS and C1 taxon from the Kaipara Harbour desktop review and port survey. Criteria were assigned following expert advice or are based on those give by Cranfield *et al.* (1998).

Taxon name	Biose-curity Status	Source of record	C1: Has the species suddenly appeared locally where it has not been found before?	C2: Has the species spread subsequently?	C3: Is the species' distribution associated with human mechanisms of dispersal?	C4: Is the species associated with, or dependent on, other introduced species?	C5: Is the species prevalent in, or restricted to, new or artificial environments?	C6: Is the species' distribution restricted compared to natives?	C7: Does the species have a disjunct worldwi-de distribut-ion?	C8: 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 NZ?	C9: Is the species isolated from the genetically and morphology-ically most similar species elsewhere in the world?
Dipolydora armata	NIS	Port Survey	no	no	no	no	no	no	yes	yes	no
Jassa slatteryi	NIS	Port Survey	yes	no	yes	no	no	yes	no	yes	yes
Lysmata vittata	C1	Port Survey	no	no	no	no	no	no	no	no	no
Pyromaia tuberculata	NIS	Port Survey	yes	yes	yes	no	no	yes	yes	yes	yes
Anguinella palmata	NIS	Port Survey	yes	yes	yes	no	yes	yes*	yes	yes	yes
Bowerbankia gracilis	NIS	Port Survey	yes	yes	yes	no	yes	yes	yes	yes	no
Conopeum seurati	NIS	Port Survey	yes	yes	yes	no	yes	yes	yes	yes	yes
Membraniporopsis tubigera	NIS	Desktop Review	yes	no	no	no	no	yes	yes	yes	no
Didemnum sp.	C1	Port Survey	Unknown	no	no	no	no	no	no	no	no
Bougainvillia muscus	C1	Port Survey	no	no	no	no	no	no	no	no	no
Spartina alterniflora	NIS	Desktop Review	yes	yes	yes	no	yes	no	no	no	yes
Spartina anglica	NIS	Desktop Review	yes	yes	yes	no	yes	no	no	no	yes
Spartina x townsendi	NIS	Desktop Review	yes	yes	yes	no	yes	no	no	no	yes
Crassostrea gigas	NIS	Port Survey and Desktop Review	yes	yes	yes	no	no	yes	yes	yes	yes
Lyrodus mediolobatus	C1	Desktop Review	no	no	yes	no	yes	no	no	yes	no
Musculista senhousia	NIS	Port Survey and Desktop Review	yes	yes	yes	no	no	yes	yes	yes	yes

Taxon name	Biose-curity Status	Source of record	C1:	C2:	C3:	C4:	C5:	C6:	C7:	C8:	C9:
Theora lubrica	NIS	Port Survey and Desktop Review	yes	yes	no	no	yes	yes	yes	yes	yes
Alexandrium affine	C1	Port Survey	yes	no	no	no	no	no	no	no	no
Alexandrium catenella	C1	Port Survey	yes	no	no	no	no	no	no	no	no
Alexandrium ostenfeldii	C1	Desktop Review	yes	no	no	no	no	no	no	no	no
Gymnodinium catenatum	C1	Port Survey and Desktop Review	yes	yes	no	no	no	no	no	no	no
Enterogonia orbicularis	C1	Desktop Review	no	no	no	no	no	no	no	no	no
Amphilectus fucorum	NIS	Port Survey	no	no	no	no	no	no	yes	yes	Unknown
Callyspongia ramosa	C1	Port Survey	yes	Unsure	Unsure	no	no	no	yes	Unlikely (short-lived viviparous larvae)	Unknown
Ciocalypta cf. *pencillus*	C1	Port Survey	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
Suberites cf. *perfectus*	C1	Port Survey	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown

Table 12: Physical characteristics of the sites sampled during the Kaipara survey.

Site number	Site name	Maximum recorded depth (m)	Secchi depth (m)	Salinity (ppt)	Water temperature (degC)	Sea state (Beaufort scale)
1	Ruawai Slipway	8.5	0.30	15	17.0	1
2	Ruawai Landing	9.3	0.27	18	16.9	1
3	Sail Point	18.7	0.86	22	16.7	1
4	Middle Channel	9.5	0.45	25	17.2	1
5	Pakaukau Point	4.0	0.72	29	16.9	1
6	Matihe Point	28.8	2.20	31	16.3	1
7	Bushy Point	4.5	1.37	31	16.6	0
8	Five Fathon Channel	11.7	2.44	34	16.3	0
9	Te Whau Point Slipway	13.0	1.60	31	16.3	0
10	Mussel Rock	8.7	2.00	31	16.3	1
11	The Funnel	28.4	1.70	30	16.7	1
12	Te Hoanga Point	20.6	1.20	27	17.5	1
13	Pahi Landing	6.6	1.10	26	18.5	1
14	Pahi Slipway	8.1	1.10	26	18.5	1
15	Kapua Point	9.6	1.14	25	17.8	1
16	Motikumara Point	19.0	1.90	30	16.9	1
17	Hargreaves Point	3.7	1.85	28	17.4	1
18	Pouto Point	22.0	2.77	35	15.9	0
19	Karaka Point	8.0	0.20	36	15.5	4
20	Kaipara River 1	19.2	1.38	36	14.8	3
21	Kaipara River 2	25.0	1.20	39	16.0	4
22	Kaipara River 3	22.0	1.72	36	16.2	4
23	Shelly Beach Slipway	18.7	0.39	40	16.4	2
24	Shelly Beach Landing	8.4	0.22	38	16.3	2
25	Ngapuke Creek	4.5	0.42	34	16.5	3
26	Waionui Inlet	7.0	1.15	37	15.1	4
27	Kaipara Head	12.4	3.52	34	16.1	4
31	Rangitira Beach*	-	-	-	-	-
Average across all sites		**13.3**	**1.30**	**30.52**	**16.61**	**1.63**
SE of average across all sites		**1.5**	**0.16**	**1.19**	**0.17**	**0.26**

* Only a beach wrack was conducted at Site 31, so physical characteristics of the water were not recorded

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Table 13: Native species recorded from Kaipara Harbour in the baseline port survey.

Phylum, Class	Order	Family	Taxon name	Recorded in desktop review?
Annelida				
Polychaeta	Eunicida	Dorvilleidae	*Schistomeringos loveni*	
Polychaeta	Eunicida	Eunicidae	*Marphysa capensis*	Yes
Polychaeta	Eunicida	Eunicidae	*Marphysa depressa*	Yes
Polychaeta	Eunicida	Lumbrineridae	*Lumbrineris sphaerocephala*	Yes
Polychaeta	Phyllodocida	Glyceridae	*Glycera lamelliformis*	Yes
Polychaeta	Phyllodocida	Goniadidae	*Glycinde trifida*	
Polychaeta	Phyllodocida	Goniadidae	*Goniada echinulata*	
Polychaeta	Phyllodocida	Hesionidae	*Ophiodromus angustifrons*	
Polychaeta	Phyllodocida	Nephtyidae	*Aglaophamus macroura*	Yes
Polychaeta	Phyllodocida	Nereididae	*Neanthes kerguelensis*	
Polychaeta	Phyllodocida	Nereididae	*Nereis falcaria*	Yes
Polychaeta	Phyllodocida	Nereididae	*Nicon aestuariensis*	
Polychaeta	Phyllodocida	Nereididae	*Perinereis amblyodonta*	Yes
Polychaeta	Phyllodocida	Nereididae	*Platynereis Platynereis_australis*_group	
Polychaeta	Phyllodocida	Phyllodocidae	*Eteone aurantiaca*	
Polychaeta	Phyllodocida	Phyllodocidae	*Eulalia microphylla*	Yes
Polychaeta	Phyllodocida	Polynoidae	*Harmothoe macrolepidota*	Yes
Polychaeta	Phyllodocida	Polynoidae	*Lepidastheniella comma*	Yes
Polychaeta	Phyllodocida	Polynoidae	*Lepidonotus jacksoni*	Yes
Polychaeta	Phyllodocida	Polynoidae	*Lepidonotus polychromus*	Yes
Polychaeta	Phyllodocida	Sigalionidae	*Labiosthenolepis laevis*	
Polychaeta	Phyllodocida	Sigalionidae	*Sigalion oviger*	
Polychaeta	Phyllodocida	Syllidae	*Trypanosyllis gigantea*	Yes
Polychaeta	Phyllodocida	Syllidae	*Trypanosyllis zebra*	
Polychaeta	Sabellida	Oweniidae	*Owenia petersenae*	Yes
Polychaeta	Sabellida	Sabellariidae	*Neosabellaria kaiparaensis*	Yes
Polychaeta	Sabellida	Sabellariidae	*Paraidanthyrsus quadricornis*	
Polychaeta	Sabellida	Serpulidae	*Spirobranchus cariniferus*	Yes
Polychaeta	Scolecida	Cossuridae	*Cossura consimilis*	
Polychaeta	Scolecida	Maldanidae	*Asychis amphiglyptus*	
Polychaeta	Scolecida	Maldanidae	*Macroclymenella stewartensis*	
Polychaeta	Scolecida	Opheliidae	*Armandia maculata*	Yes
Polychaeta	Scolecida	Orbiniidae	*Phylo novazealandiae*	
Polychaeta	Spionida	Magelonidae	*Magelona dakini*	
Polychaeta	Spionida	Spionidae	*Boccardia otakouica*	
Polychaeta	Spionida	Spionidae	*Boccardia syrtis*	
Polychaeta	Spionida	Spionidae	*Paraprionospio Paraprionospio*-A	
Polychaeta	Spionida	Spionidae	*Prionospio australiensis*	

Phylum, Class	Order	Family	Taxon name	Recorded in desktop review?
Polychaeta	Spionida	Spionidae	*Prionospio multicristata*	
Polychaeta	Spionida	Spionidae	*Scolecolepides benhami*	Yes
Polychaeta	Terebellida	Cirratulidae	*Protocirrineris nuchalis*	Yes
Polychaeta	Terebellida	Flabelligeridae	*Pherusa parmata*	Yes
Polychaeta	Terebellida	Pectinariidae	*Pectinaria australis*	Yes
Polychaeta	Terebellida	Terebellidae	*Streblosoma toddae*	
Arthropoda				
Malacostraca	Amphipoda	Aoridae	*Haplocheira barbimana*	
Malacostraca	Amphipoda	Dexaminidae	*Paradexamine pacifica*	Yes
Malacostraca	Amphipoda	Phoxocephalidae	*Torridoharpinia hurleyi*	
Malacostraca	Brachyura	Xanthidae	*Ozius truncatus*	
Malacostraca	Decapoda	Alpheidae	*Alpheus richardsoni*	
Malacostraca	Decapoda	Crangonidae	*Philocheras australis*	
Malacostraca	Decapoda	Diogenidae	*Paguristes pilosus*	
Malacostraca	Decapoda	Diogenidae	*Paguristes setosus*	
Malacostraca	Decapoda	Grapsidae	*Hemigrapsus crenulatus*	
Malacostraca	Decapoda	Grapsidae	*Leptograpsus variegatus*	
Malacostraca	Decapoda	Hymenosomatidae	*Halicarcinus varius*	Yes
Malacostraca	Decapoda	Hymenosomatidae	*Halicarcinus whitei*	
Malacostraca	Decapoda	Hymenosomatidae	*Neohymenicus pubescens*	
Malacostraca	Decapoda	Majidae	*Notomithrax minor*	
Malacostraca	Decapoda	Ocypodidae	*Macrophthalmus hirtipes*	
Malacostraca	Decapoda	Paguridae	*Lophopagurus cookii*	
Malacostraca	Decapoda	Paguridae	*Pagurus novizealandiae*	
Malacostraca	Decapoda	Paguridae	*Pagurus traversi*	
Malacostraca	Decapoda	Palaemonidae	*Periclimenes* sp. nov 1	
Malacostraca	Decapoda	Palemonidae	*Palaemon affinis*	
Malacostraca	Decapoda	Palemonidae	*Periclimenes yaldwyni*	
Malacostraca	Decapoda	Pilumnidae	*Pilumnopeus serratifrons*	
Malacostraca	Decapoda	Pinnotheridae	*Pinnotheres novaezelandiae*	
Malacostraca	Decapoda	Plagusiidae	*Plagusia chabrus*	
Malacostraca	Decapoda	Porcellanidae	*Petrolisthes elongatus*	
Malacostraca	Decapoda	Porcellanidae	*Petrolisthes novaezelandiae*	
Malacostraca	Decapoda	Portunidae	*Liocarcinus corrugatus*	
Malacostraca	Decapoda	Portunidae	*Ovalipes catharus*	
Malacostraca	Decapoda	Xanthidae	*Pilumnus lumpinus*	
Malacostraca	Decapoda	Xanthidae	*Pilumnus novaezelandiae*	
Malacostraca	Isopoda	Cirolanidae	*Natatolana narica*	
Malacostraca	Isopoda	Cirolanidae	*Natatolana rossi*	Yes
Malacostraca	Isopoda	Janiridae	*Iathrippa longicauda*	
Malacostraca	Isopoda	Sphaeromatidae	*Exosphaeroma chilensis*	
Malacostraca	Isopoda	Sphaeromatidae	*Exosphaeroma echinensis*	Yes
Malacostraca	Isopoda	Sphaeromatidae	*Pseudosphaeroma campbellensis*	
Maxillopoda	Pedunculata	Lepadidae	*Lepas pectinata*	
Maxillopoda	Pedunculata	Lepadidae	*Lepas testudinata*	

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Phylum, Class	Order	Family	Taxon name	Recorded in desktop review?
Maxillopoda	Sessilia	Archaeobalanidae	*Austrominius modestus*	
Maxillopoda	Sessilia	Balanidae	*Amphibalanus variegatus*	
Maxillopoda	Sessilia	Balanidae	*Notomegabalanus decorus*	
Pycnogonida	Pantopoda	Ammotheidae	*Achelia assimilis*	
Bacillariophyta				
Bacillariophyceae	Bacillariales	Bacillariaceae	*Cylindrotheca cloisterium*	
Bacillariophyceae	Bacillariales	Bacillariaceae	*Nitzschia closterium*	
Bacillariophyceae	Bacillariales	Bacillariaceae	*Nitzschia longissima*	
Bacillariophyceae	Bacillariales	Bacillariaceae	*Pseudo-nitzschia australis*	
Bacillariophyceae	Naviculales	Amphipleuraceae	*Amphiprora alata*	
Bacillariophyceae	Naviculales	Naviculaceae	*Meuniera membranacea*	
Coscinodiscophyceae	Asterolamprales	Asterolampraceae	*Asteromphalus flabellatus*	
Coscinodiscophyceae	Chaetocerotales	Chaetocerotaceae	*Chaetoceros affinis*	
Coscinodiscophyceae	Chaetocerotales	Chaetocerotaceae	*Chaetoceros concavicornis*	
Coscinodiscophyceae	Chaetocerotales	Chaetocerotaceae	*Chaetoceros convolutus*	
Coscinodiscophyceae	Chaetocerotales	Chaetocerotaceae	*Chaetoceros decipiens*	
Coscinodiscophyceae	Chaetocerotales	Chaetocerotaceae	*Chaetoceros didymus*	
Coscinodiscophyceae	Corethrales	Corethraceae	*Corethron criophilum*	
Coscinodiscophyceae	Coscinodiscales	Coscinodiscaceae	*Coscinodiscus wailesii*	
Coscinodiscophyceae	Coscinodiscales	Heliopeltaceae	*Actinoptychus senarius*	
Coscinodiscophyceae	Hemiaulales	Hemiaulaceae	*Cerataulina pelagica*	
Coscinodiscophyceae	Hemiaulales	Hemiaulaceae	*Eucampia zoodiacus*	
Coscinodiscophyceae	Hemiaulales	Hemiaulaceae	*Hemiaulus kauckii*	
Coscinodiscophyceae	Lithodesmidales	Lithodesmiaceae	*Ditylum brightwelli*	
Coscinodiscophyceae	Lithodesmidales	Lithodesmiaceae	*Lithodesmium undulatum*	
Coscinodiscophyceae	Melosirales	Melosiraceae	*Melosira moniliformis*	
Coscinodiscophyceae	Melosirales	Stephanopyxidaceae	*Stephanopyxis orbicularis*	
Coscinodiscophyceae	Melosirales	Stephanopyxidaceae	*Stephanopyxis turris*	
Coscinodiscophyceae	Rhizosoleniales	Rhizosoleniaceae	*Guinardia flaccida*	
Coscinodiscophyceae	Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia alata*	
Coscinodiscophyceae	Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia* cf. *hebatata*	
Coscinodiscophyceae	Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia imbricata*	
Coscinodiscophyceae	Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia robusta*	
Coscinodiscophyceae	Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia setigera*	
Coscinodiscophyceae	Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia stolterfothii*	
Coscinodiscophyceae	Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia styliformis*	
Coscinodiscophyceae	Thalassiosirales	Lauderiaceae	*Lauderia annulata*	
Coscinodiscophyceae	Thalassiosirales	Skeletonemaceae	*Skeletonema costatum*	
Coscinodiscophyceae	Thalassiosirales	Thalassiosiraceae	*Planktoniella sol*	
Coscinodiscophyceae	Thalassiosirales	Thalassiosiraceae	*Thalassiosira condensata*	
Coscinodiscophyceae	Thalassiosirales	Thalassiosiraceae	*Thalassiosira decipiens*	
Coscinodiscophyceae	Thalassiosirales	Thalassiosiraceae	*Thalassiosira hyalina*	
Coscinodiscophyceae	Thalassiosirales	Thalassiosiraceae	*Thalassiosira rotula*	

Phylum, Class	Order	Family	Taxon name	Recorded in desktop review?
Coscinodiscophyceae	Triceratiales	Triceratiaceae	*Odontella mobiliensis*	
Coscinodiscophyceae	Triceratiales	Triceratiaceae	*Odontella sinensis*	
Coscinodiscophyceae	Triceratiales	Triceratiaceae	*Triceratium alternans*	
Coscinodiscophyceae	Triceratiales	Triceratiaceae	*Triceratium favus*	
Fragilariophyceae	Striatellales	Striatellaceae	*Grammatophora marina*	
Fragilariophyceae	Thalassionemales	Thalassionemataceae	*Thalassionema frauenfeldii*	
Fragilariophyceae	Thalassionemales	Thalassionemataceae	*Thalassionema nitzschioides*	
Fragilariophyceae	Thalassionemales	Thalassionemataceae	*Thalassiothrix longisima*	
Bryozoa				
Gymnolaemata	Cheilostomata	Antroporidae	*Akatopora circumsaepta*	Yes
Gymnolaemata	Cheilostomata	Beaniidae	*Beania discodermiae*	
Gymnolaemata	Cheilostomata	Beaniidae	*Beania plurispinosa*	Yes
Gymnolaemata	Cheilostomata	Buffonellodidae	*Aimulosia marsupium*	Yes
Gymnolaemata	Cheilostomata	Bugulidae	*Bicellariella ciliata*	
Gymnolaemata	Cheilostomata	Calloporidae	*Crassimarginatella papulifera*	
Gymnolaemata	Cheilostomata	Calloporidae	*Valdemunitella valdemunita*	
Gymnolaemata	Cheilostomata	Candidae	*Caberea rostrata*	Yes
Gymnolaemata	Cheilostomata	Celleporidae	*Celleporina proximalis*	
Gymnolaemata	Cheilostomata	Celleporidae	*Galeopsis polyporus*	Yes
Gymnolaemata	Cheilostomata	Chaperiidae	*Chaperiopsis cervicornis*	Yes
Gymnolaemata	Cheilostomata	Electridae	*Conopeum oretiensis*	
Gymnolaemata	Cheilostomata	Eurystomellidae	*Eurystomella foraminigera*	Yes
Gymnolaemata	Cheilostomata	Hippothoidae	*Antarctothoa tongima*	Yes
Gymnolaemata	Cheilostomata	Microporellidae	*Calloporina angustipora*	Yes
Gymnolaemata	Cheilostomata	Microporellidae	*Microporella discors*	Yes
Gymnolaemata	Cheilostomata	Microporidae	*Opaeophora lepida*	Yes
Gymnolaemata	Cheilostomata	Smittinidae	*Parasmittina delicatula*	
Gymnolaemata	Cheilostomata	Smittinidae	*Smittina torques*	Yes
Chordata				
Actinopterygii	Anguilliformes	Congridae	*Conger wilsoni*	
Actinopterygii	Clupeiformes	Engraulidae	*Engraulis australis*	
Actinopterygii	Cypridontiformes	Hemiramphidae	*Euleptorhamphus viridis*	
Actinopterygii	Mugiliformes	Mugilidae	*Aldrichetta forsteri*	
Actinopterygii	Perciformes	Gobiesocidae	*Dellichthys morelandi*	
Actinopterygii	Perciformes	Gobiidae	*Favonigobius lentiginosus*	
Actinopterygii	Perciformes	Kyphosidae	*Girella tricuspidata*	
Actinopterygii	Perciformes	Tripterygiidae	*Forsterygion varium*	
Actinopterygii	Perciformes	Tripterygiidae	*Grahamina capito*	
Actinopterygii	Perciformes	Tripterygiidae	*Grahamina nigripenne*	
Actinopterygii	Pleuronectiformes	Pleuronectidae	*Rhombosolea plebeia*	Yes
Actinopterygii	Salmoniformes	Retropinnidae	*Retropinna retropinna*	
Actinopterygii	Scorpaeniformes	Scorpaenidae	*Scorpaena papillosa*	
Ascidiacea	Pleurogona	Molgulidae	*Molgula mortenseni*	
Ascidiacea	Pleurogona	Polyzoinae	*Polyzoa opuntia*	
Ascidiacea	Pleurogona	Styelidae	*Polycarpa pegasus*	

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Phylum, Class	Order	Family	Taxon name	Recorded in desktop review?
Cnidaria				
Anthozoa	Alcyonacea	Clavulariidae	*Clavularia novaezelandiae*	
Hydrozoa	Hydroida	Sertulariidae	*Symplectoscyphus subarticulatus*	
Hydrozoa	Leptothecata	Sertulariidae	*Dictyocladium monilifer*	
Scyphozoa	Semaeostomeae	Cyaneidae	*Desmonema* cf. *gaudichaudi*	
Echinodermata				
Asteroidea	Forcipulatida	Asteriidae	*Coscinasterias muricata*	
Asteroidea	Valvatida	Asterinidae	*Patiriella mortenseni*	
Asteroidea	Valvatida	Asterinidae	*Patiriella regularis*	Yes
Echinoidea	Clypeasteroida	Arachnoididae	*Fellaster zelandiae*	
Holothuroidea	Molpadiida	Caudinidae	*Paracaudina chilensis*	Yes
Ophiuroidea	Ophiurida	Amphiuridae	*Amphipholis squamata*	Yes
Ophiuroidea	Ophiurida	Amphiuridae	*Amphiura amokurae*	
Ophiuroidea	Ophiurida	Ophiactidae	*Ophiactis resiliens*	Yes
Magnoliophyta				
Liliopsida	Potamogetonales	Zosteraceae	*Zostera capricorni*	
Mollusca				
Bivalvia	Mytiloida	Mytilidae	*Modiolarca impacta*	
Bivalvia	Mytiloida	Mytilidae	*Perna canaliculus*	Yes
Bivalvia	Mytiloida	Mytilidae	*Xenostrobus pulex*	Yes
Bivalvia	Nuculoida	Nuculidae	*Nucula hartvigiana*	
Bivalvia	Pholadomyoida	Myochamidae	*Myadora boltoni*	
Bivalvia	Pterioida	Pectinidae	*Pecten novaezelandiae*	
Bivalvia	Veneroida	Mactridae	*Cyclomactra tristis*	
Bivalvia	Veneroida	Mactridae	*Zenatia acinaces*	
Bivalvia	Veneroida	Mesodesmatidae	*Paphies australis*	
Bivalvia	Veneroida	Mesodesmatidae	*Paphies subtriangulata*	
Bivalvia	Veneroida	Psammobiidae	*Soletellina siliquens*	
Bivalvia	Veneroida	Tellinidae	*Macomona liliana*	
Bivalvia	Veneroida	Ungulinidae	*Felaniella zelandica*	
Bivalvia	Veneroida	Veneridae	*Austrovenus stutchburyi*	
Bivalvia	Veneroida	Veneridae	*Dosinia lambata*	
Bivalvia	Veneroida	Veneridae	*Dosinia subrosea*	
Bivalvia	Veneroida	Veneridae	*Irus reflexus*	
Bivalvia	Veneroida	Veneridae	*Ruditapes largillierti*	
Gastropoda	Cephalaspidea	Philinidae	*Philine auriformis*	
Gastropoda	Docoglossa	Lottiidae	*Notoacmea helmsi*	
Gastropoda	Neogastropoda	Buccinidae	*Cominella adspersa*	
Gastropoda	Neogastropoda	Buccinidae	*Cominella glandiformis*	Yes
Gastropoda	Neogastropoda	Muricidae	*Xymene plebeius*	
Gastropoda	Neogastropoda	Olividae	*Amalda australis*	
Gastropoda	Neogastropoda	Terebridae	*Pervicacia tristis*	

Phylum, Class	Order	Family	Taxon name	Recorded in desktop review?
Gastropoda	Neotaenioglossa	Batillariidae	*Zeacumantus lutulentus*	
Gastropoda	Neotaenioglossa	Calyptraeidae	*Sigapatella tenuis*	
Gastropoda	Neotaenioglossa	Littorinidae	*Nodilittorina antipodum*	
Gastropoda	Neotaenioglossa	Turritellidae	*Maoricolpus roseus*	
Gastropoda	Nudibranchia	Dendrodorididae	*Dendrodoris citrina*	
Gastropoda	Pulmonata	Amphibolidae	*Amphibola crenata*	
Gastropoda	Systellomatophora	Onchidiidae	*Onchidella nigricans*	
Gastropoda	Vetigastropoda	Trochidae	*Diloma subrostrata*	
Gastropoda	Vetigastropoda	Trochidae	*Melagraphia aethiops*	Yes
Gastropoda	Vetigastropoda	Trochidae	*Trochus tiaratus*	
Gastropoda	Vetigastropoda	Trochidae	*Zethalia zelandica*	
Polyplacophora	Acanthochitonina	Acanthochitonidae	*Acanthochitona zelandica*	Yes
Polyplacophora	Ischnochitonina	Chitonidae	*Sypharochiton pelliserpentis*	Yes
Polyplacophora	Lepidopleurina	Leptochitonidae	*Leptochiton inquinatus*	
Myzozoa				
Dinophyceae	Dinophysiales	Dinophysiaceae	*Dinophysis acuminata*	Yes
Dinophyceae	Dinophysiales	Dinophysiaceae	*Dinophysis acuta*	Yes
Dinophyceae	Dinophysiales	Dinophysiaceae	*Dinophysis tripos*	
Dinophyceae	Gymnodiniales	Gymnodiniaceae	*Akashiwo sanguinea*	
Dinophyceae	Gymnodiniales	Gymnodiniaceae	*Gyrodinium spirale*	
Dinophyceae	Gymnodiniales	Polykrikaceae	*Polykrikos schwartzii*	
Dinophyceae	Noctilucales	Noctilucaceae	*Noctiluca scintillans*	
Dinophyceae	Peridiniales	Ceratiaceae	*Ceratium furca*	
Dinophyceae	Peridiniales	Ceratiaceae	*Ceratium fusus*	
Dinophyceae	Peridiniales	Ceratiaceae	*Ceratium horridum*	
Dinophyceae	Peridiniales	Ceratiaceae	*Ceratium lineatum*	
Dinophyceae	Peridiniales	Ceratiaceae	*Ceratium tripos*	
Dinophyceae	Peridiniales	Gonyaulacaceae	*Protoceratium reticulatum*	
Dinophyceae	Peridiniales	Oxytoxaceae	*Oxytoxum* sp.	
Dinophyceae	Peridiniales	Peridiniaceae	*Scrippsiella trochoidea*	
Dinophyceae	Peridiniales	Podolampadaceae	*Podolampas palmipes*	
Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium avellana*	
Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium conicum*	
Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium curtipeds*	
Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium depressum*	
Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium divergens*	
Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium leonis*	
Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium punctulatum*	
Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium pyroforme*	
Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium steinii*	
Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium subinerme*	
Dinophyceae	Prorocentrales	Prorocentraceae	*Prorocentrum gracile*	
Dinophyceae	Prorocentrales	Prorocentraceae	*Prorocentrum micans*	
Dinophyceae	Prorocentrales	Prorocentraceae	*Prorocentrum ovum*	

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Phylum, Class	Order	Family	Taxon name	Recorded in desktop review?
Ochrophyta				
Dictyochophyceae	Dictyochales	Dictyochaceae	*Dictyocha fibula*	
Dictyochophyceae	Dictyochales	Dictyochaceae	*Distephanus speculum*	
Phaeophyceae	Laminariales	Alariaceae	*Ecklonia radiata*	
Phaeophyceae	Sphacelariales	Stypocaulaceae	*Halopteris campanula*	
Porifera				
Demospongiae	Dictyoceratida	Dysideidae	*Euryspongia* cf. *arenaria*	
Demospongiae	Halichondrida	Halichondriidae	*Ciocalypta colvilii*	
Demospongiae	Haplosclerida	Chalinidae	Adocia cf. parietalioides	
Demospongiae	Haplosclerida	Chalinidae	*Haliclona* cf. *tenacior*	
Demospongiae	Haplosclerida	Chalinidae	*Haliclona glabra*	
Demospongiae	Poecilosclerida	Desmacellidae	*Desmacella ambigua*	
Demospongiae	Poecilosclerida	Hymedesmiidae	*Phorbas* cf. *anchorata*	
Demospongiae	Poecilosclerida	Microcionidae	*Clathria (Microciona) rubens*	
Demospongiae	Poecilosclerida	Microcionidae	*Clathria* cf. *terraenovae*	
Demospongiae	Poecilosclerida	Microcionidae	*Dictyociona contorta*	
Demospongiae	Poecilosclerida	Microcionidae	*Ophlitospongia reticulata*	
Demospongiae	Poecilosclerida	Microcionidae	*Plocamia novizelanicum*	
Rhodophyta				
Florideophyceae	Ceramiales	Ceramiaceae	*Ceramium apiculatum*	
Florideophyceae	Ceramiales	Ceramiaceae	*Ceramium flaccidum*	
Florideophyceae	Ceramiales	Dasyaceae	*Heterosiphonia squarrosa*	
Florideophyceae	Ceramiales	Delesseriaceae	*Caloglossa viellardii*	
Florideophyceae	Ceramiales	Delesseriaceae	*Hymenena variolosa*	
Florideophyceae	Ceramiales	Rhodomelaceae	*Laurencia distichophylla*	
Florideophyceae	Ceramiales	Rhodomelaceae	*Metamorphe colensoi*	
Florideophyceae	Ceramiales	Rhodomelaceae	*Polysiphonia strictissima*	
Florideophyceae	Rhodymeniales	Lomentariaceae	*Lomentaria caespitosa*	
Florideophyceae	Rhodymeniales	Lomentariaceae	*Lomentaria umbellata*	

Table 14: Non-indigenous marine species recorded from the Kaipara Harbour during the baseline port survey. Also indicated is the date of introduction or detection (d) in New Zealand, the probable means of introduction to New Zealand and spread within New Zealand (see Appendix 6), and whether the taxon was recorded from the desktop review of existing marine species records from Kaipara Harbour.

Phylum, Class	Order	Family	Taxon name	Date of introduction, or detection (d)	Probable means of introduction to NZ	Probable means of spread within NZ	Recorded in desktop review?
Annelida							
Polychaeta	Spionida	Spionidae	*Dipolydora armata*	About 1900	F2, S1, S3	F2, N1, S1, S3	
Arthropoda							
Malacostraca	Amphipoda	Ischyroceridae	*Jassa slatteryi*	1990	S1	F2, F3, NB, S1	
	Decapoda	Majidae	*Pyromaia tuberculata*	1975	S1, S3	NB, N1, S1, S3	

Bryozoa							
Gymnolaemata	Cheilostomata	Electridae	*Conopeum seurati*	Pre-1963	S1	D, F2, F3, N1	
	Ctenostomata	Nolellidae	*Anguinella palmata*	Pre-1960	S1	F1, F2, F3, S1	
		Vesiculariidae	*Bowerbankia gracilis*	Pre-1965	D, S1, S3	F1, F2, F3, S1	
Mollusca							
Bivalvia	Mytiloida	Mytilidae	*Musculista senhousia*	1978	F2, S1, S3	D, F1, F2, NB	Yes
	Pterioida	Ostreidae	*Crassostrea gigas*	1961	F1, F2, F3, S1	D, F1, F2, F3	Yes
	Veneroida	Semelidae	*Theora lubrica*	1971	S3	N1, RE, S3, S5	Yes
Porifera							
Demospongiae	Poecilosclerida	Esperiopsidae	*Amphilectus fucorum*	December 2001	S1		

Table 15: Cryptogenic category one (C1) taxa recorded from Kaipara Harbour in baseline port survey. Also indicated is the date of introduction or detection (d) in New Zealand, the probable means of introduction to New Zealand and spread within New Zealand (see Appendix 6), and whether the taxon was recorded from the desktop review of existing marine species records from Kaipara Harbour.

Phylum, Class	Order	Family	Taxon name	Date of introduction, or detection (d)	Probable means of introduction to NZ	Probable means of spread within NZ	Recorded in desktop review?
Arthropoda							
Malacostraca	Decapoda	Hippolytidae	*Lysmata vittata*	27 March 2006			
Chordata							
Ascidiacea	Enterogona	Didemnidae	*Didemnum* sp.#		S1	F3, NB, N2, S1	
Cnidaria							

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ra Harbour: Baseline survey for non-indigenous marine species
a Harbour: Baseline survey for non-indigenous marine species
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Hydrozoa	Hydroida	Bougainvilliidae	*Bougainvillia muscus*			(blank)	
Myzozoa							
Dinophyceae	Gymnodiniales	Gymnodiniaceae	*Gymnodinium catenatum*	2000	F2, N1, S3	F2, N1, S3	Yes
Dinophyceae	Peridiniales	Gonyaulacaceae	*Alexandrium affine*		F2, N1, S3	F2, N1, S3	
Dinophyceae	Peridiniales	Gonyaulacaceae	*Alexandrium catenella*	April 1996	F2, N1, S3	F2, N1, S3	
Porifera							
Demospongiae	Hadromerida	Suberitidae	*Suberites* cf. perfectus				
Demospongiae	Halichondrida	Halichondriidae	*Ciocalypta* cf. *pencillus*				
Demospongiae	Haplosclerida	Callyspongiidae	*Callyspongia ramosa*	approx. 1923	S1	S1	

Because of the complex taxonomy of this genus, *Didemnum* specimens from the second survey could not be identified to species level, but are reported here collectively as a species group "*Didemnum* sp."

Table 16: Cryptogenic category two (C2) taxa recorded from Kaipara Harbour in the baseline port survey. Also indicated is the date of introduction or detection (d) in New Zealand, the probable means of introduction to New Zealand (see Appendix 6), and whether the taxon was recorded from the desktop review of existing marine species records from Kaipara Harbour. No C2 taxa recorded in the survey were also recorded in the desktop review.

Phylum, Class	Order	Family	Taxon name	Date of introduction, or detection (d)	Probable means of introduction to NZ
Annelida					
Polychaeta	Phyllodocida	Nereididae	*Neanthes* aff. *succinea*	January 2006	
Polychaeta	Phyllodocida	Nereididae	*Perinereis Perinereis*-A		
Polychaeta	Phyllodocida	Phyllodocidae	*Pirakia Pirakia*-A		
Polychaeta	Sabellida	Serpulidae	*Spirobranchus S. polytrema* complex	2001	D, S1, S3
Polychaeta	Terebellida	Ampharetidae	*Amphicteis Amphicteis*-A		

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ara Harbour: Baseline survey for non-indigenous marine species
ra Harbour: Baseline survey for non-indigenous marine species
a Harbour: Baseline survey for non-indigenous marine species
Harbour: Baseline survey for non-indigenous marine species
Harbour: Baseline survey for non-indigenous marine species
arbour: Baseline survey for non-indigenous marine species
rbour: Baseline survey for non-indigenous marine species
bour: Baseline survey for non-indigenous marine species
our: Baseline survey for non-indigenous marine species
ur: Baseline survey for non-indigenous marine species
r: Baseline survey for non-indigenous marine species
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Baseline survey for non-indigenous marine species
Baseline survey for non-indigenous marine species

Polychaeta	Terebellida	Terebellidae	*Lanice Lanice*-01 [conchilega / aoteoroae]		
Porifera					
Demospongiae	Halichondrida	Halichondriidae	*Halichondria* new sp. 1	November 2001	
Demospongiae	Haplosclerida	Chalinidae	*Adocia* new sp. 10	September 2006	
Demospongiae	Haplosclerida	Chalinidae	*Haliclona* new sp. 21	September 2006	
Demospongiae	Haplosclerida	Chalinidae	*Haliclona* new sp. 3	December 2001	
Demospongiae	Haplosclerida	Chalinidae	*Haliclona* new sp. 5	December 2001	
Demospongiae	Haplosclerida	Chalinidae	*Haliclona* new sp. 6	December 2001	
Demospongiae	Haplosclerida	Chalinidae	*Haliclona* new sp. 9	November 2002	
Demospongiae	Poecilosclerida	Microcionidae	*Clathria* new sp. 1	March 2002	
Demospongiae	Poecilosclerida	Microcionidae	*Clathria* new sp. 3	March 2002	
Demospongiae	Poecilosclerida	Microcionidae	*Ophlitospongia* new sp. 1	March 2002	
Demospongiae	Poecilosclerida	Raspaillidae	*Eurypon* new sp. 1	September 2006	
Demospongiae	Poecilosclerida	Tedaniidae	*Tedania* new sp. 5	September 2006	

Table 17: Indeterminate taxa recorded from the Kaipara Harbour in baseline port survey. This group includes: (1) organisms that were damaged or juvenile and lacked crucial morphological characteristics, and (2) taxa for which there is not sufficient taxonomic or systematic information available to allow positive identification to species level. No Indeterminate taxa recorded in the survey were also recorded in the desktop review.

Phylum, Class	Order	Family	Taxon name
Annelida			
Polychaeta			Polychaeta Indet.
Polychaeta	Eunicida	Lumbrineridae	Lumbrineridae Indet.
Polychaeta	Eunicida	Onuphidae	Onuphidae Indet.
Polychaeta	Phyllodocida	Glyceridae	Glycera sp.
Polychaeta	Phyllodocida	Hesionidae	*Ophiodromus hesionid*-KPR854
Polychaeta	Phyllodocida	Nephtyidae	*Aglaophamus aglaophamus*-A
Polychaeta	Phyllodocida	Nephtyidae	*Aglaophamus* sp.
Polychaeta	Phyllodocida	Nereididae	Nereididae Indet.
Polychaeta	Phyllodocida	Nereididae	*Nereis* sp.
Polychaeta	Phyllodocida	Phyllodocidae	Phyllodocidae Indet.
Polychaeta	Phyllodocida	Polynoidae	Harmothoe sp.
Polychaeta	Phyllodocida	Polynoidae	Polynoidae Indet.
Polychaeta	Phyllodocida	Syllidae	Syllidae Indet.

Phylum, Class	Order	Family	Taxon name
Polychaeta	Sabellida	Serpulidae	*Serpula* sp.
Polychaeta	Scolecida	Capitellidae	Capitellidae Indet.
Polychaeta	Terebellida	Cirratulidae	*Aphelochaeta aphelochaeta*-1 undescribed
Polychaeta	Terebellida	Flabelligeridae	Flabelligeridae
Polychaeta	Terebellida	Terebellidae	Terebellidae Indet.
Arthropoda			
Insecta	Diptera		Diptera larva
Malacostraca	Amphipoda		Amphipoda Indet.
Malacostraca	Isopoda	Idoteidae	Idotea sp. nov
Malacostraca	Mysida		Mysida Indet.
Bacillariophyta			
Bacillariophyceae	Achnanthales	Cocconeidaceae	*Cocconeis* sp.
Bacillariophyceae	Bacillariales	Bacillariaceae	*Nitzschia* sp.
Bacillariophyceae	Naviculales	Amphipleuraceae	*Amphiprora* sp.
Bacillariophyceae	Naviculales	Naviculaceae	*Amphora* sp.
Bacillariophyceae	Naviculales	Naviculaceae	*Diploneis* sp.
Bacillariophyceae	Naviculales	Naviculaceae	*Navicula* sp.
Bacillariophyceae	Naviculales	Pleurosigmataceae	*Gyrosigma* sp.
Bacillariophyceae	Naviculales	Pleurosigmataceae	*Pleurosigma* sp.
Bacillariophyceae	Pennales	Surirellaceae	*Surirella* sp.
Coscinodiscophyceae	Chaetocerotales	Chaetocerotaceae	*Chaetoceros* sp.
Coscinodiscophyceae	Coscinodiscales	Coscinodiscaceae	*Coscinodiscus* sp.
Coscinodiscophyceae	Leptocylindrales	Leptocylindraceae	*Leptocylindrus* sp.

Phylum, Class	Order	Family	Taxon name
Coscinodiscophyceae	Melosirales	Melosiraceae	*Melosira* sp.
Coscinodiscophyceae	Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia* sp.
Coscinodiscophyceae	Thalassiosirales	Skeletonemaceae	*Detonula* sp.
Coscinodiscophyceae	Thalassiosirales	Thalassiosiraceae	*Thalassiosira* sp.
Fragilariophyceae	Licmophorales	Licmophoraceae	*Licmophora* sp.
Bryozoa			
			Bryozoa Indet.
Gymnolaemata	Cheilostomata	Flustridae	*Gregarinidra* sp.
Gymnolaemata	Cheilostomata	Phidoloporidae	*Rhynchozoon* sp.
Gymnolaemata	Ctenostomata	Alcyonidiidae	*Alcyonidium* sp.
Chlorophyta			
Ulvophyceae	Bryopsidales	Codiaceae	*Codium* sp.
Ulvophyceae	Cladophorales	Cladophoraceae	*Rhizoclonium* sp.
Ulvophyceae	Ulvales	Ulvaceae	*Ulva* sp.
Chordata			
Ascidiacea			Ascidiacea
Cnidaria			
Anthozoa	Actiniaria	Diadumenidae	*Diadumene* sp.
Anthozoa	Actiniaria	Sagartiidae	*Actinothoe* sp.
Hydrozoa	Anthoathecata	Tubulariidae	*Ectopleura* sp.
Echinodermata			
Ophiuroidea	Ophiurida	Amphiuridae	*Amphiura* sp.

Phylum, Class	Order	Family	Taxon name
Mollusca			
Bivalvia			Bivalvia
Gastropoda			Gastropoda
Gastropoda	Docoglossa	Lottiidae	*Notoacmea* sp.
Myzozoa			
Dinophyceae			Unidentifiable cyst
Dinophyceae	Gymnodiniales	Gymnodiniaceae	*Gymnodinium* sp.
Dinophyceae	Peridiniales	Ceratiaceae	*Ceratium* sp.
Dinophyceae	Peridiniales	Gonyaulacaceae	*Alexandrium* sp.
Dinophyceae	Peridiniales	Gonyaulacaceae	*Gonyaulax* sp.
Dinophyceae	Peridiniales	Peridiniaceae	*Scrippsiella* sp.
Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium* sp.
Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium* sp. 1
Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium* sp. 2
Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium* sp. 3
Nemertea			
			Nemertea
Ochrophyta			
Dictyochophyceae	Dictyochales	Dictyochaceae	*Dictyota* sp.
Platyhelminthes			
			Platyhelminthes
Rhodophyta			
Florideophyceae	Ceramiales	Ceramiaceae	*Griffithsia* sp.

Phylum, Class	Order	Family	Taxon name
Florideophyceae	Ceramiales	Dasyaceae	*Dasya* sp.
Florideophyceae	Ceramiales	Rhodomelaceae	*Polysiphonia* sp.
Florideophyceae	Gigartinales	Solieriaceae	Solieriaceae Indet.
Florideophyceae	Gracilariales	Gracilariaceae	*Gracilaria* sp. Indet.
Florideophyceae	Rhodymeniales	Rhodymeniaceae	*Rhodymenia* sp.
Sipuncula			
			Sipuncula
Unidentified			
			Plantae
			Unidentified algae
			Unknown

Table 18: Depth class and method of collection for NIS and C1 taxa collected during the Kaipara Harbour survey. Data are numbers of samples each species occurred in.

Taxon Name	Biosecurity Status	Method *	>0	<0 to -5	<-10 to -15	<-15 to -20	<-15 to -20	<-20	Total
Bowerbankia gracilis	NIS	ANCH			1				**1**
Conopeum seurati	NIS	ANCH			2				**2**
		PSC		2					**2**
Crassostrea gigas	NIS	ANCH			2				**2**
		PSC		14					**14**
		PSCM		1					**1**
Theora lubrica	NIS	ANCH		7	1				**8**
		BSLD		3	1	1			**5**
Bougainvillia muscus	C1	ANCH			1	2			**3**
		BSLD			1				**1**
Didemnum sp.	C1	PSC		5					**5**
Lysmata vittata	C1	MISC			1				**1**
Alexandrium affine	C1	CYST			1				**1**
		PHYT				1			**1**
Alexandrium catenella	C1	CYST		1					**1**
		PHYT					1		**1**
Amphilectus fucorum	NIS	ANCH						1	**1**

Anguinella palmata	NIS	BSLD			1				**1**
Callyspongia ramosa	C1	BSLD WRACK MISC	 2 		1 1				**1** **2** **1**
Ciocalypta cf. *pencillus*	C1	ANCH			1				**1**
Dipolydora armata	NIS	ANCH			1				**1**
Gymnodinium catenatum	C1	CYST		2					**2**
Jassa slatteryi	NIS	ANCH PSC		 1	1 				**1** **1**
Musculista senhousia	NIS	ANCH BSLD		7 3	3 5		 1		**10** **9**
Pyromaia tuberculata	NIS	BSLD		1	1	1		1	**4**
Suberites cf. *perfectus*	C1	ANCH		1					**1**
Total number of NIS & C1 specimens			**2**	**50**	**26**	**4**	**1**	**2**	**85**
Proportion of all NIS & C1 specimens (%)			**2.4**	**58.8**	**30.6**	**4.7**	**1.2**	**2.4**	**100**
Total number of NIS & C1 taxa			**1**	**11**	**14**	**3**	**1**	**2**	**19**
Proportion of all NIS & C1 taxa (%)			**5.3**	**57.9**	**73.7**	**15.8**	**5.3**	**10.5**	**#**

* Survey methods: ANCH = anchor box dredge; BGRB = benthic grab; BSLD = benthic sled; CYST = dinoflagellate cyst core; CRBTP = crab trap; FSHTP = fish trap; PHYT = phytoplankton tow; SHRTP = shrimp trap; STFTP = seastar trap; PSC = piling quadrat scrapings; VISS = opportunistic visual search; WRACK = beach wrack search.

The proportion of taxa in each depth class sums to greater than 100%, as some taxa were recorded from more than one depth class

Table 19: Depth class and method of collection for each native species collected during the Kaipara Harbour survey. Data are numbers of samples each species occurred in.

Taxon name	Method*	>0	<0 to -5	<-10 to -15	<-15 to -20	<-15 to -20	<-20	Total
Adocia cf. *parietalioides*	BSLD		1			2		**3**
Aldrichetta forsteri	SEINE		9					**9**
Alpheus richardsoni	ANCH		1		1			**2**
	BSLD		1					**1**
	PHYT		1					**1**
	SEINE		1					**1**
	SHRTP			1				**1**
Armandia maculata	ANCH		2	4	2	1	1	**10**
Austrominius modestus	ANCH		1	3				**4**
	PSC		22					**22**
	PSCM		1					**1**
Austrovenus stutchburyi	ANCH		6	4				**10**
	BSLD		1		1	1		**3**
	CRBTP		3					**3**
	SEINE		1					**1**
Beania plurispinosa	ANCH			5	1			**6**
	BSLD		1	2	1			**4**
	CRBTP		1					**1**

Taxon name	Method*	>0	<0 to -5	<-10 to -15	<-15 to -20	<-15 to -20	<-20	Total
	PSC		3					**3**
	MISC			1				**1**
Cominella adspersa	ANCH		4	5			1	**10**
	BSLD		3	1	1			**5**
	CRBTP		5	2				**7**
Coscinasterias muricata	ANCH		1	2	1	1	1	**6**
	BSLD		1		1			**2**
	PSC		2					**2**
Desmacella ambigua	ANCH			1				**1**
Dosinia subrosea	ANCH			1	1			**2**
Favonigobius lentiginosus	BSLD		1					**1**
	SEINE		4					**4**
Glycera lamelliformis	ANCH		11	2	1		1	**15**
	BSLD		1					**1**
Grahamina capito	POIS		2					**2**
Halicarcinus varius	ANCH		1	1			2	**4**
	BSLD		1					**1**
	CRBTP		1	1				**2**
	PSC		3					**3**
Harmothoe macrolepidota	ANCH		1				1	**2**
	BSLD						1	**1**

Taxon name	Method*	>0	<0 to -5	<-10 to -15	<-15 to -20	<-15 to -20	<-20	Total
	PSC		1					**1**
	SEINE		1					**1**
	MISC			1				**1**
Labiosthenolepis laevis	ANCH		3	1	1			**5**
	BSLD		1					**1**
	PHYT		1					**1**
Lepidastheniella comma	ANCH					1		**1**
Lepidonotus polychromus	ANCH			2	1			**3**
	PSC		10					**10**
Lumbrineris sphaerocephala	ANCH						1	**1**
	BSLD					1		**1**
Macrophthalmus hirtipes	ANCH		16	3				**19**
	BSLD		4			1		**5**
	CRBTP		1	2				**3**
	PSC		1					**1**
	SHRTP		1	1				**2**
Maoricolpus roseus	ANCH		1	9	4	1	1	**16**
	BSLD		2	2	1			**5**
	PSCM		1					**1**
Modiolarca impacta	ANCH				1			**1**
Molgula mortenseni	ANCH				1			**1**
Natatolana narica	ANCH				1			**1**
	SEINE		1					**1**

Taxon name	Method*	>0	<0 to -5	<-10 to -15	<-15 to -20	<-15 to -20	<-20	Total
	SHRTP		3	6				**9**
Natatolana rossi	SHRTP		8	6				**14**
Neanthes kerguelensis	ANCH						1	**1**
	BSLD			2		1		**3**
	PSC		2					**2**
	MISC			1				**1**
Neohymenicus pubescens	PSC		1					**1**
Nereis falcaria	ANCH			3	1			**4**
	BSLD			1		1		**2**
	PSC		2					**2**
	MISC			1				**1**
Notomithrax minor	ANCH			3	1	1		**5**
	BSLD		1	1	1			**3**
Paguristes pilosus	ANCH		1					**1**
	BSLD			1	2			**3**
Patiriella mortenseni	ANCH		1	2				**3**
	BSLD		1		2			**3**
Patiriella regularis	ANCH			3	1			**4**
	BSLD		2	2				**4**
Pectinaria australis	ANCH			1				**1**
	BSLD				1			**1**
Periclimenes yaldwyni	BSLD		1	2	1		2	**6**
	SHRTP			1				**1**

Taxon name	Method*	>0	<0 to -5	<-10 to -15	<-15 to -20	<-15 to -20	<-20	Total
Perna canaliculus	PSC		2					**2**
	SEINE		1					**1**
Petrolisthes elongatus	ANCH			2	1		1	**4**
	BSLD		1	3		1		**5**
	PSC		10					**10**
	MISC			1				**1**
Petrolisthes novaezelandiae	ANCH			1				**1**
Philine auriformis	ANCH		1					**1**
	BSLD		1					**1**
Philocheras australis	ANCH				1			**1**
	BSLD		1	3	2	1		**7**
	SEINE		1					**1**
	SHRTP			3				**3**
Phylo novazealandiae	ANCH		1		1			**2**
Pilumnopeus serratifrons	ANCH			5				**5**
	BSLD		1	2				**3**
	CRBTP		1					**1**
	PSC		4					**4**
Plagusia chabrus	BSLD					1		**1**
	PSC		2					**2**
	WRACK	1						**1**
Platynereis	ANCH		1	2		2		**5**

Taxon name	Method*	>0	<0 to -5	<-10 to -15	<-15 to -20	<-15 to -20	<-20	Total
Platynereis_australis_group	BSLD		1					**1**
Polysiphonia strictissima	ANCH		2			1	1	**4**
	CRBTP		4	1				**5**
Protocirrineris nuchalis	ANCH			1				**1**
Protoperidinium avellana	CYST		9	4	3		1	**17**
Protoperidinium subinerme	CYST				1			**1**
	PHYT		4					**4**
Pseudosphaeroma campbellensis	ANCH				1			**1**
	PSC		4					**4**
Schistomeringos loveni	ANCH					1		**1**
	PSC		1					**1**
Spirobranchus cariniferus	PSC		1					**1**
Streblosoma toddae	ANCH		1	4			1	**6**
	PSC		3					**3**
Torridoharpinia hurleyi	ANCH		2	1	1			**4**
Xenostrobus pulex	PSC		6					**6**
	PSCM		1					**1**
Xymene plebeius	ANCH		3	1	1			**5**
	BSLD		1				1	**2**
Acanthochitona zelandica	ANCH			1		1		**2**
	BSLD			2				**2**
Aglaophamus macroura	ANCH		5	1	2	4		**12**
Amphipholis squamata	ANCH			1	1	1		**3**

Taxon name	Method*	>0	<0 to -5	<-10 to - 15	<-15 to - 20	<-15 to - 20	<-20	Total
Beania discodermiae	ANCH			3				**3**
	BSLD				1			**1**
Caberea rostrata	BSLD					1		**1**
Ceramium apiculatum	BSLD				1			**1**
	CRBTP		2	5				**7**
Ceramium flaccidum	CRBTP			1				**1**
Forsterygion varium	PSC		1					**1**
Glycinde trifida	ANCH		2	1				**3**
Heterosiphonia squarrosa	PSC		2					**2**
Hymenena variolosa	CRBTP		1					**1**
Irus reflexus	BSLD					1		**1**
Lepidonotus jacksoni	ANCH						1	**1**
Lophopagurus cookii	ANCH					1		**1**
Macomona liliana	ANCH		12	4				**16**
	BSLD		1					**1**
	CRBTP			1				**1**
Macroclymenella stewartensis	ANCH		1					**1**
Nicon aestuariensis	ANCH		9		1			**10**
	BSLD		1					**1**
Notomegabalanus decorus	ANCH			1	2		1	**4**
	BSLD			2		1		**3**
	PSC		4					**4**
Ophiodromus angustifrons	ANCH			1				**1**

Taxon name	Method*	>0	<0 to -5	<-10 to -15	<-15 to -20	<-15 to -20	<-20	Total
Owenia petersenae	ANCH		1			1	1	**3**
	BSLD		1					**1**
Pagurus novizealandiae	BSLD			2				**2**
	CRBTP			1				**1**
Paradexamine pacifica	ANCH		1					**1**
	BSLD		1		1			**2**
	CRBTP			4				**4**
	PSC		2					**2**
	SEINE		1					**1**
Periclimenes sp. nov 1	BSLD					1		**1**
Pherusa parmata	ANCH			1	1			**2**
	PSC		3					**3**
Prionospio multicristata	ANCH		1		1			**2**
Protoperidinium punctulatum	CYST		7	1	2	1	3	**14**
	PHYT		4					**4**
Symplectoscyphus subarticulatus	ANCH					1		**1**
Sypharochiton pelliserpentis	PSC		1					**1**
Trypanosyllis zebra	ANCH						1	**1**
Zostera capricorni	ANCH					1		**1**
Boccardia syrtis	ANCH		1					**1**
Cossura consimilis	PHYT		1					**1**
Eulalia microphylla	PSC		4					**4**

Taxon name	Method*	>0	<0 to -5	<-10 to -15	<-15 to -20	<-15 to -20	<-20	Total
	PSCM		1					**1**
Marphysa depressa	ANCH		1					**1**
Onchidella nigricans	PSC		12					**12**
	PSCM		1					**1**
Palaemon affinis	BSLD		1	1				**2**
	CRBTP			6				**6**
	PSC		2					**2**
	SEINE		1					**1**
	SHRTP		1					**1**
Pilumnus novaezelandiae	ANCH				1		1	**2**
	BSLD					1		**1**
	PSC		1					**1**
	MISC			1				**1**
Pinnotheres novaezelandiae	ANCH				1			**1**
	PSC		1					**1**
Protoperidinium conicum	CYST		2					**2**
Achelia assimilis	BSLD				1			**1**
Actinoptychus senarius	PHYT		9					**9**
Aimulosia marsupium	ANCH			2	1			**3**
	BSLD				1			**1**
Akashiwo sanguinea	PHYT		8					**8**
Akatopora circumsaepta	ANCH					2		**2**

Taxon name	Method*	>0	<0 to -5	<-10 to - 15	<-15 to - 20	<-15 to - 20	<-20	Total
Amalda australis	ANCH		4	1	1	1		**7**
	BSLD		1	1	1			**3**
Amphibalanus variegatus	PSC		3					**3**
Amphibola crenata	WRACK	1						**1**
Amphiprora alata	PHYT		1					**1**
Amphiura amokurae	ANCH			1				**1**
Antarctothoa tongima	ANCH			3	1			**4**
	BSLD				1			**1**
	CRBTP			1				**1**
Asteromphalus flabellatus	PHYT		11					**11**
Asychis amphiglyptus	ANCH		2					**2**
Bicellariella ciliata	ANCH			1				**1**
	PSC		3					**3**
Boccardia otakouica	BSLD			1				**1**
Calloporina angustipora	BSLD			2				**2**
Caloglossa viellardii	PSC		5					**5**
Celleporina proximalis	MISC			1				**1**
Cerataulina pelagica	PHYT		18					**18**
Ceratium furca	PHYT		12					**12**
Ceratium fusus	PHYT		10					**10**
Ceratium horridum	PHYT		3					**3**
Ceratium lineatum	PHYT		1					**1**
Ceratium tripos	PHYT		11					**11**

Taxon name	Method*	>0	<0 to -5	<-10 to -15	<-15 to -20	<-15 to -20	<-20	Total
Chaetoceros affinis	PHYT		8					**8**
Chaetoceros concavicornis	PHYT		3					**3**
Chaetoceros convolutus	PHYT		1					**1**
Chaetoceros decipiens	PHYT		20					**20**
Chaetoceros didymus	PHYT		5					**5**
Chaperiopsis cervicornis	ANCH			5		1	1	**7**
	BSLD		1		1			**2**
	CRBTP			1				**1**
Ciocalypta colvilii	ANCH		1			1		**2**
Clathria (Microciona) rubens	ANCH			1	2			**3**
	BSLD			3		3		**6**
Clathria cf. *terraenovae*	ANCH			3			1	**4**
	BSLD				1			**1**
	MISC			1				**1**
Clavularia novaezelandiae	ANCH				1			**1**
Cominella glandiformis	ANCH		3					**3**
	BSLD		2	1	1	1		**5**
	CRBTP		4					**4**
	PSC		3					**3**
	SEINE		2					**2**
	SHRTP		1	2				**3**
	WRACK	1						**1**

Taxon name	Method*	>0	<0 to -5	<-10 to -15	<-15 to -20	<-15 to -20	<-20	Total
Conger wilsoni	CRBTP			3				**3**
Conopeum oretiensis	ANCH					2	1	**3**
	BSLD		1	2				**3**
Corethron criophilum	PHYT		2					**2**
Coscinodiscus wailesii	PHYT		7					**7**
Crassimarginatella papulifera	ANCH		1					**1**
Cyclomactra tristis	ANCH		1					**1**
Cylindrotheca cloisterium	PHYT		2					**2**
Dellichthys morelandi	ANCH			2				**2**
	BSLD		1					**1**
Dendrodoris citrina	ANCH						1	**1**
Desmonema cf. *gaudichaudi*	CRBTP		2	7				**9**
	SEINE		3					**3**
Dictyocha fibula	PHYT		2					**2**
Dictyociona contorta	ANCH			1				**1**
	BSLD			3				**3**
Dictyocladium monilifer	BSLD						1	**1**
Diloma subrostrata	ANCH			1				**1**
	SEINE		3					**3**
Dinophysis acuminata	PHYT		3					**3**
Dinophysis acuta	PHYT		1					**1**
Dinophysis tripos	PHYT		1					**1**

Taxon name	Method*	>0	<0 to -5	<-10 to -15	<-15 to -20	<-15 to -20	<-20	Total
Distephanus speculum	PHYT		1					**1**
Ditylum brightwelli	PHYT		21					**21**
Dosinia lambata	ANCH		1					**1**
Ecklonia radiata	CRBTP			1				**1**
	PSC		1					**1**
Engraulis australis	CRBTP		1					**1**
Eteone aurantiaca	ANCH		1					**1**
Eucampia zoodiacus	PHYT		16					**16**
Euleptorhamphus viridis	SEINE		1					**1**
Euryspongia cf. *arenaria*	BSLD					1		**1**
Eurystomella foraminigera	ANCH			6				**6**
	BSLD		1	1	1			**3**
Exosphaeroma chilensis	PSC		3					**3**
Exosphaeroma echinensis	ANCH				1			**1**
Felaniella zelandica	ANCH		1	1			1	**3**
Fellaster zelandiae	ANCH		3	4	6	4		**17**
	BSLD		1	1	1			**3**
Galeopsis polyporus	ANCH			5	1			**6**
	BSLD		1	1	1			**3**
	CRBTP			1				**1**
Girella tricuspidata	SEINE		3					**3**
Goniada echinulata	ANCH		1					**1**
Grahamina nigripenne	SEINE		1					**1**

Taxon name	Method*	>0	<0 to -5	<-10 to -15	<-15 to -20	<-15 to -20	<-20	Total
Grammatophora marina	PHYT		3					**3**
Guinardia flaccida	PHYT		25					**25**
Gyrodinium spirale	PHYT		1					**1**
Halicarcinus whitei	ANCH			1				**1**
	BSLD		1	1				**2**
	CRBTP		5					**5**
	SEINE		1					**1**
Haliclona cf. tenacior	BSLD			1				**1**
Haliclona glabra	BSLD			1				**1**
Halopteris campanula	BSLD			1		1		**2**
Haplocheira barbimana	ANCH		3	1				**4**
	BSLD					1		**1**
	PSC		1					**1**
Hemigrapsus crenulatus	ANCH			1				**1**
	CRBTP		4	1				**5**
	SEINE		3					**3**
Iathrippa longicauda	ANCH					1	1	**2**
Lauderia annulata	PHYT		19					**19**
Laurencia distichophylla	CRBTP		1	3				**4**
Lepas pectinata	WRACK	1						**1**
Lepas testudinata	WRACK	1						**1**
Leptochiton inquinatus	ANCH			4	1			**5**
Leptograpsus variegatus	WRACK	1						**1**

Taxon name	Method*	>0	<0 to -5	<-10 to -15	<-15 to -20	<-15 to -20	<-20	Total
Liocarcinus corrugatus	CRBTP		1					**1**
Lithodesmium undulatum	PHYT		27					**27**
Lomentaria caespitosa	WRACK	1						**1**
Lomentaria umbellata	BSLD				1			**1**
Magelona dakini	ANCH		2					**2**
	PHYT		1					**1**
Marphysa capensis	ANCH		1					**1**
Melagraphia aethiops	WRACK	1						**1**
Melosira moniliformis	PHYT		4					**4**
Metamorphe colensoi	CRBTP		1					**1**
Meuniera membranacea	PHYT		14					**14**
Microporella discors	BSLD			1	1			**2**
Myadora boltoni	ANCH			1				**1**
Neosabellaria kaiparaensis	BSLD			1				**1**
Nitzschia closterium	PHYT		5					**5**
Nitzschia longissima	PHYT		1					**1**
Noctiluca scintillans	PHYT		9					**9**
Nodilittorina antipodum	PSC		3					**3**
Notoacmea helmsi	SEINE		1					**1**
Nucula hartvigiana	ANCH		8	10	3	1	1	**23**
	BSLD		1	1				**2**
Odontella mobiliensis	PHYT		4					**4**

Taxon name	Method*	>0	<0 to -5	<-10 to -15	<-15 to -20	<-15 to -20	<-20	Total
Odontella sinensis	PHYT		28					**28**
Opaeophora lepida	ANCH			3				**3**
	BSLD			1				**1**
Ophiactis resiliens	ANCH				1			**1**
Ophlitospongia reticulata	PSC		1					**1**
Ovalipes catharus	ANCH			1				**1**
	CRBTP		1	3				**4**
Oxytoxum sp.	PHYT		1					**1**
Ozius truncatus	WRACK	1						**1**
Paguristes setosus	ANCH		1	1	4	2		**8**
	BSLD			1		1		**2**
	CRBTP			1				**1**
	PSC		1					**1**
Pagurus traversi	ANCH			2				**2**
	BSLD			1				**1**
	PSC		1					**1**
Paphies australis	ANCH		4					**4**
Paphies subtriangulata	ANCH				1			**1**
Paracaudina chilensis	ANCH		1					**1**
Paraidanthyrsus quadricornis	ANCH				1	1	1	**3**
	BSLD			1				**1**
Paraprionospio Paraprionospio-A	ANCH		1					**1**

Taxon name	Method*	>0	<0 to -5	<-10 to -15	<-15 to -20	<-15 to -20	<-20	Total
Parasmittina delicatula	BSLD					1		**1**
Pecten novaezelandiae	ANCH		1					**1**
	BSLD		1					**1**
Perinereis amblyodonta	PSCM		1					**1**
Pervicacia tristis	ANCH				2	1		**3**
Phorbas cf. *anchorata*	BSLD					1		**1**
	PSC		2					**2**
	MISC			1				**1**
Pilumnus lumpinus	BSLD					1		**1**
	PSC		1					**1**
Planktoniella sol	PHYT		1					**1**
Plocamia novizelanicum	ANCH			1				**1**
Podolampas palmipes	PHYT		1					**1**
Polycarpa pegasus	PSC		4					**4**
Polykrikos schwartzii	CYST						1	**1**
	PHYT		1					**1**
Polyzoa opuntia	ANCH				1			**1**
Prionospio australiensis	ANCH				1			**1**
Prorocentrum gracile	PHYT		2					**2**
Prorocentrum micans	PHYT		1					**1**
Prorocentrum ovum	PHYT		8					**8**
Protoceratium reticulatum	CYST		3					**3**
Protoperidinium curtipeds	PHYT		10					**10**

Taxon name	Method*	>0	<0 to -5	<-10 to -15	<-15 to -20	<-15 to -20	<-20	Total
Protoperidinium depressum	PHYT		2					**2**
Protoperidinium divergens	PHYT		1					**1**
Protoperidinium leonis	PHYT		8					**8**
Protoperidinium pyroforme	PHYT		11					**11**
Protoperidinium steinii	PHYT		11					**11**
Pseudo-nitzschia australis	PHYT		21					**21**
Retropinna retropinna	CRBTP		1					**1**
	SEINE		1					**1**
Rhizosolenia alata	PHYT		3					**3**
Rhizosolenia cf. hebatata	PHYT		2					**2**
Rhizosolenia imbricata	PHYT		16					**16**
Rhizosolenia robusta	PHYT		16					**16**
Rhizosolenia setigera	PHYT		5					**5**
Rhizosolenia stolterfothii	PHYT		20					**20**
Rhizosolenia styliformis	PHYT		7					**7**
Rhombosolea plebeia	CRBTP		2					**2**
	SEINE		4					**4**
Ruditapes largillierti	ANCH		2	3	1	1	2	**9**
	BSLD				1			**1**
Scolecolepides benhami	ANCH		1					**1**
	BSLD		1					**1**
	PHYT		1					**1**

Taxon name	Method*	>0	<0 to -5	<-10 to -15	<-15 to -20	<-15 to -20	<-20	Total
Scorpaena papillosa	MISC			1				**1**
Scrippsiella trochoidea	CYST		1	1				**2**
	PHYT		6					**6**
Sigalion oviger	ANCH		1					**1**
Sigapatella tenuis	ANCH			6	1	1	1	**9**
	BSLD			1	1		1	**3**
Skeletonema costatum	PHYT		1					**1**
Smittina torques	ANCH			4				**4**
	BSLD				1			**1**
Soletellina siliquens	ANCH		6					**6**
Stephanopyxis orbicularis	PHYT		14					**14**
Stephanopyxis turris	PHYT		1					**1**
Thalassionema frauenfeldii	PHYT		21					**21**
Thalassionema nitzschioides	PHYT		22					**22**
Thalassiosira decipiens	PHYT		3					**3**
Thalassiosira hyalina	PHYT		26					**26**
Thalassiosira rotula	PHYT		4					**4**
Thalassiothrix longisima	PHYT		1					**1**
Triceratium alternans	PHYT		6					**6**
Triceratium favus	PHYT		3					**3**
Trochus tiaratus	BSLD			1				**1**
Trypanosyllis gigantea	PSC		1					**1**

Taxon name	Method*	>0	<0 to -5	<-10 to -15	<-15 to -20	<-15 to -20	<-20	Total
Valdemunitella valdemunita	ANCH			2	1			**3**
	BSLD			1				**1**
Zeacumantus lutulentus	ANCH		2					**2**
	BSLD		1		1			**2**
	CRBTP		3					**3**
	SEINE		3					**3**
Zenatia acinaces	ANCH		1					**1**
Zethalia zelandica	ANCH			1			1	**2**
Total number of native specimens		**9**	**1065**	**306**	**106**	**65**	**41**	**1592**
Proportion of all native specimens (%)		**0.6**	**66.9**	**19.2**	**6.7**	**4.1**	**2.6**	**100**
Total number of native taxa		**9**	**201**	**103**	**70**	**51**	**34**	**272**
Proportion of all native taxa (%)		**3.3**	**73.9**	**37.9**	**25.7**	**18.8**	**12.5**	**#**

* Survey methods: ANCH = anchor box dredge; BGRB = benthic grab; BSLD = benthic sled; CYST = dinoflagellate cyst core; CRBTP = crab trap; FSHTP = fish trap; PHYT = phytoplankton tow; SHRTP = shrimp trap; STFTP = seastar trap; PSC = piling quadrat scrapings; VISS = opportunistic visual search; WRACK = beach wrack search.

The proportion of taxa in each depth class sums to greater than 100%, as some taxa were recorded from more than one depth class

Appendices

Appendix 1: Sampling procedures for ZBS2005-19 surveys.

These sampling procedures were specified by MAF Biosecurity New Zealand in the tender documents for Project ZBS2005-19. Modifications to the procedures necessitated by local conditions in the Kaipara Harbour survey are described in the "Methods" section of this current report and were agreed to by MAF Biosecurity New Zealand prior to the survey.

(Derived and modified from Hewitt and Martin 1996, 2001)

All samples collected are to be labeled with data that will allow the determination of: the date samples were collected; where the sampling occurred (regional); the site of collection (wharf, breakwater etc); the sample method (pile, core, qualitative); and the depth. The Hewitt and Martin protocols provide an easy and informative site code and sample labeling method; however other methods may be considered and will need to be negotiated with Biosecurity New Zealand to ensure that specimen linkage with sample information can be maintained. Special care should be given to quality assurance, quality control including chain-of-custody.

1.0 Dinoflagellates

1.1. Sediment sampling for cyst-forming species (small cores)

Sediment cores are taken from locations where the deposition and undisturbed accumulation of dinoflagellate cysts are likely to occur. Selection of sites will be based on depth, local biogeography and sediment characteristics of the area. As a general guide, sites where there is an accumulation of uncompacted fine sediment to a depth of 20-30 cm are suitable sites for constructing the sedimentary history of the port environment however, recent work has shown that sandy substrates should not be overlooked (C. Bolch pers.comm.). These samples are taken using cores. The cores will provide information on the formation of dinoflagellate blooms. Coarse-grained habitats may provide gross level information (presence/absence) for a port environment. At each site, sediment cores are to be taken by divers using 20 cm long tubes with 2.5 cm internal diameter. Tubes are forced into the substrate then capped at each end with a rubber bung to provide an airtight seal. Cores are labeled and are stored upright in the dark at 4°C prior to size fractionation and examination for dinoflagellate cysts.

1.2. Sediment preparation and cyst identification

The top 6 cm of sediment core is to be carefully extruded from the coring tube and stored at 4°C in a sealed container until further examination. Subsamples (approx. 1-2 cm^3) of each core sample are mixed with filtered seawater to obtain a watery slurry. Subsamples (5-10 mL) are sonicated for 2 min (Braun Labsonic homogenizer, intermediate probe, 100 watts) to dislodge detritus particles. The sample is screened through a 90 µm sieve and the remaining fraction is panned to remove denser sand grains and large detrital particles. Subsamples (1 mL) are examined and counted on wet-mount slides, using a compound light microscope. Where possible, a total of at least 100 cysts are counted in ach sample. Identification of species follows Bolch and Hallegraeff (1990). Cysts of suspected toxic species are photographed with a light microscope using bright field or differential interference contrast illumination.

1.3. Cyst germination

Following sonication and size-fractionation of sediments, cysts of suspected toxic species are located and isolated by micropipette under a light microscope and then washed twice in filtered seawater. Individual cysts are placed into tissue culture wells containing 2mL of 75% filtered seawater with nutrients added according to medium GPM of Loeblich (1975). Additional incubations are to be carried out using size-fractionated sediments. Subsamples of the 20-90µm size fraction are added to 20mL of growth medium in sterile polystyrene petri-dishes, and sealed with parafilm. All incubations are be carried out at 20ºC at a light intensity of 80$\mu Em^{-2}s^{-1}$ (12h light:12h dark) and examined regularly for germination. Active swimming dinoflagellate cells from incubations should be isolated by micropipette, washed in sterile growth medium and their identity determined where possible.

1.4. Plankton sampling and culture

Plankton samples are to be collected by vertical and horizontal tows of a hand-deployed plankton net (25cm diam. Opening, 20µm Nytal mesh, Swiss Screens, Melbourne Vic.). The samples should be sealed in plankton jars and labeled using waterproof labels, placed in a cooled container and returned to the laboratory, net samples diluted 1:1 with growth medium. Germanium dioxide (10$mg.l^{-1}$) is added to inhibit overgrowth by diatom species and these enrichment cultures incubated as described above. Incubations are examined regularly by light microscopy, and single cells of suspected toxic species isolated by micropipette for further culture and toxicity determination.

1.5. Toxicity testing

Suspected toxic species are grown in laboratory culture, under the conditions described previously, and tested for toxin (saxitoxin) production by High Performance Liquid Chromatography (HPLC) (Oshima *et al.* 1989).

2.0 Crabs, Macroalgae, Seastars

2.1. Trapping

Crab species are sampled using light-weight plastic-coated wire-framed traps (60cm long, 45cm wide and 20cm high) covered 1.27cm square mesh netting. Entry to the trap is through slits at the apex of inwardly-directed V-shaped panels at each end of the trap. The internal bait bag should be baited with fish heads or carcasses. Traps weighted with chain or lead weights and deployed with surface buoys. Whenever possible, traps should be deployed in the late afternoon and recovered early the next morning. Each collected sample is labeled using waterproof labels. Crab traps are also effective for targeting the known introduced species *Charybdis japonica* and *Carcinus maenas*.

2.2. Visual searches – wharves and marinas

Visual searches for crab, target species (e.g., *Charybdis japonica, Undaria pinnatifida, Asterias amurensis*) and unusual/rare species (species not seen before in the region) should also be made at selected wharves in the port and marina areas. Divers are to swim the length of the wharf at two depths (5m and bottom) to provide a completed visual survey of the outer wharf between about 5m depth and the bottom (10-14m). Surveys of beach wrack are to be made of suitable beaches to collect crab exuviae. Each collected sample is labeled using waterproof labels.

2.3 Visual searches – other regions

Visual searches for crab, macroalgae and target species will be carried out by divers in rocky reef, rocky rip-rap, shipwrecks, kelp and seagrass meadows, over soft bottoms and beach searches. Divers will either be free swimming or towed using a manta board (snorkel). When using the manta board, (skin) divers will be towed along 100m transects at a speed of less than 2 knots. Beach wrack surveys along beach and estuaries will search the beach using parallel transects to the waters edge at distances of 2, 5 and 10 m (and further if required) up the shoreline. Each collected sample is labelled using waterproof labels.

3.0 Zooplankton

Zooplankton is sampled with a standard 100µm mesh, 70cm diameter free-fall drop net. The net is weighted so as to achieve a fall rate of approximately 1m per second and the depth reached is monitored using a Tekna maximum indicating (divers) depth gauge (or similar) attached to the frame of the net. Each drop is timed with a stopwatch and the net is allowed to fall from the surface to a depth 0.5-1 m from the substrate. Timing commences when the cod end of the net sinks below the surface. One drop is conducted at each site. On recovery the net is washed down on the outside only to avoid contamination of the sample. Each individual sample is labelled using waterproof labels. Retained plankton is preserved in 5% formalin and returned to the laboratory for sorting and identification. Replicate plankton tows are made at each sample site.

4.0 Hard Substrate Invertebrates and Plants

4.1 Wharf pile communities

Piles or projecting steel facings are to be selected from wharves having different types of shipping activity. Three piles or facings are to be selected in series from near one end of each wharf, starting about 10 m from the end to reduce "edge" effects, with 10 to 20 m distance separating each pile or facing. Three outer and three inner piles may be sampled from wharves with inner piles, which are likely to have much reduced water movement or ambient light levels. Thus the minimum number of piles sampled is three outer and the maximum is six (three outer and three inner). Data suggests that sampling inner piles increases biodiversity information but it does not significantly increase detection of introduced species compared to sampling outer piles only.

The selected piles or facings are to be marked (spray paint) and their positions recorded (GPS) and photographed. For each pile divers then take:

a) Video film of the outer surface of each pile/facing from approximately high-water level down to the deepest exposed part of the pile/facing using digital video cameras (or similar). The video camera is to be fitted with lights to ensure colour correctness of the footage. A distance-measuring rod with a scale and digital depth meter is also attached to the camera to ensure that the camera remains a constant distance (approx. 50 cm) from the pile or substrate. The scale and depth meter are positioned so they fall within the field of view of the camera and provide real-time depth information on the video footage.

b) Still photographs using an underwater film camera (e.g., Nikonos V) or a digital camera (of adequate resolution) are taken using a 35 mm lens and overlens to provide a 1:6 frame image (which is suitable for taxonomic work). A strobe is used to ensure that colour correctness is maintained. The use of the framer and strobe both ensure that higher-resolution records of the fouling communities and selected species are taken and can be compared between and amongst quadrats images. Each quadrat is photographed. The 1:6 framer ensures that four photographs will cover the $0.1m^2$ quadrat. Thus, to photograph three piles, with three quadrats each will use 36 images. Divers will record the order of photographs by using a label within the images or noting pile and photo order on a dive slate that is then recorded on the boat data sheet.

c) Quantitative 0.1 m^2 (33.33 v 33.33 cm) quadrat samples of the fouling communities present at three depths (0.5, 3.0 and 7.0 m) are collected by scraping the attached flora and fauna as carefully as possible into plastic bags. These samples are labeled (using pre-labeled waterproof labels) and sealed under water. The samples are then rough sorted within 12 hours of collection and narcotised where needed (e.g., anemones, chitons, flatworms) and preserved in the suitable fixative (5% formalin or 70% ethanol) for subsequent fine sorting and identification in the laboratory.

4.2. Breakwaters

Using equipment detailed in section 4.1 above, divers will take video and still photographs and collect representative samples of the attached plant and animal communities within a distance of 0.5 m from a weighted transect line. Each sample is labeled using waterproof labels to indicate that it is a qualitative sample. The transect line is 50 m in distance and therefore an area of 50 m^2 is covered. Transects run parallel to the breakwater. Typically, breakwaters are sampled on the inside and outside of the structure.

5.0 Soft Substrate Invertebrates and Plants

5.1. Epibenthos

Visual searches by divers to locate and collect representative samples of soft-bottom epibenthic species are to be carried out at selected sites as described in sections 2.2 and 2.3. Each individual sample for a location is labeled as qualitative sample using waterproof labels.

At each wharf to be sampled, divers will video a 50 m transect between one of the piles and the outer series of infaunal cores (see section 5.2), along a weighted transect line marked at 1m intervals. Video and 35 mm still photographs will also be taken at offshore dredge disposal sites and within kelp forests and seagrass meadows. Qualitative samples may also be taken during this sampling activity. Samples taken are labeled using waterproof labels.

5.2. Benthic Infauna

Divers will take infaunal samples using a tubular 0.025m^2 (17.9cm internal diameter) hand corer. The corer is 40 cm in length and marked (grooves) at 20 cm and 25 cm from the bottom to indicate the depth to which a core is taken. The upper end of the corer is closed except for a mesh-covered 8 cm diameter hole, which is sealed with a rubber bung to aid retention of the infaunal sample when the corer is withdrawn from the sediment.

When sampling around wharves, channel markers and facings, a core is taken from the bottom of each outer pile or facing sampled. A second set of three replicated cores are then taken 50 m directly out from the wharf/facing. Thus, for each wharf area sampled this provides a total of six core samples (three at the base of the piles/facings and three 50 m out from the piles/facings).

Each core sampled is transferred to a 1-mm mesh bag with a drawstring mouth and then sieved underwater, either in situ or after the divers returns to the surface. Each individual sample is labeled using waterproof labels. The retained sieved material is then washed into a plastic bag and preserved in 5% buffered formalin for subsequent sorting and identification in the laboratory.

To avoid the use of divers, core samples may also be taken using vessel deployed grab samplers (see Hewitt and Martin 2001). If using vessel deployed grab samples caution must be taken to ensure that the cores taken at the base of the piles/facings occurs within 1m out from the base of the pile/facing.

6.0 Fish

6.1. Poison Stations

Rotenone, clove oil or a similar poison is to be used to sample fish associated with shipwrecks, hulks, breakwaters and around the base of piles and facings. The poison is mixed according to instructions immediately before use and dispensed using squeeze bottles. Poisoned fish are collected by divers and snorklers using hand nets and either frozen or preserved in buffered 5% formalin for identification and photographing upon return to the laboratory. The use of poisons may require permits or may not be allowed within a region. In such cases an alternative method to poison sampling the fish must be negotiated with Biosecurity New Zealand.

6.2. Nets

Seine nets are to be used to collect fish on ocean beaches and in estuaries. All species of fish and invertebrate taken with the seine nets are to be recorded and a representative sample collected and preserved (frozen or buffered 5% formalin) for identification upon return to the laboratory. Each species collected must be photographed. The use of nets may require permits or may not be allowed within a region. In such cases an alternative method to net sampling the fish must be negotiated with Biosecurity New Zealand.

7.0 Environmental Data

7.1. Temperature, salinity and dissolved oxygen

A submersible data logger (SDL) equipped with pressure, conductivity and temperature sensors will be used to record data on salinity and water temperature at 0.5 m intervals from the surface to near bottom. Light levels will be estimated from Secchi disk readings. The

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researchers undertaking this work should also endeavour to collect existing salinity, water temperature and dissolved oxygen information from the region to provide a seasonal and temporal overview of the salinity and water temperature. It is expected that collected and existing data will be analysed and reported upon within the survey report. Field data is recorded on boat data sheets.

7.2. Sediment Analysis

7.2.1 Sediment Collection

Sediment samples (minimum 100 g wet weight) are to be taken for analysis of grain size and organic content, to characterise the habitats of any introduced epibenthic and infaunal species found. Samples are taken with each set of infaunal cores and at other selected sites. Thus as a minimum 2 sediment samples are collected (one at the base of the pile/facing and one 50 m out from the base of the pile/facing) when core samples are collected. The sediment is collected by divers using sealable plastic containers, which are then labeled and frozen to stabilise the organic content levels and returned to the laboratory for analysis.

7.2.2 Particle Size Analysis

After samples are thawed in the laboratory a sub-sample, approximately 25 g (dry weight), of sediment is taken for organic content analysis. The remaining sediment is wet-sieved through a 2mm mesh sieve and separated into <2 mm and > 2 mm fractions. Both fractions and the organic content sub-sampled are then oven dried at 80ºC (2-4 days). The two fractions are analysed as follows:

- > 2 mm fraction. The total fraction is dry-sieved through a nest of sieves and the fraction retained on each sieve (2, 2.8, 4, 5.6, and 8 mm meshes: 0.5 Phi intervals) is weighed. Sediment retained on the largest sieve includes all particles with size larger than 8 mm. The individual sieved weights are then added to the dry weight of the > 2 mm fraction to give a total dry weight for the entire sediment sample. The proportion of each component in the > 2 mm fraction is then calculated as a percentage of the total dry sample.
- < 2 mm fraction. The dry weight of the total < 2 mm fraction is measured to 0.01 g and the sediment or, depending on the amount available, a sub-sample (taken by "coning and quartering") is analysed using a Malvern Laser Particle Size Analyser. Particle size data from this analysis is then combined with data analysis of the > 2 mm fraction.

7.2.3 Organic Content

Approximately 25 g of dry, unsieved sediment is weighed in a crucible to 0.00001 g then ashed in a muffle furnace at 480ºC for 4 hrs. The crucible is allowed to cool before being reweighed. The difference between the net dry and net ash-free weights is then calculated. This difference, or weight loss, is expressed as a percentage of the initial dry weight and represents the organic content of the sediment sample.

8.0 References

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Appendix 2. Geographic locations (NZGD49) of sample sites in the Kaipara Harbour initial port baseline survey

Site number (BNZ-specified)	Site name	Sampling method*	Easting	Northing	Number of sample units
1	Ruawai Slipway	ANCH	2601823	6562547	1
1	Ruawai Slipway	ANCH	2601932	6562585	1
1	Ruawai Slipway	ANCH	2601933	6562548	1
1	Ruawai Slipway	ANCH	2601954	6562566	1
1	Ruawai Slipway	ANCH	2601977	6562580	1
1	Ruawai Slipway	ANCH	2601979	6562551	1
1	Ruawai Slipway	BSLD	2601824	6562728	1
1	Ruawai Slipway	CRBTP	2601933	6562753	3
1	Ruawai Slipway	CRBTP	2601957	6562671	3
1	Ruawai Slipway	CYST	2601849	6562665	1
1	Ruawai Slipway	CYST	2601893	6562617	1
1	Ruawai Slipway	CYST	2601904	6562613	1
1	Ruawai Slipway	CYST	2601907	6562614	1
1	Ruawai Slipway	CYST	2601919	6562618	1
1	Ruawai Slipway	CYST	2601962	6562580	1
1	Ruawai Slipway	PHYT	2601956	6562588	1
1	Ruawai Slipway	PHYT	2601974	6562588	1
1	Ruawai Slipway	PHYT	2601993	6562550	1
1	Ruawai Slipway	PSC	2602423	6562375	4

Site number (BNZ-specified)	Site name	Sampling method*	Easting	Northing	Number of sample units
1	Ruawai Slipway	SEDIMENT	2601823	6562547	2
1	Ruawai Slipway	SHRTP	2601933	6562753	3
1	Ruawai Slipway	SHRTP	2601957	6562671	3
1	Ruawai Slipway	ZOOP	2601738	6562594	1
1	Ruawai Slipway	ZOOP	2601767	6562738	1
1	Ruawai Slipway	ZOOP	2601826	6562627	1
2	Ruawai Landing	BSLD	2602403	6562342	1
2	Ruawai Landing	WRACK	2602466	6562369	3
3	Sail Point	ANCH	2605783	6556321	1
3	Sail Point	ANCH	2605825	6556307	1
3	Sail Point	ANCH	2605866	6556244	1
3	Sail Point	BSLD	2605814	6556256	1
3	Sail Point	CYST	2605508	6556269	1
3	Sail Point	CYST	2605514	6556265	1
3	Sail Point	CYST	2605517	6556262	1
3	Sail Point	SEDIMENT	2605866	6556244	2
3	Sail Point	SEINE	2605978	6555723	1
3	Sail Point	SEINE	2606001	6555680	1
3	Sail Point	SEINE	2606022	6555630	1
4	Middle Channel	ANCH	2608210	6554383	1
4	Middle Channel	ANCH	2608210	6554507	1
4	Middle Channel	ANCH	2608315	6554347	1

Site number (BNZ-specified)	Site name	Sampling method*	Easting	Northing	Number of sample units
4	Middle Channel	BSLD	2608307	6554352	1
4	Middle Channel	CYST	2608186	6554493	1
4	Middle Channel	CYST	2608210	6554472	1
4	Middle Channel	CYST	2608232	6554450	1
4	Middle Channel	PHYT	2608211	6554348	1
4	Middle Channel	PHYT	2608224	6554418	1
4	Middle Channel	PHYT	2608261	6554344	1
4	Middle Channel	SEDIMENT	2608315	6554347	2
4	Middle Channel	ZOOP	2608160	6554432	1
4	Middle Channel	ZOOP	2608183	6554445	1
4	Middle Channel	ZOOP	2608256	6554440	1
5	Pakaukau Point	ANCH	2614096	6553649	1
5	Pakaukau Point	ANCH	2614103	6553612	1
5	Pakaukau Point	ANCH	2614111	6553636	1
5	Pakaukau Point	BSLD	2614068	6553660	1
5	Pakaukau Point	CYST	2614075	6553649	1
5	Pakaukau Point	CYST	2614080	6553660	1
5	Pakaukau Point	CYST	2614088	6553643	1
5	Pakaukau Point	SEDIMENT	2614103	6553612	2
6	Matihe Point	ANCH	2612341	6548836	1
6	Matihe Point	ANCH	2612384	6548823	1
6	Matihe Point	ANCH	2612407	6548769	1

Site number (BNZ-specified)	Site name	Sampling method*	Easting	Northing	Number of sample units
6	Matihe Point	BSLD	2612339	6548801	1
6	Matihe Point	CYST	2612426	6548482	1
6	Matihe Point	CYST	2612433	6548480	1
6	Matihe Point	CYST	2612453	6548491	1
6	Matihe Point	SEDIMENT	2612341	6548836	2
7	Bushy Point	ANCH	2619446	6548773	1
7	Bushy Point	ANCH	2619461	6548788	1
7	Bushy Point	ANCH	2619479	6548767	1
7	Bushy Point	BSLD	2619456	6548793	1
7	Bushy Point	CYST	2619431	6548919	1
7	Bushy Point	CYST	2619449	6548825	1
7	Bushy Point	CYST	2619451	6548823	1
7	Bushy Point	SEDIMENT	2619446	6548773	2
8	Five Fathom Channel	ANCH	2617159	6544415	1
8	Five Fathom Channel	ANCH	2617163	6544478	1
8	Five Fathom Channel	ANCH	2617167	6544446	1
8	Five Fathom Channel	BSLD	2617139	6544486	1
8	Five Fathom Channel	CYST	2617163	6544478	3
8	Five Fathom Channel	PHYT	2617182	6544429	1
8	Five Fathom Channel	PHYT	2617195	6544278	1
8	Five Fathom Channel	PHYT	2617198	6544394	1
8	Five Fathom Channel	SEDIMENT	2617163	6544478	2

Site number (BNZ-specified)	Site name	Sampling method*	Easting	Northing	Number of sample units
8	Five Fathom Channel	ZOOP	2617101	6544456	1
8	Five Fathom Channel	ZOOP	2617112	6544443	1
8	Five Fathom Channel	ZOOP	2617143	6544463	1
9	Te Whau Point Slipway	ANCH	2623081	6548833	1
9	Te Whau Point Slipway	ANCH	2623098	6548857	1
9	Te Whau Point Slipway	ANCH	2623100	6548862	1
9	Te Whau Point Slipway	ANCH	2623108	6548938	1
9	Te Whau Point Slipway	ANCH	2623113	6548933	1
9	Te Whau Point Slipway	ANCH	2623113	6548870	1
9	Te Whau Point Slipway	BSLD	2623182	6548943	1
9	Te Whau Point Slipway	CRBTP	2623035	6548780	3
9	Te Whau Point Slipway	CRBTP	2623037	6548799	3
9	Te Whau Point Slipway	CYST	2623085	6548964	1
9	Te Whau Point Slipway	CYST	2623105	6548925	1
9	Te Whau Point Slipway	CYST	2623106	6548977	1
9	Te Whau Point Slipway	CYST	2623153	6549058	1
9	Te Whau Point Slipway	CYST	2623155	6548995	1
9	Te Whau Point Slipway	CYST	2623168	6549061	1
9	Te Whau Point Slipway	MISC	2623098	6548857	1
9	Te Whau Point Slipway	PHYT	2623130	6548864	1
9	Te Whau Point Slipway	PHYT	2623135	6548836	1
9	Te Whau Point Slipway	PHYT	2623149	6548858	1

Site number (BNZ-specified)	Site name	Sampling method*	Easting	Northing	Number of sample units
9	Te Whau Point Slipway	POIS	2623077	6548879	1
9	Te Whau Point Slipway	PSC	2623076	6548883	7
9	Te Whau Point Slipway	SEDIMENT	2623098	6548857	2
9	Te Whau Point Slipway	SHRTP	2623035	6548780	3
9	Te Whau Point Slipway	SHRTP	2623037	6548799	3
9	Te Whau Point Slipway	ZOOP	2623060	6548935	1
9	Te Whau Point Slipway	ZOOP	2623099	6548901	1
9	Te Whau Point Slipway	ZOOP	2623124	6548895	1
10	Mussel Rock	BSLD	2623073	6548596	1
11	The Funnel	ANCH	2626528	6550726	1
11	The Funnel	ANCH	2626652	6550682	1
11	The Funnel	ANCH	2626717	6550571	1
11	The Funnel	BSLD	2626779	6550583	1
11	The Funnel	CYST	2626627	6550821	1
11	The Funnel	CYST	2626637	6550826	1
11	The Funnel	CYST	2626648	6550820	1
11	The Funnel	SEDIMENT	2626717	6550571	2
12	Te Hoanga Point	ANCH	2630639	6553563	1
12	Te Hoanga Point	ANCH	2630675	6553574	1
12	Te Hoanga Point	ANCH	2630703	6553549	1
12	Te Hoanga Point	BSLD	2630738	6553580	1
12	Te Hoanga Point	CYST	2630706	6553609	1

Site number (BNZ-specified)	Site name	Sampling method*	Easting	Northing	Number of sample units
12	Te Hoanga Point	CYST	2630712	6553612	1
12	Te Hoanga Point	CYST	2630869	6553691	1
12	Te Hoanga Point	PHYT	2630717	6553640	1
12	Te Hoanga Point	PHYT	2630727	6553597	1
12	Te Hoanga Point	PHYT	2630742	6553604	1
12	Te Hoanga Point	SEDIMENT	2630639	6553563	1
12	Te Hoanga Point	SEDIMENT	2630703	6553549	1
12	Te Hoanga Point	ZOOP	2630562	6553537	1
12	Te Hoanga Point	ZOOP	2630592	6553549	1
12	Te Hoanga Point	ZOOP	2630720	6553581	1
13	Pahi Landing	ANCH	2621415	6560177	1
13	Pahi Landing	ANCH	2621417	6560176	1
13	Pahi Landing	ANCH	2621424	6560181	1
13	Pahi Landing	BSLD	2621374	6560171	1
13	Pahi Landing	CRBTP	2621426	6560248	3
13	Pahi Landing	CRBTP	2621453	6560232	3
13	Pahi Landing	CYST	2621382	6560208	1
13	Pahi Landing	CYST	2621385	6560226	1
13	Pahi Landing	CYST	2621393	6560244	1
13	Pahi Landing	PHYT	2621403	6560202	1
13	Pahi Landing	PHYT	2621416	6560209	1
13	Pahi Landing	PHYT	2621441	6560149	1

Site number (BNZ-specified)	Site name	Sampling method*	Easting	Northing	Number of sample units
13	Pahi Landing	POIS	2621458	6559882	1
13	Pahi Landing	SEDIMENT	2621417	6560176	2
13	Pahi Landing	SHRTP	2621426	6560248	3
13	Pahi Landing	SHRTP	2621453	6560232	3
13	Pahi Landing	ZOOP	2621417	6560168	1
13	Pahi Landing	ZOOP	2621420	6560168	1
13	Pahi Landing	ZOOP	2621429	6560166	1
14	Pahi Slipway	ANCH	2621253	6560185	1
14	Pahi Slipway	ANCH	2621256	6560137	1
14	Pahi Slipway	ANCH	2621266	6560104	1
14	Pahi Slipway	ANCH	2621269	6560058	1
14	Pahi Slipway	ANCH	2621280	6560094	1
14	Pahi Slipway	ANCH	2621287	6560050	1
14	Pahi Slipway	BSLD	2621306	6560070	1
14	Pahi Slipway	CYST	2621188	6560199	1
14	Pahi Slipway	CYST	2621188	6560203	1
14	Pahi Slipway	CYST	2621193	6560201	1
14	Pahi Slipway	CYST	2621196	6560197	1
14	Pahi Slipway	CYST	2621199	6560190	1
14	Pahi Slipway	CYST	2621202	6560195	1
14	Pahi Slipway	PSC	2621264	6560065	12
14	Pahi Slipway	SEDIMENT	2621280	6560094	2

Site number (BNZ-specified)	Site name	Sampling method*	Easting	Northing	Number of sample units
14	Pahi Slipway	SEINE	2621082	6560292	1
14	Pahi Slipway	SEINE	2621112	6560319	1
14	Pahi Slipway	SEINE	2621116	6560306	1
14	Pahi Slipway	WRACK	2621257	6560097	1
15	Kapua Point	ANCH	2622337	6555280	1
15	Kapua Point	ANCH	2622398	6555288	1
15	Kapua Point	ANCH	2622418	6555299	1
15	Kapua Point	BSLD	2622429	6557154	1
15	Kapua Point	CYST	2622374	6557053	1
15	Kapua Point	CYST	2622383	6557068	1
15	Kapua Point	CYST	2622461	6557095	1
15	Kapua Point	SEDIMENT	2622398	6555288	1
15	Kapua Point	SEDIMENT	2622418	6555299	1
16	Motikumara Point	ANCH	2625767	6544495	1
16	Motikumara Point	ANCH	2625814	6544500	1
16	Motikumara Point	ANCH	2625854	6544458	1
16	Motikumara Point	BSLD	2625810	6544561	1
16	Motikumara Point	CYST	2625790	6544605	1
16	Motikumara Point	CYST	2625795	6544613	1
16	Motikumara Point	CYST	2625826	6544584	1
16	Motikumara Point	PHYT	2625747	6544545	1
16	Motikumara Point	PHYT	2625757	6544569	1

Site number (BNZ-specified)	Site name	Sampling method*	Easting	Northing	Number of sample units
16	Motikumara Point	PHYT	2625773	6544543	1
16	Motikumara Point	SEDIMENT	2625814	6544500	1
16	Motikumara Point	SEDIMENT	2625854	6544458	1
16	Motikumara Point	WRACK	2625812	6544588	3
16	Motikumara Point	ZOOP	2625790	6544529	1
16	Motikumara Point	ZOOP	2625807	6544540	1
16	Motikumara Point	ZOOP	2625829	6544499	1
17	Hargreaves Point	ANCH	2634159	6544458	1
17	Hargreaves Point	ANCH	2634184	6544464	1
17	Hargreaves Point	ANCH	2634186	6544550	1
17	Hargreaves Point	BSLD	2634184	6544571	1
17	Hargreaves Point	CYST	2634218	6544546	1
17	Hargreaves Point	CYST	2634223	6544550	1
17	Hargreaves Point	CYST	2634319	6544665	1
17	Hargreaves Point	PHYT	2634106	6544515	1
17	Hargreaves Point	PHYT	2634123	6544542	1
17	Hargreaves Point	PHYT	2634160	6544538	1
17	Hargreaves Point	SEDIMENT	2634159	6544458	1
17	Hargreaves Point	SEDIMENT	2634186	6544550	1
17	Hargreaves Point	ZOOP	2634171	6544488	1
17	Hargreaves Point	ZOOP	2634176	6544493	1
17	Hargreaves Point	ZOOP	2634176	6544512	1

Site number (BNZ-specified)	Site name	Sampling method*	Easting	Northing	Number of sample units
18	Pouto Point	ANCH	2616639	6537473	1
18	Pouto Point	ANCH	2616697	6537346	1
18	Pouto Point	ANCH	2616700	6537329	1
18	Pouto Point	BSLD	2616648	6537419	1
18	Pouto Point	CYST	2616697	6537329	3
18	Pouto Point	PHYT	2616675	6537339	1
18	Pouto Point	PHYT	2616717	6537277	1
18	Pouto Point	PHYT	2616740	6537281	1
18	Pouto Point	SEDIMENT	2616639	6537473	1
18	Pouto Point	SEDIMENT	2616697	6537346	1
18	Pouto Point	WRACK	2616593	6537275	3
18	Pouto Point	ZOOP	2616690	6537322	1
18	Pouto Point	ZOOP	2616698	6537300	1
18	Pouto Point	ZOOP	2616711	6537287	1
19	Karaka Point	ANCH	2634667	6531915	1
19	Karaka Point	ANCH	2634710	6532005	1
19	Karaka Point	ANCH	2634722	6532035	1
19	Karaka Point	BSLD	2633417	6531941	1
19	Karaka Point	CYST	2634864	6532091	3
19	Karaka Point	PHYT	2634927	6532348	1
19	Karaka Point	PHYT	2634929	6532251	1
19	Karaka Point	PHYT	2635032	6532285	1

Site number (BNZ-specified)	Site name	Sampling method*	Easting	Northing	Number of sample units
19	Karaka Point	SEDIMENT	2634667	6531915	1
19	Karaka Point	SEDIMENT	2634710	6532005	1
19	Karaka Point	WRACK	2634761	6532393	3
19	Karaka Point	ZOOP	2634647	6531901	1
19	Karaka Point	ZOOP	2634669	6531897	1
19	Karaka Point	ZOOP	2634914	6531957	1
20	Kaipara River 1	ANCH	2621133	6530055	1
20	Kaipara River 1	ANCH	2621172	6530043	1
20	Kaipara River 1	ANCH	2621219	6530063	1
20	Kaipara River 1	BSLD	2621228	6530087	1
20	Kaipara River 1	CYST	2621172	6530043	1
20	Kaipara River 1	CYST	2621219	6530063	2
20	Kaipara River 1	SEDIMENT	2621133	6530055	2
21	Kaipara River 2	ANCH	2629014	6522293	1
21	Kaipara River 2	ANCH	2629253	6521938	1
21	Kaipara River 2	ANCH	2629594	6523529	1
21	Kaipara River 2	BSLD	2629218	6523977	1
21	Kaipara River 2	CYST	2629594	6523529	3
21	Kaipara River 2	SEDIMENT	2629253	6521938	1
21	Kaipara River 2	SEDIMENT	2629594	6523529	1
22	Kaipara River 3	ANCH	2633483	6519485	1
22	Kaipara River 3	ANCH	2633529	6519592	1

Site number (BNZ-specified)	Site name	Sampling method*	Easting	Northing	Number of sample units
22	Kaipara River 3	ANCH	2633561	6519758	1
22	Kaipara River 3	BSLD	2633526	6519407	1
22	Kaipara River 3	CYST	2633561	6519758	3
22	Kaipara River 3	SEDIMENT	2633483	6519485	1
22	Kaipara River 3	SEDIMENT	2633529	6519592	1
22	Kaipara River 3	VISD	2633910	6519933	1
23	Shelly Beach Slipway	ANCH	2633972	6513992	1
23	Shelly Beach Slipway	ANCH	2633988	6513981	1
23	Shelly Beach Slipway	ANCH	2633991	6513981	1
23	Shelly Beach Slipway	ANCH	2633994	6513975	1
23	Shelly Beach Slipway	ANCH	2634000	6513986	1
23	Shelly Beach Slipway	ANCH	2634007	6513982	1
23	Shelly Beach Slipway	BSLD	2634032	6513954	1
23	Shelly Beach Slipway	CRBTP	2633995	6513977	3
23	Shelly Beach Slipway	CRBTP	2634012	6513971	3
23	Shelly Beach Slipway	CYST	2633979	6513997	1
23	Shelly Beach Slipway	CYST	2633981	6514009	1
23	Shelly Beach Slipway	CYST	2633984	6514001	1
23	Shelly Beach Slipway	CYST	2633988	6513997	1
23	Shelly Beach Slipway	CYST	2633991	6514001	1
23	Shelly Beach Slipway	CYST	2633991	6514005	1
23	Shelly Beach Slipway	PHYT	2634102	6513921	1

Site number (BNZ-specified)	Site name	Sampling method*	Easting	Northing	Number of sample units
23	Shelly Beach Slipway	PHYT	2634175	6514000	1
23	Shelly Beach Slipway	PHYT	2634178	6513944	1
23	Shelly Beach Slipway	PSC	2633999	6513921	12
23	Shelly Beach Slipway	SEDIMENT	2633972	6513992	1
23	Shelly Beach Slipway	SEDIMENT	2633994	6513975	1
23	Shelly Beach Slipway	SHRTP	2633995	6513977	3
23	Shelly Beach Slipway	SHRTP	2634012	6513971	3
23	Shelly Beach Slipway	ZOOP	2634063	6513981	1
23	Shelly Beach Slipway	ZOOP	2634097	6514018	1
23	Shelly Beach Slipway	ZOOP	2634099	6513934	1
24	Shelly Beach Landing	ANCH	2633941	6514115	1
24	Shelly Beach Landing	ANCH	2633962	6514101	1
24	Shelly Beach Landing	ANCH	2633975	6514073	1
24	Shelly Beach Landing	BSLD	2633995	6514132	1
24	Shelly Beach Landing	CYST	2633951	6514114	1
24	Shelly Beach Landing	CYST	2633960	6514107	1
24	Shelly Beach Landing	CYST	2633971	6514122	1
24	Shelly Beach Landing	SEDIMENT	2633962	6514101	1
24	Shelly Beach Landing	SEDIMENT	2633975	6514073	1
25	Ngapuke Creek	ANCH	2637899	6513109	1
25	Ngapuke Creek	ANCH	2637931	6513067	1
25	Ngapuke Creek	ANCH	2637968	6513037	1

Site number (BNZ-specified)	Site name	Sampling method*	Easting	Northing	Number of sample units
25	Ngapuke Creek	BSLD	2637915	6513103	1
25	Ngapuke Creek	CRBTP	2637970	6513083	3
25	Ngapuke Creek	CRBTP	2638074	6513109	3
25	Ngapuke Creek	CYST	2637898	6513135	1
25	Ngapuke Creek	CYST	2637916	6513149	1
25	Ngapuke Creek	CYST	2637930	6513092	1
25	Ngapuke Creek	PHYT	2637954	6513074	1
25	Ngapuke Creek	PHYT	2637984	6513107	1
25	Ngapuke Creek	PHYT	2637991	6513015	1
25	Ngapuke Creek	SEDIMENT	2637899	6513109	1
25	Ngapuke Creek	SEDIMENT	2637931	6513067	1
25	Ngapuke Creek	SHRTP	2637970	6513083	3
25	Ngapuke Creek	SHRTP	2638074	6513109	3
25	Ngapuke Creek	ZOOP	2637691	6513244	1
25	Ngapuke Creek	ZOOP	2637768	6513207	1
25	Ngapuke Creek	ZOOP	2637839	6513199	1
26	Waionui Inlet	ANCH	2620585	6529838	1
26	Waionui Inlet	ANCH	2620600	6529845	1
26	Waionui Inlet	ANCH	2620695	6529923	1
26	Waionui Inlet	BSLD	2620654	6529960	1
26	Waionui Inlet	CYST	2620585	6529838	1
26	Waionui Inlet	CYST	2620600	6529845	1

Site number (BNZ-specified)	Site name	Sampling method*	Easting	Northing	Number of sample units
26	Waionui Inlet	CYST	2620695	6529923	1
26	Waionui Inlet	PHYT	2620598	6529906	1
26	Waionui Inlet	PHYT	2620599	6529893	1
26	Waionui Inlet	PHYT	2620616	6529846	1
26	Waionui Inlet	POIS	2620721	6529943	1
26	Waionui Inlet	SEDIMENT	2620600	6529845	1
26	Waionui Inlet	SEDIMENT	2620695	6529923	1
26	Waionui Inlet	SEINE	2620749	6529846	3
26	Waionui Inlet	WRACK	2620755	6529852	3
26	Waionui Inlet	ZOOP	2620642	6529879	1
26	Waionui Inlet	ZOOP	2620694	6529934	1
26	Waionui Inlet	ZOOP	2620727	6529959	1
27	Kaipara Head	ANCH	2613177	6533952	1
27	Kaipara Head	ANCH	2613361	6533977	1
27	Kaipara Head	ANCH	2613583	6534116	1
27	Kaipara Head	BSLD	2613090	6533958	1
27	Kaipara Head	CYST	2613583	6534116	3
27	Kaipara Head	SEDIMENT	2613177	6533952	1
27	Kaipara Head	SEDIMENT	2613361	6533977	1
31	Rangitira Beach	WRACK	2636847	6487194	3

*Survey methods: ANCH = Anchor box dredge; BSLD = benthic sled; PSC = quadrat scrapings on wharf pilings and other hard structures; VISD = qualitative visual survey; CYST = dinoflagellate cyst core; CRBTP = crab trap, SHRTP = shrimp trap; PHYT = phytoplankton net tow; ZOOP = zooplankton net tow; POIS = fish poison station; SEINE = beach seine netting; SEDIMENT = sediment sample; WRACK = beach wrack survey. Photo stills and videos are not listed – these were conducted at the same locations as the PSC locations.

- Appendix 3: Sampling site/method combinations specified by BNZ that were not conducted

Site number	Site name	Method code	Replicate(s)	Reason for not sampling
1	Rauwai Slipway	Poison station	1	Very poor visibilty so no poison sampling could be conducted
14	Pahi Slipway	Beach wrack walk	5m & 10m from water edge	Tide was in so only the 2 m wrack could be conducted

Appendix 4. Media Release circulated as part of the public awareness programme

Media Release **18 September 2006**

Kaipara Harbour to be surveyed for marine pests

Researchers from the National Institute of Water & Atmospheric Research (NIWA) will be surveying Kaipara Harbour and marinas for foreign marine organisms next week.

The survey is being carried out as part of a nationwide port surveillance programme set up by Biosecurity New Zealand in 2001.

It is designed to determine which non-native marine species have already become established in New Zealand and to develop a baseline for early detection of new pests. Additional surveillance surveys are targeted at eight problem species, including the clubbed tunicate *Styela clava*, an invasive sea squirt.

A NIWA field team will carry out a thorough search of all port and marina structures, seabed habitats, and beaches, collecting samples of plants, plankton, invertebrates, fish, and seafloor sediments. They will also lay down baited traps overnight to collect crabs and shrimps.

The samples collected will be identified by experts in New Zealand and overseas to determine their origins. This process can take several months. Seabed communities and fouling organisms will be photographed and filmed to identify species that have not been captured in individual samples.

Surveys will take place (weather permitting) from 25 to 30 September (Southern Kaipara) and 9 to 13 October (Northern Kaipara).

Weno Iti (of Te Küwaha, NIWA's Mäori Research & Development Unit) and field team leader Crispin Middleton have been consulting with local hapu representatives Brenda Steele (Ngati Whätua Nga Rima o Kaipara) and Julie Ann Chetham (Nga Uri o Hau) over the survey.

Boat operators should watch out for divers during daylight hours from 8 am to 5 pm. Divers will be operating around the wharves and marinas at depths of 5 m and close to the seafloor. They will also be operating around rocky reefs, rocky rip-rap, shipwrecks, kelp and seagrass meadows, over soft bottoms, and around beaches.

Dive vessels are clearly marked as 'Research vessels' and the skippers will be monitoring local VHF channels. A dive flag will be prominently displayed whenever diving is underway.

Biosecurity New Zealand and NIWA would like to hear from anyone who has seen any new or unusual plants or animals in the harbour.

To report any suspicious finds, please call the free Biosecurity New Zealand hotline: **0800 80 99 66**

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Additional Information

The survey will cover the following sites:

Ruawai slipway
Ruawai landing
Sail Point

Middle channel
Pakaukau Point
Matihe Point
Bushy Point
Five Fathom channel
Te Whau Point slipway
Mussel rock
The Funnel
Te Hoanga Point
Pahi landing
Pahi slipway
Kapua Point
Motukumara Point
Hargreaves Basin
Pouto Point
Karaka Point
Kaipara River (3 sites)
Shelly Beach slipway
Shelly Beach landing
Ngapuke Creek
Waionui Inlet

Kaipara Head (conditions permitting)
Rangitira Beach

ENDS

Appendix 5: 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
Including **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, including shrimps, crabs, lobsters, amphipods, tanaids and several other groups. 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 (phylum Ulvophyceae), red algae (phylum Rhodophyceae) and brown algae (phylum 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

Including **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 6: Species information sheets for each non-indigenous species recorded from the Kaipara survey or desktop review of existing marine species records.

The species information sheets are designed to summarise basic information on the biology, ecology, distribution (international and national), and potential impacts of each of the non-indigenous species that was recorded during the port baseline survey. They are modeled on similar fact sheets that have been developed for on-line databases on non-indigenous marine species elsewhere in the world (e.g NIMPIS, NISbase, NASbase, Global Invasive Species Database, NEMESIS, Baltic Sea Alien Species, etc). Information on each species was compiled from available literature, on-line databases on alien marine species, searchable databases with taxonomic and/or biogeographic data (e.g. ITIS, OBIS, Australian Faunal Directory, Algaebase, Fishbase, etc) and from background material provided by the specialist taxonomists who identified the specimens. Key published sources of information for each species are listed on the bottom of each sheet. Whilst the sources of all photographs and diagrams are acknowledged, we have not sought specific permission to use them.

Pathways for introduction and dispersal

Likely pathways for the introduction and spread of each species are classified according to the 22 vector categories used by Hayes *et al.* (2005) in recent risk profiling of priority Australian marine pests (Table 1). Three additional categories – N1, N2, N3 – have been added to describe different pathways for natural spread of the species within New Zealand. For each species, the likely pathways of introduction to New Zealand are largely derived from

Cranfield *et al.* (1998), published information, or expert opinion. The categories met by any given species are indicated in its species information sheet.

Table 1: Potential pathways for the introduction and spread of non-indigenous species within New Zealand (after Hayes *et al.* 2005).

Code	Description
B1	Biocontrol: deliberate translocation as a biocontrol agent
B2	Biocontrol: accidental translocation with deliberate biocontrol release
C	Canals: natural range expansion through man-made canals
D	Debris: transport of species on human generated debris
F1	Fisheries: deliberate translocations of fish or shellfish to establish or support fishery
F2	Fisheries: accidental with deliberate translocations of fish or shellfish
F3	Fisheries: accidental with fishery products, packing or substrate
F4	Fisheries: accidental as bait
IR1	Individual release: deliberate release by individuals
IR2	Individual release: accidental release by individuals (e.g. aquarium discards)
NB	Navigation buoys and marina floats: accidental as attached or free-living fouling organisms
P1	Plant introductions: deliberate translocation of plant species (e.g. for erosion control)
P2	Plant introductions: accidental with deliberate plant translocations
RE	Recreational equipment: accidental with recreational equipment
S1	Ships: accidental as attached or free-living fouling organisms
S2	Ships: accidental with solid ballast (e.g. rocks, sand, etc)
S3	Ships: accidental with ballast water, sea water systems, live wells or other deck basins
S4	Ships: accidental associated with cargo
S5	Ships: accidental associated with dredge spoil
SP	Seaplanes: accidental as attached or free-living fouling organisms

Code	Description
SR1	Scientific research: deliberate release with research activities
SR2	Scientific research: accidental release with research activities
U	Unknown
N1	Natural: planktonic dispersal
N2	Natural: rafting of adults on biogenic substrata
N3	Natural: long-distance movement of adults

Potential impacts

The impacts on New Zealand ecosystems have not been documented for most species. Where detailed information is available on known impacts of the species here or overseas, this is included. "Potential impacts" were identified on the basis of the species' life habits or those of similar functional species. We classified "potential" impacts into the 15 categories used by Hayes *et al.* (2005) to evaluate the impacts of priority Australian marine pests (Table 2). The categories met by any given species are indicated in its species information sheet. Some species met none of the potential impact categories and therefore none of these categories are listed for those species.

Table 2: Categories used to identify potential impacts of each species (after Hayes *et al.* 2005).

Impact category	Code	Description
Human health	H1	Human health
Economic	M1	Aquatic transport
Economic	M2	Water abstraction/nuisance fouling
Economic	M3	Loss of aquaculture/commercial/recreational harvest

Economic	M4	Loss of public/tourist amenity
Economic	M5	Damage to marine structures/archaeology
Environmental	E1	Detrimental habitat modification
Environmental	E2	Alters trophic interactions and food-webs
Environmental	E3	Dominates/out competes and limits resources of native species.
Environmental	E4	Predation of native species
Environmental	E5	Introduces/facilitates new pathogens, parasites or other NIS
Environmental	E6	Alters bio-geochemical cycles
Environmental	E7	Induces novel behavioral or eco-physiological responses
Environmental	E8	Genetic impacts: hybridisation and introgression
Environmental	E9	Herbivory

Distribution maps

We followed the approach used by the Australian National Introduced Marine Pest Information System (NIMPIS) to present information on the global distribution of each species. NIMPIS uses a bioregional classification of the world's oceans developed by The World Conservation Union (IUCN) to define areas for conservation purposes (Kelleher *et al.* 1995). A conservative approach has been adopted whereby a species is considered present in all areas of a bioregion if it has been recorded from any location within that bioregion's boundaries[2]. Since bioregions represent environmentally similar geographic areas, if a species is present in one portion of a bioregion, there is a strong likelihood that it could spread via natural processes to other areas in that bioregion. Nonetheless, the species does not

[2] The geographic locations of each sample in which the species was found during the New Zealand port baseline surveys are available within the BIODS database associated with this project.

necessarily occur throughout the entire bioregion. In preparing the maps, published distribution information was not always precise, so if a location record indicated a whole country or large area of coastline and provided no further information, all regions encompassing that country or coastline were shaded on our maps. Also note that the species could occur in other (unshaded) regions, but we have not seen records for these regions. The same conditions apply to the New Zealand distribution maps, which divides New Zealand and its offshore islands into 16 regions (after Francis 1996).

We have made our best attempt to identify the provenance of each species. In each case we have attempted to identify: (1) the natural biogeographic range of the species ("native range"), (2) bioregions in which it has been introduced by humans (deliberately or inadvertently; "non-native" range), and (3) regions in which the species' provenance is uncertain ("cryptogenic" range). In many instances, the provenance for particular bioregions is not clear from existing distribution records. In some cases this is because we have not been able to access primary monographs or publications that might resolve this, but in most cases it is simply because the biogeographic information and/or systematics do not permit clear identification of provenance. In these instances, we have had to make our own interpretations of the information available to us.

References

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Hayes, K.; Sliwa, C.; Migus, S.; McEnnulty, F.; Dunstan, P. (2005). National priority pests. Part II, Ranking of Australian marine pests. Report undertaken for the Department of Environment and Heritage by CSIRO Marine Research. Commonwealth of Australia. 102 p

Appendix 7. Species x sample x site results for all taxa recorded by each method from the Kaipara Harbour port survey.

Please email surveillance@mpi.govt.nz to receive the results for each sampling method used below

Appendix 7a. Results from the pile scraping quadrats.
Appendix 7b. Results from the benthic sled samples.
Appendix 7c. Results from the crab trap samples.
Appendix 7d. Results from the dinoflagellate cyst core samples.
Appendix 7e. Results from the anchor box dredge samples.
Appendix 7f. Results from the shrimp trap samples.
Appendix 7g. Results from the phytoplankton tow samples.
Appendix 7h. Results from the beach seine net samples.
Appendix 7i. Results from the beach wrack samples.
Appendix 7j. Results from the zooplankton tow samples.
Appendix 7k. Results from the wharf piling miscellaneous searches.
Appendix 7l. Results from the miscellaneous searches.