Taharoa Terminal

First baseline survey for non-indigenous marine species (Research Project ZBS2005-19)

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Executive summary

This report describes the results of the first port baseline survey of Taharoa Terminal, undertaken from late May to early July 2006. The survey provides an inventory of native, non indigenous and cryptogenic marine species at the Taharoa Terminal 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 and coastal environments of Taharoa.

- A wide range of sampling techniques was used to collect marine organisms from habitats at Taharoa. Fouling assemblages were scraped from hard substrata by divers, benthic assemblages were sampled using an anchor box dredge, large hand corer and diver visual surveys, 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 at the Taharoa Terminal and surrounding coastal environments according to priorities identified by MAF Biosecurity New Zealand. In total, 27 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 port baseline survey, a desktop review was conducted to compile an inventory of non-indigenous marine species that have been recorded previously from Taharoa and surrounding areas. No non-indigenous species had been reported from the area. Two cryptogenic category one taxa (C1: those whose identity as native or non-indigenous is ambiguous), both dinoflagellates, had been reported from Taharoa previously.

- The initial port baseline survey of Taharoa Terminal recorded a total of 328 species or higher taxa. The collection consisted of 212 native taxa, six non-indigenous taxa, 12 cryptogenic category one taxa, four cryptogenic category two taxa (C2: 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 93 taxa being indeterminate (unable to be identified to species level).

- The six non-indigenous species (NIS) recorded from the initial baseline survey included three algae (*Polysiphonia subtilissima, Polysiphonia brodiei* and *Polysiphonia* aff. *sertularioides*), one freshwater plant (*Elodea canadensis*), one barnacle (*Austromegabalanus nigrescens*) and one bryozoan (*Electra angulata*). The 12 C1 taxa included the annelid *Heteromastus filiformis*, the bryozoan *Scruparia ambigua*, the ascidian *Diplosoma listerianum*, the hydroids *Clytia hemisphaerica* and *Obelia dichotoma*, the dinoflagellates *Gymnodinium catenatum, Alexandrium catenella, A. affine, A. ostenfeldii* and *A. tamarense*, the sponge *Chondropsis topsentii*, and the red alga *Ceramium cliftonianum*. One NIS – the barnacle *Austromegabalanus nigrescens* – and one C1 – the alga *Ceramium cliftonianum* – had not previously been recorded in New Zealand. The other NIS and C1 taxa are known to have established populations within New Zealand, but their occurrence at Taharoa represents an extension of the known range in New Zealand for one of them (*Polysiphonia brodiei*) and a possible extension for another two (*Clytia hemisphaerica* and *Obelia dichotoma*).

- The 18 NIS and C1 taxa collected during the Taharoa port survey were represented by 138 records. More than three-quarters of these were collected in the quadrat scrapings from the offshore mooring buoy, at depths of 0.5 m and 2 m. The 31 records resulting from the other methods were collected in samples from depths ranging from the intertidal to 35 m depth.

- The distribution of NIS and C1 taxa in the Taharoa area appears to be centred around the mooring buoy. Seven taxa were recorded only on the mooring buoy, another three were only recorded from samples within 1 km of the buoy, and a further five were recorded from samples within 3 km of the buoy.

- Four taxa recorded from the initial port baseline survey of Taharoa Terminal appear to be new to science. Classed as C2, these are the bryozoan *Celleporina* sp. and the polychaetes *Notomastus Notomastus*-B, *Asychis Asychis*-B and *Paraprionospio Paraprionospio*-A [pinnata]. The Taharoa records represent the first records for *Celleporina* sp. and *Notomastus Notomastus*-B.

- None of the species recorded during the Taharoa Terminal port survey or during the desktop review of existing species records are on the New Zealand Unwanted Organisms Register. However, three diatoms recorded from the port survey are on both the Australian CCIMPE Trigger List and an Australian list of 37 priority international pests. Another two species, the dinoflagellate *Gymnodinium catenatum* (recorded in both the port survey and previously), and the red alga *Polysiphonia brodiei* (recorded in the port survey), are included on an Australian list of 53 Australian priority domestic pests.

- Eight toxin-producing species were recorded during the Taharoa Terminal port baseline survey – the native dinoflagellates *Lingulodinium polyedrum*, *Dinophysis acuta* and *D. tripos,* the native diatom *Pseudo-nitzschia australis* and the C1 dinoflagellates *Alexandrium catenella*, *A. tamarense*, *A. ostenfeldii* and *Gymnodinium catenatum*. Only the latter two species have previously been recorded from Taharoa. Another two native diatoms recorded during the port survey, *Chaetoceros convolutus* and *C. concavicornis*, are considered harmful to fish due to their barbed setae, but are not directly toxic.

- Two hundred and twenty-eight of the 234 species (>97 %) that were identified in the port survey were not represented amongst the 42 taxa recorded during the desktop review. The port baseline survey thus represents a valuable addition to the knowledge of the flora and fauna of the Taharoa area. The low overlap in species composition between the desktop review of existing marine species records and the records from the port baseline survey can be attributed to the paucity of previous sampling in the area, 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).

- Almost all of the non-indigenous and C1 taxa recorded during the Taharoa port survey or desktop review could have arrived in New Zealand accidentally by international shipping or spread from other locations in New Zealand (including translocation by shipping). Approximately half of them could also have arrived at Taharoa by natural means.

- Ten of the 18 species may have been introduced in hull fouling assemblages, one through the domestic aquarium trade, two either by hull fouling or by rafting on natural or man-made substrata, and five either in ballast water or on ocean currents.

- The distribution of NIS and C1 taxa in the Taharoa area appears to be centred around the mooring buoy. Seven taxa were recorded only on the mooring buoy, and a total of 15 of the 18 taxa were recorded only in samples taken within 3 km from the buoy. It is suggested that maintaining the mooring buoy clear of fouling organisms will reduce the likelihood of NIS and C1 taxa becoming established at Taharoa and prevent them from being translocated to other locations in New Zealand.

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”, in “Baseline survey methods” section) 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 re-surveyed 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:

- Taharoa 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 Taharoa Terminal 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 species. Organisms that could not be identified to species level are also listed as indeterminate taxa (see “Baseline survey methods: Definitions of biosecurity status”).

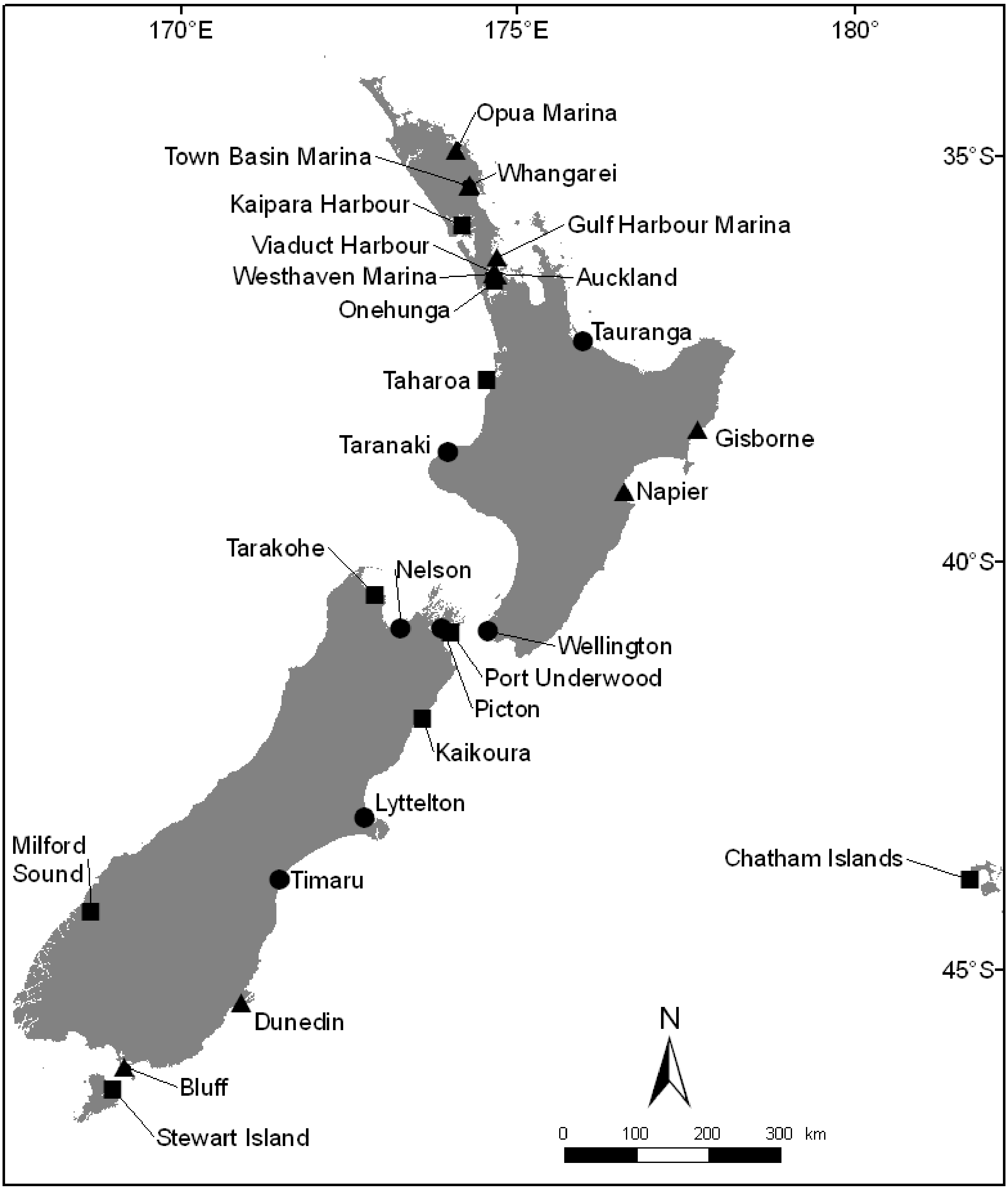

Figure 1: Commercial shipping ports in New Zealand where baseline non-indigenous species surveys have been conducted. Group 1 ports (circles) were surveyed in the summer of 2001/2002 and re-surveyed in the summer of 2004/2005, Group 2 ports (triangles) were surveyed in the summer of 2002/2003 and re-surveyed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

DESCRIPTION OF TAHAROA TERMINAL

General features

Taharoa is located on an exposed area on the west coast of the North Island of New Zealand (Figure 1). It is 150 km south of Auckland and a steam of approximately 20 km south of Kawhia Harbour. Taharoa has the largest iron sand deposit in New Zealand, covering 1,600 hectares with estimated reserves of 300 million tonnes (New Zealand Steel 2004). Mining for the iron sands in Taharoa commenced in 1972.

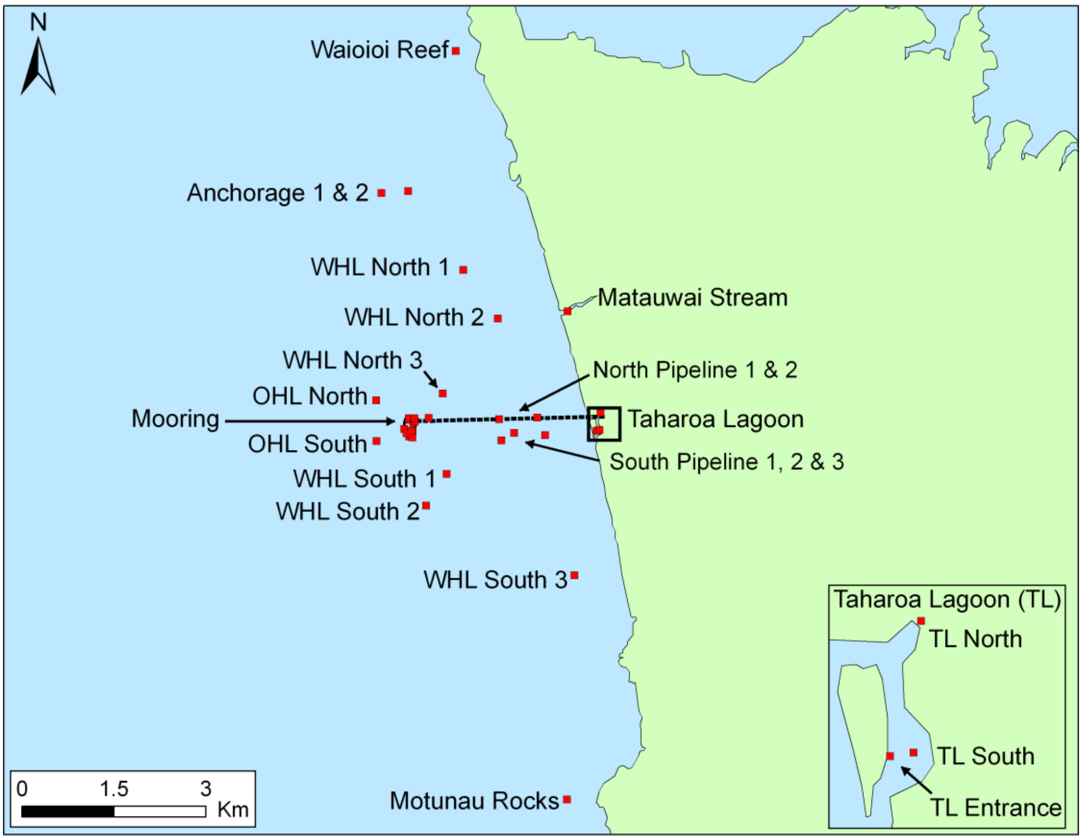

Figure 2: Taharoa Terminal and surrounding area, with sampling sites indicated. The dotted line indicates the submerged pipeline leading to the offshore mooring buoy. OHL: Outside Harbour Limits. WHL: Within Harbour Limits. Details of the mooring buoy sites are shown in Figure 5.

Port operation, development and maintenance activities

The Taharoa Terminal is an ironsand loading facility operated by New Zealand Steel Ltd, a subsidiary of BlueScope Steel Ltd. Shipping operations at the terminal are administered by McMaster Marine Ltd. Access to the site is restricted and is highly weather-dependent. The nearest sheltered anchorage and boat launching facilities are in Kawhia Harbour (approximately one hour from the site).

There are no land-based port facilities at Taharoa. Mineral sands are mixed with water and pumped as a slurry from the on-shore mine site through two parallel pipelines to a single buoy mooring approximately 2.5 km offshore (Figure 3), where the slurry is transferred to a bulk carrier for export (New Zealand Steel 2004).

The mooring buoy is 11 m in diameter, anchored in approximately 32 m water depth by six chains. It has two floating hoses approximately 20 m long floating alongside attached to a pivoting arm. There is a 2 m fender surrounding the buoy. The buoy is steel with aluminium anodes providing cathodic protection to prevent the steel from corroding. The buoy does not have antifouling paint. Marine fouling, particularly mussels and barnacles, build up on the buoy but are usually cleared off by heavy storms in the winter. During the summer, sections are manually cleaned for inspection. The buoy is occasional towed to protected harbours for maintenance; it was last towed in 2005 to Kawhia Harbour, and is planned to be towed to Onehunga in 2008 or 2009 (Alan Rutherford, Marine Mooring Consultants under contract to NZ Steel Mining, pers. comm.).

Figure 3: The Taharoa Terminal offshore mooring buoy and floating hoses

Imports and exports

The Taharoa Terminal is an export terminal for iron sands mined at Taharoa. No imports are made to the terminal. Mining began in 1972, and exports peaked in the mid 1980's at around two million tonnes per annum (Chadwick and Brown 2005). Currently, approximately one million tonnes of iron sands are exported from the terminal each year. The product is exported to Japan, South Korea and China (New Zealand Steel 2004), with China currently representing approximately 75 % of the market and Japan 25 %. Occasional half-shipments to South Korea and Taiwan have occurred in the past (Mike O'Connell, Blue Scope Steel, pers. comm.).

The volumes and value of goods exported through the Taharoa Terminal are summarised below using data from Statistics New Zealand (2006b). The data are for the financial years ending June 2002 to June 2005. Also available from Statistics New Zealand (2006a) was a breakdown of cargo value by country of destination for each calendar year; we analysed the data for the period January 2002 to December 2005 inclusive.

In the financial year ending June 2005, 991,385 tonnes gross weight were loaded for overseas export from the Taharoa Terminal, valued at $17 million (Statistics New Zealand 2006b). This represented a 33.7 % increase by weight compared compared to the year ending June 2002, but a 15 % decline in value (Table 1). For the financial years ending June 2002 to 2005, overseas cargo loaded at Taharoa Terminal accounted for 2.9 to 4.5 % by weight and 0.1 % by value of the total overseas cargo loaded at New Zealand's seaports (Table 1).

The Taharoa Terminal loaded cargo for export to three countries of final destination[1] between 2002 and 2005 inclusive (Statistics New Zealand 2006a). During this time, Japan was the only country that was exported to each year, receiving 57 % of the total exports. The People's Republic of China was exported to in 2003, 2004 and 2005, receiving 42 % of the exports, and Taiwan received just 1 %, in 2004 (Figure 4).

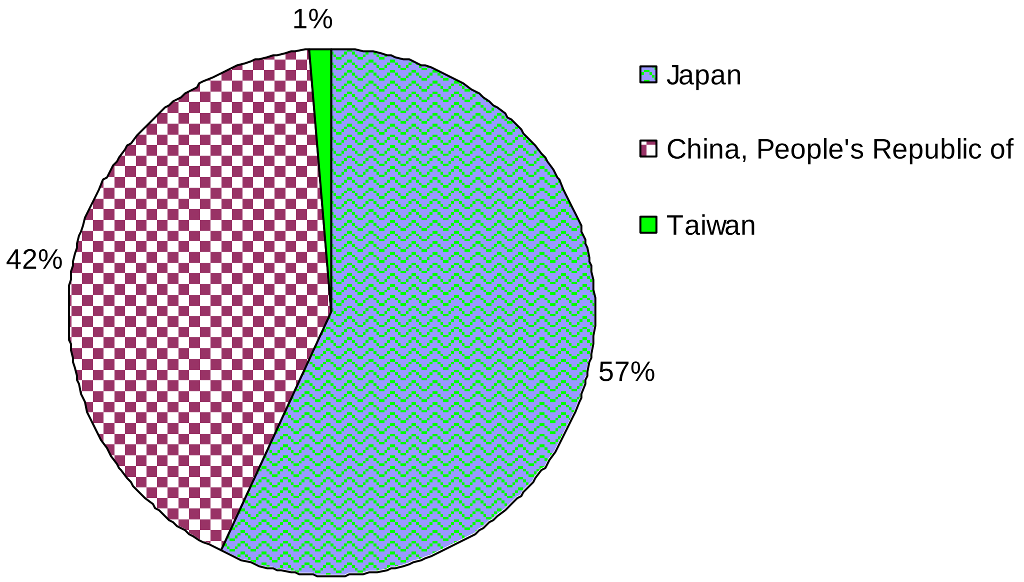

Figure 4: Countries of final destination that cargo was loaded for at the Taharoa Terminal. The data are percentages of the total cargo loaded at the port for the period January 2002 to December 2005 inclusive (data sourced from Statistics New Zealand 2006a).

Shipping movements and ballast discharge patterns

The Taharoa Terminal is currently serviced by only one vessel, the 143,000 DWT bulk carrier MV *Taharoa Express*. At 275 m long, it is the largest cargo ship trading in New Zealand (Maritime New Zealand 2007). This vessel will be replaced in December 2009, and will be replaced by one or two new vessels (Mike O'Connell, Blue Scope Steel, pers. comm.). The *Taharoa Express* makes a round voyage from Taharoa to its north Asian markets and back in around 45 days, and spends approximately three days on the mooring buoy at Taharoa taking on its cargo, weather permitting (Alan Rutherford, Marine Mooring Consultants under contract to NZ Steel Mining, pers. comm.).

Since June 2005, vessels in New Zealand have been required to comply with the Import Health Standard for Ships' Ballast Water from All Countries (Biosecurity New Zealand 2005). No ballast water is allowed to be discharged without the express permission of a Ministry of Agriculture and Forestry (MAF) inspector. To allow discharge, vessel 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 200m depth); demonstrating ballast water is fresh (2.5 ppt sodium chloride); or having the ballast water treated by a MAF approved treatment system. Ballast water loaded in Tasmania and Port Philip Bay in Victoria (Australia) may not be discharged into New Zealand water under any circumstances, due to

[1] The country of final destination is not necessarily the country that the ship carrying the commodity goes to immediately after departing from the Taharoa Terminal; it is the final destination of the goods. For ship movements see "Shipping movements and ballast discharge patterns".

the presence of several high-risk non-indigenous species in those areas (Biosecurity New Zealand 2005).

As a solely export facility, the Taharoa Terminal receives a disproportionately high volume of ballast water discharge (Green 2000). Currently approximately 50,000 tonnes of ballast water are discharged each time the *Taharoa Express* is moored at the Taharoa Terminal buoy (Alan Rutherford, Marine Mooring Consultants under contract to NZ Steel Mining, pers. comm.). Data available for the nine months from January to September 1999 shows that Taharoa had the second-largest volume of international ballast water discharge (around 200,000 tonnes) in New Zealand during this time, second only to New Plymouth (Wotton 2001). NZ Steel has been taking ballast water samples during each vessel visit, over approximately the last 20 years, to monitor for marine invasive species (Mike O'Connell, Blue Scope Steel, pers. comm.). However, these results were not available to us at the time we inquired about them.

Existing biological information

There is little existing biological information available for the area around the Taharoa terminal. Most research around this area has focused instead on the geophysical characteristics of the commercially important ironsand resources in the coastal dunes (eg. Lawton and Hochstein 1993; Christie and Brathwaite 1997 and references therein; Hesp et al. 1999) and oceanographic characteristics of the area (eg. Franklin 1973; Pickrill and Mitchell 1979).

Two toxic dinoflagellate species have been recorded from Taharoa. Cysts of *Gymnodinium catenatum* were detected in low to moderate densities in surface sediment samples collected in December and January 2001 (Taylor and MacKenzie 2001). No motile cells of this species were found. *Gymnodinium catenatum* is one of four toxic dinoflagellates listed on the Australian Ballast Water Management Advisory Council's schedule of non-indigenous pest species. A second potentially toxic dinoflagellate species, *Alexandrium ostenfeldii*, has also been recorded from Taharoa (MacKenzie et al. 1996). This species produces biotoxins known to cause paralytic shellfish poisoning. *A. ostenfeldii* was, until recently, believed to be confined to the western European coast (Iceland and Norway, Denmark, Belgium and Spain), but since the 1990's has been reported from Egypt, western north America, the Kamchatka Peninsula and north eastern Canada (Faust and Gulledge 2002). Its native provenance is uncertain and the species is therefore considered cryptogenic throughout its range.

Cranfield et al. (1998) reviewed the published literature and classified 159 species as being adventive in New Zealand. None of these were reported from the Taharoa coastal area, perhaps partly due to historically less intensive sampling effort along this coast. Numerous species were reported with distributions including locations on the west coast of the North Island, such as three estuarine cord grass species in the genus *Spartina*, recorded northwards from Kaipara Harbour; 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 *Balanus variegatus*[2] recorded from Kaipara Harbour; 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 around Taharoa, 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*; the caryophylliid *Tethocyathus cylindraceus*; the bryozoans *Bugula flabellata* and *B. neritina*; the Pacific Oyster *Crassostrea gigas*; the nudibranch gastropod *Okenia plana*; and the ascidian *Corella eumyota*.

The non-indigenous terrestrial plants lupin, marram grass, and pine trees have been planted on the inland dunes as part of rehabilitation efforts following mining at Taharoa (Chadwick and Brown 2005). These inland dunes rate only 1 out of a potential score of 20 for their ecological status. By comparison, the foredunes rated 12 (Partridge 1992, in Taylor and Smith 1997).

A wind farm has been proposed to be built on the Taharoa area. The resource consent application for this proposal included a study of the foreshore ecology around Te Waitere, a small town on the southern side of Kawhia harbour, just north of the Taharoa coastal area. No non-indigenous species were identified from the benthic core samples taken. Four deposit-feeding polychaete taxa dominated the benthic infaunal community, and no species of "particular conservation value" were identified (Tonkin & Taylor Ltd 2005). It should be noted that this sheltered harbour is quite a different ecological environment to that of the Taharoa coastal area.

Baseline survey methods

REVIEW OF MARINE SPECIES RECORDS FROM TAHAROA

Prior to undertaking the Taharoa Terminal port baseline survey, we conducted a desktop review of biological records (including historical) of marine species previously recorded from Taharoa. 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).

During our desktop review, we compiled a list of all species records that we encountered from Taharoa or from nearby locations on the west coast of the North Island of New Zealand, 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

[2] *Balanus variegatus*, now known as *Amphibalanus variegatus*, is now 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.).

for each taxonomic group to relevant experts for them to review species names, reliability of the records and biosecurity statuses. 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 TAHAROA TERMINAL

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 at and around the Taharoa Terminal, between May 23rd and July 1st, 2006.

A variety of sampling techniques was used for the survey of Milford Sound. 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 baseline port 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). Due to the exposed nature of the coastline around the Taharoa Terminal and structure of the sites, some of the sampling methods and sites were varied in agreement with MAF Biosecurity New Zealand. The sites and methods employed at the Taharoa Terminal are detailed below.

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 Taharoa Terminal is provided in Table 2, and the spatial distribution for each of the sample methods is shown in Figure 11 to Figure 19. 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.

The survey of Taharoa terminal was undertaken in two blocks from May 23 to 25 and June 29 to July 1, 2006. All diver sampling and shore-based sampling was completed during the first block, whilst the remaining sampling techniques and locations were completed during the second block. A vessel was chartered to conduct the offshore sampling from. The commercial diving company Commercial Dive Services NZ Ltd were subcontracted to conduct the diving because of the hazardous nature of the site. The commercial divers were briefed on the sample sites, sampling methods and quality control at a meeting prior to the field trip and then again whilst in the field, directly before diving. The NIWA field team leader on board the charter vessel directed the sampling.

Fouling communities

Fouling assemblages on the mooring buoy were surveyed using photographic stills and video, scraping samples, and qualitative visual surveys.

The mooring buoy was divided into quadrants, with each quadrant encompassing one sampling "site" (Figure 5). Video transects were filmed by divers at the mooring sites before quadrat scrape samples were taken. Divers recorded video transects continuously from the surface of the buoy to its base and back to the surface. Following the video transects, quadrats (25 cm x 40 cm) were secured to the mooring buoy and still images were taken with a high-resolution digital camera. Four overlapping photographic stills were taken in each quadrat to cover the area. Due to the size and structure of the mooring buoy at Taharoa Terminal, quadrat samples from the four mooring buoy sites were taken at eight equally spaced locations within each sampling site (Figure 5). Quadrats were set at depths of -0.5 and -2.0 metres (ie total of 64 quadrat scrapes; deeper quadrats were not possible as the buoy had a maximum draught of around 2.5 m). Once the first diver had obtained the photographic images, a second diver then removed fouling organisms from the buoy 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 charter boat for processing by NIWA scientific staff. 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.

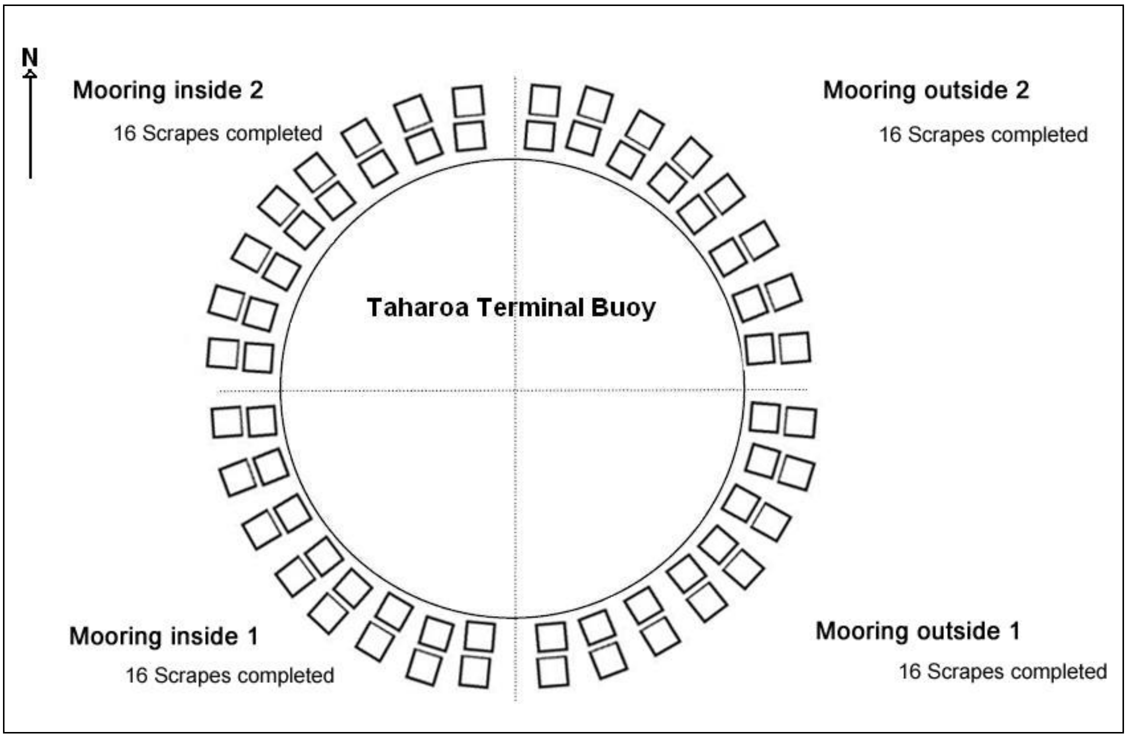

Figure 5: Schematic aerial view of quadrat scrape sampling at the four sites on the Taharoa Terminal offshore mooring buoy. Pairs of squares represent one quadrat at 0.5 m depth and one quadrat at 2 m depth. Eight pairs, or 16 quadrats, were sampled within each site on the buoy; there were four sites on the buoy in total.

Benthic infauna

Benthic infauna were collected by sieving sediment collected using a large hand corer or an anchor box dredge (Figure 6). The large hand corer is 150 mm in diameter and 400 mm long. It is inserted 200 mm into the sediment, resulting in a sediment sample 150 mm in diameter by 200 mm length. The large hand corer was used only at the very shallow coastal estuarine sites (sites 11, 12 and 13). At all other sites, an anchor box dredge was used to collect the sediment without needing to conduct excessively deep dives. 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. At each site, triplicate samples were taken 50 m out from the pile and hard structure site (where applicable).

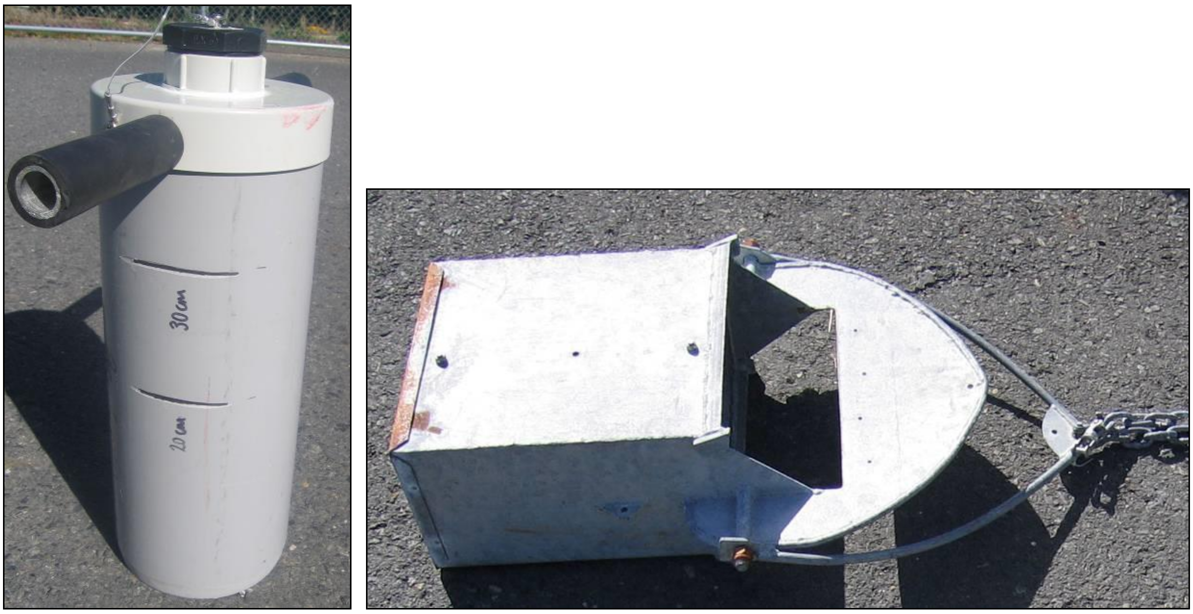

Figure 6: Large hand corer (left) and anchor box dredge (right) for sampling benthic infauna

Dinoflagellate cyst-forming species

Sediments collected in the anchor box dredge were collected to search for dinoflagellate cysts. Attempts were initially made to collect these samples using the TFO gravity corer ("javelin corer") that has been used during previous New Zealand port surveys, but due to the nature of the sediments in the area (typically fine iron sand) this method failed to collect suitable samples. Sediment samples were kept on ice and refrigerated prior to dispatch to the specialist taxonomist.

Dinoflagellates, phytoplankton and zooplankton in the water column

A 100 µm net with a diameter of 70 cm was used to sample zooplankton in the water column. The net dropped vertically to approximately 1 metre 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 of 25 cm was used to sample dinoflagellates and phytoplankton species. This net was towed just below the water surface behind the charter vessel at slow speed for 1 minute then retrieved, washed down, placed in sample containers and labelled for laboratory analysis.

Figure 7: Zooplankton net commencing its vertical drop.

Epibenthos

Larger benthic organisms were sampled using qualitative visual surveys, Ocklemann sled tows, crab box traps and shrimp traps.

Qualitative visual surveys and benthic sleds

Qualitative visual surveys for crabs, macroalgae and target species were conducted by scuba divers on the rocky reefs at sites 26 and 27. However, these proved difficult due to very high surge and poor visibility close to shore.

At all other sites, an Ocklemann sled (hereafter referred to as a “sled”) was used in lieu of qualitative visual surveys to reduce the risks involved with sampling in >30 metre depths. The 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.

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

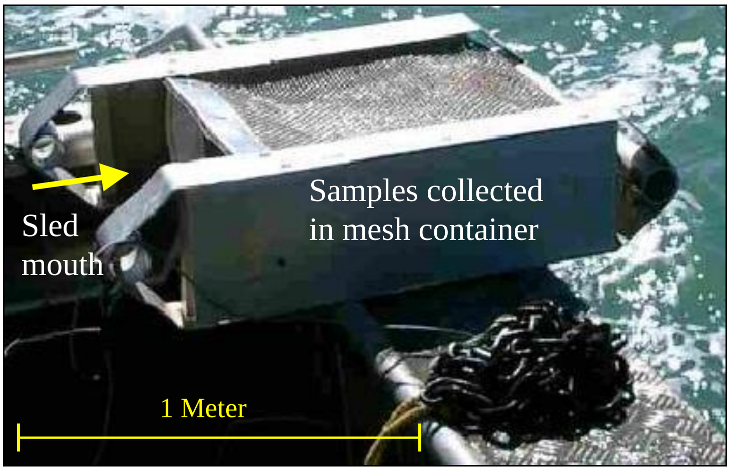

Figure 8: Ocklemann sled for sampling epibenthos

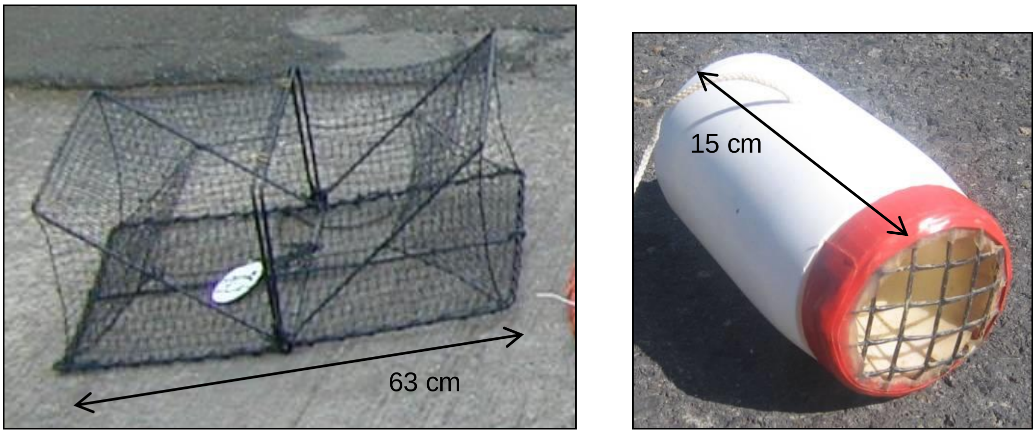

Figure 9: Crab box trap (left) and shrimp trap (right)

Fishes

Fishes were sampled using poison stations and beach seine netting.

Poison stations were sampled over hard substrates using clove oil at two sites on the mooring buoy (sites 1 and 3). At these sites, the poison stations were done in the underwater chain lockers on the mooring buoy, which are recesses at about 3 m depth where the chain that anchors the buoy attaches to it. These areas were 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.

Beach seine nets were used to sample fish species at estuaries and beaches (Figure 10). The 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).

Sediments

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 the 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. Two replicate sediment samples from two separate anchor box dredge or large hand core samples were taken at each site, except at the Taharoa Lagoon sites (sites 11, 12, 13), where six replicate sediment samples were taken at each site.

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 ºC 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 ºC 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:

1. 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.
2. Sediments retained on each sieve were dried and weighed.
3. 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.
4. 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.
5. 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.
6. 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. Typically, 250,000 to 500,000 particles were counted per sample.
7. The proportion of particles in each of five size categories (ranging from clay to small pebbles) 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 onboard the research vessel, 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 or 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).

Because of the difficulty of identifying all species from the zooplankton samples, an alternative approach was taken, in consultation with MAF Biosecurity New Zealand, whereby the samples were only screened for target non-indigenous species. The species looked for were larvae that were or were suspected to be 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*. Identifications were not made for organisms other than these species in the samples. Cumaceans, ostracods 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 "Definitions of biosecurity status", below).

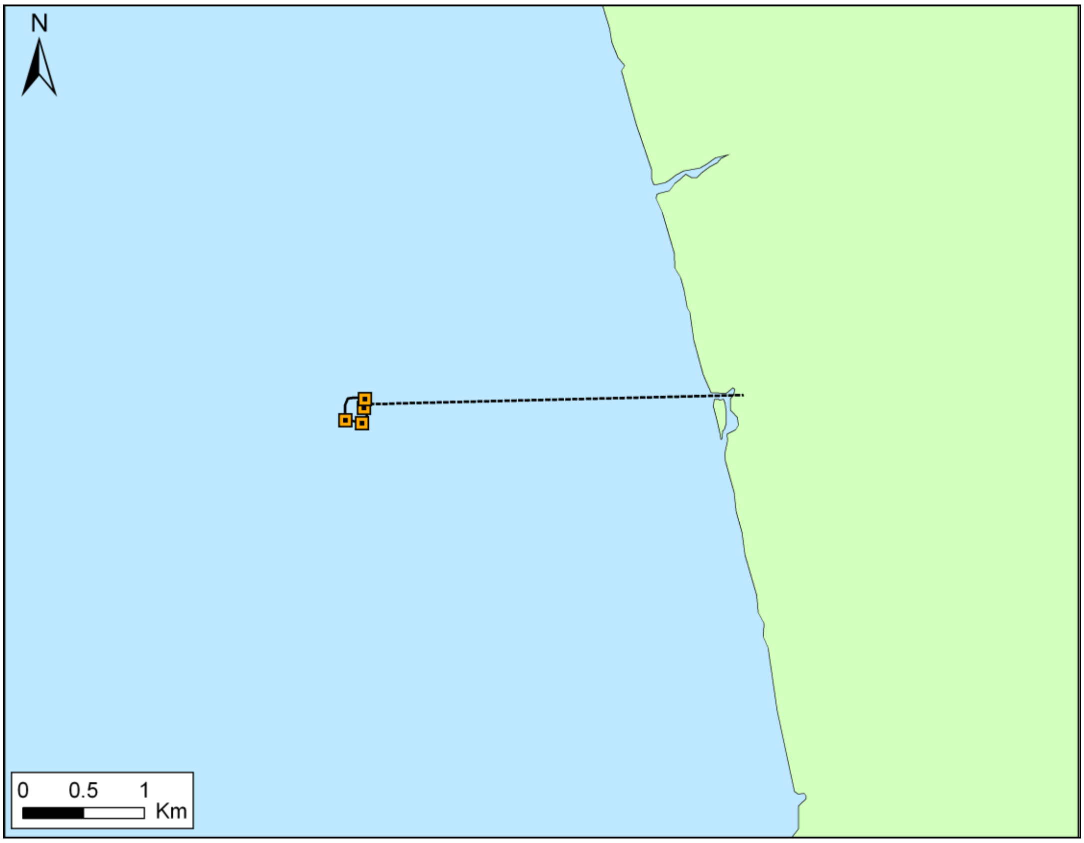

Figure 11: Fouling assemblage sites sampled by quadrat scraping, photographic stills and video, and qualitative visual surveys. Note that the four sites were distributed in equal quadrants around the mooring buoy as shown in Figure 5, but the buoy's swinging motion caused the GPS position of the "Mooring Inside 2" site to appear misplaced.

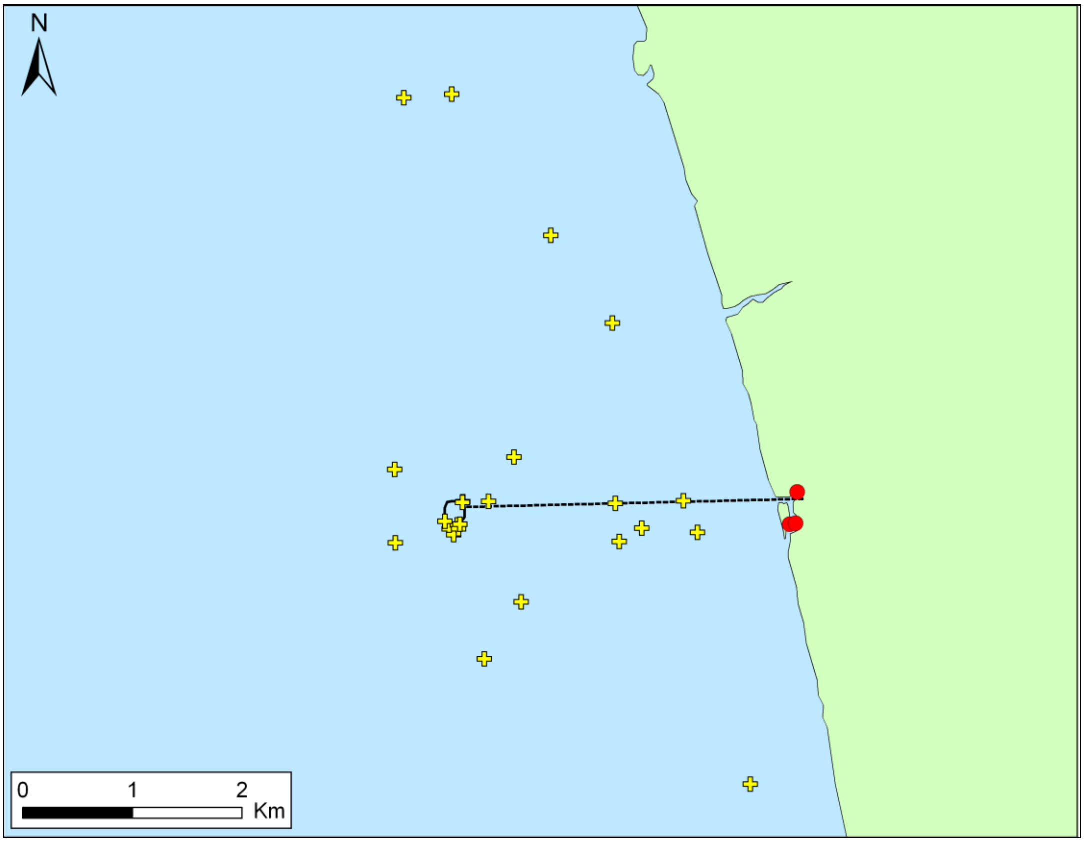

Figure 12: Benthic infauna sites sampled using anchor box dredge (yellow crosses) and large hand corer (red circles)

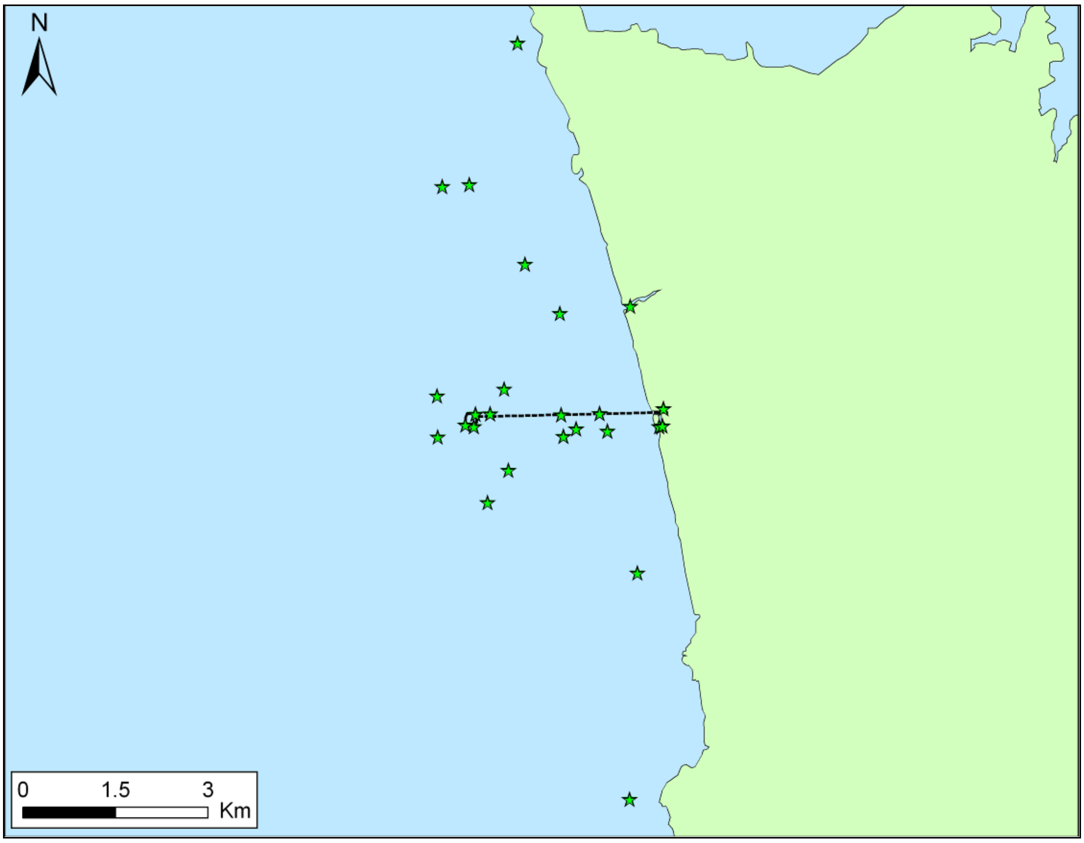

Figure 13: Cyst-forming dinoflagellate sample sites

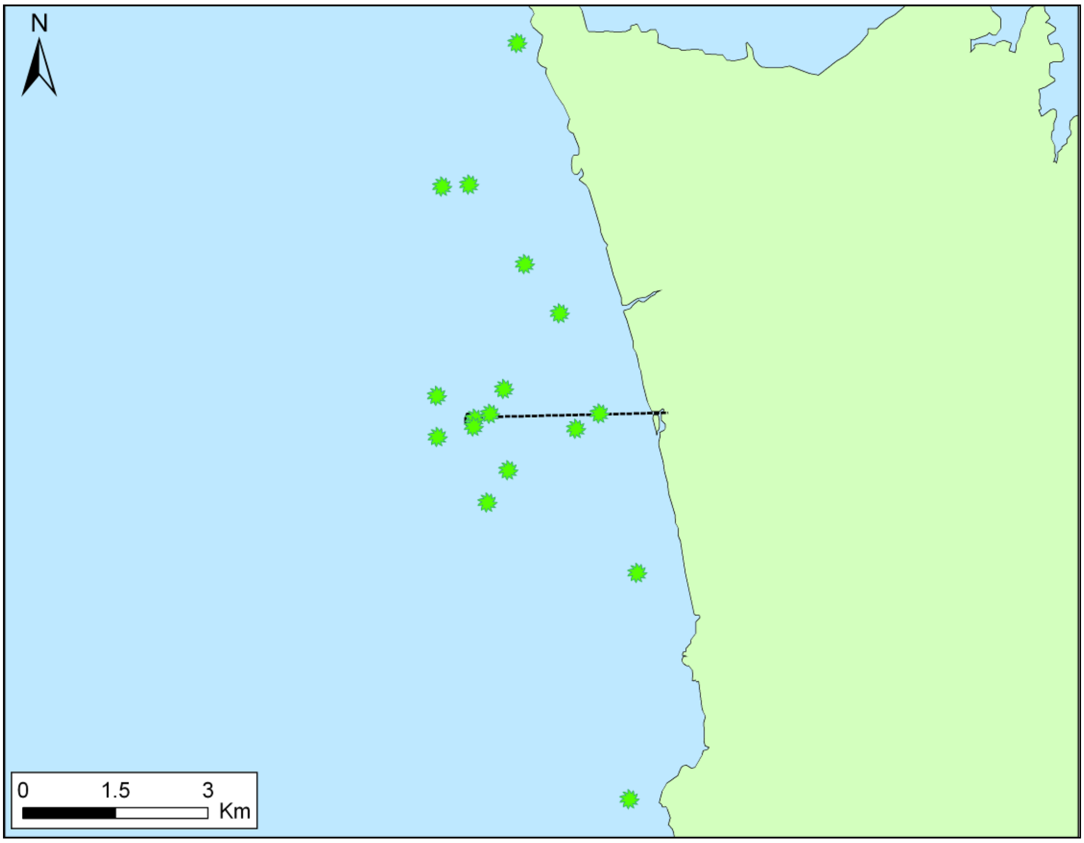

Figure 14: Plankton sampling sites using both 100 µm and 20 µm nets

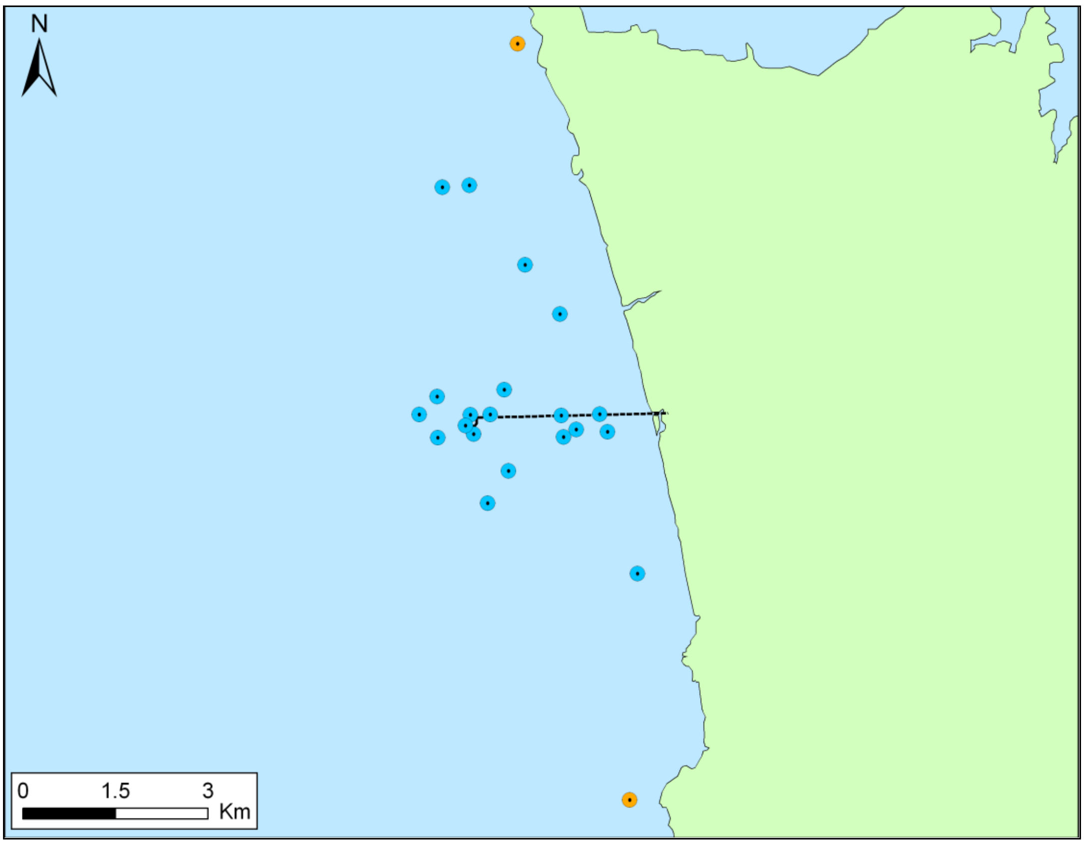

Figure 15: Epibenthos sites sampled using Ocklemann benthic sled (blue circles) and qualitative diver visual surveys (orange circles)

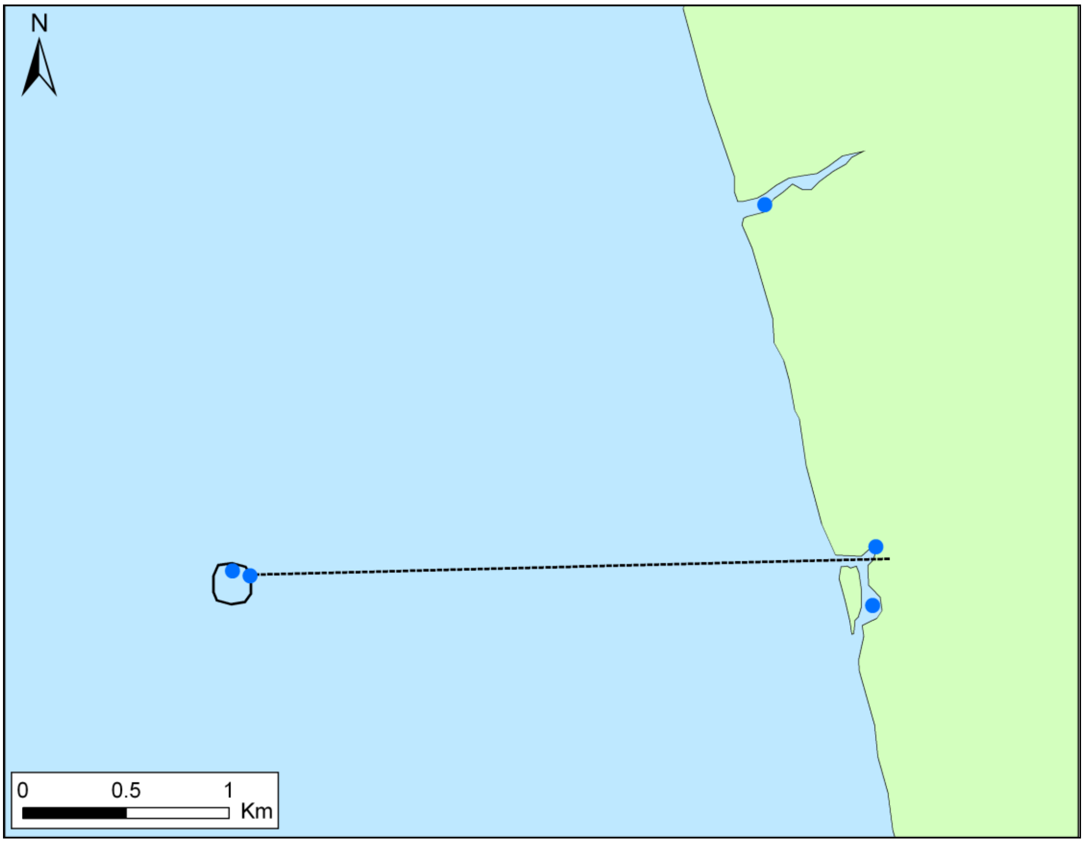

Figure 16: Epibenthos sites sampled using both box traps and shrimp traps

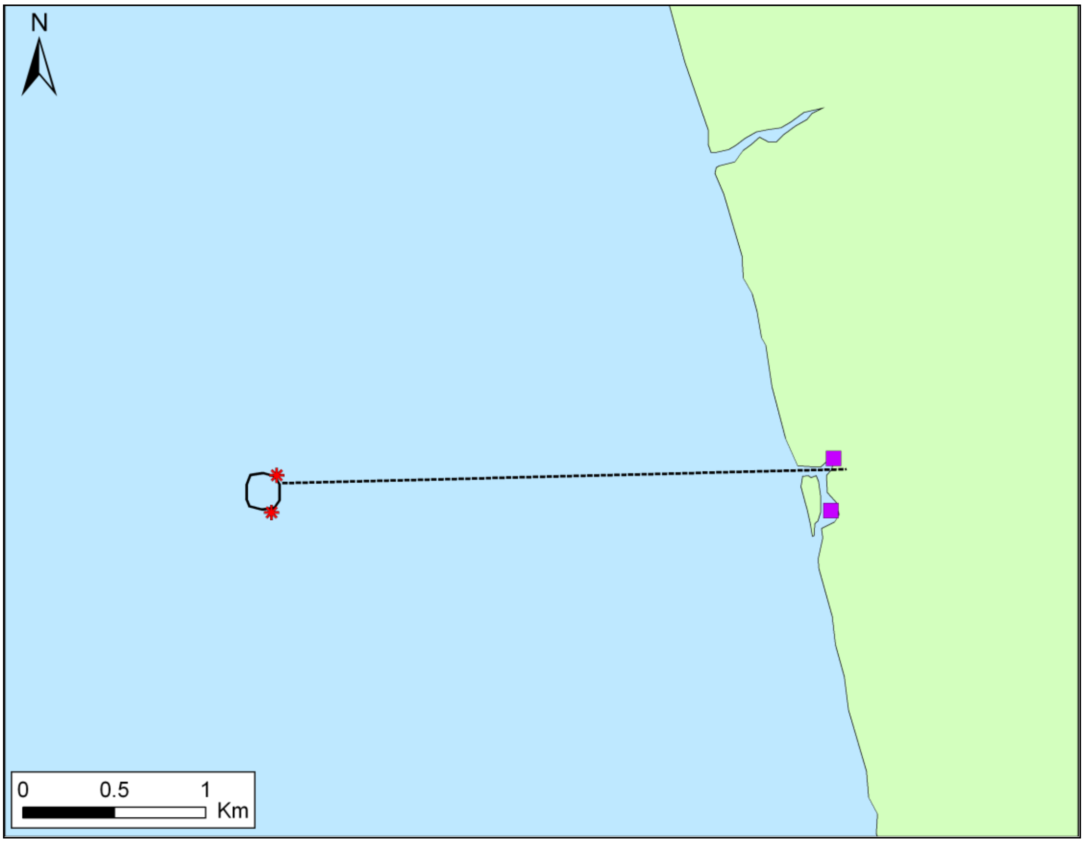

Figure 17: Fish sampling sites using poison stations (red stars) and beach seining (purple squares)

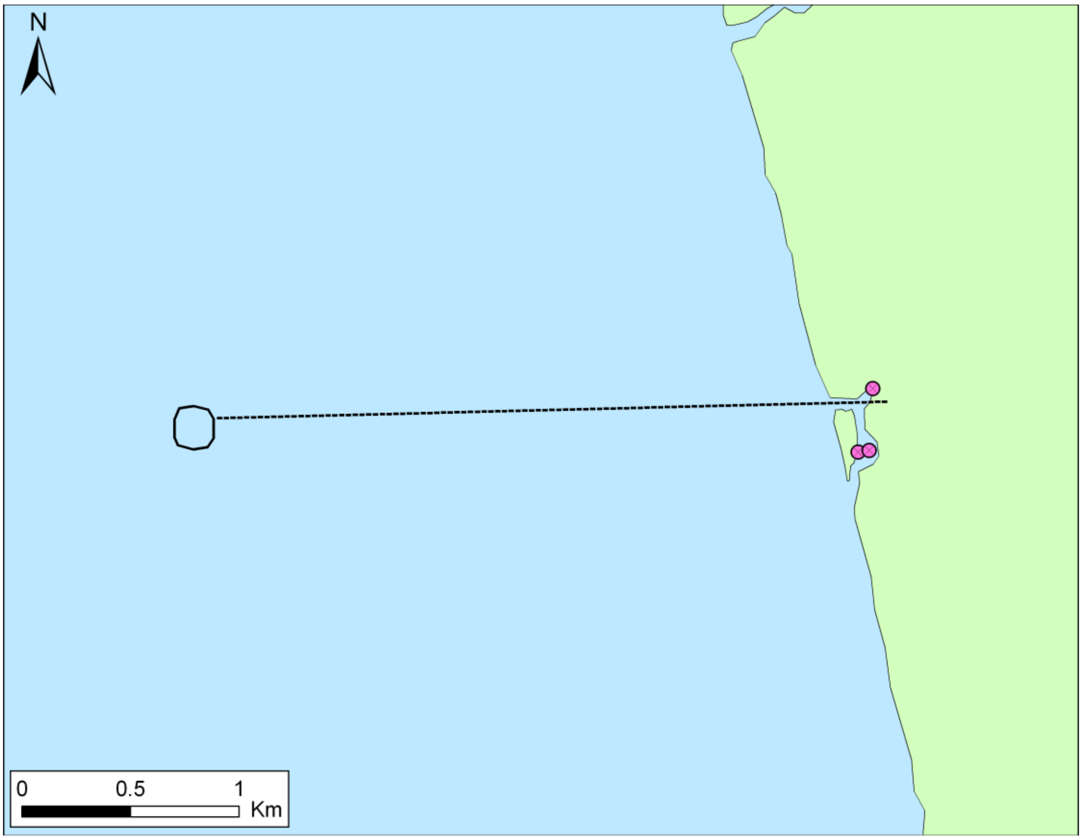

Figure 18: Beach wrack qualitative visual sampling sites

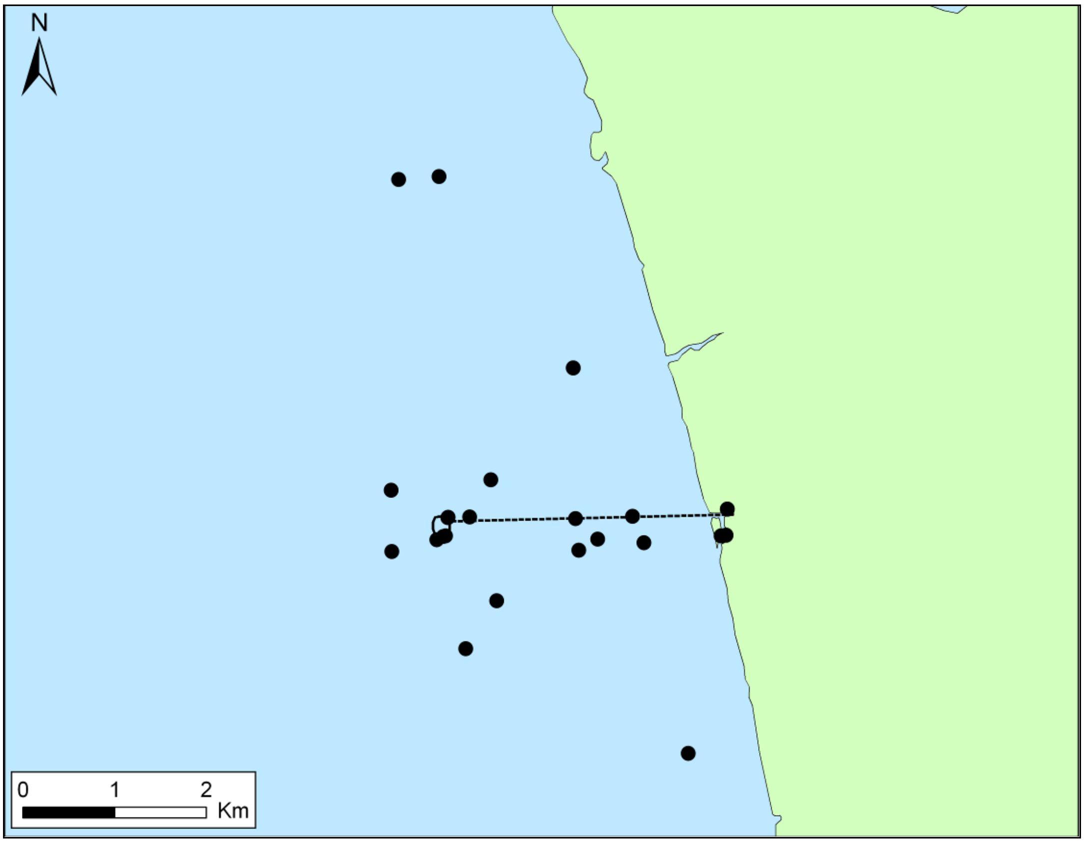

Figure 19: Sediment sampling sites

DEFINITIONS OF BIOSECURITY STATUS

Each species recovered during the survey was classified into one of five categories ("biosecurity statuses") 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 statuses 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. 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 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.

Public awareness of the Tahara Terminal port survey was developed in several ways.In consultation with MAF Biosecurity New Zealand, representatives of each of the stakeholder groups were contacted directly by the NIWA project team. The purposes of the Taharoa port survey, and of the national port baseline survey programme in general, were discussed with each representative. This discussion also covered the survey methods and their likely environmental effects around Taharoa. It also requested assistance from the stakeholders in reporting any occurrences of unusual or suspect species. A brief background document on the proposed survey, which described the purpose and conduct of the surveys in more detail, was then sent to each stakeholder group along with a form seeking written consent for the activity.

Shortly after the the field survey was completed a joint media statement on the national port survey programme and the survey of the Taharoa Terminal was released by NIWA and MAF Biosecurity New Zealand. Release of the media statement after the survey was necessitated by the short interval between contracting and the required completion date of the surveys. The release outlined the activities undertaken during the survey and encouraged any public reports or observations on potentially introduced species, including providing points of contact for reporting (Appendix 4). The public awareness programme included a communication plan that outlined the personnel (in NIWA and MAF Biosecurity New Zealand) who are authorised to respond to media enquiries and scope of issues that they were authorised to address.

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

<u>Media</u>

- New Zealand Press Association
- Hamilton Press
- Waitomo News

- Te Awamutu Courier
- Waikato Times
- Raglan Chronicle

Stakeholders
- Environment Waikato
- Taharoa C Inc.

No reports of suspect organisms were received from members of the public following the press coverage.

Results

REVIEW OF MARINE SPECIES RECORDS FROM TAHAROA

There has been very little marine biological research done on the west coast of New Zealand in the Taharoa area (see "Introduction: Existing biological information"). Consequently, we found records for only 42 different marine species during our desktop review of existing marine species records from Taharoa and nearby areas. All except one of these records are from a single source - the dataset compiled from Ministry of Fisheries trawl surveys - accessed through OBIS (NIWA 2008). Forty of the 42 records are native species, comprising 38 ray-finned fish, seven elasmobranchs, one crab and one cephalopod mollusc (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 remaining two records are cryptogenic category one (C1) taxa, meaning that their status in New Zealand as native or non-indigenous is uncertain. These two C1 taxa are the dinoflagellates *Alexandrium ostenfeldii* and *Gymnodinium catenatum* (Table 7). Both are cosmopolitan, oceanic species, and both are capable of producing Paralytic Shellfish Poisoning (PSP) toxins (see "Cyst- and toxin-producing species", below). For general descriptions of the main groups of organisms discussed in this report, refer to Appendix 5. Available information on the ecology of each of these NIS and C1 species, their global and New Zealand distributions, vectors and potential impacts are provided in Appendix 6. A list of Chapman and Carlton's (1994) criteria (see "Definitions of biosecurity status", above) that were met by the C1 taxa is given in Table 8.

In New Zealand, *Alexandrium ostenfeldii* was first recorded as cysts in sediments near the Taharoa Terminal, in May 1992 (MacKenzie et al. 1996). It has since been recorded from all coasts of the North and South Islands, except the north-west South Island (despite sampling having been conducted for it in Westport and Nelson, MacKenzie et al. 1996). Evidence from toxin analyses suggest that *Alexandrium ostenfeldii* may be native in New Zealand (MacKenzie et al. 1996), but as this has not been confirmed, it is classed here as C1 (Table 7).

Gymnodinium catenatum was first recorded in New Zealand in the year 2000, from Ninety Mile Beach in the far north-west of the North Island (Taylor and MacKenzie 2001). It has since been recorded from a variety of locations throughout the North Island of New Zealand (including in the port surveys of Opua, Whangarei, Auckland, Gisborne, Napier, New Plymouth and Wellington), and in Port Underwood in the north of the South Island (Taylor and MacKenzie 2001; Inglis et al. 2006h, 2006i, 2006c, 2006e, 2006g, 2006b, 2006j; Inglis et al. 2006l).

PORT BASELINE SURVEY OF TAHAROA TERMINAL

Port environment

Twenty-six different sites were sampled at and around the Taharoa terminal (Figure 2, Table 9). Maximum recorded depths varied from around 35 m at the Outside Harbour Limits sites and over 30 m at the offshore mooring buoy sites, to less than 1 m at the Taharoa Lagoon sites and Matauwai Stream (Table 9). Turbidity was greatest at South Pipeline 3 and Motunau Rocks (approximately 1.5 m secchi depth), whilst it was least at the Within Harbour Limits, Outside Harbour Limits, Mooring Inside and some Pipeline sites (approximately 4.0 to 4.5 m secchi depth; Table 9). Apart from the Taharoa Lagoon sites and Matauwai Stream, which were freshwater, salinities ranged from 30 ppt to 38 ppt. Water temperature was fairly constant across sites, with an average of 14.3 ± 0.2 degrees Celsius (Table 9). Sea states were no higher than three on the Beaufort scale during the survey (ie. approximately 7-10 knots wind speed and wave heights less than 0.6 m), but this does not necessarily reflect usual conditions at the site, as sampling could only be conducted during relatively calm conditions.

The organic content of sediments in the Taharoa area was low, with a mean LOI across all 58 analysed samples from 23 sites of 0.51 % ± 0.10 (Figure 20). Organic content was generally lower close to the coast (ie. the Taharoa Lagoon sites, and also the North Pipeline 1 site), and higher on the most seaward sites (ie. the Mooring Outside sites and Outside Harbour Limits sites). Loss on ignition results ranged from a minimum of 0.003 % ± 0.003 % at the Taharoa Lagoon Entrance to a maximum of 2.75 % ± 2.75 at the site Mooring Outside 1 (Figure 20).

Sediments at the sampling sites at Taharoa were strongly dominated by sand-sized particles, with very few particles in the larger and smaller size classes. There was little variation in particle sizes between sites (Table 10).

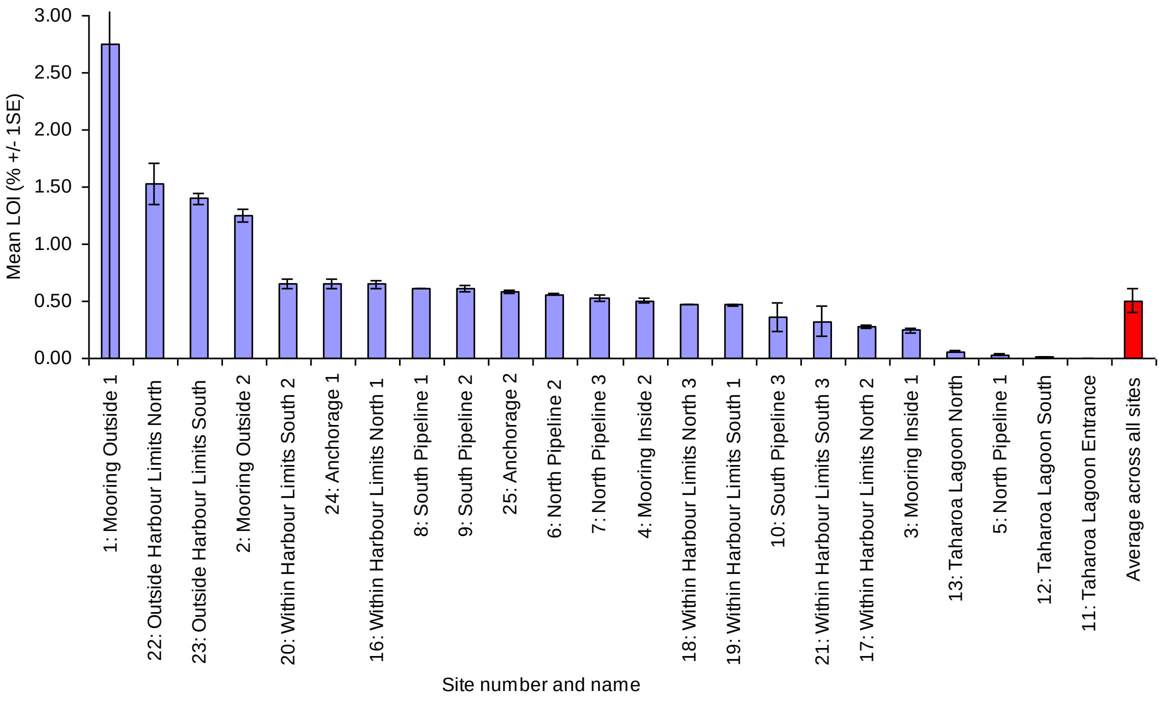

Figure 20: Organic content as determined by loss on ignition analyses of sediments from 23 sites at and around Taharoa Terminal (n=2 at all sites except sites 11, 12 and 13, where n=6).

Species recorded

A total of 328 species or higher taxa were identified from the initial baseline survey of the Taharoa Terminal. This collection consisted of 212 native taxa (Table 11), 6 non-indigenous taxa (Table 12), 12 cryptogenic category one taxa (Table 13) and 4 cryptogenic category two taxa (Table 14), zooplankton (which were screened for target non-indigenous species but not otherwise identified), with the remaining 93 taxa being indeterminate (Table 15, Figure 21).

The biota in survey included a diverse array of organisms from 18 phyla, as well as five specimens that couldn't be identified to phylum (Figure 22). 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 6.

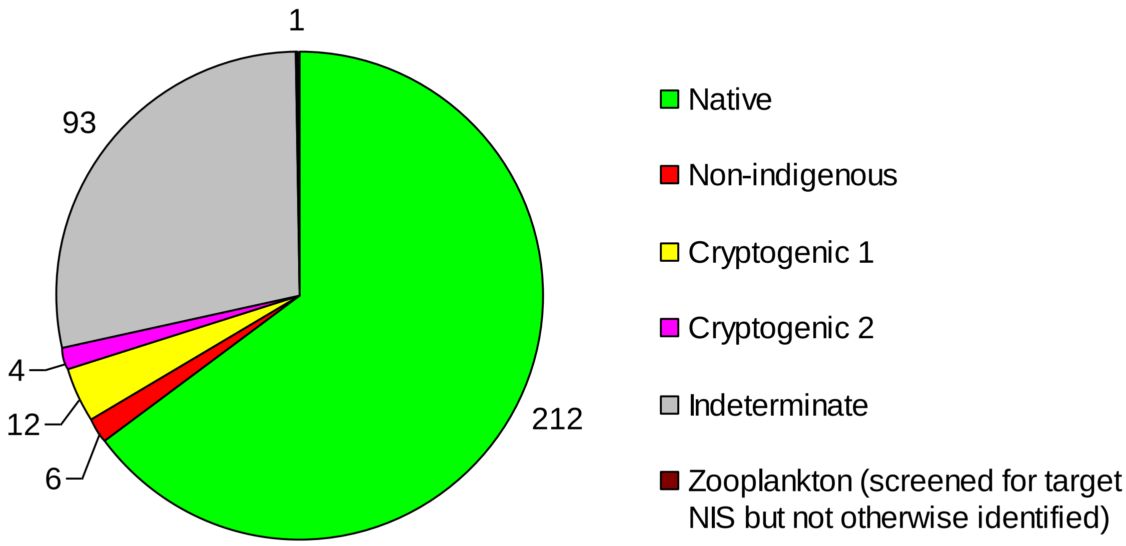

Figure 21: Biosecurity status of marine species collected from the Taharoa Terminal port survey. Values indicate the number of taxa in each biosecurity category. Zooplankton are included separately because they were screened for target NIS but non-target species were not identified.

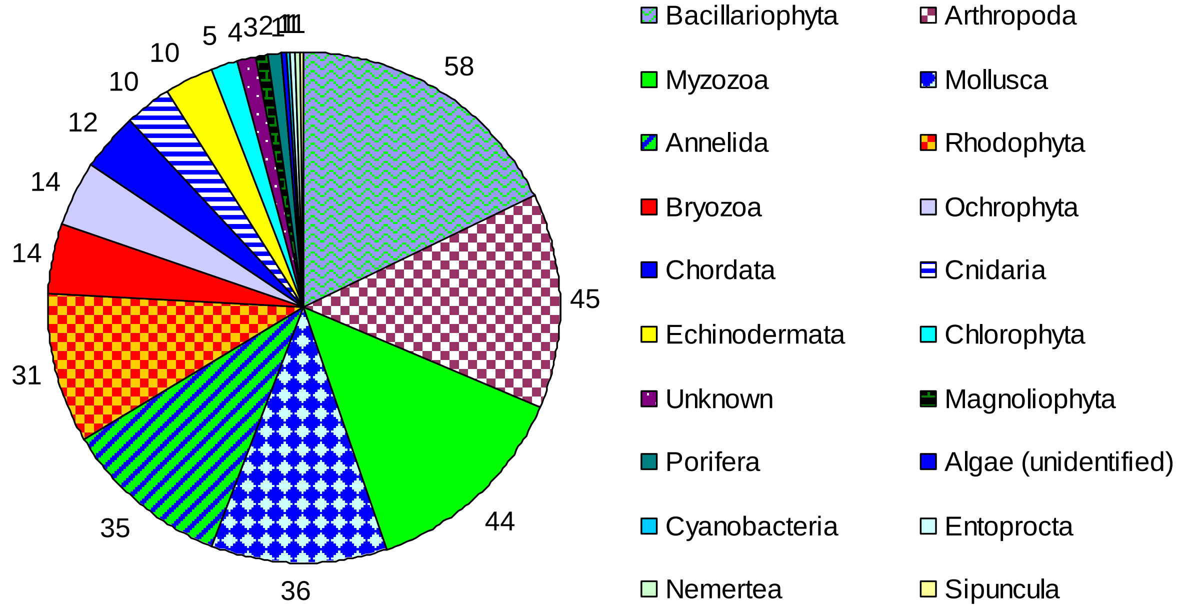

Figure 22: Phyla collected from the Taharoa port survey. Values indicate the number of taxa in each of these groups.

Native taxa

The 212 native taxa recorded during the Taharoa Terminal port survey (Table 11) represented 65 % of all taxa identified from this location and included diverse assemblages of diatoms (phylum Bacillariophyta 58 taxa), arthropods (crustaceans and a sea spider; 45 taxa), dinoflagellates (phylum Myzozoa; 44 taxa), molluscs (36 taxa), annelids (35 taxa), and red algae (phylum Rhodophyta; 31 taxa). A number of other groups were also recorded, including other algae and some flowering plants, bryozoans, fishes, cnidarians, echinoderms, sponges, cyanobacteria, entoprocts, nemerteans and sipunculids (Table 11).

Non-indigenous and cryptogenic category 1 (C1) taxa

The six non-indigenous species (NIS) recorded from the Taharoa Terminal port survey (Table 12) represented just under 2 % of all taxa identified during the survey. The six taxa are the barnacle *Austromegabalanus nigrescens*, the bryozoan *Electra angulata*, the magnoliophyte (flowering plant) *Elodea canadensis*, and the red algae "*Polysiphonia* aff. *sertularioides* THH"[3], *P. brodiei* and *P. subtilissima*.

The 12 cryptogenic category one taxa (C1) recorded from the Taharoa Terminal port survey (Table 13) represented 3.7 % of all taxa identified during the survey. The 12 taxa are the annelid *Heteromastus filiformis*, the bryozoan *Scruparia ambigua*, the ascidian *Diplosoma listerianum*, the hydroids *Clytia hemisphaerica* and *Obelia dichotoma*, the dinoflagellates *Gymnodinium catenatum, Alexandrium catenella, A. affine, A. ostenfeldii* and *A. tamarense*, the sponge *Chondropsis topsentii*, and the red alga *Ceramium cliftonianum*.

A list of Chapman and Carlton's (1994) criteria (see "Introduction: Definitions of biosecurity status") that were met by the NIS and C1 taxa recorded in this survey is given in Table 8. Possible means of introduction to New Zealand and their dates of introduction or description

[3] THH = Taharoa specimens. These specimens are distinguished from specimens with the same species name from other locations, because further taxonomic investigation is required to confirm whether the specimens of *Polysiphonia* aff. *sertularioides* from Taharoa are the same species as those found in other parts of the country (W. Nelson, NIWA, pers. comm.).

are provided in Table 12 and Table 13. As discussed below, some of these taxa represent new species records for New Zealand (see “Results: Species not previously recorded in New Zealand”), or extensions to their known ranges in New Zealand (see “Results: Range extensions”).

Four of the species (*Heteromastus filiformis*, *Scruparia ambigua*, *Clytia hemisphaerica* and *Obelia dichotoma*) have been present in New Zealand for almost a century or more but have distributions outside New Zealand that suggest non-native origins, whilst some of the other species (*Diplosoma listerianum*, *Gymnodinium catenatum*, *Alexandrium ostenfeldii* and *Ceramium cliftonianum*) have only been recorded in New Zealand in much more recent times (Table 13).

Available information on the ecology of each NIS species, its global and New Zealand distribution, vectors and potential impacts is provided in Appendix 7. 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.

The NIS *Austromegabalanus nigrescens* (Lamarck, 1818) occurred in quadrat scrape samples taken at all four quadrat scrape sites - Mooring Outside 1, Mooring Outside 2, Mooring Inside 1 and Mooring Inside 2 (Figure 23).

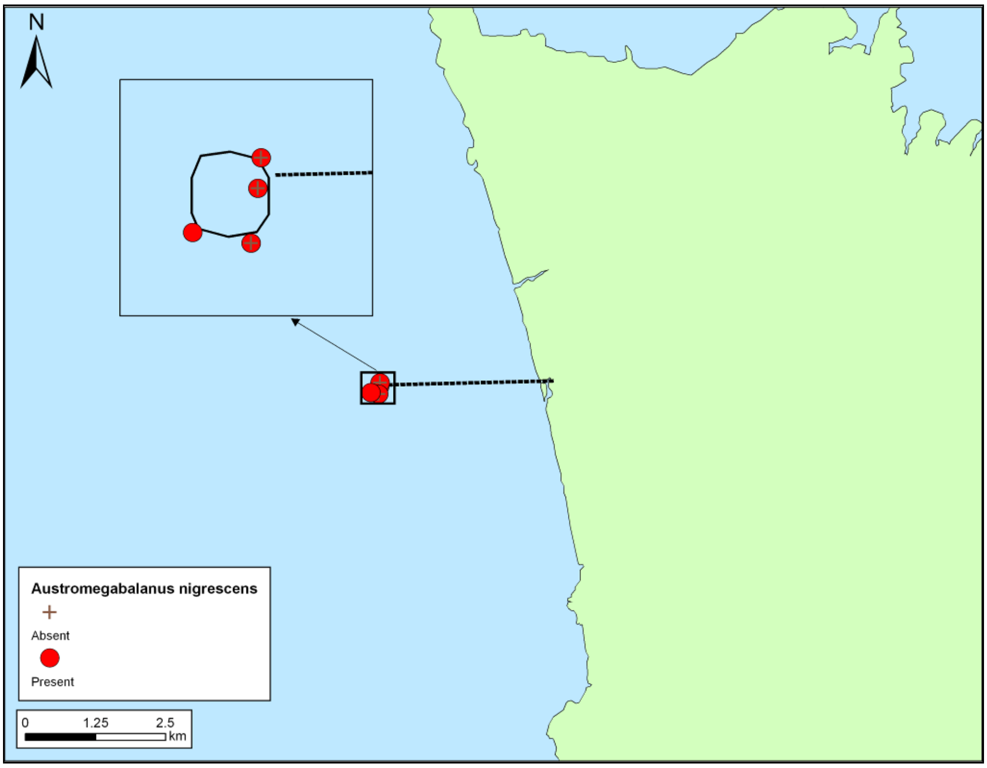

Figure 23: ***Austromegabalanus nigrescens* distribution in the Taharoa port survey.**

The NIS *Electra angulata* Levinsen, 1909 occurred in anchor box dredge samples taken at Outside Harbour Limits North, Mooring Inside 2 and South Pipeline 1, and in a benthic sled sample taken at South Pipeline 1 (Figure 24).

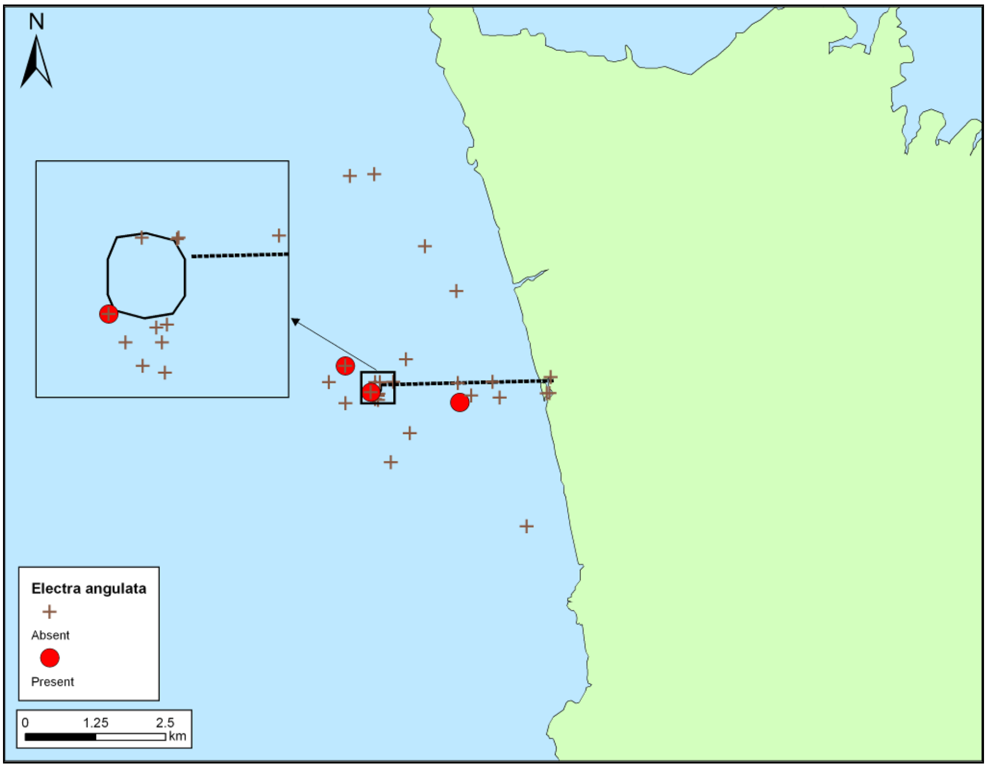

Figure 24: ***Electra angulata*** **distribution in the Taharoa port survey.**

The freshwater NIS *Elodea canadensis* Michx occurred in a beach wrack sample taken at Taharoa Lagoon Entrance (Figure 25).

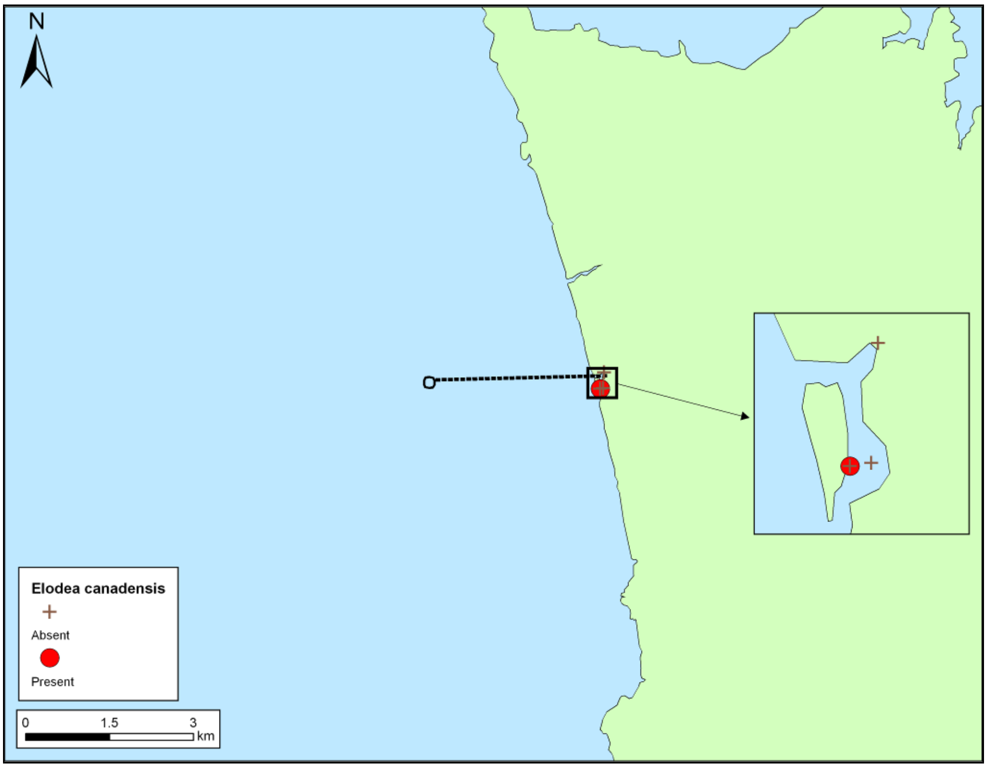

Figure 25: ***Elodea canadensis*** **distribution in the Taharoa port survey.**

The NIS *Polysiphonia* aff. *sertularioides* THH occurred in quadrat scrape samples taken at Mooring Inside 2 (Figure 26).

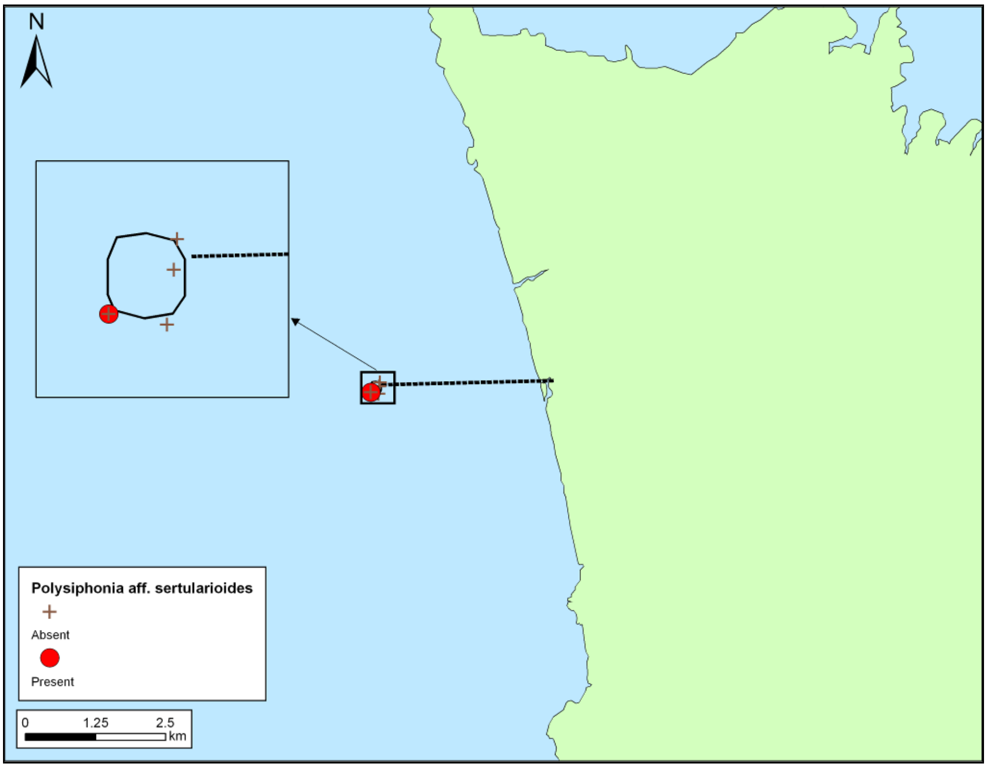

Figure 26: ***Polysiphonia*** **aff.** ***sertularioides*** **THH distribution in the Taharoa port survey.**

The NIS *Polysiphonia brodiei* (Dillwyn) Sprengel, 1827 occurred in an anchor box dredge sample from Mooring Outside 1 and in quadrat scrape samples taken at all four sites on the mooring buoy - Mooring Outside 1, Mooring Outside 2, Mooring Inside 1 and Mooring Inside 2 (Figure 27).

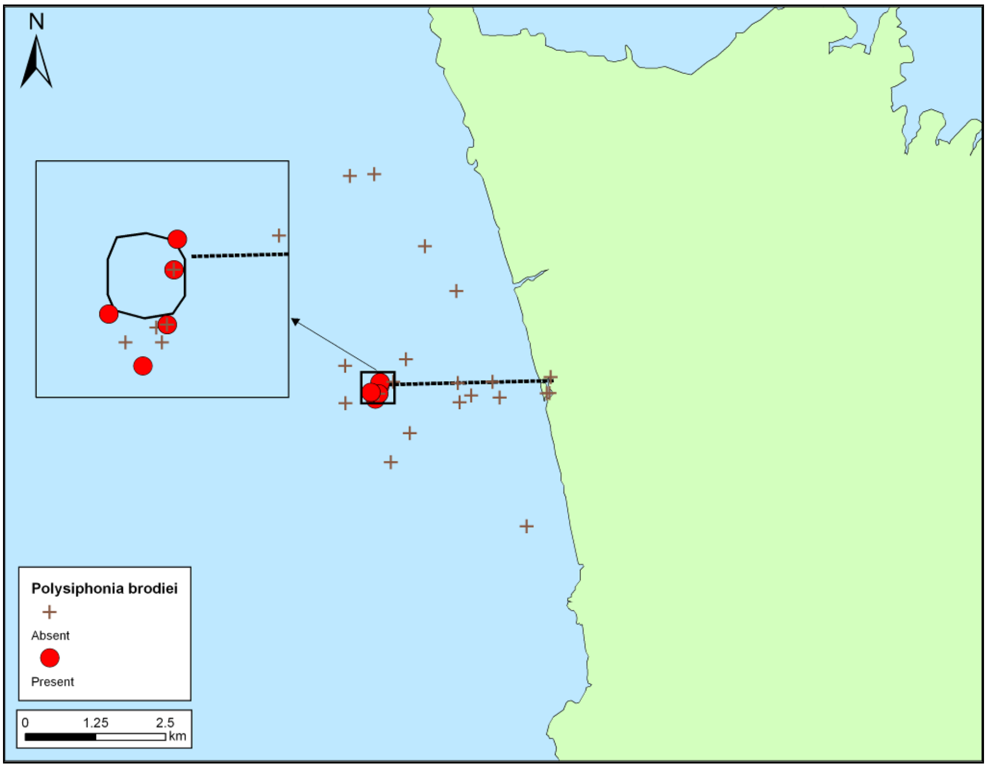

Figure 27: ***Polysiphonia brodiei*** **distribution in the Taharoa port survey.**

The NIS *Polysiphonia subtilissima* Montagne occurred in a quadrat scrape sample taken at Mooring Inside 2 (Figure 28).

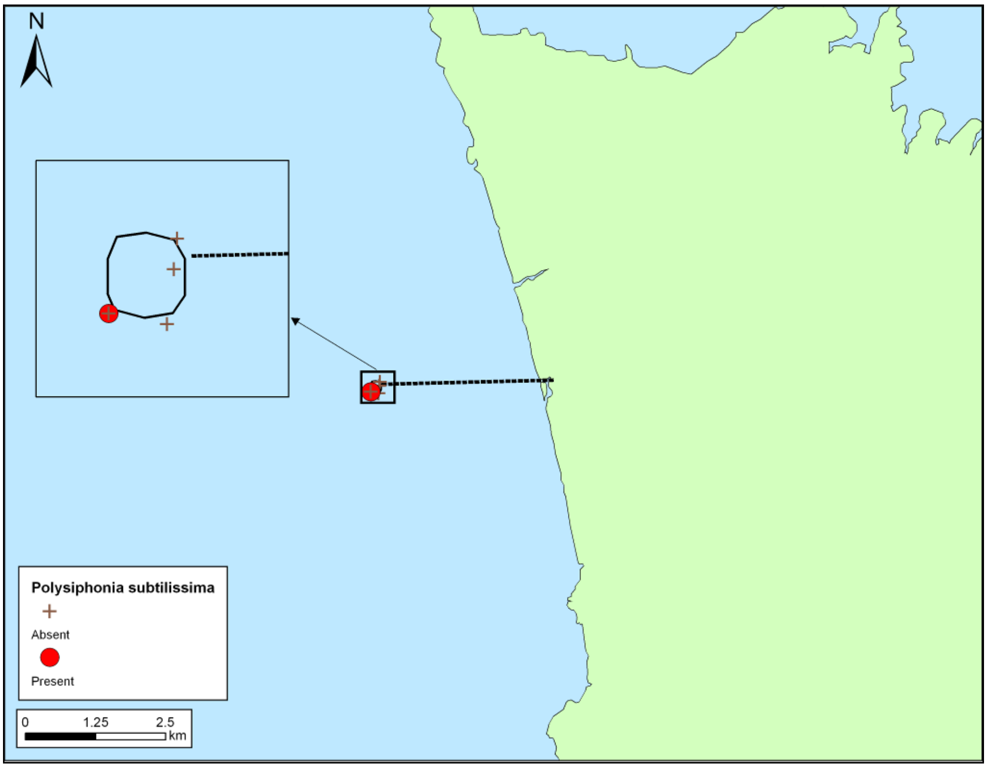

Figure 28: ***Polysiphonia subtilissima*** **distribution in the Taharoa port survey.**

The C1 species *Heteromastus filiformis* (Claparède, 1864) occurred in an anchor box dredge sample taken at Mooring Outside 1 (Figure 29).

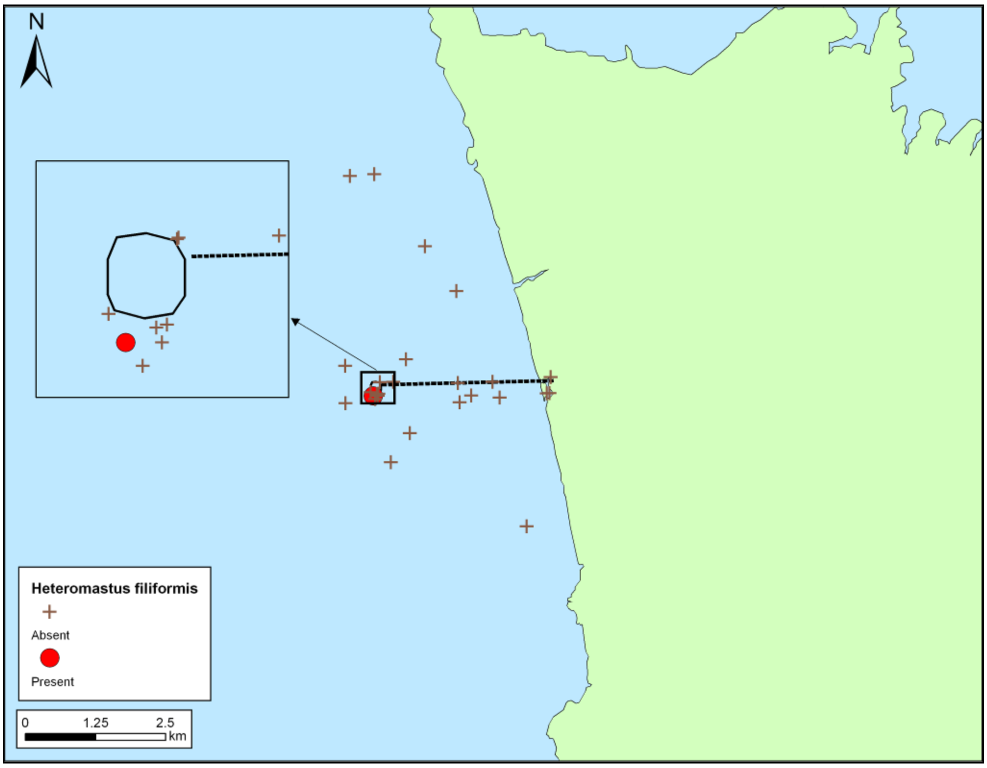

Figure 29: *Heteromastus filiformis* distribution in the Taharoa port survey.

The C1 species *Scruparia ambigua* (d'Orbigny, 1841) occurred in quadrat scrape samples taken at Mooring Inside 2 (Figure 30).

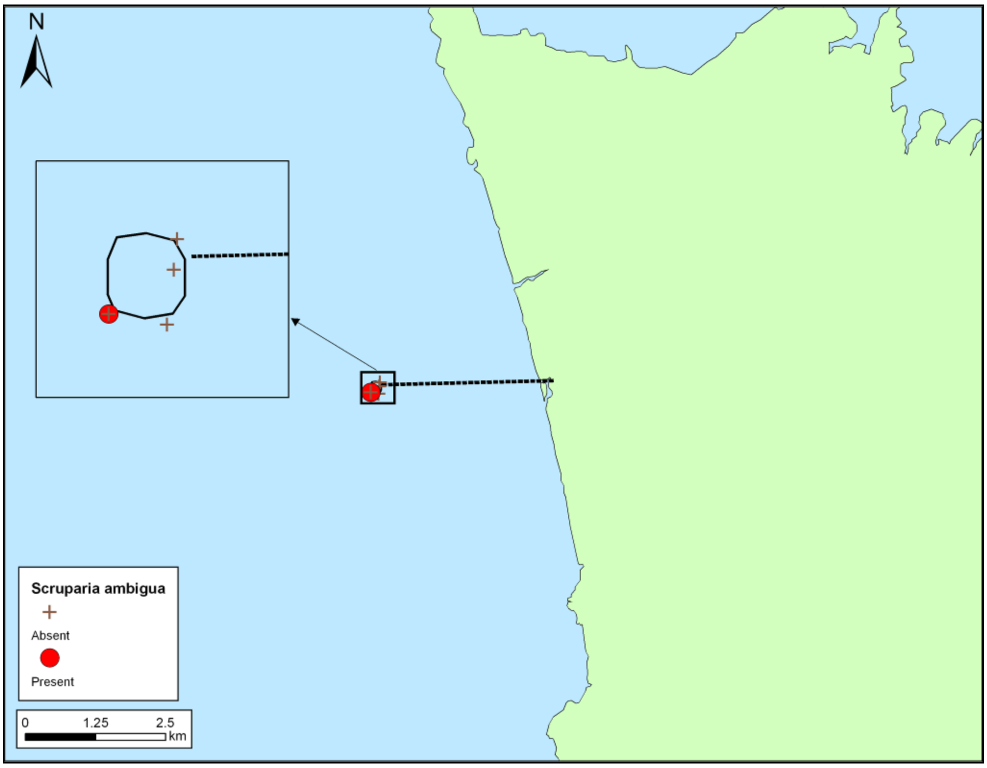

Figure 30: *Scruparia ambigua* distribution in the Taharoa port survey.

The C1 species *Diplosoma listerianum* (Milne-Edwards, 1841) occurred in quadrat scrape samples taken at Mooring Inside 2 and Mooring Outside 2 (Figure 31).

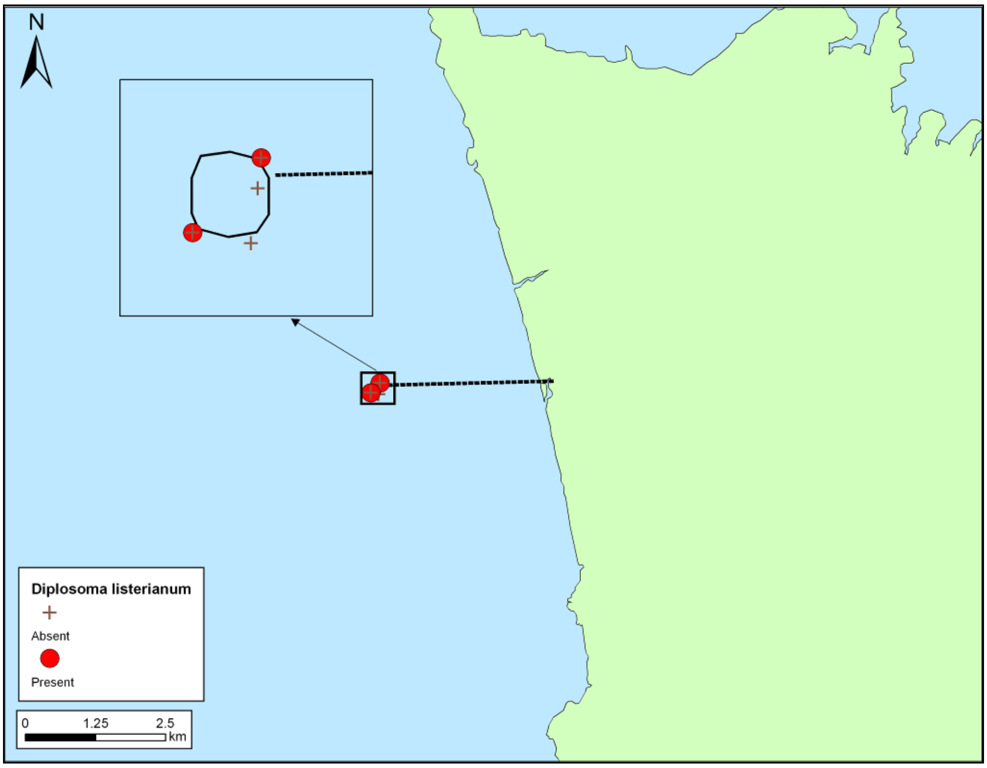

Figure 31: ***Diplosoma listerianum* distribution in the Taharoa port survey.**

The C1 species *Clytia hemisphaerica* (Linnaeus, 1767) occurred in a quadrat scrape sample taken at Mooring Inside 1 (Figure 32).

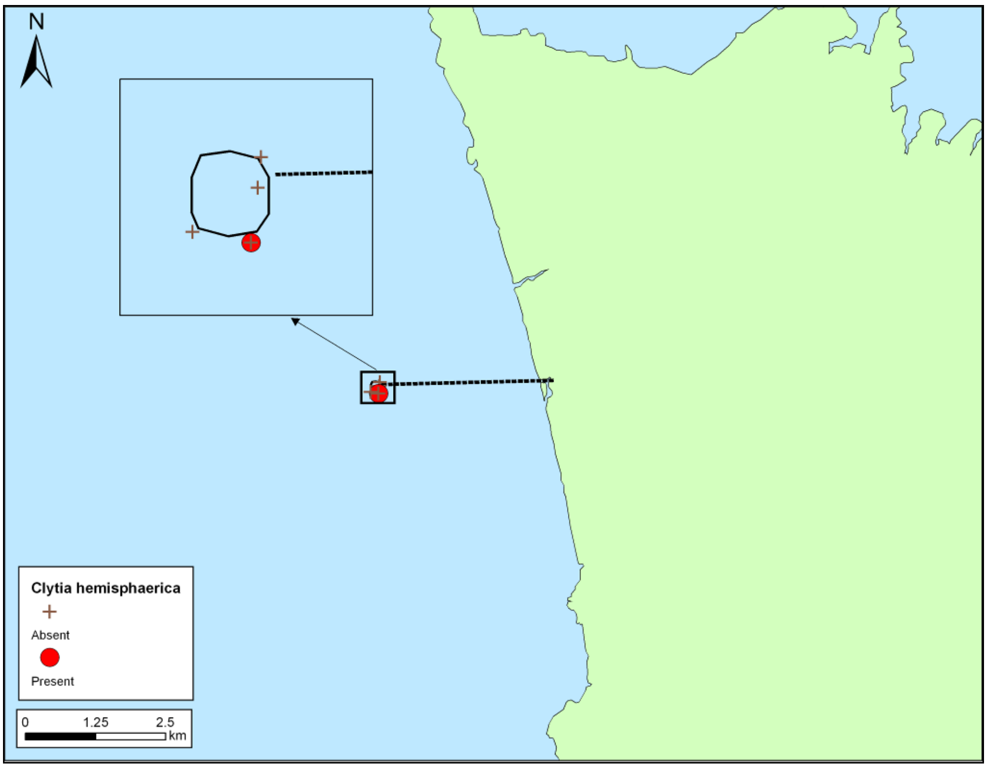

Figure 32: *Clytia hemisphaerica* distribution in the Taharoa port survey.

The C1 species *Obelia dichotoma* (Linnaeus, 1758) occurred in quadrat scrape samples taken at Mooring Inside 1, Mooring Inside 2 and Mooring Outside 2 (Figure 33).

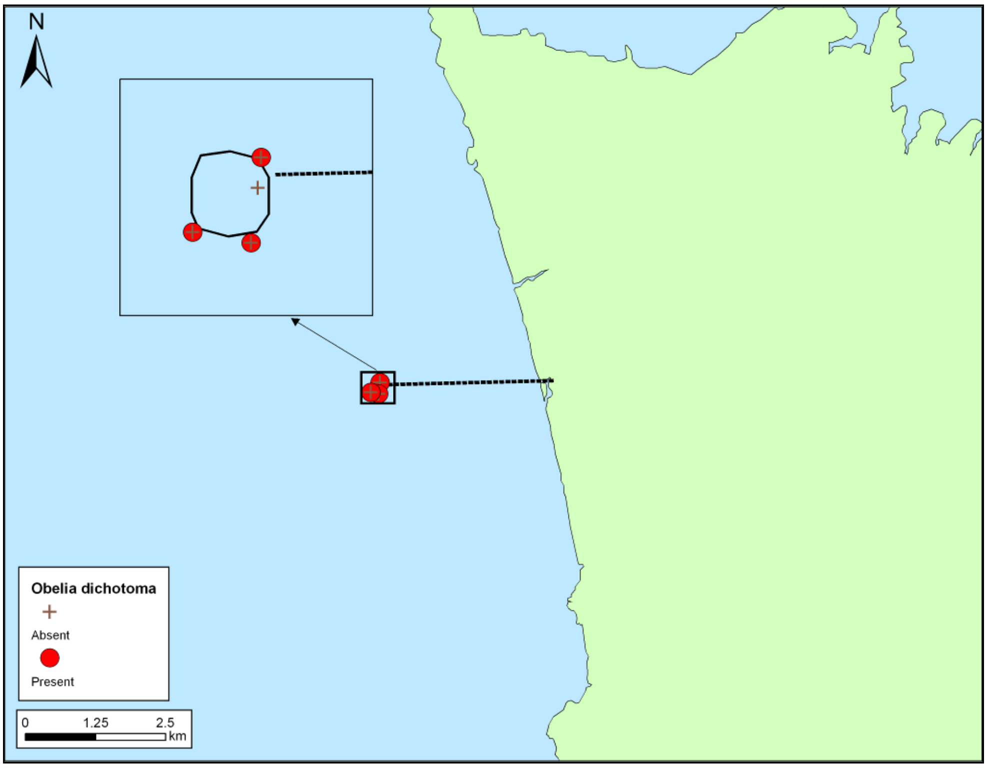

Figure 33: *Obelia dichotoma* distribution in the Taharoa port survey.

The C1 species *Gymnodinium catenatum* Graham 1943 occurred in cyst core samples taken at Mooring Outside 1, Mooring Inside 2, Within Harbour Limits South 1, Within Harbour Limits North 1, Outside Harbour Limits North, North Pipeline 2, North Pipeline 3, South Pipeline 1 and South Pipeline 2 (Figure 34).

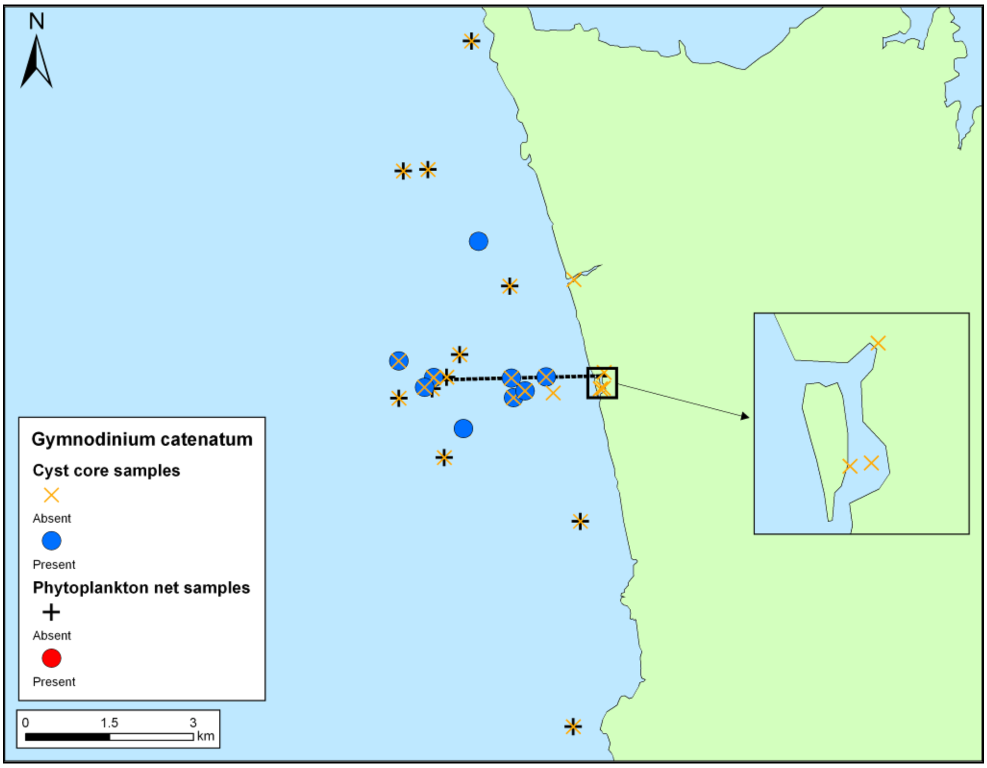

Figure 34: ***Gymnodinium catenatum*** **distribution in the Taharoa port survey. Occurrences in both cyst and phytoplankton samples are shown.**

The C1 species *Alexandrium catenella* (Whedon and Kofoid) Balech 1985 occurred in a phytoplankton sample taken at Waioioi Reef (Figure 35).

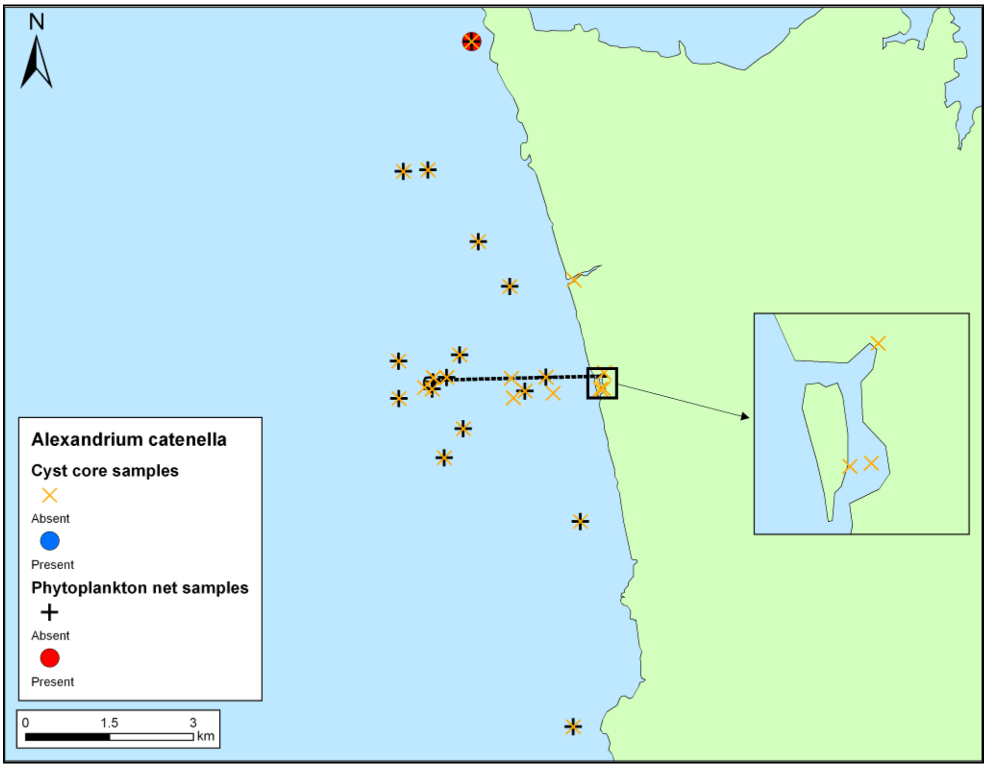

Figure 35: ***Alexandrium catenella*** **distribution in the Taharoa port survey. Occurrences in both cyst and phytoplankton samples are shown.**

The C1 species *Alexandrium affine* (Inoue et Fukuyo) Balech 1984 occurred in a phytoplankton sample taken at Within Harbour Limits North 3 (Figure 36).

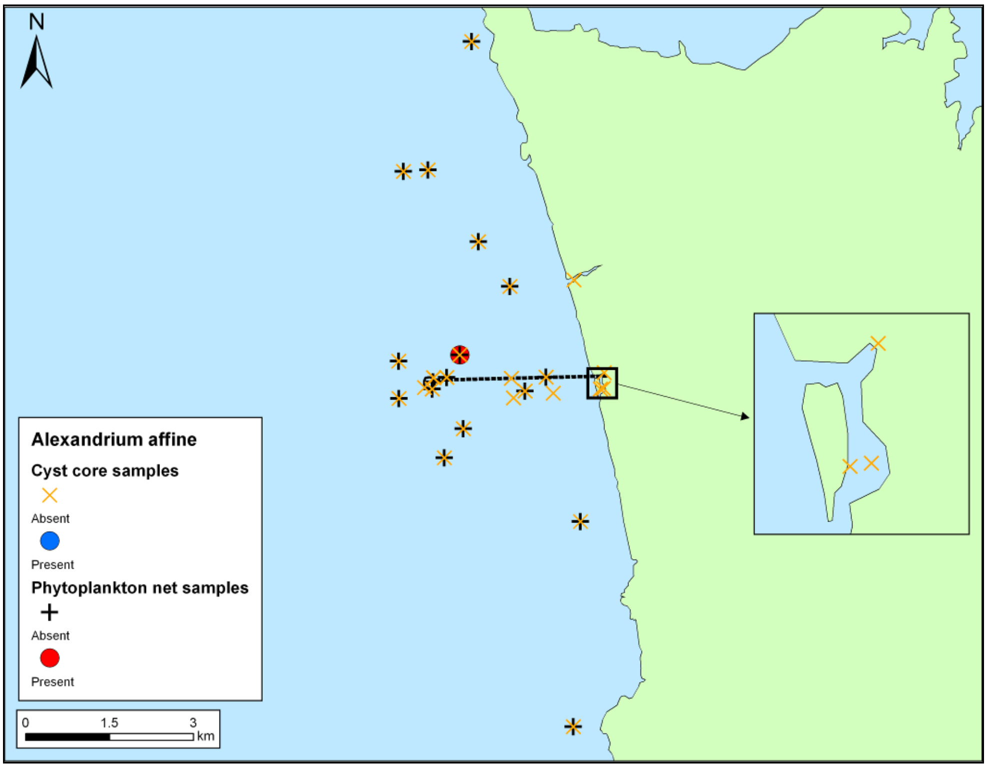

Figure 36: ***Alexandrium affine*** **distribution in the Taharoa port survey. Occurrences in both cyst and phytoplankton samples are shown.**

The C1 species *Alexandrium ostenfeldii* (Paulsen) Balech & Tangen occurred in cyst core samples taken at Taharoa Lagoon North and Within Harbour Limits North 1 (Figure 37).

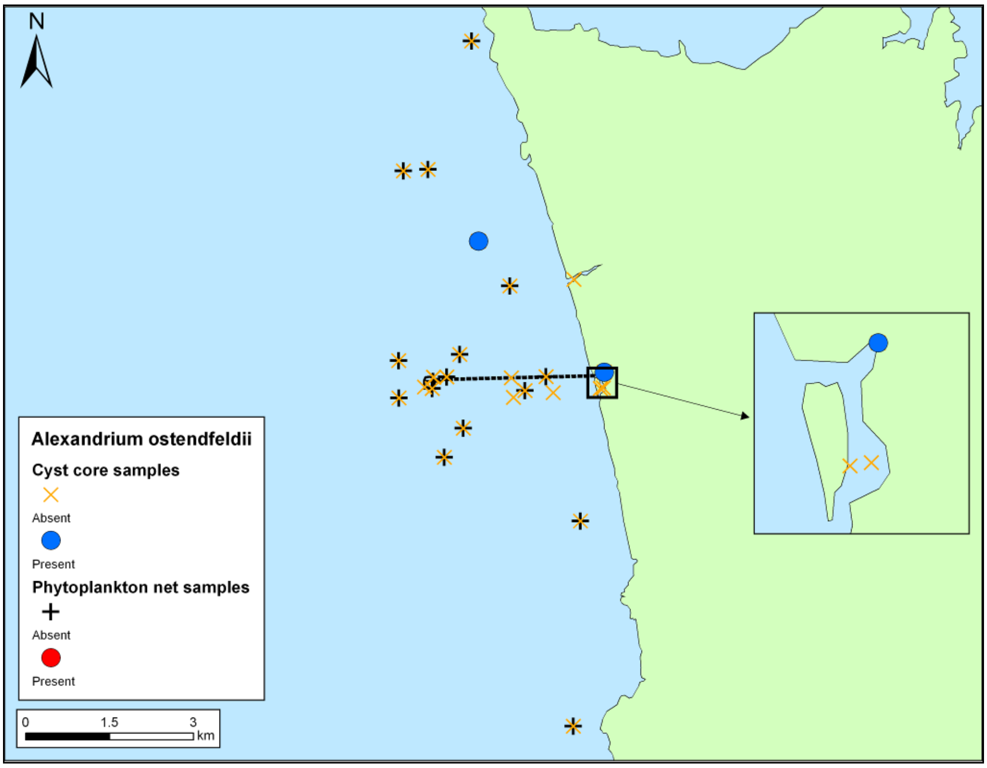

Figure 37: *Alexandrium ostenfeldii* distribution in the Taharoa port survey. Occurrences in both cyst and phytoplankton samples are shown.

The C1 species *Alexandrium tamarense* (Lebour, 1925) Balech, 1985 occurred in cyst core samples taken at Taharoa Lagoon North (Figure 38).

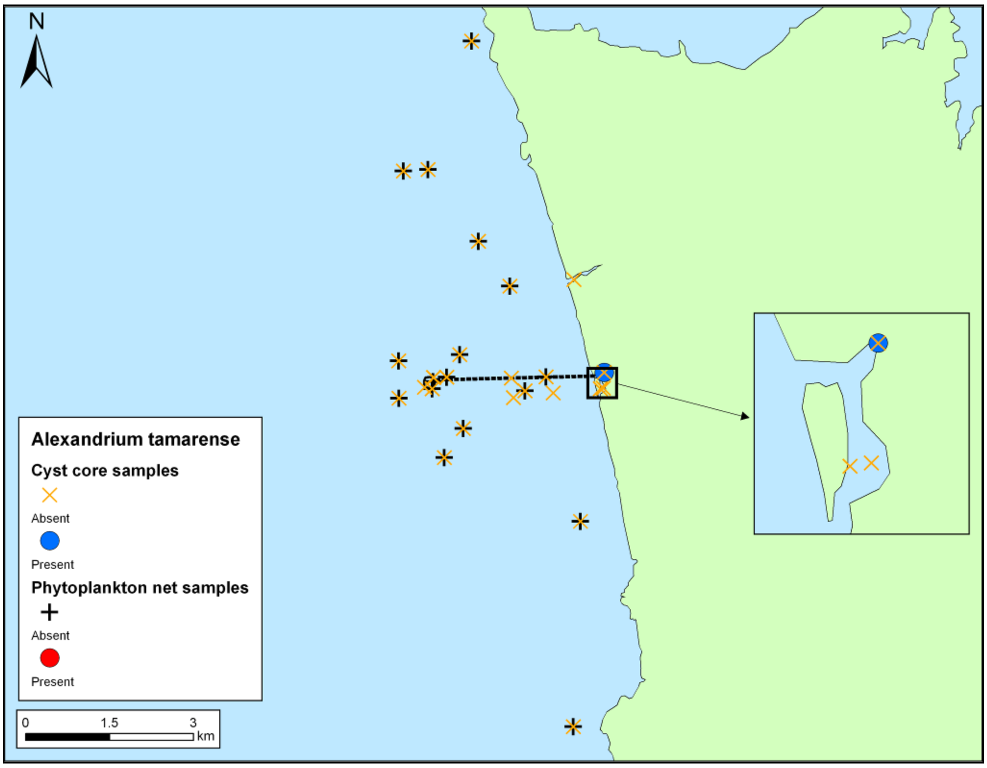

Figure 38: *Alexandrium tamarense* distribution in the Taharoa port survey. Occurrences in both cyst and phytoplankton samples are shown.

The C1 species *Chondropsis topsentii* Dendy, 1924 occurred in a visual dive search undertaken at Motunau Rocks (Figure 39).

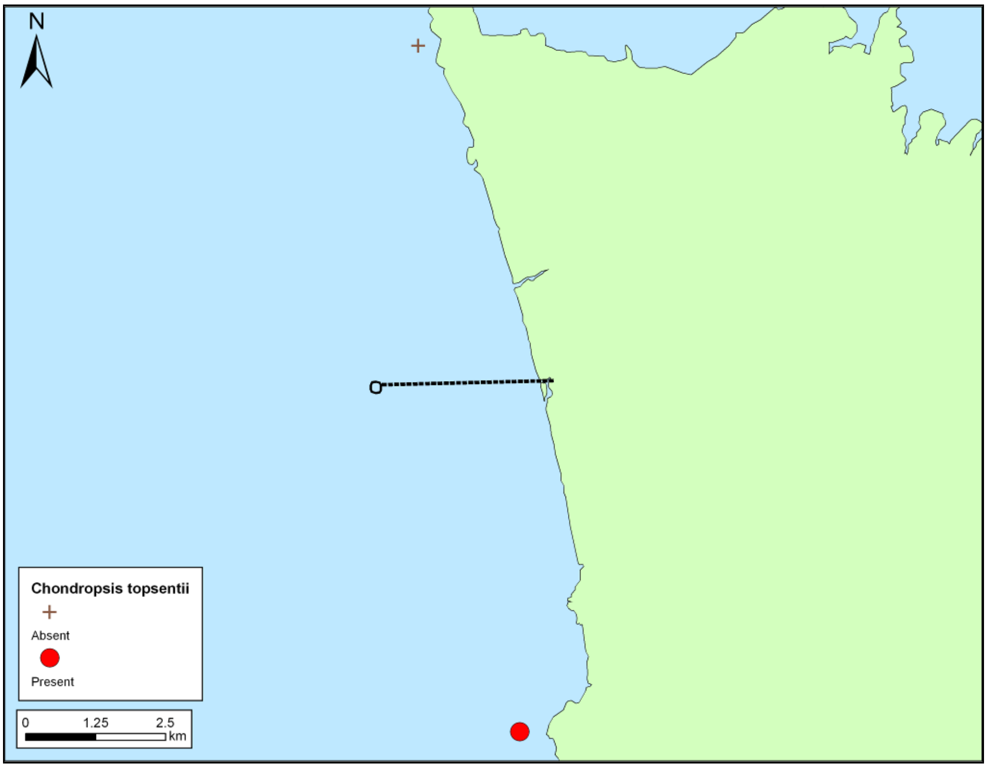

Figure 39: ***Chondropsis topsentii* distribution in the Taharoa port survey.**

The C1 species *Ceramium cliftonianum* J.Agardh occurred in anchor box dredge samples taken at Within Harbour Limits South 3 and Mooring Outside 1 and in quadrat scrape samples from all four sites on the mooring buoy - Mooring Outside 1, Mooring Outside 2, Mooring Inside 1 and Mooring Inside 2 (Figure 40).

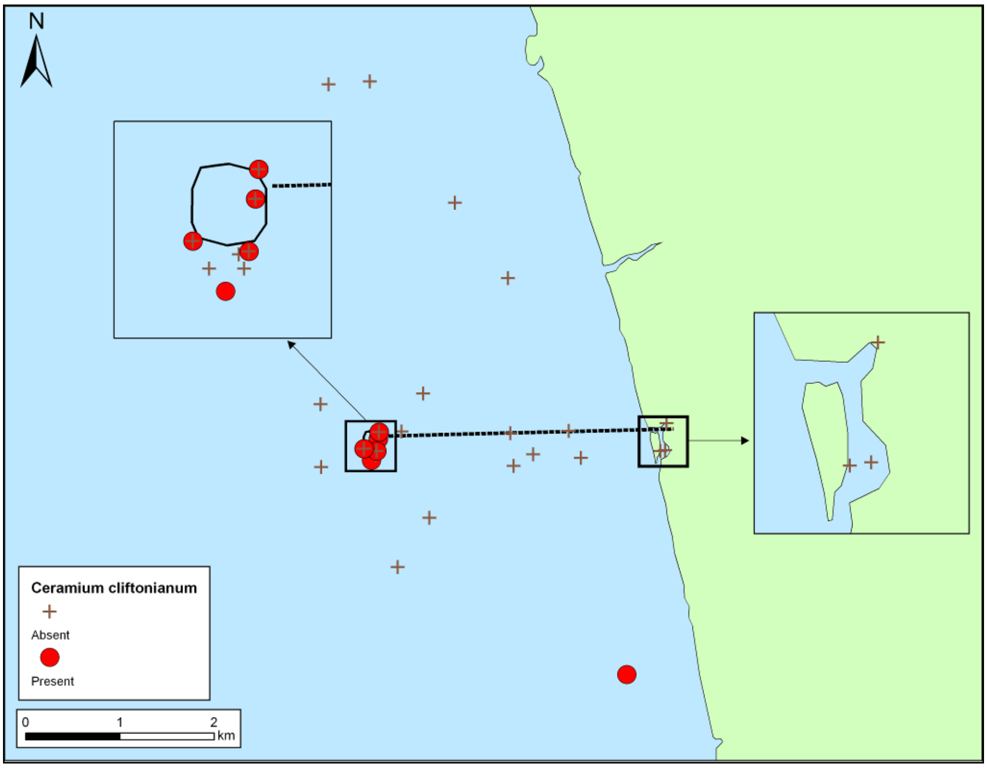

Figure 40: ***Ceramium cliftonianum* distribution in the Taharoa port survey.**

Cryptogenic category two taxa (C2)

Four cryptogenic category two (C2) taxa were recorded during the Taharoa Terminal port survey (Table 14). These included three polychaetes and a bryozoan. 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. The Taharoa Terminal port survey records represent the first records for some of these taxa (see "Species not previously recorded in New Zealand", below).

Indeterminate taxa

Ninety-three organisms from the Taharoa Terminal port survey were classified as indeterminate taxa. This represents 28 % of all determinations made from this survey (Figure 21). Indeterminate taxa from the Taharoa Terminal port survey were mostly diatoms, red algae and arthropods, with several other groups also represented (Table 15).

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 Milford Sound. Only juvenile calanoid copepods were found in these samples.

Notifiable and unwanted species

None of the species recorded from the Taharoa Terminal port survey are currently listed on the New Zealand Register of Unwanted Organisms (Table 4). However, some species do occur on target species lists used in Australia, as described below.

The Australian Consultative Committee on Introduced Marine Pest Emergencies (CCIMPE) has recently endorsed a Trigger List (Table 5) of marine pest species (CCIMPE 2006). Three taxa on this list have been recorded from Taharoa, all during the port baseline survey. These are *Pseudo-nitzschia seriata* (now synonymised as *Pseudo-nitzschia australis*), *Chaetoceros concavicornis* and *C. convolutus*. We are not aware of previous records of these species from Taharoa. All three are diatoms and are listed as "Holoplankton alert species", which means that their presence should be notified, but an eradication response within Australia is highly unlikely. They are all considered native in New Zealand, due to their cosmopolitan oceanic distributions, and all are potentially harmful species (see "Results: Cyst- and toxin-producing species", 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. 2005a). A similar watch list for New Zealand is currently being prepared by MAF Biosecurity NZ. Two of the 53 Australian priority domestic pests have been recorded around the Taharoa Terminal. These are the dinoflagellate *Gymnodinium catenatum* (recorded in both the port survey and in previous studies, Taylor and MacKenzie 2001), and the red alga *Polysiphonia brodiei* (recorded in the port survey). *Gymnodinium catenatum* was given the highest impact ranking of all 53 taxa by Hayes et al. (2005a), and *P. brodiei* was ranked eighth. *G. catenatum* is considered to be C1 in NZ, and *P. brodiei* is non-indigenous. Available information on the ecology of each of these species, their global and New Zealand distributions, vectors and potential impacts is provided in Appendix 6. Three of the 37 priority international pests identified by Hayes et al. (2005a) have also been recorded around the Taharoa Terminal. These are the same three diatoms as those discussed in the preceding paragraph, on the CCIMPE Trigger List "Holoplankton alert species" (CCIMPE 2006).

Species not previously recorded in New Zealand

Four species recorded from the first port baseline survey of Taharoa Terminal are new records from New Zealand waters. The first, *Austromegabalanus nigrescens*, is native to Australia and non-indigenous in New Zealand. The Taharoa Terminal port survey collection represents the first record of *A. nigrescens* in New Zealand and is potentially the first known introduction of this species to fixed substrata (Hosie and Ahyong 2008). The population of *A. nigrescens* at Taharoa appears to already be established, with four ovigerous specimens and the sizes of individuals spanning several generations (Hosie and Ahyong 2008).

The second species, *Ceramium cliftonianum*, is also native to Australia. It is classed here as C1 in New Zealand due to taxonomic uncertainty. The genus *Ceramium* is poorly known in New Zealand and is under-collected. This species shows similarities to a number of other species of *Ceramium* which may have priority over this taxon (refer Womersley 1988). Clarification of the status of this species as native or non-indigenous in New Zealand requires attention on the genus and thorough regional collections (W. Nelson, NIWA, pers. comm). Further information on the global and New Zealand distributions of *Ceramium cliftonianum* and *Austromegabalanus nigrescens* is provided in Appendix 6.

The other two taxa, *Celleporina* sp. and *Notomastus Notomastus*-B are classed as cryptogenic category 2 (C2), and are new to science. Neither have been formally described yet. Both of these genera have widespread global distributions (GBIF 2007). Although the specimens identified as *Notomastus Notomastus*-B from the Taharoa Terminal port baseline survey do appear to be a new taxon, the material collected is limited and this family is notoriously easy to misinterpret (G. Read, NIWA, pers. comm.).

A fifth taxon, the alga *Polysiphonia* aff. *sertularioides* THH, is probably not a new species to New Zealand, but uncertainty in the identity of the specimens collected from Taharoa means that it could turn out to be a new species (W. Nelson, NIWA, pers. comm.). Confirmed records of *Polysiphonia sertularioides*, which is non-indigenous to New Zealand, exist from most other regions of New Zealand (see Appendix 6).

Range extensions

One of the NIS recorded from the Taharoa Terminal port survey samples, the alga *Polysiphonia brodiei*, was not previously known from this area, and the Taharoa port survey record represents an extension to the known range of this species in New Zealand. *Polysiphonia brodiei* was previously known from Wellington, Golden Bay, Nelson, Lyttelton, Timaru, Dunedin, Bluff, Fiordland (Dusky, Doubtful, Milford and George Sounds) and Stewart Island (Adams 1994; Cranfield et al. 1998, W. Nelson, pers. comm.; Nelson et al. 2002; Inglis et al. 2006f; Inglis et al. 2006d, 2006a; Inglis et al. 2006k).

Records for another two taxa, the C1 hydroids *Clytia hemisphaerica* and *Obelia dichotoma*, might represent range extensions, although it should be noted that although these species do not appear to have been recorded from this area, this does not necessarily mean that they do not occur there (J. Watson, Hydrozoan Research Laboratory, pers. comm.). The same caveat also applies to most other taxa.

Further information on the distribution and ecology of these three taxa is provided in the species information sheets (Appendix 6).

Cyst- and toxin-producing species

Cysts of 13 dinoflagellate taxa (Phylum Myzozoa) were collected during this survey. Seven of these are considered native species (*Polykrikos schwartzii*, *Lingulodinium polyedrum*, *Scrippsiella trochoidea, Protoperidinium avellana, P. leonis, P. punctulatum* and *P. subinerme*; Table 11), three are cryptogenic category one (C1) species (*Gymnodinium catenatum, Alexandrium ostenfeldii* and *Alexandrium tamarense*; Table 13) and three are indeterminate (*Gonyaulax* sp., *Protoperidinium* sp. and "Peridiniales (?)"; Table 15). The three C1 species and one of the native species, *Lingulodinium polyedrum*, are known to produce toxins, as described below. Of the organisms identified from the phytoplankton samples (96 different dinoflagellate, diatom and ochrophyte taxa; Appendix 7), four toxin-producing species were identified - the native dinoflagellates *Dinophysis acuta* and *D. tripos*, the native diatom *Pseudo-nitzschia australis* and the C1 dinoflagellate *Alexandrium catenella*. The toxicity of these four taxa are also described below. 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 (Rines 1998; Kraberg and Montagnes 2007).

The eight toxin-producing species recorded during the Taharoa Terminal port survey are all widely distributed worldwide. Characteristics of their toxicity are described below; for further information on their ecology, distribution, vectors and potential impacts, see Appendix 6. *Alexandrium ostenfeldii*, *A. tamarense* and *Gymnodinium catenatum* are capable of producing Paralytic Shellfish Poisoning (PSP) toxins. *A. ostenfeldii* is one of the least toxic of all the *Alexandrium* species tested for PSP toxins, but it may be hazardous for shellfish consumers in New Zealand (MacKenzie et al. 1996). *Alexandrium tamarense* produces very potent PSP neurotoxins which can affect humans, other mammals, fish and birds (Larsen and Moestrup 1989, in Faust and Gulledge 2002). It is associated with toxic PSP blooms (Hay et al. 2000; Faust and Gulledge 2002; New Zealand Food Safety Authority 2003), although not all strains of *A. tamarense* are toxic (Faust and Gulledge 2002). *Gymnodinium catenatum* forms red tides, and is the only gymnodinioid that is capable of producing PSP (Faust and Gulledge 2002).

Alexandrium catenella also produces strong PSP toxins, as well as c1-c4 toxins, saxitoxins (SXT) and gonyautoxins (GTX) and ichthyotoxins. These toxins can poison shellfish and, via shellfish consumption, affect humans, other mammals, fish and birds. Numerous human illnesses and several deaths have occurred after consumption of shellfish infected with *Alexandrium catenella* (Faust and Gulledge 2002). Ichthyotoxins (toxins that poison fish) have also been reported in cultured media of *A. catenella* (Ogata and Kodama 1986).

Lingulodinium polyedrum produces a yessotoxin (Armstrong and Kudela 2006; Morton et al. 2007) and can form blooms known as "red tides" which have been associated with fish and shellfish mortality events (Faust and Gulledge 2002). The presence of a PSP toxin, saxitoxin, has also been reported in water samples taken during a bloom of *L. polyedrum* (Bruno 1990, in Faust and Gulledge 2002). However, it is not listed as producing marine biotoxins by either of the recent reviews of the non-commercial marine biotoxin monitoring programme in New Zealand (Hay et al. 2000; New Zealand Food Safety Authority 2003).

Dinophysis acuta and *Dinophysis tripos* are associated with Diarrhetic Shellfish Poisoning (DSP) events, but no blooms have been reported for *Dinophysis tripos*, and it appears that not all *Dinophysis acuminata* blooms are toxic (Faust and Gulledge 2002). *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).

Depth stratification trends

The proportion of native taxa, and of NIS and C1 taxa combined, recorded from different depth classes approximately reflected the sampling effort conducted in each depth class (Figure 41). The greatest number of samples (45 %) were collected between 0 m and 10 m depth, and this depth range was also where the greatest proportion of NIS and C1 taxa (72 %) and native taxa (58 %) were recorded. Lesser sampling effort in the intertidal (beach wrack surveys only) and deeper depths (to a maximum of 35 m) was reflected by fewer taxa being recorded from those depths.

Thirteen of the 18 NIS and C1 taxa (72 %) were collected between 0 m and 10 m depth (Table 16). Eleven of these 14 taxa were not recorded from deeper samples, whilst the other three taxa (*Alexandrium ostenfeldii*, *Ceramium cliftonianum* and *Polysiphonia brodiei*) were also collected from a single sample each from greater depths. The five taxa that were not collected in samples from 0 m to 10 m depth were the bryozoan *Electra angulata*, the dinoflagellate *Gymnodinium catenatum*, the sponge *Chondropsis topsentii*, the polychaete *Heteromastus filiformis* and the freshwater plant *Elodea canadensis* (collected near a freshwater stream on a beach wrack survey). The latter three species were only recorded from a single sample each during the survey.

One hundred and twenty-three of the 212 native taxa (58 %) were recorded between 0 m and 10 m depth (Table 17). One hundred and one of these were only recorded from this depth range, whilst the other 22 were also recorded from deeper collections. Fewer taxa were recorded in the 20-30 m range compared with the 0-10 m, 10-20 m and 30-40 m ranges. Twenty-five taxa were only recorded in samples from the 10-20 m depth range, 12 taxa were only recorded from 20-30 m depth, and 21 taxa were only recorded from over 30 m depth.

The 18 NIS and C1 taxa collected during the Taharoa port survey were represented by 138 records. These were recorded from 79 of the 477 samples examined by experts. They occurred in samples collected by seven of the 14 different sampling methods (Table 16). More than three-quarters of these records (107 of the 138 records; 77.5 %) were collected in the quadrat scrapings from the offshore mooring buoy, at depths of 0.5 m and 2 m. The 31 records resulting from the other six methods were collected in samples from depths ranging from the intertidal (a beach wrack survey) to 35 m depth (Table 16). In contrast to the patterns seen for NIS and C1 species, the quadrat scraping method only returned 10.4 % of the 1681 native records collected from Taharoa (Table 17). The most native records resulted from phytoplankton samples (48.5 %, collected from just below the water surface) followed by anchor box dredge samples (31.4 %, collected from depths of 7 m to 35 m).

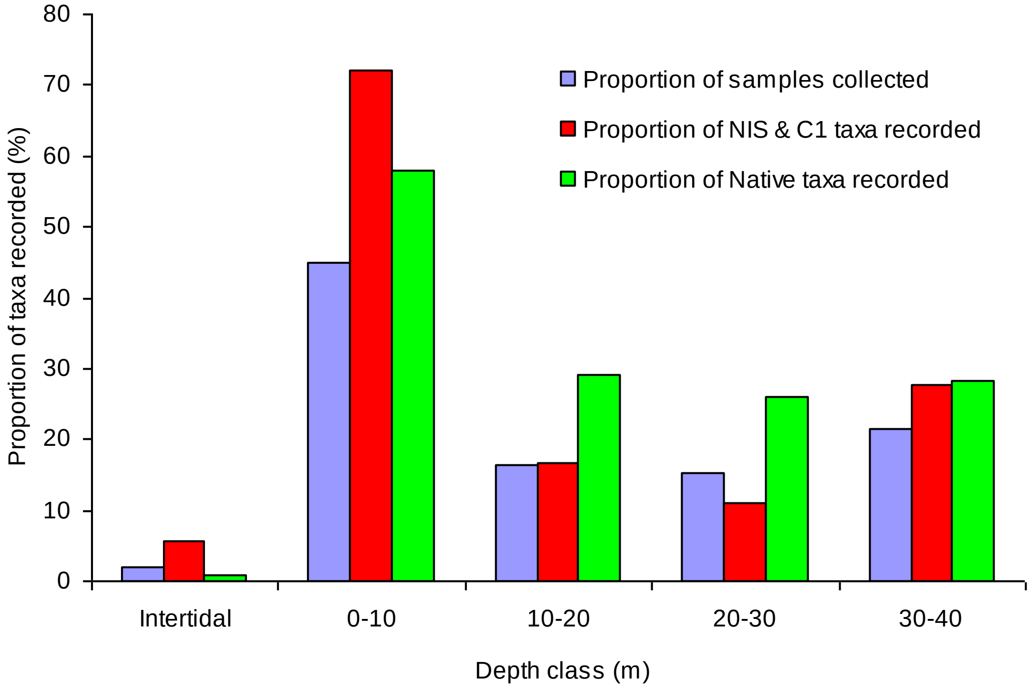

Figure 41: Proportion of taxa recorded from five depth classes during the Taharoa port survey. The proportion of taxa sums to a total of >100% across depth classes, as some taxa were recorded from more than one depth class.

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

Almost all of the non-indigenous and cryptogenic category 1 species recorded from Taharoa during the port survey and review of existing species records could have arrived in New Zealand via international shipping. Approximately half of them could also have arrived by natural means. Shipping may act as a vector by transporting organisms either directly from overseas or through domestic spread (natural and/or anthropogenic) from other New Zealand ports.

The possible vectors for the introduction to New Zealand of the NIS and C1 taxa recorded in Taharoa are indicated in Table 12 and Table 13, respectively. Likely vectors of introduction are largely derived from Cranfield et al. (1998) and expert opinion. They suggest that ten of the 18 species probably arrived in New Zealand on ships' hulls, one through the domestic aquarium trade, two either by hull fouling or by rafting on natural or man-made substrata, and five either in ballast water or on ocean currents. Four of the NIS and C1 species present around Taharoa have been in New Zealand for almost a century or more, whilst roughly double that number have been introduced or detected only in approximately the last decade (Table 12, Table 13).

COMPARISON BETWEEN DESKTOP REVIEW OF EXISTING RECORDS AND PORT BASELINE SURVEY RECORDS

Two hundred and thirty four taxa (excluding indeterminate taxa) were recorded during the port baseline survey of Taharoa, compared with only 42 in the desktop review of existing species records from the area. This highlights the paucity of biological information from this part of the New Zealand coast, with most of it, prior to the port baseline survey, having come from Ministry of Fisheries trawl surveys (see also "Introduction: Existing biological information" and "Results: Review of marine species records from Taharoa"). Of the 42 taxa recorded in the desktop review, only six were subsequently recorded during the initial port baseline survey of Taharoa (four native (Table 6) and two C1 (Table 7)). Similarly, 228 of the

234 species (>97 %) that were identified in the port survey 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 Taharoa area, apparently adding more than 220 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 Taharoa. Importantly, both of the C1 taxa previously recorded from the Taharoa area were detected in the port baseline survey. These dinoflagellates are potentially toxic (see “Results: Cyst- and toxin-producing species”).

Assessment of the risk of new introductions to the port

The similarity in environments between Taharoa and its trading partners, and the high volume of ballast water that is discharged at Taharoa, suggest that the Taharoa Terminal is at risk from introduction of non-indigenous marine species. However, this risk is tempered by the fact that Taharoa only receives one vessel, which is likely to make management of these risks feasible.

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). The sole vessel servicing the Taharoa Terminal, the bulk carrier MV *Taharoa Express*, makes a round voyage between Taharoa and its northern Asian markets approximately every 45 days (Mike O’Connell, Blue Scope Steel, pers. comm.; see “Introduction: Shipping movements and ballast discharge patterns”). These northern Asian markets (primarily China, followed by Japan and occasionally South Korea and Taiwan) are located in temperate regions that have coastal environments similar to New Zealand’s.

Bulk carriers that arrive empty, such as the MV *Taharoa Express*, discharge high volumes of ballast water. Currently approximately 50,000 tonnes of ballast water are discharged each time the *Taharoa Express* is moored at the Taharoa Terminal buoy (Alan Rutherford, Marine Mooring Consultants under contract to NZ Steel Mining, pers. comm.). The potential risk of introductions via ballast water at Taharoa is therefore high. However, current management regimes reduce this risk by requiring exchange or treatment of ballast water prior to discharge in New Zealand (Biosecurity New Zealand 2005), and monitoring of ballast water samples during each vessel visit (Mike O’Connell, Blue Scope Steel, pers. comm.).

Assessment of translocation risk for NIS and C1 taxa found in the port

There appears to be limited risk of translocation of NIS and C1 taxa from Taharoa to elsewhere in New Zealand. The sole merchant vessel operating at Taharoa, the MV *Taharoa Express*, sails directly between Taharoa and its north Asian markets, without stopping elsewhere in New Zealand except under exceptional circumstances[4]. The offshore mooring buoy used by the MV *Taharoa Express* is located 2.5 km offshore and access to the site is restricted. There are no mooring facilities for other private or commercial vessels at Taharoa. The nearest sheltered anchorage and boat launching facilities are in Kawhia Harbour (approximately one hour from the Taharoa Terminal). It is recommended that the trading route between Taharoa and Asia continue to be a direct service without stops at other New Zealand ports, to reduce the risk of translocation of organisms from Taharoa. If emergencies require vessels from Taharoa to stop elsewhere in New Zealand, it could be prudent for that port of call to be closely monitored following the vessel's visit, especially if ballast water has been discharged, to allow the early detection and management of any translocated organisms before they become established.

The offshore mooring buoy at the Taharoa Terminal is occasionally transported from Taharoa to other parts of New Zealand for maintenance, and thus probably presents the most likely vector for translocation of organisms from Taharoa. It was last towed in 2005 to Kawhia Harbour, and is planned to be towed to Onehunga in 2008 or 2009 (Alan Rutherford, Marine Mooring Consultants under contract to NZ Steel Mining, pers. comm.). The mooring buoy is not coated with antifouling paint. Fouling organisms on the buoy are usually cleared off by heavy storms during the winter, and during the summer sections of the buoy are manually cleaned for inspection of the structure (Alan Rutherford, Marine Mooring Consultants under contract to NZ Steel Mining, pers. comm.).

During the port survey, the mooring buoy was found to be fouled with four NIS (the algae *Polysiphonia subtilissima*, *P. brodiei*, *P.* aff. *sertularioides* THH and the barnacle *Austromegabalanus nigrescens*) and five C1 species (the alga *Ceramium cliftonianum*, the bryozoan *Scruparia ambigua*, the hydroids *Obelia dichotoma* and *Clytia hemisphaerica*, and the ascidian *Diplosoma listerianum*) (Appendix 7). These four NIS and one of the C1 taxa (*Ceramium cliftonianum*) have not previously been recorded from the west coast of the North Island. The three *Polysiphonia* species are known from elsewhere in New Zealand. No other records of *C. cliftonianum* exist from New Zealand (W. Nelson, NIWA, pers. comm.), and the only other New Zealand record of *Austromegabalanus nigrescens* is not from fixed substrate, but from a vessel in the Port of Auckland (Hosie and Ahyong 2007). The towing of the Taharoa Terminal mooring buoy may facilitate translocation of these species to parts of New Zealand where they do not currently occur.

One of these species, the alga *Polysiphonia brodiei*, is listed as a medium-high priority invasive species in Australia and was given an impact ranking of eighth out of 53 domestic marine priority pests in Australia (Hayes et al. 2005a). *Polysiphonia brodiei* occurs as a nuisance fouling species and may also reduce the performance of fouled vessels. The translocation of this species to other parts of New Zealand is therefore especially undesirable.

The other four C1 taxa collected from the mooring buoy (*Scruparia ambigua*, *Obelia dichotoma*, *Clytia hemisphaerica* and *Diplosoma listerianum*) have all previously been recorded from the west coast of the North Island as well as other parts of New Zealand (see species information sheets, Appendix 6). Their translocation on the mooring buoy may therefore present less of a risk for introducing them to locations around New Zealand.

The other nine NIS and C1 taxa recorded from the Taharoa port survey were not recorded on the mooring buoy, and might therefore be less likely to be translocated to other parts of New

[4] In June 2007 the *Taharoa Express* was forced to anchor in Tasman Bay for over two weeks, de-ballasting and re-ballasting whilst correcting a list caused by its shifting cargo and conducting repairs (Maritime New Zealand 2007). In 2004 the vessel drifted towards a beach on the west coast south of Auckland after losing its power (The New Zealand Herald 2007).

Zealand by anthropogenic vectors. However, five of these taxa are planktonic dinoflagellates, and could be spread on ocean currents as well as by anthropogenic means such as within ballast water. All nine of these taxa have been recorded from several other parts of New Zealand (see Appendix 6 for further information on the distribution, ecology and potential pathways for spread of these species).

Management of existing NIS and C1 taxa in the port

Biosecurity management in the Taharoa area is the joint responsibility of MAF Biosecurity New Zealand and Environment Waikato. Although marine species are not addressed directly in the Regional Coastal Plan, Environment Waikato states that it will co-ordinate its response to animal and plant pest management through pest management strategies developed under the Biosecurity Act 1993. These strategies include restrictions on ballast water exchange (see "Introduction: Shipping movements and ballast discharge patterns") and a "watch list" for potential marine pest species, which is currently being prepared by MAF Biosecurity NZ. The Regional Coastal Plan does, however, outline rules concerning the introduction of exotic plant species (including marine), the management of ballast water, and raising public awareness about exotic species (Environment Waikato 2007).

Six of the 18 NIS and C1 taxa recorded in the Taharoa port survey appear to be well established in the port, having been recorded from five or more samples. These six taxa are the hydroid *Obelia dichotoma*, the barnacle *Austromegabalanus nigrescens*, the algae *Ceramium cliftonianum* and *Polysiphonia brodiei*, the bryozoan *Electra angulata* and the dinoflagellate *Gymnodinium catenatum*. In contrast, the remaining twelve taxa occurred in only one or two samples each (Table 16). These species may not be well established in the Taharoa area (with the probable exception of *A. ostenfeldii*, which has previously been recorded from Taharoa; see "Results: Review of marine species records from Taharoa"). The control of these species may therefore warrant particular attention before their populations become established and widespread in the Taharoa area. A more detailed delimitation survey is needed for these species to determine their current distribution and abundance more accurately before any control measures are considered. For most marine NIS, eradication by physical removal or chemical treatment is not yet a cost-effective option. Local population controls may be worth considering for the more restricted species noted above, but control efforts should perhaps be scaled by the potential impacts of the species, where these are known, and the extent to which they already occur throughout New Zealand. Of the 18 taxa, only *Alexandrium affine*, *A. catenella*, *A. tamarense*, *Austromegabalanus nigrescens* and *Ceramium cliftonianum* have been recorded from no or few other locations around New Zealand (see species information sheets in Appendix 6 for information about the ecology, distribution and potential impacts of each species).

A relatively simple control option may be available for the unique case of Taharoa, where the offshore mooring buoy is one of the only areas of hard substrata available to foul for organisms arriving on ships at the Taharoa Terminal. As noted in the preceding section, nine of the 18 NIS and C1 taxa recorded during the port survey were recorded on the mooring buoy. Seven of these nine taxa (*Polysiphonia subtilissima*, *P.* aff. *sertularioides* THH, *Austromegabalanus nigrescens*, *Scruparia ambigua*, *Obelia dichotoma*, *Clytia hemisphaerica* and *Diplosoma listerianum*) were not recorded from any other locations during the port survey. The two exceptions, *Polysiphonia brodiei* and *Ceramium cliftonianum*, also occurred in only one or two anchor box dredge samples, respectively. On this basis, it is suggested that the complete cleaning (and containment of the removed organisms) of the offshore mooring buoy to remove all fouling organisms could effectively reduce the number of NIS and C1 organisms in the Taharoa area. It is recommended that after the buoy is cleaned, it be painted with antifouling paint and regularly maintained in such a manner to prevent new fouling occurring. Maintaining the mooring buoy clear of fouling organisms will also greatly reduce the likelihood of translocating non-indigenous organisms from Taharoa when the buoy is towed elsewhere for maintenance (see previous section).

The distribution of NIS and C1 taxa in the Taharoa area appears to be centred around the mooring buoy. In addition to the seven taxa that were recorded only on the mooring buoy, another three were only recorded from samples within 1 km of the buoy (*Alexandrium affine*, *Polysiphonia brodiei* and *Heteromastus filiformis*), and a further five were recorded from samples within 3 km of the buoy (*Elodea canadensis*, *Alexandrium tamarense*, *A. ostenfeldii*, *Gymnodinium catenatum* and *Electra angulata*). Despite 18 samples (cyst, benthic, planktonic and epibenthic samples) having been collected from sites more than 3 km from the mooring buoy, only three NIS and C1 taxa occurred in this outer area (*Ceramium cliftonianum*, *Alexandrium catenella* and *Chondropsis topsentii*). Based on this distribution, it is suggested that management attention be focused on the buoy and the areas within 3 km of it. Such management attention could include restrictions on the uptake or translocation of ballast water or sediments from these areas, as well as applying antifouling paint to the mooring buoy itself.

Prevention of new introductions

Interception of unwanted species transported by shipping is best achieved offshore, through control and treatment of ships destined for Taharoa 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 for effective in-situ treatment of biofouling and sea-chests. MAF 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. A companion project is investigating the risk from fouling assemblages carried on vessels that travel to Fiordland, the Chatham Islands and New Zealand sub-Antarctic Islands. 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.

The Taharoa Terminal is at risk from new marine introductions because it trades with countries that have similar marine environments to New Zealand, and because large volumes of ballast water are discharged here. However, new introductions to Taharoa could be relatively easily prevented because it receives only one vessel. It is suggested that the ballast water from this vessel continue to be monitored for NIS, and that it is ensured that the vessel and offshore mooring buoy are kept adequately painted with antifouling coatings.

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 port baseline 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 re-surveying

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. 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 initial port baseline survey of Taharoa Terminal recorded 328 species or higher taxa. This has greatly increased the existing knowledge of species occurring in the Taharoa area; only six of these taxa occurred in our desktop review of existing marine species records from the Taharoa area. The initial port baseline survey has highlighted the diversity of the Taharoa marine assemblage, with results indicating that most of its NIS and C1 taxa are concentrated within several kilometres of the offshore mooring buoy.

Despite the large number of species detected, the large area of habitat available for marine organisms and the logistic difficulties of sampling in exposed environments 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. 2006c). 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; 33 % of native species recorded in the Taharaoa Terminal port survey occurred in just a single sample, and almost half occurred in only one or two samples. 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 at Taharoa and for monitoring the rate of new incursions by NIS 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 a NIS or C1 organism 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).

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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 species	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 "Species indeterminata" 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	An organism occurring within its natural past or	Native

species	present range and dispersal potential (organisms whose dispersal potential is independent of human intervention).	
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.	
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: Cohen and Carlton (1998), Gray (2000), Carlton (2001), Gotelli and Colwell (2001), Colautii and MacIsaac (2004), Occhipinti-Ambrogi and Galil (2004) and Falk-Petersen et al. (2006).

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Tables

Table 1: Weight and value of overseas cargo loaded at Taharoa Terminal between the 2001-2002 and 2004-2005 financial years (data from Statistics New Zealand (2006b))

Year ended June	Gross weight (tonnes)	% weight change from previous year	Value (Free On Board) ($million)	% value change from previous year	% by weight of all NZ Seaports	% by value of all NZ Seaports
2002	741,568		20		3.0	0.1
2003	743,492	0.3	17	-15.0	2.9	0.1
2004	745,268	0.2	14	-17.6	3.3	0.1
2005	991,385	33.0	17	21.4	4.5	0.1
Change from 2002 to 2005	249,817	33.7	-3	-15.0		

Table 2: Summary of sampling effort during the Taharoa Terminal port baseline survey. Exact geographic locations of survey sites are provided in Appendix 2. Planned sampling that was not conducted is listed in Appendix 3.

Site number	Site name	Quadrat scraping	Photo stills and video	Large hand corer	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	Total
1	Mooring Outside 1	16	32		6	2	6	3	3		1			1			70
2	Mooring Outside 2	16	32		6	2	6 (2)				1	6	6				75
3	Mooring Inside 1	16	32		6	2	6	3	3		1			1			70
4	Mooring Inside 2	16	32		6	2	6 (3)				1	6	6				75
5	North Pipeline 1				6	2	6	3	3		1						21
6	North Pipeline 2				6	2	6				1						15
7	North Pipeline 3				6	2	6	3	3		1						21
8	South Pipeline 1				6	2	6				1						15
9	South Pipeline 2				6	2	6	3	3		1						21
10	South Pipeline 3				6	2	6 (4)				1						15
11	Taharoa Lagoon Entrance			6		6	6 (5)									3	21
12	Taharoa Lagoon South			6		6	6 (5)					6	6		3	3	36
13	Taharoa Lagoon North			6		6	6					6	6		3	3	36
15	Matauwai Stream						3					6	6				15
16	Within Harbour Limits North 1				3	2	3	3	3 (2)		1						15
17	Within Harbour Limits North 2				3	2	3	3	3		1						15
18	Within Harbour Limits North 3				3	2	3	3	3		1						15
19	Within Harbour Limits South 1				3	2	3	3	3		1						15
20	Within Harbour Limits South 2				3	2	3	3	3		1						15
21	Within Harbour Limits South 3				3	2	3 (1)	3	3		1						15
22	Outside Harbour Limits North				3	2	3	3	3		1						15

Site number	Site name	Quadrat scraping	Photo stills and video	Large hand corer	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	Total
23	Outside Harbour Limits South				3	2	3	3	3		1						15
24	Anchorage 1				3	2	3	3	3		1						15
25	Anchorage 2				3	2	3	3	3		1						15
26	Motunau Rocks						3	3	3	1							10
27	Waioioi Reef						3 (2)	3	5	1							13
Total		64	128	18	90	58	117 (103)	51	53 (52)	2	20	30	30	2	6	9	678 (663)

* Numbers in parentheses indicate the number of samples actually examined by specialists for cysts and phytoplankton. Some cyst and phytoplankton samples from the Taharoa Terminal survey were lost after despatch from the field survey site, and therefore were not identified by specialists.

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	Sabellida	*Sabella spallanzanii*
Arthropoda	Malacostraca	Decapoda	*Carcinus maenas*
Arthropoda	Malacostraca	Decapoda	*Eriocheir sinensis*
Echinodermata	Asteroidea	Forcipulatida	*Asterias amurensis*
Mollusca	Bivalvia	Myoida	*Potamocorbula amurensis*
Chlorophyta	Ulvophyceae	Caulerpales	*Caulerpa taxifolia*
Ochrophyta	Phaeophyceae	Laminariales	*Undaria pinnatifida*
Chordata	Ascidiacea	Pleurogona	*Styela clava*

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

WATCHING BRIEF SPECIES

	Scientific Name/s	Common Name/s
3. Watching List		
	Species Name	**Common Name**
1	*Styela clava*	Clubbed Tunicate
2	*Euchone limnicola*	Sabellid Polychaete Worm
3	*Theora lubrica*	Asian Semelid Bivalve
4	*Polydora websteri*	Mudworm
5	*Polydora cornuta*	Spionid Polychaete
6	*Boccardia proboscidea*	Spionid Polychaete
7	*Alitta succinea*	Pile Worm
8	*Petrolisthes elongatus*	New Zealand Half Shell Crab
9	*Ciona intestinalis.*	Sea Vase

	Scientific Name/s	Common Name/s
4. Notification/More Information List (more information required before it could be on CCIMPE Trigger List but CCIMPE may still need to know about it if it arrives and may respond after consideration)		
	Scientific Name/s	**Common Name/s**
1	*Womersleyella setacea*	Red Macroalga
2	*Bonnemaisonia hamifera*	Red Macroalga
3	*Balanus eburneus*	Ivory Barnacle
4	*Hydroides dianthus*	Limy Tubeworm
5	*Tortanus dextrilobatus*	Asian Copepod
6	*Tridentiger barbatus*	Shokihazi Goby
7	*Siganus luridus*	Dusky Spinefoot
8	*Pseudodiaptomus marinus*	Asian Copepod
9	*Acartia tonsa*	Asian Copepod
10	*Rhithropanopeus harrisii*	Harris Mud Crab
11	*Callinectes sapidus*	Blue Crab
12	*Beroe ovata*	Ctenophore
13	*Blackfordia virginica*	Ctenophore
	*Caulerpa racemosa***	Green Macroalga

** *Caulerpa racemosa* was nominated due to concern about an 'invasive strain' in the Mediterranean – question marks exist over whether this strain originates from Australia. Recent evidence suggests that the 'invasive strain' occurs naturally in Australia therefore it is likely that this species will be removed from all lists during the annual review.

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

Phylum & Class	Order	Family	Taxon name	Reference	Recorded in port survey?
Arthropoda					
Malacostraca	Decapoda	Portunidae	*Ovalipes catharus*	NIWA (2008)	Yes
Chordata					
Actinopterygii	Clupeiformes	Clupeidae	*Sardinops neopilchardus*	NIWA (2008)	
Actinopterygii	Clupeiformes	Clupeidae	*Sprattus muelleri*	NIWA (2008)	
Actinopterygii	Clupeiformes	Engraulidae	*Engraulis australis*	NIWA (2008)	
Actinopterygii	Gadiformes	Merlucciidae	*Macruronus novaezelandiae*	NIWA (2008)	
Actinopterygii	Gadiformes	Moridae	*Auchenoceros punctatus*	NIWA (2008)	
Actinopterygii	Gadiformes	Moridae	*Pseudophycis bachus*	NIWA (2008)	
Actinopterygii	Mugiliformes	Mugilidae	*Aldrichetta forsteri*	NIWA (2008)	Yes
Actinopterygii	Perciformes	Arripidae	*Arripis trutta*	NIWA (2008)	
Actinopterygii	Perciformes	Carangidae	*Pseudocaranx dentex*	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	Centrolophidae	*Seriolella punctata*	NIWA (2008)	
Actinopterygii	Perciformes	Cheilodactylidae	*Nemadactylus macropterus*	NIWA (2008)	
Actinopterygii	Perciformes	Gempylidae	*Thyrsites atun*	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	Uranoscopidae	*Genyagnus monopterygius*	NIWA (2008)	
Actinopterygii	Perciformes	Uranoscopidae	*Kathetostoma giganteum*	NIWA (2008)	
Actinopterygii	Pleuronectiformes	Bothidae	*Arnoglossus scapha*	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)	Yes
Actinopterygii	Pleuronectiformes	Pleuronectidae	*Rhombosolea leporina*	NIWA (2008)	Yes
Actinopterygii	Pleuronectiformes	Pleuronectidae	*Rhombosolea plebeia*	NIWA (2008)	
Actinopterygii	Scorpaeniformes	Triglidae	*Chelidonichthys kumu*	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	Triakidae	*Galeorhinus galeus*	NIWA (2008)	
Elasmobranchii	Carcharhiniformes	Triakidae	*Lepidotrigla brachyoptera*	NIWA (2008)	
Elasmobranchii	Carcharhiniformes	Triakidae	*Mustelus lenticulatus*	Hewitt & Funnell (2005)	
Elasmobranchii	Rajiformes	Myliobatidae	*Myliobatis tenuicaudatus*	NIWA (2008)	
Elasmobranchii	Rajiformes	Rajidae	*Dipturus nasutus*	NIWA (2008)	
Elasmobranchii	Squaliformes	Squalidae	*Squalus acanthias*	NIWA (2008)	
Elasmobranchii	Squaliformes	Squalidae	*Squalus mitsukurii*	NIWA (2008)	
Mollusca				NIWA (2008)	
Cephalopoda	Teuthida	Loliginidae	*Sepioteuthis australis*	NIWA (2008)	

Table 7: Cryptogenic category one (C1) taxa recorded during the desktop review of existing marine species records from Taharoa and nearby areas. Also indicated are the probable means of introduction to New Zealand (H = Hull fouling, B = Ballast water transport), the date of introduction or detection (d) in New Zealand, and whether the taxon was subsequently recorded in the Taharoa port 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?
Myzozoa							
Dinophyceae	Gymnodiniales	Gymnodiniaceae	*Gymnodinium catenatum*	Taylor & Mackenzie (2001)	B or on ocean currents	2000 d	Yes
Dinophyceae	Peridiniales	Gonyaulacaceae	*Alexandrium ostenfeldii*	Hay et al. (2000), Mackenzie et al. (1996), Ostergaard et al. (1997)	B or on ocean currents	1992 d	Yes

Table 8: The Chapman and Carlton (1994) criteria (C1 – C9) that each NIS and C1 taxon from the Taharoa desktop review and port survey meets. Criteria were assigned following expert advice or are based on those give by Cranfield et al. (1998).

Species	Biosecurity status	Source of record	C1: Has the species suddenly appeared locally where it has not been found before?	C2: Has the species spread subsequ-ently?	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 worldwide distribution?	C8: Are dispersal mechanisms of the species inadequate to reach NZ, and is passive dispersal in ocean currents unlikely to bridge ocean gaps to reach NZ?	C9: Is the species isolated from genetically and morphologically most similar species elsewhere in the world?
***Austromegabalanus nigrescens* (Arthropoda)**	NIS	Port survey	Yes		Yes		Yes				Yes
***Electra angulata* (Bryozoa)**	NIS	Port survey	Yes	Yes	Yes		Yes		Yes	Yes	Yes
***Elodea canadensis* (Magnoliophyta)**	NIS	Port survey			Yes						
***Polysiphonia* aff. *sertularioides* (THH)* (Rhodophyta)**	NIS	Port survey									
***Polysiphonia brodiei* (Rhodophyta)**	NIS	Port survey	Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes
***Polysiphonia subtilissima* (Rhodophyta)**	NIS	Port survey	Yes	Yes			Yes	Yes	Yes	Yes	Yes

Species	Biosecurity status	Source of record	C1: Has the species suddenly appeared locally where it has not been found before?	C2: Has the species spread subsequ-ently?	C3: Is the species' distributio n associated with human mechanis ms 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 worldwide distribution?	C8: Are dispersal mechanis ms of the species inadequate to reach NZ, and is passive dispersal in ocean currents unlikely to bridge ocean gaps to reach NZ?	C9: Is the species isolated from genetically and morpholog ically most similar species elsewhere in the world?
***Heteromastus filiformis* (Annelida)**	C1	Port survey								Yes	
***Scruparia ambigua* (Bryozoa)**	C1	Port survey		Uncertain, due to inadequat e records of presence/ absence around NZ.	Not necessesari ly. Can foul hulls, but can also grow on natural substrata such as seaweeds or other bryozoans. Nothing to preclude it from drifting throughout southern oceans.	Sometimes, but not entirely. It's an opportunisti c epizooite epiphyte. Often attaches to another bryozoan NIS, *Bugula flabellata*.			Semi-cosmopolitan but not really disjunct.		Unknown
***Diplosoma listerianum* (Chordata)**	C1	Port survey	Yes	Yes			Yes	Yes	Yes	Yes	

Species	Biosecurity status	Source of record	C1: Has the species suddenly appeared locally where it has not been found before?	C2: Has the species spread subsequ-ently?	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 worldwide distribution?	C8: Are dispersal mechanisms of the species inadequate to reach NZ, and is passive dispersal in ocean currents unlikely to bridge ocean gaps to reach NZ?	C9: Is the species isolated from genetically and morphologically most similar species elsewhere in the world?
***Clytia hemisphaerica* (Cnidaria)**	C1	Port survey			Probably, but unknown		Yes	Unknown; known distributions reflect sampling effort		Unknown. The dispersal stage is a medusa, so over long periods there is no reason it couldn't spread worldwide by the medusa.	Unknown
***Obelia dichotoma* (Cnidaria)**	C1	Port survey			Probably, but unknown		Yes	Unknown; known distributions reflect sampling effort		Unknown. The dispersal stage is a medusa, so over long periods there is no reason it couldn't spread worldwide by the medusa.	Unknown

Species	Biosecurity status	Source of record	C1: Has the species suddenly appeared locally where it has not been found before?	C2: Has the species spread subsequ-ently?	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 worldwide distribution?	C8: Are dispersal mechanisms of the species inadequate to reach NZ, and is passive dispersal in ocean currents unlikely to bridge ocean gaps to reach NZ?	C9: Is the species isolated from genetically and morphologically most similar species elsewhere in the world?
***Gymnodinium catenatum* (Myzozoa)**	C1	Desktop review & port survey	Yes	Yes							
***Alexandrium affine* (Myzozoa)**	C1	Port survey	Yes								
***Alexandrium catenella* (Myzozoa)**	C1	Port survey									
***Alexandrium ostenfeldii* (Myzozoa)**	C1	Desktop review & port survey	Yes								
***Alexandrium tamarense* (Myzozoa)**	C1	Port survey	Yes								
***Chondropsis topsentii* (Porifera)**	C1	Port survey	Yes		Yes		Yes	Yes		Yes	
***Ceramium cliftonianum* (Rhodophyta)**	C1	Port survey						Yes		Yes	

* THH = Taharoa specimens. Further taxonomic investigation is required to confirm whether the specimens of *Polysiphonia* aff. *sertularioides* from Taharoa are the same species as those found in other parts of the country.

Table 9: Physical characteristics of the sites sampled during the Taharoa survey.

Site number	Site name	Maximum recorded depth (m)	Secchi depth (m)	Salinity (ppt)	Water temperature (degC)	Sea state (Beaufort scale)
1	Mooring Outside 1	31.8	2.2	30	16.6	3
2	Mooring Outside 2	31.5	2.5	36	14	1
3	Mooring Inside 1	32.0	4.5	38	14	2
4	Mooring Inside 2	33.6	4.0	35	13.9	2
5	North Pipeline 1	30.5	3.5	36	13.6	2
6	North Pipeline 2	19.1	4.5	36	13.4	2
7	North Pipeline 3	11.0	4.0	36	13	2
8	South Pipeline 1	24.0	4.1	36	13.3	2
9	South Pipeline 2	18.5	4.2	35	13.2	2
10	South Pipeline 3	7.7	1.6	30	16.8	2
11	Taharoa Lagoon Entrance	0.25	TS	0	14.7	1
12	Taharoa Lagoon South	0.3	TS	0	14.7	1
13	Taharoa Lagoon North	0.4	TS	0	14.7	1
15	Matauwai Stream	0.25	TS	0	14.7	1
16	Within Harbour Limits North 1	18.5	4.1	35	13.3	2
17	Within Harbour Limits North 2	15.1	4.5	38	13.4	2
18	Within Harbour Limits North 3	25.9	4.0	36	13.7	2
19	Within Harbour Limits South 1	29.0	4.1	37	13.8	2
20	Within Harbour Limits South 2	31.5	4.0	35	14	2
21	Within Harbour Limits South 3	8.7	4.2	38	13.8	2
22	Outside Harbour Limits North	35.0	4.2	38	13.8	2
23	Outside Harbour Limits South	34.7	4.1	35	13.9	2
24	Anchorage 1	26.1	4.5	38	13.7	2
25	Anchorage 2	24.6	4.5	38	13.4	2
26	Motunau Rocks	11.1	1.5	31	16.7	2
27	Waioioi Reef	12.4	2.0	31	16.4	2
Average across all sites		19.8	3.7	29.9	14.3	1.8
SE of average across all sites		2.3	0.2	2.6	0.2	0.1

TS: Site was too shallow to obtain secchi depth; the bottom was visible from the surface.

Table 10: Sediment particle sizes at 23 sites sampled (n=1) during the first port baseline survey of Taharoa Terminal. Data are percent net dry weight in each size class.

Site number	Site name	Clay <3.9um, >2um	Silt <62.5um, >3.9um	Sand >62.5um, <2mm	Gravel >2mm, <4mm	Small pebbles >4mm, <8mm
1	Mooring Outside 1	0.05	23.52	76.43	0.00	0.00
2	Mooring Outside 2	0.01	2.84	94.27	1.38	1.50
3	Mooring Inside 1	0.00	1.58	98.18	0.24	0.00
4	Mooring Inside 2	0.00	2.09	96.90	0.38	0.62
5	North Pipeline 1	0.00	0.82	99.06	0.13	0.00
6	North Pipeline 2	0.00	1.71	98.26	0.02	0.00
7	North Pipeline 3	0.00	0.36	99.40	0.00	0.24
8	South Pipeline 1	0.00	2.55	97.43	0.02	0.00
9	South Pipeline 2	0.00	1.78	98.23	0.00	0.00
10	South Pipeline 3	0.00	0.99	99.01	0.00	0.00
11	Taharoa Lagoon Entrance	0.00	0.20	99.80	0.00	0.00
12	Taharoa Lagoon South	0.00	0.30	99.70	0.00	0.00
13	Taharoa Lagoon North	0.00	0.24	99.76	0.00	0.00
16	Within Harbour Limits North 1	0.00	1.50	98.50	0.00	0.00
17	Within Harbour Limits North 2	0.00	2.35	97.58	0.06	0.00
18	Within Harbour Limits North 3	0.00	2.21	97.78	0.00	0.00
19	Within Harbour Limits South 1	0.00	2.01	96.52	0.16	1.32
20	Within Harbour Limits South 2	0.00	1.94	97.96	0.06	0.05
21	Within Harbour Limits South 3	0.00	0.53	99.26	0.21	0.00
22	Outside Harbour Limits North	0.01	3.89	96.00	0.11	0.00
23	Outside Harbour Limits South	0.01	4.39	95.41	0.20	0.00
24	Anchorage 1	0.00	3.69	93.85	0.00	2.44
25	Anchorage 2	0.00	3.34	96.47	0.00	0.17

Table 11: Native taxa recorded from Taharoa in the first port baseline survey. Also indicated is whether the taxon was recorded from the desktop review of existing marine species records from Tharaoa and nearby locations. None are new records for New Zealand.

Phylum & Class	Order	Family	Taxon name	Recorded in desktop review?
Annelida				
Polychaeta	Eunicida	Lumbrineridae	*Lumbrineris sphaerocephala*	
Polychaeta	Eunicida	Onuphidae	*Onuphis aucklandensis*	
Polychaeta	Phyllodocida	Glyceridae	*Glycera lamelliformis*	
Polychaeta	Phyllodocida	Glyceridae	*Glycera russa*	
Polychaeta	Phyllodocida	Goniadidae	*Glycinde trifida*	
Polychaeta	Phyllodocida	Goniadidae	*Goniada echinulata*	
Polychaeta	Phyllodocida	Nephtyidae	*Aglaophamus macroura*	
Polychaeta	Phyllodocida	Nephtyidae	*Aglaophamus verrilli*	
Polychaeta	Phyllodocida	Nereididae	*Cheilonereis peristomialis*	
Polychaeta	Phyllodocida	Nereididae	*Perinereis camiguinoides*	
Polychaeta	Phyllodocida	Nereididae	*Platynereis australis group*	
Polychaeta	Phyllodocida	Polynoidae	*Lepidonotus polychromus*	
Polychaeta	Phyllodocida	Sigalionidae	*Sigalion oviger*	
Polychaeta	Phyllodocida	Sigalionidae	*Sthenelais novaezealandiae*	
Polychaeta	Sabellida	Oweniidae	*Owenia petersenae*	
Polychaeta	Sabellida	Sabellariidae	*Neosabellaria kaiparaensis*	
Polychaeta	Sabellida	Serpulidae	*Galeolaria hystrix*	
Polychaeta	Scolecida	Opheliidae	*Armandia maculata*	
Polychaeta	Scolecida	Orbiniidae	*Phylo novazealandiae*	
Polychaeta	Scolecida	Scalibregmatidae	*Travisia kerguelensis*	
Polychaeta	Spionida	Spionidae	*Prionospio australiensis*	
Polychaeta	Spionida	Spionidae	*Spiophanes modestus*	
Polychaeta	Terebellida	Ampharetidae	*Ampharete kerguelensis*	
Arthropoda				
Malacostraca	Amphipoda	Phoxocephalidae	*Torridoharpinia hurleyi*	
Malacostraca	Amphipoda	Phoxocephalidae	*Waitangi rakiura*	
Malacostraca	Decapoda	Callianassidae	*Callianassa filholi*	
Malacostraca	Decapoda	Crangonidae	*Philocheras australis*	
Malacostraca	Decapoda	Crangonidae	*Philocheras pilosoides*	
Malacostraca	Decapoda	Diogenidae	*Paguristes setosus*	
Malacostraca	Decapoda	Hymenosomatidae	*Hymenosoma depressum*	
Malacostraca	Decapoda	Ogyrididae	*Ogyrides delli*	
Malacostraca	Decapoda	Paguridae	*Lophopagurus (A.) cooki*	
Malacostraca	Decapoda	Paguridae	*Lophopagurus laurentae*	
Malacostraca	Decapoda	Paguridae	*Pagurus albidianthus*	
Malacostraca	Decapoda	Paguridae	*Pagurus novizealandiae*	
Malacostraca	Decapoda	Pinnotheridae	*Pinnotheres novaezelandiae*	
Malacostraca	Decapoda	Plagusiidae	*Plagusia chabrus* *	
Malacostraca	Decapoda	Portunidae	*Ovalipes catharus*	Yes
Malacostraca	Isopoda	Austrarcturellidae	*Pseudarcturella crenulata*	
Malacostraca	Isopoda	Chaetiliidae	*Macrochiridothea uncinata*	
Malacostraca	Isopoda	Cirolanidae	*Natatolana narica*	
Malacostraca	Isopoda	Cirolanidae	*Natatolana sp.*	
Malacostraca	Isopoda	Cirolanidae	*Pseudaega quarta*	
Malacostraca	Isopoda	Cirolanidae	*Pseudaega secunda*	
Malacostraca	Isopoda	Holognathidae	*Cleantis tubicola*	

Phylum & Class	**Order**	**Family**	**Taxon name**	**Recorded in desktop review?**
Malacostraca	Isopoda	Holognathidae	*Holognathus stewarti*	
Malacostraca	Isopoda	Idoteidae	*Pseudidotea richardsoni*	
Malacostraca	Isopoda	Sphaeromatidae	*Cassidina typa*	
Malacostraca	Mysida	Mysidae	*Tenagomysis longisquama*	
Malacostraca	Mysida	Mysidae	*Tenagomysis producta*	
Malacostraca	Mysida	Mysidae	*Tenagomysis tenuipes*	
Maxillopoda	Sessilia	Archaeobalanidae	*Austrominius modestus*	
Maxillopoda	Sessilia	Balanidae	*Notomegabalanus decorus*	
Maxillopoda	Sessilia	Tetraclitidae	*Epopella plicata*	
Pycnogonida	Pantopoda	Ammotheidae	*Achelia assimilis*	
Bacillariophyta				
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	*Bacteriastrum delicatulum*	
Coscinodiscophyceae	Chaetocerotales	Chaetocerotaceae	*Chaetoceros affinis*	
Coscinodiscophyceae	Chaetocerotales	Chaetocerotaceae	*Chaetoceros concavicornis*	
Coscinodiscophyceae	Chaetocerotales	Chaetocerotaceae	*Chaetoceros convolutus*	
Coscinodiscophyceae	Chaetocerotales	Chaetocerotaceae	*Chaetoceros decipiens*	
Coscinodiscophyceae	Corethrales	Corethraceae	*Corethron criophilum*	
Coscinodiscophyceae	Coscinodiscales	Coscinodiscaceae	*Coscinodiscus wailesii*	
Coscinodiscophyceae	Coscinodiscales	Heliopeltaceae	*Actinoptychus senarius*	
Coscinodiscophyceae	Hemiaulales	Hemiaulaceae	*Cerataulina pelagica*	
Coscinodiscophyceae	Hemiaulales	Hemiaulaceae	*Hemiaulus kauckii*	
Coscinodiscophyceae	Lithodesmidales	Lithodesmiaceae	*Ditylum brightwelli*	
Coscinodiscophyceae	Lithodesmidales	Lithodesmiaceae	*Lithodesmium undulatum*	
Coscinodiscophyceae	Melosirales	Stephanopyxidaceae	*Stephanopyxis orbicularis*	
Coscinodiscophyceae	Melosirales	Stephanopyxidaceae	*Stephanopyxis turris*	
Coscinodiscophyceae	Rhizosoleniales	Rhizosoleniaceae	*Guinardia flaccida*	
Coscinodiscophyceae	Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia alata*	
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	*Thalassiosira decipiens*	
Coscinodiscophyceae	Thalassiosirales	Thalassiosiraceae	*Thalassiosira hyalina*	
Coscinodiscophyceae	Thalassiosirales	Thalassiosiraceae	*Thalassiosira rotula*	
Coscinodiscophyceae	Triceratiales	Triceratiaceae	*Odontella mobiliensis*	
Coscinodiscophyceae	Triceratiales	Triceratiaceae	*Odontella sinensis*	
Coscinodiscophyceae	Triceratiales	Triceratiaceae	*Triceratium favus*	
Fragilariophyceae	Striatellales	Striatellaceae	*Grammatophora marina*	
Fragilariophyceae	Thalassionemales	Thalassionemataceae	*Thalassionema frauenfeldii*	
Fragilariophyceae	Thalassionemales	Thalassionemataceae	*Thalassionema nitzschioides*	
Bryozoa				
Gymnolaemata	Cheilostomata	Aeteidae	*Aetea australis*	
Gymnolaemata	Cheilostomata	Bitectiporidae	*Schizosmittina cinctipora*	
Gymnolaemata	Cheilostomata	Calloporidae	*Crassimarginatella papulifera*	

Phylum & Class	Order	Family	Taxon name	Recorded in desktop review?
Gymnolaemata	Cheilostomata	Hippothoidae	*Celleporella tongima*	
Gymnolaemata	Cheilostomata	Hippothoidae	*Plesiothoa trigemma*	
Gymnolaemata	Cheilostomata	Microporidae	*Opaeophora lepida*	
Gymnolaemata	Ctenostomata	Immergentiidae	*Immergentia zelandica*	
Chlorophyta				
Ulvophyceae	Bryopsidales	Codiaceae	*Codium fragile*	
Chordata				
Actinopterygii	Atheriniformes	Atherinidae	*Atherinomorus lacunosa*	
Actinopterygii	Mugiliformes	Mugilidae	*Aldrichetta forsteri*	Yes
Actinopterygii	Perciformes	Blenniidae	*Parablennius laticlavius*	
Actinopterygii	Perciformes	Tripterygiidae	*Forsterygion varium*	
Actinopterygii	Pleuronectiformes	Pleuronectidae	*Peltorhamphus novaezeelandiae*	Yes
Actinopterygii	Pleuronectiformes	Pleuronectidae	*Rhombosolea leporina*	Yes
Actinopterygii	Salmoniformes	Galaxiidae	*Galaxias maculatus*	
Actinopterygii	Salmoniformes	Retropinnidae	*Retropinna retropinna*	
Elasmobranchii	Carcharhiniformes	Scyliorhinidae	*Cephaloscyllium isabellum*	
Cnidaria				
Anthozoa	Actiniaria	Diadumenidae	*Diadumene neozelandica*	
Hydrozoa	Anthoathecata	Hydractiniidae	*Hydractinia novaezelandiae*	
Hydrozoa	Hydroida	Aglaopheniidae	*Aglaophenia acanthocarpa*	
Hydrozoa	Hydroida	Haleciidae	*Hydrodendron mirabile*	
Hydrozoa	Hydroida	Sertulariidae	*Amphisbetia bispinosa*	
Hydrozoa	Hydroida	Sertulariidae	*Amphisbetia fasciculata*	
Echinodermata				
Asteroidea	Forcipulatida	Asteriidae	*Coscinasterias muricata*	
Asteroidea	Forcipulatida	Asteriidae	*Stichaster australis*	
Echinoidea	Clypeasteroida	Arachnoididae	*Fellaster zelandiae*	
Echinoidea	Echinoida	Echinometridae	*Evechinus chloroticus*	
Ophiuroida	Ophiurida	Amphiuridae	*Amphiura eugenie*	
Ophiuroida	Ophiurida	Ophiocomidae	*Ophiopterus antipodum*	
Magnoliophyta				
Liliopsida	Arales	Arecidae	*Lemna minor*	
Liliopsida	Najadales	Potamogetonaceae	*Potamogeton crispus*	
Mollusca				
Bivalvia	Myoida	Hiatellidae	*Hiatella arctica*	
Bivalvia	Mytiloida	Mytilidae	*Perna canaliculus*	
Bivalvia	Mytiloida	Mytilidae	*Xenostrobus pulex*	
Bivalvia	Nuculoida	Nuculidae	*Nucula nitidula*	
Bivalvia	Pholadomyoida	Myochamidae	*Myadora striata*	
Bivalvia	Veneroida	Lucinidae	*Divalucina cumingi*	
Bivalvia	Veneroida	Mactridae	*Maorimactra ordinaria*	
Bivalvia	Veneroida	Mactridae	*Scalpomactra scalpellum*	
Bivalvia	Veneroida	Mactridae	*Spisula aequilatera*	
Bivalvia	Veneroida	Psammobiidae	*Gari lineolata*	
Bivalvia	Veneroida	Tellinidae	*Tellinota edgari*	
Bivalvia	Veneroida	Veneridae	*Dosinia anus*	
Cephalopoda	Sepiida	Sepiadariidae	*Sepioloidea pacifica*	
Gastropoda	Basommatophora	Siphonariidae	*Siphonaria australis*	
Gastropoda	Cephalaspidae	Philinidae	*Philine powelli*	
Gastropoda	Neogastropoda	Buccinidae	*Austrofusus glans*	
Gastropoda	Neogastropoda	Conidae	*Neoguraleus amoenus*	
Gastropoda	Neogastropoda	Conidae	*Phenotoma zealandica*	
Gastropoda	Neogastropoda	Muricidae	*Dicathais orbita*	

Phylum & Class	**Order**	**Family**	**Taxon name**	**Recorded in desktop review?**
Gastropoda	Neogastropoda	Muricidae	*Xymene traversi*	
Gastropoda	Neogastropoda	Olividae	*Amalda australis*	
Gastropoda	Neogastropoda	Olividae	*Amalda depressa*	
Gastropoda	Neogastropoda	Terebridae	*Pervicacia tristis*	
Gastropoda	Neogastropoda	Volutidae	*Alcithoe swainsoni*	
Gastropoda	Neotaenioglossa	Calyptraeidae	*Sigapatella tenuis*	
Gastropoda	Neotaenioglossa	Cassidae	*Semicassis pyrum*	
Gastropoda	Neotaenioglossa	Hydrobiidae	*Potamopyrgus antipodarum*	
Gastropoda	Neotaenioglossa	Struthiolariidae	*Struthiolaria papulosa*	
Gastropoda	Vetigastropoda	Trochidae	*Micrelenchus huttonii*	
Polyplacophora	Ischnochitonina	Mopaliidae	*Plaxiphora caelata*	
Scaphopoda	Dentaliida	Dentaliidae	*Dentalium nanum*	
Myzozoa				
Dinophyceae	Dinophysiales	Dinophysiaceae	*Dinophysis acuta*	
Dinophyceae	Dinophysiales	Dinophysiaceae	*Dinophysis rotundata*	
Dinophyceae	Dinophysiales	Dinophysiaceae	*Dinophysis tripos*	
Dinophyceae	Gymnodiniales	Gymnodiniaceae	*Akashiwo sanguinea*	
Dinophyceae	Gymnodiniales	Gymnodiniaceae	*Gymnodinium abbreviatum*	
Dinophyceae	Gymnodiniales	Polykrikaceae	*Polykrikos schwartzii*	
Dinophyceae	Noctilucales	Noctilucaceae	*Noctiluca scintillans*	
Dinophyceae	Peridinales	Protoperidiniaceae	*Protoperidinium pellucidum*	
Dinophyceae	Peridinales	Protoperidiniaceae	*Protoperidinium pyroforme*	
Dinophyceae	Peridinales	Protoperidiniaceae	*Protoperidinium steinii*	
Dinophyceae	Peridiniales	Ceratiaceae	*Ceratium arietinum*	
Dinophyceae	Peridiniales	Ceratiaceae	*Ceratium candelabrum*	
Dinophyceae	Peridiniales	Ceratiaceae	*Ceratium furca*	
Dinophyceae	Peridiniales	Ceratiaceae	*Ceratium fusus*	
Dinophyceae	Peridiniales	Ceratiaceae	*Ceratium horridum*	
Dinophyceae	Peridiniales	Ceratiaceae	*Ceratium tripos*	
Dinophyceae	Peridiniales	Gonyaulacaceae	*Lingulodinium polyedrum*	
Dinophyceae	Peridiniales	Peridiniaceae	*Scrippsiella trochoidea*	
Dinophyceae	Peridiniales	Podolampadaceae	*Podolampas bipes*	
Dinophyceae	Peridiniales	Podolampadaceae	*Podolampas palmipes*	
Dinophyceae	Peridiniales	Protoperidiniaceae	*Diplopsalis lenticula*	
Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium avellana*	
Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium brevipes*	
Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium cerasus*	
Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium curtipeds*	
Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium depressum*	
Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium leonis*	
Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium punctulatum*	
Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium subinerme*	
Dinophyceae	Prorocentrales	Prorocentraceae	*Prorocentrum gracile*	
Dinophyceae	Prorocentrales	Prorocentraceae	*Prorocentrum micans*	
Dinophyceae	Prorocentrales	Prorocentraceae	*Prorocentrum ovum*	
Dinophyceae	Pyrocystales	Pyrocystaceae	*Pyrocystis lunula*	
Ochrophyta				
Dictyochophyceae	Dictyochales	Dictyochaceae	*Dictyocha fibula*	
Dictyochophyceae	Dictyochales	Dictyochaceae	*Distephanus speculum*	
Dictyochophyceae	Dictyochales	Dictyochaceae	*Glossophora kunthii*	
Phaeophyceae	Ectocarpales	Ectocarpaceae	*Hincksia granulosa*	
Phaeophyceae	Ectocarpales	Scytosiphonaceae	*Endarachne binghamiae*	
Phaeophyceae	Ectocarpales	Scytothamnaceae	*Scytothamnus australis*	

<u>Phylum</u> & Class	**Order**	**Family**	**Taxon name**	**Recorded in desktop review?**
Phaeophyceae	Fucales	Sargassaceae	*Carpophyllum maschalocarpum*	
Phaeophyceae	Fucales	Sargassaceae	*Carpophyllum plumulosum*	
Phaeophyceae	Sphacelariales	Cladostephaceae	*Cladostephus spongiosus*	
<u>Porifera</u>				
Demospongiae	Poecilosclerida	Mycalidae	*Mycale (Carmia) tasmani*	
<u>Rhodophyta</u>				
Florideophyceae	Ceramiales	Ceramiaceae	*Antithamnionella adnata*	
Florideophyceae	Ceramiales	Ceramiaceae	*Aristoptilon mooreanum*	
Florideophyceae	Ceramiales	Rhodomelaceae	*Chondria macrocarpa*	
Florideophyceae	Ceramiales	Rhodomelaceae	*Cladhymenia coronata*	
Florideophyceae	Ceramiales	Rhodomelaceae	*Cladhymenia oblongifolia*	
Florideophyceae	Ceramiales	Rhodomelaceae	*Dasyclonium harveyanum*	
Florideophyceae	Ceramiales	Rhodomelaceae	*Dipterosiphonia heteroclada*	
Florideophyceae	Ceramiales	Rhodomelaceae	*Vidalia colensoi*	
Florideophyceae	Corallinales	Corallinaceae	*Arthrocardia corymbosa*	
Florideophyceae	Corallinales	Corallinaceae	*Corallina officinalis*	
Florideophyceae	Corallinales	Corallinaceae	*Haliptilon roseum*	
Florideophyceae	Gracilariales	Gracilariaceae	*Melanthalia abscissa*	
Florideophyceae	Nemaliales	Gelidiaceae	*Pterocladia lucida*	
Florideophyceae	Stylonematales	Stylonemataceae	*Stylonema alsidii*	

* The biosecurity status of *Plagusia chabrus* was reported as C1 in earlier New Zealand port survey reports. It has since been revised to Native after review by Dr Shane Ahyong.

Table 12: Non-indigenous taxa recorded from the first port baseline survey of Taharoa Terminal. Also indicated are whether the Taharoa port survey collection represents a new record for New Zealand or an extension to the known range of the species in New Zealand, the probable means of introduction to New Zealand (H = Hull fouling, B = Ballast water transport), the date of introduction or detection (d) in New Zealand, and if the taxon was recorded from the desktop review of existing marine species records from Taharoa and nearby locations.

Phylum & Class	Order	Family	Taxon name	New record for New Zealand?	Range extension?	Probable means of introduction to NZ	Date of introduction, or detection (d)	Recorded in desktop review?
Arthropoda								
Maxillopoda	Sessilia	Balanidae	*Austromegabalanus nigrescens*	Yes	No	H	2006 d	
Bryozoa								
Gymnolaemata	Cheilostomata	Electridae	*Electra angulata*	No	No	H	?	
Magnoliophyta								
Liliopsida	Hydrocharitales	Alismatidae	*Elodea canadensis*	No	No	Domestic aquaria	?	
Rhodophyta								
Florideophyceae	Ceramiales	Rhodomelaceae	*Polysiphonia* aff. *sertularioides* (THH*)	Probably not, but not certain of this species' identity, so could be	Uncertain	Uncertain, but probably H	2006 d (for Taharoa specimens*)	
Florideophyceae	Ceramiales	Rhodomelaceae	*Polysiphonia brodiei*	No	Yes	H	Pre-1938	
Florideophyceae	Ceramiales	Rhodomelaceae	*Polysiphonia subtilissima*	No	No	H	Pre-1974	

* THH = Taharoa specimens. Further taxonomic investigation is required to confirm whether the specimens of *Polysiphonia* aff. *sertularioides* from Taharoa are the same species as those found in other parts of the country.

Table 13: Cryptogenic category one taxa recorded from the first port baseline survey of Taharoa Terminal. Also indicated are whether the Taharoa port survey collection represents a new record for New Zealand or an extension to the known range of the species in New Zealand, the probable means of introduction to New Zealand (H = Hull fouling, B = Ballast water transport), the date of introduction or detection (d) in New Zealand, and whether the taxon was recorded from the desktop review of existing marine species records from Taharoa and nearby locations.

Phylum & Class	Order	Family	Taxon name	New record for New Zealand?	Range extension?	Probable means of introduction to New Zealand	Date of introduction, or detection (d)	Recorded in desktop review?
Annelida								
Polychaeta	Scolecida	Capitellidae	*Heteromastus filiformis*	No	No	H	Pre-1900	
Bryozoa								
Gymnolaemata	Cheilostomata	Scrupariidae	*Scruparia ambigua*	No	No	H or by rafting	1911 d	
Chordata								
Ascidiacea	Enterogona	Didemnidae	*Diplosoma listerianum*	No	No	H	Pre-1996	
Cnidaria								
Hydrozoa	Hydroida	Campanulariidae	*Clytia hemisphaerica*	No	Yes? #	H	~1875 d	
Hydrozoa	Hydroida	Campanulariidae	*Obelia dichotoma*	No	Yes? #	H	~1875 d	
Myzozoa								
Dinophyceae	Gymnodiniales	Gymnodiniaceae	*Gymnodinium catenatum*	No	No	B or on ocean currents	2000 d	Yes
Dinophyceae	Peridiniales	Gonyaulacaceae	*Alexandrium catenella*	No	Yes? #	B or on ocean currents	1996 d	
Dinophyceae	Peridiniales	Gonyaulacaceae	*Alexandrium affine*	No	Yes? #	B or on ocean currents		
Dinophyceae	Peridiniales	Gonyaulacaceae	*Alexandrium ostenfeldii*	No	No	B or on ocean currents	1992 d	Yes
Dinophyceae	Peridiniales	Gonyaulacaceae	*Alexandrium tamarense*	No	Yes? #	B or on ocean currents		
Porifera								
Demospongiae	Poecilosclerida	Chondropsidae	*Chondropsis topsentii* *	No	Yes	H	Pre-1988	
Rhodophyta								
Florideophyceae	Ceramiales	Ceramiaceae	*Ceramium cliftonianum*	Yes	First NZ record	H or by rafting	2007 d	

These species do not appear to have been recorded from the Taharoa area previously, and the Taharoa records therefore represent extensions to their known ranges. However, this could reflect a lack of sampling effort rather than true absence of the species. For the dinoflagellate species in particular, their cosmopolitan oceanic distributions, planktonic life histories and occurrences elsewhere in New Zealand suggest that they could certainly have been present in the Taharoa area at times prior to the date of this port survey.

* The biosecurity status of *Chondropsis topsentii* was reported as NIS in earlier New Zealand port survey reports. It has since been revised to C1, following expert advice explaining that there is uncertainty about whether the New Zealand specimens are the same species as in Australia, or a different species that is native to New Zealand, as explained by Michelle Kelly (NIWA, pers. comm.): "Bergquist and Fromont (1988) considered the New Zealand specimens to be conspecific with the species from Port Phillip, Victoria. These are particularly difficult sponges to differentiate but this species is characterised by the presence of very fine strongyles and no sigma microscleres, and the New Zealand sponges are exactly the same. This is also a potential adventive species, and the third from Port Phillip to the southern harbours [of New Zealand]."

Table 14: Cryptogenic category two (C2) taxa recorded from the first port baseline survey of Taharoa Terminal. Also indicated is whether the taxon represents a new record for New Zealand and if it was recorded from the desktop review of existing marine species records from Milford Sound and nearby locations..

Phylum & Class	Order	Family	Taxon name	New record for New Zealand?	Recorded in desktop review?
Annelida					
Polychaeta	Scolecida	Capitellidae	*Notomastus Notomastus*-B	Yes, but there is limited material, and this family is notoriously easy to misinterpret (G. Read, NIWA, pers. comm.)	
Polychaeta	Scolecida	Maldanidae	*Asychis Asychis*-B	No	
Polychaeta	Spionida	Spionidae	*Paraprionospio Paraprionospio*-A [*pinnata*]	No	
Bryozoa					
Gymnolaemata	Cheilostomata	Celleporidae	*Celleporina* sp. THH *	Yes	

* THH = Taharoa specimens. This is a new, undescribed species. Further taxonomic investigation is required to confirm its identity, including whether the specimens of *Celleporina* sp. from Taharoa are the same species as those found in other parts of the country (D. Gordon, NIWA, pers. comm.).

Table 15: Indeterminate taxa recorded from the Taharoa Terminal in the first baseline port survey. Also indicated is whether the taxon was recorded from the desktop review of existing marine species records from Taharoa and nearby locations.

Class	Order	Family	Taxon name	Recorded in desktop review?
Unknown				
?			Diatoms	
?			Egg mass	
?			Unidentifiable	
?			Unidentified algae	
Annelida				
Polychaeta			Polychaeta	
Polychaeta	Eunicida	Lumbrineridae	Lumbrineridae Indet	
Polychaeta	Phyllodocida	Goniadidae	Goniadidae	
Polychaeta	Phyllodocida	Nephtyidae	*Nephtys*	
Polychaeta	Phyllodocida	Phyllodocidae	*Eulalia*	
Polychaeta	Phyllodocida	Phyllodocidae	Phyllodocidae Indet	
Polychaeta	Scolecida	Maldanidae	Maldanidae	
Polychaeta	Terebellida	Ampharetidae	Ampharetidae	
Arthropoda				
?			Crustacea	
Malacostraca	Amphipoda		Amphipoda	
Malacostraca	Amphipoda	Lysianassidae	Lysianassidae sp.	
Malacostraca	Amphipoda	Oedicerotidae	Oedicerotidae	
Malacostraca	Amphipoda	Stegocephalidae	Stegocephalidae	
Malacostraca	Cumacea		Cumacea	
Malacostraca	Decapoda		Brachyura	
Malacostraca	Decapoda	Paguridae	*Pagurus* sp.	
Malacostraca	Isopoda	Idoteidae	*Euidotea*	
Malacostraca	Tanaidacea		*Tanaidacea* sp.	
Ostracoda			Ostracoda	
Pycnogonida			Pycnogonida	
Bacillariophyta				
Bacillariophyceae	Achnanthales	Cocconeidaceae	*Cocconeis*	
Bacillariophyceae	Bacillariales	Bacillariaceae	*Nitzschia*	
Bacillariophyceae	Bacillariales	Bacillariaceae	*Pseudo-nitzschia*	
Bacillariophyceae	Naviculales	Naviculaceae	*Amphora*	
Bacillariophyceae	Naviculales	Naviculaceae	*Diploneis*	
Bacillariophyceae	Naviculales	Naviculaceae	*Navicula*	
Bacillariophyceae	Naviculales	Pleurosigmataceae	*Gyrosigma*	
Bacillariophyceae	Naviculales	Pleurosigmataceae	*Pleurosigma*	
Coscinodiscophyceae	Chaetocerotales	Chaetocerotaceae	*Chaetoceros*	
Coscinodiscophyceae	Coscinodiscales	Coscinodiscaceae	*Coscinodiscus*	
Coscinodiscophyceae	Coscinodiscales	Heliopeltaceae	*Actinoptychus*	
Coscinodiscophyceae	Leptocylindrales	Leptocylindraceae	*Leptocylindrus*	
Coscinodiscophyceae	Melosirales	Hyalodiscaceae	*Hyalodiscus*	
Coscinodiscophyceae	Melosirales	Melosiraceae	*Melosira*	
Coscinodiscophyceae	Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia*	
Coscinodiscophyceae	Thalassiosirales	Skeletonemaceae	*Detonula*	
Coscinodiscophyceae	Thalassiosirales	Skeletonemaceae	*Skeletonema*	
Coscinodiscophyceae	Thalassiosirales	Thalassiosiraceae	*Thalassiosira*	
Fragilariophyceae	Fragilariales	Fragilariaceae	*Fragilaria*	
Fragilariophyceae	Thalassionemales	Thalassionemataceae	*Thalassionema*	

Class	Order	Family	Taxon name	Recorded in desktop review?
Bryozoa				
?			Unidentified bryozoan	
Gymnolaemata	Ctenostomata	Alcyonidiidae	Alcyonidium	
Gymnolaemata	Ctenostomata	Triticellidae	*Triticella*	
Stenolaemata	Cyclostomata	Tubuliporidae	*Tubulipora* sp.	
Chlorophyta				
Ulvophyceae	Bryopsidales	Codiaceae	*Codium* sp.	
Ulvophyceae	Cladophorales	Cladophoraceae	*Cladophora* sp.	
Ulvophyceae	Cladophorales	Cladophoraceae	*Cladophora* sp.?	
Ulvophyceae	Ulvales	Ulvaceae	*Ulva* sp.	
Chordata				
Actinopterygii	Salmoniformes	Galaxiidae	*Galaxias* sp.	
Ascidiacea			Ascidiacea	
Cnidaria				
Hydrozoa			Hydrozoa	
Hydrozoa	Hydroida		Hydroida	
Cyanobacteria				
?			Cyanobacteria	
Echinodermata				
Ophiuroidea			Ophiuroidea	
Asteroidea			Asteroidea	
Echinoidea	Echinoida		Echinoida	
Holothuroidea			Holothuroidea	
Entoprocta				
Kamptozoa	Coloniales	Pedicellinidae	*Pedicellina*	
Mollusca				
?			Mollusca	
Bivalvia	Myoida	Hiatellidae	*Hiatella*	
Bivalvia	Ostreoida	Ostreidae	Ostreidae	
Gastropoda			Gastropod	
Gastropoda	Thecosomata		Thecosomata	
Dinophyceae	Gymnodiniales	Gymnodiniaceae	*Gymnodinium*	
Dinophyceae	Peridiniales	Ceratiaceae	*Ceratium*	
Dinophyceae	Peridiniales	Gonyaulacaceae	*Gonyaulax* sp.	
Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium* sp.	
Dinophyceae	Peridiniales (?)		Peridiniales (?)	
Dinophyceae	Prorocentrales	Prorocentraceae	*Prorocentrum*	
Nemertea				
?			Nemertea	
Ochrophyta				
Phaeophyceae	Dictyotales	Dictyotaceae	*Zonaria*	
Phaeophyceae	Ectocarpales		Ectocarpales	
Phaeophyceae	Ectocarpales	Ectocarpaceae	*Ectocarpus* sp.	
Phaeophyceae	Sphacelariales	Stypocaulaceae	*Halopteris* sp.	
Xanthophyceae	Vaucheriales	Vaucheriaceae	Vaucheria	
Rhodophyta				
Bangiophyceae	Erythropeltidales		Erythropeltidales [1]	
Florideophyceae	Acrochaetiales	Acrochaetiaceae	*Audouinella* sp.	
Florideophyceae	Ceramiales		Ceramiales	
Florideophyceae	Ceramiales	Ceramiaceae	*Ceramium* sp.	
Florideophyceae	Ceramiales	Ceramiaceae	*Griffithsia* sp.	
Florideophyceae	Ceramiales	Dasyaceae	*Dasya* sp.	
Florideophyceae	Ceramiales	Rhodomelaceae	*Lophosiphonia*	

Class	Order	Family	Taxon name	Recorded in desktop review?
Florideophyceae	Ceramiales	Rhodomelaceae	*Polysiphonia* sp.	
Florideophyceae	Ceramiales	Rhodomelaceae	*Pterosiphonia*	
Florideophyceae	Corallinales	Corallinaceae	*Corallina*	
Florideophyceae	Corallinales	Corallinaceae	*Jania* sp.	
Florideophyceae	Plocamiales	Plocamiaceae	*Plocamium* sp.	
Florideophyceae	Rhodymeniales	Rhodomeniaceae	*Rhodymenia* sp.	
Sipuncula				
?			Sipuncula	

Table 16: Depth class and method of collection for each NIS and C1 species collected during the Taharoa port survey. Data are numbers of samples each species occurred in.

Species	Biosec. status	Method*	Intertidal	0 – 10 m	>10 – 20 m	>20 – 30 m	>30 – 40 m	Total
Alexandrium affine	C1	PHYT		1				1
Alexandrium catenella	C1	PHYT		1				1
Alexandrium tamarense	C1	CYST		2				2
Alexandrium ostenfeldii	C1	CYST		1	1			2
Austromegabalanus nigrescens	NIS	PSC		28				28
Ceramium cliftonianum	C1	ANCH					1	35
		PSC		34				
Chondropsis topsentii	C1	VISD			1			1
Clytia hemisphaerica	C1	PSC		1				1
Diplosoma listerianum	C1	PSC		2				2
Electra angulata	NIS	ANCH				2	2	5
		BSLD				1		
Elodea Canadensis	NIS	WRACK	1					1
Gymnodinium catenatum	C1	CYST			6	5	3	14
Heteromastus filiformis	C1	ANCH					1	1
Obelia dichotoma	C1	PSC		10				10
Polysiphonia brodiei	NIS	ANCH					1	35
		PSC		34				
Polysiphonia aff. *sertularioides* THH	NIS	PSC		2				2
Polysiphonia subtilissima	NIS	PSC		1				1
Scruparia ambigua	C1	PSC		2				2
Total number of NIS & C1 records			**1**	**113**	**8**	**8**	**8**	**138**
Proportion of all NIS & C1 records (%)			**0.7**	**81.9**	**5.8**	**5.8**	**5.8**	**100**
Total number of NIS & C1 taxa			**1**	**13**	**3**	**2**	**5**	**18**
Proportion of all NIS & C1 taxa (%)			**5.6**	**72.2**	**16.7**	**11.1**	**27.8**	**#**

* Survey methods: ANCH = Anchor box dredge for benthic infauna; BSLD = benthic sled; PSC = quadrat scrapings on mooring buoy; VISD = qualitative visual survey; CYST = dinoflagellate cyst core; PHYT = phytoplankton net tow; WRACK = beach wrack survey.

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 17: Depth class and method of collection for each native species collected during the Taharoa port survey. Data are numbers of samples each species occurred in.

Species	Method*	Intertidal	0 - 10 m	>10 - 20 m	>20 - 30 m	>30 - 40 m	Total
Achelia assimilis	ANCH				1		1
Actinoptychus senarius	PHYT		38				38
Aetea australis	PSC		6				6
Aglaophamus macroura	ANCH		7	12	11	9	39
Aglaophamus verrilli	ANCH				1	7	8
Aglaophenia acanthocarpa	ANCH			1			1
	BSLD			1			1
Akashiwo sanguinea	PHYT		2				2
Alcithoe swainsoni	CRBTP					1	1
Aldrichetta forsteri	SEINE		3				3
Amalda australis	ANCH		1	8	7	8	24
	BSLD		1	2	3		6
Amalda depressa	ANCH		1	8		1	10
	BSLD			1			1
Ampharete kerguelensis	ANCH			4	3	3	10
	BSLD			1			1
Amphiprora alata	PHYT		2				2
Amphisbetia bispinosa	ANCH				1		1
Amphisbetia fasciculata	ANCH			2	1	2	5
Amphiura eugenie	ANCH				9	15	24
Antithamnionella adnata	PSC		2				2
Aristoptilon mooreanum	VISD			1			1
Armandia maculata	ANCH				1		1
Arthrocardia corymbosa	ANCH			1	2		3
	BSLD			2	1		3
Asteromphalus flabellatus	PHYT		47				47
Atherinomorus lacunosa	POIS					1	1
	SEINE		2				2
Austrofusus glans	ANCH				6	9	15
	BSLD				2		2
	CRBTP					10	10
	CYST			1			1
Austrominius modestus	PSC		36				36
Bacteriastrum delicatulum	PHYT		1				1
Callianassa filholi	BSLD			1			1
Carpophyllum maschalocarpum	BSLD		1				1
	CYST			1			1
Carpophyllum plumulosum	ANCH			1			1
	VISD			1			1
Cassidina typa	ANCH				2	1	3
	BSLD				2		2
Celleporella tongima	ANCH					1	1
Cephaloscyllium isabellum	CRBTP					1	1
Cerataulina pelagica	PHYT		5				5
Ceratium arietinum	PHYT		11				11
Ceratium candelabrum	PHYT		4				4
Ceratium furca	PHYT		10				10
Ceratium fusus	PHYT		23				23
Ceratium horridum	PHYT		3				3

Species	Method*	Intertidal	0 - 10 m	>10 - 20 m	>20 - 30 m	>30 - 40 m	Total
Ceratium tripos	PHYT		34				34
Chaetoceros affinis	PHYT		1				1
Chaetoceros concavicornis	PHYT		1				1
Chaetoceros convolutus	PHYT		1				1
Chaetoceros decipiens	PHYT		8				8
Cheilonereis peristomialis	SHRTP					1	1
Chondria macrocarpa	ANCH			1			1
Cladhymenia coronata	BSLD			1			1
Cladhymenia oblongifolia	VISD			1			1
Cladostephus spongiosus	VISD			1			1
Cleantis tubicola	BSLD			1			1
Codium fragile	PSC		1				1
Corallina officinalis	ANCH			1			1
	BSLD			1			1
Corethron criophilum	PHYT		3				3
Coscinasterias muricata	PSC		2				2
Coscinodiscus wailesii	PHYT		38				38
Crassimarginatella papulifera	PSC		7				7
Dasyclonium harveyanum	VISD			1			1
Dentalium nanum	ANCH				4	2	6
Diadumene neozelandica	PSC		4				4
Dicathais orbita	PSC		2				2
Dictyocha fibula	PHYT		13				13
Dinophysis acuta	PHYT		4				4
Dinophysis rotundata	PHYT		4				4
Dinophysis tripos	PHYT		16				16
Diplopsalis lenticula	PHYT		13				13
Dipterosiphonia heteroclada	BSLD			1			1
Distephanus speculum	PHYT		27				27
Ditylum brightwelli	PHYT		32				32
Divalucina cumingi	ANCH				1		1
Dosinia anus	ANCH		1	5	1	1	8
	BSLD		1				1
Endarachne binghamiae	VISD			1			1
Epopella plicata	PSC		2				2
Evechinus chloroticus	VISD			1			1
Fellaster zelandiae	ANCH		7	7			14
	BSLD			1			1
Forsterygion varium	POIS					1	1
Galaxias maculatus	SEINE		1				1
Galeolaria hystrix	PSC		1				1
Gari lineolata	ANCH					1	1
Glossophora kunthii	VISD			1			1
Glycera lamelliformis	ANCH					2	2
Glycera russa	ANCH		2	2	1	1	6
Glycinde trifida	ANCH			1	2	2	5
Goniada echinulata	ANCH				2	1	3
Grammatophora marina	PHYT		1				1
Guinardia flaccida	PHYT		29				29
Gymnodinium abbreviatum	PHYT		1				1
Haliptilon roseum	ANCH		1	2	2		5
	BSLD			1	1		2

Species	Method*	Intertidal	0 - 10 m	>10 - 20 m	>20 - 30 m	>30 - 40 m	Total
Hemiaulus kauckii	PHYT		1				1
Hiatella arctica	ANCH				1		1
	PSC		2				2
Hincksia granulosa	PSC		20				20
Holognathus stewarti	BSLD				1		1
Hydractinia novaezelandiae	ANCH					2	2
Hydrodendron mirabile	PSC		1				1
Hymenosoma depressum	BSLD					2	2
Immergentia zelandica	ANCH				1		1
Lauderia annulata	PHYT		14				14
Lemna minor	WRACK	1					1
Lepidonotus polychromus	PSC		1				1
Lingulodinium polyedrum	CYST					3	3
Lithodesmium undulatum	PHYT		14				14
Lophopagurus (A.) cooki	ANCH				6	12	18
	BSLD					4	4
	CRBTP					2	2
Lophopagurus laurentae	ANCH					1	1
Lumbrineris sphaerocephala	PSC		4				4
Macrochiridothea uncinata	ANCH		1				1
	BSLD		1				1
Maorimactra ordinaria	ANCH			1	1	2	4
Melanthalia abscissa	VISD			1			1
Meuniera membranacea	PHYT		13				13
Micrelenchus huttonii	ANCH				1		1
Myadora striata	ANCH			14			14
Mycale (Carmia) tasmani	PSC		4				4
Natatolana narica	SHRTP					11	11
Natatolana sp.	ANCH				1		1
	BSLD					1	1
Neoguraleus amoenus	ANCH					1	1
Neosabellaria kaiparaensis	ANCH				4	7	11
Nitzschia closterium	PHYT		2				2
Nitzschia longissima	PHYT		3				3
Noctiluca scintillans	PHYT		6				6
Notomegabalanus decorus	PSC		10				10
Nucula nitidula	ANCH			4	23	26	53
	BSLD		1				1
Odontella mobiliensis	PHYT		21				21
Odontella sinensis	PHYT		6				6
Ogyrides delli	ANCH			1		3	4
Onuphis aucklandensis	ANCH		1		2	4	7
Opaeophora lepida	ANCH					1	1
Ophiopterus antipodum	PSC		1				1
Ovalipes catharus	ANCH			2	1		3
Owenia petersenae	ANCH					3	3
Paguristes setosus	ANCH			6	16	18	40
	BSLD		1	4	2		7
	CRBTP					1	1
Pagurus albidianthus	ANCH		1	5	1	3	10
	BSLD			4	1		5

Species	Method*	Intertidal	0 - 10 m	>10 - 20 m	>20 - 30 m	>30 - 40 m	Total
Pagurus novizealandiae	BSLD			1			1
	CRBTP					7	7
Parablennius laticlavius	POIS					1	1
Peltorhamphus novaezeelandiae	BSLD			1			1
Perinereis camiguinoides	PSC		5				5
Perna canaliculus	PSC		40				40
Pervicacia tristis	ANCH			3	1	1	5
	BSLD					1	1
Phenotoma zealandica	ANCH				1		1
Philine powelli	ANCH			1			1
Philocheras australis	ANCH			1			1
	BSLD				1		1
Philocheras pilosoides	ANCH					1	1
Phylo novazealandiae	ANCH					1	1
Pinnotheres novaezelandiae	ANCH		1	2	1		4
Plagusia chabrus	PSC		12				12
	VISD			1			1
Platynereis australis group	PSC		1				1
Plaxiphora caelata	PSC		4				4
Plesiothoa trigemma	PSC		1				1
Podolampas bipes	PHYT		3				3
Podolampas palmipes	PHYT		6				6
Polykrikos schwartzii	PHYT		1				1
Potamogeton crispus	WRACK	1					1
Potamopyrgus antipodarum	BCOR		2				2
Prionospio australiensis	ANCH				1		1
Prorocentrum gracile	PHYT		2				2
Prorocentrum micans	PHYT		10				10
Prorocentrum ovum	PHYT		29				29
Protoperidinium avellana	CYST		2		4	2	8
Protoperidinium brevipes	PHYT		1				1
Protoperidinium cerasus	PHYT		1				1
Protoperidinium curtipeds	PHYT		8				8
Protoperidinium depressum	PHYT		8				8
Protoperidinium leonis	PHYT		15				15
Protoperidinium pellucidum	PHYT		2				2
Protoperidinium punctulatum	CYST		1	2	4	2	9
Protoperidinium pyroforme	PHYT		4				4
Protoperidinium steinii	PHYT		5				5
Protoperidinium subinerme	CYST			2			2
Pseudaega quarta	ANCH				2		2
Pseudaega secunda	ANCH				1		1
Pseudarcturella crenulata	ANCH				4	2	6
Pseudidotea richardsoni	ANCH			1	2		3
Pseudo-nitzschia australis	PHYT		39				39
Pterocladia lucida	BSLD			1			1
	VISD			1			1
Pyrocystis lunula	PHYT		7				7
Retropinna retropinna	SEINE		3				3
Rhizosolenia alata	PHYT		43				43
Rhizosolenia imbricata	PHYT		15				15
Rhizosolenia robusta	PHYT		8				8

Species	Method*	Intertidal	0 - 10 m	>10 - 20 m	>20 - 30 m	>30 - 40 m	Total
Rhizosolenia setigera	PHYT		5				5
Rhizosolenia stolterfothii	PHYT		3				3
Rhizosolenia styliformis	PHYT		3				3
Rhombosolea leporina	SEINE		1				1
Scalpomactra scalpellum	ANCH				4	4	8
Schizosmittina cinctipora	PSC		1				1
Scrippsiella trochoidea	CYST		2				2
	PHYT		3				3
Scytothamnus australis	VISD			1			1
Semicassis pyrum	ANCH			1	1		2
Sepioloidea pacifica	BSLD					1	1
Sigalion oviger	ANCH			9	3	1	13
Sigapatella tenuis	ANCH			1	7	8	16
Siphonaria australis	PSC		1				1
Skeletonema costatum	PHYT		3				3
Spiophanes modestus	ANCH			1			1
Spisula aequilatera	ANCH			9	5	13	27
	BSLD			1			1
Stephanopyxis orbicularis	PHYT		12				12
Stephanopyxis turris	PHYT		3				3
Sthenelais novaezealandiae	ANCH			7	7	5	19
	BSLD		1				1
Stichaster australis	VISD			1			1
Struthiolaria papulosa	ANCH				1		1
Stylonema alsidii	PSC		1				1
Tellinota edgari	ANCH					1	1
Tenagomysis longisquama	ANCH			1			1
	BSLD		2	1	3	3	9
Tenagomysis producta	BSLD					1	1
Tenagomysis tenuipes	ANCH		1				1
	BSLD			1		2	3
	PSC		2				2
Thalassionema frauenfeldii	PHYT		39				39
Thalassionema nitzschioides	PHYT		44				44
Thalassiosira decipiens	PHYT		14				14
Thalassiosira hyalina	PHYT		4				4
Thalassiosira rotula	PHYT		22				22
Torridoharpinia hurleyi	ANCH			1	2	4	7
Travisia kerguelensis	ANCH			15	5	2	22
Triceratium favus	PHYT		1				1
Vidalia colensoi	BSLD		1		1		2
	VISD			1			1
Waitangi rakiura	ANCH			1	3	1	5
Xenostrobus pulex	PSC		1				1
Xymene traversi	VISD			1			1
Total number of native records		**2**	**1042**	**192**	**193**	**252**	**1681**
Proportion of all native records (%)		**0.1**	**62.0**	**11.4**	**11.5**	**15.0**	**100.0**
Total number of native taxa		**2**	**123**	**62**	**55**	**60**	**212**
Proportion of all native taxa (%)		**0.9**	**58.0**	**29.2**	**25.9**	**28.3**	**#**

* Survey methods: ANCH = Anchor box dredge for benthic infauna; BCOR = large hand corer for benthic infauna; BSLD = benthic sled; PSC = quadrat scrapings on mooring buoy; VISD = qualitative visual survey; CYST = dinoflagellate cyst core; CRBTP = crab trap, SHRTP = shrimp trap; PHYT = phytoplankton net tow; POIS = fish poison station; SEINE = beach seine netting; WRACK = beach wrack survey.

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 Taharoa Terminal port survey are described in the “Methods” section of this current report and were agreed to by MAF Biosecurity New Zealand prior to the survey.

Appendix A: Sampling Procedures

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

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 (10mg.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 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 Taharoa Terminal initial port baseline survey

Site number	Site name	Sampling method #	Easting	Northing	Number of sample units
1	Mooring Outside 1	ANCH	2656563	6334996	1
1	Mooring Outside 1	ANCH	2656550	6335031	1
1	Mooring Outside 1	ANCH	2656518	6334941	1
1	Mooring Outside 1	ANCH	2656478	6334996	1
1	Mooring Outside 1	ANCH	2656602	6335241	2
1	Mooring Outside 1	BSLD	2655687	6335244	1
1	Mooring Outside 1	CYST	2656602	6335241	6
1	Mooring Outside 1	PHYT	2656591	6335166	3
1	Mooring Outside 1	POIS	2656602	6335241	1
1	Mooring Outside 1	PSC	2656591	6335166	17
1	Mooring outside 1	SEDIMENT	2656550	6335031	1
1	Mooring outside 1	SEDIMENT	2656478	6334996	1
1	Mooring Outside 1	ZOOP	2656591	6335166	3
2	Mooring Outside 2	ANCH	2656599	6335238	6
2	Mooring Outside 2	BSLD	2656516	6335241	1
2	Mooring Outside 2	CRBTP	2656529	6335215	6
2	Mooring Outside 2	CYST	2656599	6335238	6
2	Mooring Outside 2	PSC	2656599	6335238	16
2	Mooring Outside 2	SEDIMENT	2656599	6335238	2
2	Mooring Outside 2	SHRTP	2656529	6335215	6
3	Mooring Inside 1	ANCH	2656575	6335038	6
3	Mooring Inside 1	BSLD	2656570	6334925	1
3	Mooring Inside 1	CYST	2656575	6335038	6
3	Mooring Inside 1	PHYT	2656575	6335038	3
3	Mooring Inside 1	POIS	2656575	6335038	1
3	Mooring Inside 1	PSC	2656575	6335038	16
3	Mooring Inside 1	SEDIMENT	2656575	6335038	2
3	Mooring Inside 1	ZOOP	2656575	6335038	3
4	Mooring Inside 2	ANCH	2656438	6335063	6
4	Mooring Inside 2	BSLD	2656438	6335063	1
4	Mooring Inside 2	CRBTP	2656615	6335191	6
4	Mooring Inside 2	CYST	2656438	6335063	6
4	Mooring Inside 2	PSC	2656438	6335063	16
4	Mooring Inside 2	SEDIMENT	2656602	6335241	2
4	Mooring Inside 2	SHRTP	2656615	6335191	6
5	North Pipeline 1	ANCH	2656838	6335246	6
5	North Pipeline 1	BSLD	2656838	6335246	1
5	North Pipeline 1	CYST	2656838	6335246	6
5	North Pipeline 1	PHYT	2656838	6335246	3
5	North Pipeline 1	SEDIMENT	2656838	6335246	2
5	North Pipeline 1	ZOOP	2656838	6335246	3
6	North Pipeline 2	ANCH	2657993	6335227	6
6	North Pipeline 2	BSLD	2657993	6335227	1
6	North Pipeline 2	CYST	2657993	6335227	6
6	North Pipeline 2	SEDIMENT	2657993	6335227	2
7	North Pipeline 3	ANCH	2658614	6335250	6

Site number	Site name	Sampling method #	Easting	Northing	Number of sample units
7	North Pipeline 3	BSLD	2658614	6335250	1
7	North Pipeline 3	CYST	2658614	6335250	6
7	North Pipeline 3	PHYT	2658614	6335250	3
7	North Pipeline 3	SEDIMENT	2658614	6335250	2
7	North Pipeline 3	ZOOP	2658614	6335250	3
8	South Pipeline 1	ANCH	2658028	6334881	6
8	South Pipeline 1	BSLD	2658028	6334881	1
8	South Pipeline 1	CYST	2658028	6334881	6
8	South Pipeline 1	SEDIMENT	2658028	6334881	2
9	South Pipeline 2	ANCH	2658235	6335002	6
9	South Pipeline 2	BSLD	2658235	6335002	1
9	South Pipeline 2	CYST	2658235	6335002	6
9	South Pipeline 2	PHYT	2658235	6335002	3
9	South Pipeline 2	SEDIMENT	2658235	6335002	2
9	South Pipeline 2	ZOOP	2658235	6335002	3
10	South Pipeline 3	ANCH	2658741	6334965	6
10	South Pipeline 3	BSLD	2658741	6334965	1
10	South Pipeline 3	CYST	2658741	6334965	6
10	South Pipeline 3	SEDIMENT	2658741	6334965	2
11	Taharoa Lagoon Entrance	BCOR	2659584	6335039	6
11	Taharoa Lagoon Entrance	CYST	2659584	6335039	6
11	Taharoa Lagoon Entrance	SEDIMENT	2659584	6335039	6
11	Taharoa Lagoon Entrance	WRACK	2659584	6335039	3
12	Taharoa Lagoon South	BCOR	2659635	6335047	6
12	Taharoa Lagoon South	CRBTP	2659635	6335047	6
12	Taharoa Lagoon South	CYST	2659635	6335047	6
12	Taharoa Lagoon South	SEDIMENT	2659635	6335047	6
12	Taharoa Lagoon South	SEINE	2659635	6335047	3
12	Taharoa Lagoon South	SHRTP	2659635	6335047	6
12	Taharoa Lagoon South	WRACK	2659635	6335047	3
13	Taharoa Lagoon North	BCOR	2659651	6335332	6
13	Taharoa Lagoon North	CRBTP	2659651	6335332	6
13	Taharoa Lagoon North	CYST	2659651	6335332	6
13	Taharoa Lagoon North	SEDIMENT	2659651	6335332	6
13	Taharoa Lagoon North	SEINE	2659651	6335332	3
13	Taharoa Lagoon North	SHRTP	2659651	6335332	6
13	Taharoa Lagoon North	WRACK	2659651	6335332	3
15	Matauwai Stream	CRBTP	2659111	6336989	6
15	Matauwai Stream	CYST	2659111	6336989	3
15	Matauwai Stream	SHRTP	2659111	6336989	6
16	Within Harbour Limits North 1	ANCH	2657405	6337670	3
16	Within Harbour Limits North 1	BSLD	2657405	6337670	1
16	Within Harbour Limits North 1	CYST	2657405	6337670	3
16	Within Harbour Limits North 1	PHYT	2657405	6337670	3
16	Within Harbour Limits North 1	SEDIMENT	2657968	6336871	2
16	Within Harbour Limits North 1	ZOOP	2657405	6337670	3
17	Within Harbour Limits North 2	ANCH	2657968	6336871	3
17	Within Harbour Limits North 2	BSLD	2657968	6336871	1
17	Within Harbour Limits North 2	CYST	2657968	6336871	3
17	Within Harbour Limits North 2	PHYT	2657968	6336871	3

Site number	Site name	Sampling method #	Easting	Northing	Number of sample units
17	Within Harbour Limits North 2	SEDIMENT	2657968	6336871	2
17	Within Harbour Limits North 2	ZOOP	2657968	6336871	3
18	Within Harbour Limits North 3	ANCH	2657068	6335648	3
18	Within Harbour Limits North 3	BSLD	2657068	6335648	1
18	Within Harbour Limits North 3	CYST	2657068	6335648	3
18	Within Harbour Limits North 3	PHYT	2657068	6335648	3
18	Within Harbour Limits North 3	SEDIMENT	2657068	6335648	2
18	Within Harbour Limits North 3	ZOOP	2657068	6335648	3
19	Within Harbour Limits South 1	ANCH	2657134	6334330	3
19	Within Harbour Limits South 1	BSLD	2657134	6334330	1
19	Within Harbour Limits South 1	CYST	2657134	6334330	3
19	Within Harbour Limits South 1	PHYT	2657134	6334330	3
19	Within Harbour Limits South 1	SEDIMENT	2657134	6334330	2
19	Within Harbour Limits South 1	ZOOP	2657134	6334330	3
20	Within Harbour Limits South 2	ANCH	2656797	6333809	3
20	Within Harbour Limits South 2	BSLD	2656797	6333809	1
20	Within Harbour Limits South 2	CYST	2656797	6333809	3
20	Within Harbour Limits South 2	PHYT	2656797	6333809	3
20	Within Harbour Limits South 2	SEDIMENT	2656797	6333809	2
20	Within Harbour Limits South 2	ZOOP	2656797	6333809	3
21	Within Harbour Limits South 3	ANCH	2659225	6332668	3
21	Within Harbour Limits South 3	BSLD	2659225	6332668	1
21	Within Harbour Limits South 3	CYST	2659225	6332668	3
21	Within Harbour Limits South 3	PHYT	2659225	6332668	3
21	Within Harbour Limits South 3	SEDIMENT	2659225	6332668	2
21	Within Harbour Limits South 3	ZOOP	2659225	6332668	3
22	Outside Harbour Limits North	ANCH	2655980	6335536	3
22	Outside Harbour Limits North	BSLD	2655980	6335536	1
22	Outside Harbour Limits North	CYST	2655980	6335536	3
22	Outside Harbour Limits North	PHYT	2655980	6335536	3
22	Outside Harbour Limits North	SEDIMENT	2655980	6335536	2
22	Outside Harbour Limits North	ZOOP	2655980	6335536	3
23	Outside Harbour Limits South	ANCH	2655986	6334868	3
23	Outside Harbour Limits South	BSLD	2655986	6334868	1
23	Outside Harbour Limits South	CYST	2655986	6334868	3
23	Outside Harbour Limits South	PHYT	2655986	6334868	3
23	Outside Harbour Limits South	SEDIMENT	2655986	6334868	2
23	Outside Harbour Limits South	ZOOP	2655986	6334868	3
24	Anchorage 1	ANCH	2656064	6338926	3
24	Anchorage 1	BSLD	2656064	6338926	1
24	Anchorage 1	CYST	2656064	6338926	3
24	Anchorage 1	PHYT	2656064	6338926	3
24	Anchorage 1	SEDIMENT	2656064	6338926	2
24	Anchorage 1	ZOOP	2656064	6338926	3
25	Anchorage 2	ANCH	2656502	6338956	3
25	Anchorage 2	BSLD	2656502	6338956	1
25	Anchorage 2	CYST	2656502	6338956	3
25	Anchorage 2	PHYT	2656502	6338956	3
25	Anchorage 2	SEDIMENT	2656502	6338956	2
25	Anchorage 2	ZOOP	2656502	6338956	3

Site number	Site name	Sampling method #	Easting	Northing	Number of sample units
26	Motunau Rocks	CYST	2659099	6329000	3
26	Motunau Rocks	PHYT	2659099	6329000	3
26	Motunau Rocks	VISD	2659099	6329000	1
26	Motunau Rocks	ZOOP	2659099	6329000	3
27	Waioioi Reef	CYST	2657284	6341252	3
27	Waioioi Reef	PHYT	2657284	6341252	5
27	Waioioi Reef	VISD	2657284	6341252	1
27	Waioioi Reef	ZOOP	2657284	6341252	3

Survey methods: ANCH = Anchor box dredge for benthic infauna; BCOR = large hand corer for benthic infauna; BSLD = benthic sled; PSC = quadrat scrapings on mooring buoy; 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 MAF Biosecurity New Zealand that were not conducted

Site number	Site name	Sampling method*	Replicate(s)	Reason for not sampling
5	North Pipeline 1	POIS	1	Pipes usually covered by sand so no hard structures available to sample. Sites removed from survey design with approval by MAF Biosecurity New Zealand
7	North Pipeline 3	POIS	1	
9	South Pipeline 2	POIS	1	
11	Taharoa Lagoon Entrance	VISD	1	Very shallow site so diving not possible
11	Taharoa Lagoon Entrance	POIS	1	Very shallow freshwater stream - diving not possible. Site removed from survey design with approval by MAF BNZ
12	Taharoa Lagoon South	PHYT	1-3	Very shallow freshwater stream - plankton tows not possible. Site removed from survey design with approval by MAF BNZ
12	Taharoa Lagoon South	ZOOP	1-3	Very shallow freshwater stream - plankton tows not possible. Site removed from survey design with approval by MAF BNZ
12	Taharoa Lagoon South	VISD	1	Very shallow site so diving not possible
12	Taharoa Lagoon South	POIS	1	Very shallow freshwater stream - diving not possible. Site removed from survey design with approval by MAF BNZ
13	Taharoa Lagoon North	PHYT	1-3	Very shallow freshwater stream - plankton tows not possible.
13	Taharoa Lagoon North	ZOOP	1-3	Very shallow freshwater stream - plankton tows not possible.
13	Taharoa Lagoon North	VISD	1	Very shallow site so diving not possible
14	Waiohipa Stream	CYST, PHYT, ZOOP, CRBTP, SHRTP, VISD, POIS, SEINE, WRACK & Photos	All	Site not surveyed due to difficulty of access, time required to access site, and unsuitability as habitat for invasive species. Site removed from survey design with approval by MAF Biosecurity New Zealand.
15	Matauwai Stream	PHYT	1-3	Very shallow freshwater stream - plankton tows not possible.
15	Matauwai Stream	ZOOP	1-3	Very shallow freshwater stream - plankton tows not possible.
15	Matauwai Stream	VISD	1	Very shallow site so diving not possible
15	Matauwai Stream	POIS	1	Very shallow site so diving not possible
15	Matauwai Stream	SEINE	1-3	Stream <1 m wide - too narrow to seine net
15	Matauwai Stream	WRACK	2m, 5m and 10m from water edge	Very shallow site - unsuitable terrain

*Sampling methods: ANCH = Anchor box dredge for benthic infauna; BCOR = large hand corer for benthic infauna; BSLD = benthic sled; PSC = quadrat scrapings 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.

Appendix 4: Media Release circulated as part of the Public Awareness Programme

Media Release **31 August 2006**

Ports surveyed for marine pests

Researchers from the National Institute of Water & Atmospheric Research (NIWA) have recently surveyed ports at Milford Sound (Fiordland) and Taharoa Ironsands Terminal (Waikato) for foreign marine organisms.

The surveys were carried out in May and June as part of a nationwide port surveillance programme set up by Biosecurity New Zealand in 2001.

The surveys are designed to determine which non-native marine species have already become established and to develop a baseline for early detection of new pests. Additional surveillance surveys are targeted at eight problem species, two of which have been recorded in New Zealand.

A team of divers carried 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 also laid baited traps to collect crabs and shrimps. Video and still images were captured of seabed communities and fouling organisms to identify species growing on underwater structures such as wharf pilings.

The 1645 samples (1130 from Taharoa and 515 from Milford) are being distributed to experts in New Zealand and overseas for identification through Biosecurity New Zealand's Marine Invasives Taxonomic Service, managed by NIWA. This process will take several months.

Once identified, NIWA will report on each species' status (whether native, non-native, or of unknown status), its location at the surveyed ports, and its known distribution within New Zealand and globally. Biosecurity New Zealand will use this information to assess any management actions required. Their conclusions will be made publicly available.

'Port users and operators, including fishers and boat-owners, can play an active role in marine biosecurity by reporting the presence of new or unusual organisms to Biosecurity New Zealand', says NIWA survey project leader Dr Graeme Inglis.

To report suspicious finds, please phone the free Biosecurity New Zealand hotline:
0800 80 99 66.

For further information, please contact:

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Additional Information:

1. The Milford Sound survey was carried out from 7 to 14 June, covering the area from Deepwater Basin to Poison Bay.

2. The Taharoa Ironsands Terminal survey was carried out over 8 days from 23 May to 1 July. The survey area extended from Waioioi Reef to Waiohipa Stream.

3. The eight problem species targeted by additional surveillance are:
   - *Asterias amurensis* (North Pacific seastar)
   - *Carcinus maenas* (European shore crab),
   - *Caulerpa taxifolia* (aquarium weed)
   - *Eriochier sinensis* (Chinese mitten crab)
   - *Potamocorbula amurensis* (Asian clam)
   - *Sabella spallanzanii* (Mediterranean fanworm) *Styela clava* (clubbed tunicate - a seasquirt)*
   - *Undaria pinnatifida* (undaria – a type of seaweed)*

   * These species are known to be in New Zealand. The rest have not been recorded in New Zealand.

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 attached to each of their body segments as well as external gills. The anterior segments bear the tentacles used as sensory organs, tasting palps and eyespots, however, some are blind. 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 Arthropoda

The Arthropoda are a very large group of organisms, with well-known members including crustaceans, insects and spiders.

Crustaceans: The crustaceans (including Classes Malacostra, Cirripedia and other smaller classes) 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.

Pycnogonids: The pycnogonids, or sea spiders, are 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 millimetres to many centimetres and superficially resemble spiders found on land.

Phylum Bacillariophyta

Diatoms: Diatoms are abundant unicellular organisms that are capable of inhabiting marine and freshwater environments. Their cell walls are made of silica which form radial or bilaterally symmetrical patterns. They reproduce asexually and produce energy via photosynthesis.

Phylum Brachiopoda

Brachiopods have a shell consisting of two valves that enclose the animal. Most living brachiopods are fixed to the substrate with a leathery holdfast called a pedicle. They feed via a lophophore; a cartilage based fan with flexible filaments. They are specialists in nutrient poor environments, have low metabolic rates and very small body to lophophore ratios.

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.

Phyla Chlorophyta, Rhodophyta and Ochrophyta

Macroalgae: Marine macroalgae are highly diverse and are grouped under several phyla. The green algae are in phylum Chlorophyta; red algae are in phylum Rhodophyta, and the brown algae are in phylum Ochrophyta. Whilst the green and red algae fall under Kingdom Plantae, the brown algae (Phylum Ochrophyta) are grouped in the Kingdom Chromista. Despite their disparate systematics, most red, green and brown algae perform many similar ecological functions. 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.

Phylum Chordata

Ascidiacea: Ascidians are sometimes referred to as 'sea squirts' or 'tunicates'. 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.

Actinopterygii: The class Actinopterygii refers to the ray-finned fishes. This is an extremely diverse group. Approximately 200 families of fish are represented in New Zealand waters ranging from tropical and subtropical groups in the north to sub Antarctic groups in the south. They can be classified ecologically according to depth habitat preferences; for example, fish that live on or near the sea floor are considered demersal while those living in the upper water column are termed pelagics.

Elasmobranchii: The class Elasmobranchii are one of two classes of cartilaginous fishes, including sharks, skates and rays.

Phylum Cyanobacteria

Cyanobacteria or blue-green algae are photosynthetic prokaryotes. They form a pigment during photosynthesis that leads to their blue-green colour and some species are also capable of fixing nitrogen under certain circumstances. They lack cilia and perform locomotion by gliding across surfaces. They also possess thick cell walls to protect them from desiccation. They show considerable morphological diversity and are found in a wide variety of terrestrial and aquatic habitats.

Phylum Cnidaria

Anthozoa: The class Anthozoa includes the true corals, sea anemones and sea pens.

Hydrozoa: The class Hydrozoa includes hydroids, fire corals and many medusae. Of these, only hydroids were recorded in the port surveys. 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.

Scyphozoa: Scyphozoans are the true jellyfish.

Phylum Echinodermata

Echinoderms: The phylum echinodermata is made up of five classes. They are: Crinoidea (sea lilies), Asteroidea (sea stars), Holothuroidea (sea cucumbers), Ophiuroidea (brittle stars), and Echinoidea (sea urchins). This phylum is an exclusively marine phylum that lack eyes or brains but have radially symmetrical body plans. Their most notable features are their external calcareous plates and spines from which they get their name (Echinoderm means ‘spiny-skinned’). Internally they are unique as well with a hydraulic water vascular system that controls their movement and is monitored by the madreporite which controls their intake of water. They occupy a wide range of habitats including subtidal and intertidal zones.

Phylum Entoprocta
Superficially this phylum is very similar to the Bryozoans and both are referred to as moss animals. There are about 60 known species worldwide and all of them are small with no individual exceeding 1.5mm in length. They live in moss-like colonies containing thousands of individuals, forming mats of considerable size. Each animal is crowned with a circlet of ciliated tentacles, within which lies the mouth. The defining characteristic between entoprocts and bryozoans is the location of the anal opening. In entoprocts it is within the crown circlet, in bryozoans the anus is located outside the tentacles.

Phylum Haptophyta
Most species from this phylum are single-celled flagellates, also having amoeboid, coccoid, palmelloid or filamentous stages. The cells are golden or yellow-brown due to the presence of accessory pigments. It usually has two flagella of equal or sub equal length both of which are smooth and an appendage between them called a haptonema which may be used for capturing food. The surface of the cell is covered in granules and calcified scales may potentially be visible under a light microscope.

Phylum Magnoliophyta
Seagrasses: The Magnoliophyta are the flowering plants, or angiosperms. Most of these are terrestrial, but the Magnoliophyta also include marine representatives – the seagrasses. The only Mangnoliophyte encountered in the port surveys was the seagrass *Zostera*.

Phylum Mollusca
Molluscs: There are 4 main classes of Mollusca which include Polyplacophora (Chitons), Gastropoda (marine snails, sea hares, nudibranchs and limpets), Bivalvia (mussels, clams, oysters), and Cephalopoda (squid, cuttlefish and octopus). They are a highly diverse group of marine animals characterised by the presence of an external or internal shell. There are two structures in this phylum that are found no where else in the animal kingdom; they are the mantle and the radula. The mantle is a fold in the body wall that secretes the calcareous shell which is typical of the phylum. The radula is a toothed, tongue or ribbon like organ variously modified for special feeding techniques.

Phylum Myzozoa
Dinoflagellates: Dinoflagellates are a large group of unicellular algae that live in the water column or within the sediments. 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 Nemertea
Ribbon worms: The ribbon worms are cylindrical to somewhat flattened, highly contractile, soft-bodied, unsegmented worms. Generally they are small but a few species can reach up to 6m in length. They are usually very slender, brightly coloured, and have an unusual anterior proboscis equipped with a sharp spine to capture prey. They live by either burrowing in sand,

living in algal clumps or mats or in oyster shells. They reproduce sexually as well as asexually by fragmentation.

Phylum Platyhelminthes

Flatworms: The flatworms are unsegmented, flattened, and very soft-bodied. The mouth is located ventrally near the midpoint of the animal or at the anterior end. There are three Classes of flatworm; Turbellaria, Trematoda, and the Cestoda. Many are very small but some can reach considerable sizes and they range in colour from very drab, transparent animals to ones with bright colours.

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 are a taxonomically difficult group of marine invertebrates. Most sponges possess skeletal support from need-like spicules and 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 Sipuncula

Sipunculids: The phylum Sipuncula (peanut worms) is a group of unsegmented, marine coelomates that are closely related to annelids and molluscs. They have two body regions: a trunk and a more slender proboscis or introvert. This introvert lies enrolled in the body cavity of the animal giving it an oval or peanut shape and only when it is feeding does the introvert fold out. They have a variety of epidermal structures, such as papillae, hooks and shields. They live in a variety of habitats including burrows in silt and sand, under rock crevices and some species bore into coral or soft rock. They have also been known to inhabit the empty shells and tubes of other species.

Appendix 6. Species information sheets for each non-indigenous and cryptogenic category 1 species recorded from the Taharoa Terminal port 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 and cryptogenic category one (C1) taxa 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
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[5]. 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 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 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.

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.

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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

[5] 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.

Appendix 7. Species x sample x site results for all taxa recorded by each method from the Taharoa Terminal 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 anchor box dredge samples.

Appendix 7c: Results from the dinoflagellate cyst core samples.

Appendix 7d: Results from the fish trap samples.

Appendix 7e: Results from the crab trap samples.

Appendix 7f: Results from the seastar trap samples.

Appendix 7g: Results from the shrimp trap samples.

Appendix 7h: Results anchor box dredge samples.

Appendix 7i: Results from beach wrack surveys

Appendix 7j: Results from the wharf piling miscellaneous searches.