Gulf Harbour Marina

Second baseline survey for non-indigenous marine species (Research Project ZBS2005/18)

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Executive summary

- This report describes the results of a repeat port baseline survey of the Gulf Harbour Marina undertaken in April 2006. The survey provides a second inventory of native, non-indigenous and cryptogenic marine taxa within the port and compares the biota with that recorded during an earlier port baseline survey of the Gulf Harbour Marina undertaken in April 2003.

- The survey is part of a nationwide investigation of native and non-native marine biodiversity in 25 international shipping ports and five marinas of first entry for yachts entering New Zealand from overseas.

- To allow a direct comparison between the initial baseline survey and the resurvey of the Gulf Harbour Marina, the survey used the same methodologies and sampled the same sites (where possible) as in the initial baseline survey. To improve the description of the biota of the marina, some additional survey sites were added during the repeat survey.

- Sampling methods used in both surveys were based on protocols developed by the Australian Centre for Research on Introduced Marine Pests (CRIMP) for baseline surveys of non-indigenous species (NIS) in ports. Modifications were made to the CRIMP protocols for use in New Zealand port and marina conditions. These are described in more detail in the body of the report.

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

- Sampling effort was distributed in the Gulf Harbour Marina according to priorities identified in the CRIMP protocols, which are designed to maximise the chances of detecting non-indigenous species. Most effort was concentrated on high-risk locations and habitats where non-indigenous species were most likely to be found.

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

- As a result of ongoing taxonomic work, some identifications made during the initial baseline survey of the Gulf Harbour Marina have undergone revision since the publication of that report. The revised data indicate that a total of 123 species or higher taxa were identified in the first survey of the Gulf Harbour Marina in April 2003. They consisted of 78 native species, 14 non-indigenous species, 17 cryptogenic taxa (those whose geographic origins are uncertain) and 14 indeterminate taxa (taxa for which there is insufficient taxonomic or systematic information available to allow identification to species level).

- During the repeat survey, 146 species or higher taxa were recorded, including 79 native species, 23 non-indigenous species, 13 cryptogenic taxa and 31 indeterminate taxa. Many species were common to both surveys. Around 54 % of the native species, 48 % of the non-indigenous species and 46 % of the cryptogenic taxa recorded during the repeat survey were also found in the earlier survey.

- The 23 non-indigenous species found in the repeat survey of the Gulf Harbour Marina included representatives of six phyla. The non-indigenous species detected were: (Annelida) *Hydroides ezoensis, Hydroides elegans, Pseudopolydora corniculata, Pseudopolydora paucibranchiata*; (Arthropoda) *Apocorophium acutum, Monocorophium acherusicum, Amphibalanus amphitrite*; (Bryozoa) *Bugula neritina, B. stolonifera, Schizoporella errata, Watersipora subtorquata, Watersipora arcuata, Celleporaria aperta, Bowerbankia gracilis, Scrupocellaria* n. sp.*, Zoobotryon verticillatum*; (Chordata) *Ascidiella aspersa, Diplosoma listerianum, Styela clava* (Mollusca) *Musculista senhousia*, *Crassostrea gigas*, *Theora lubrica*; and (Porifera) *Vosmaeropsis* cf. *macera*. Eleven of these species - *Pseudopolydora corniculata, Pseudopolydora paucibranchia, Monocorophium acherusicum, Amphibalanus amphitrite, Bugula stolonifera, Watersipora arcuata, Celleporaria apera, Bowerbankia gracilis, Diplosoma listerianum, Styela clava* and *Musculista senhousia* - were not recorded in the earlier baseline survey of the Gulf Harbour Marina. In addition, three non-indigenous species that were recorded in the first survey – (Arthropoda) *Ericthonius pugnax*; (Mollusca) *Limaria orientalis* and (Ochrophyta) *Cutleria multifida* – were not found during the repeat survey.

- No species recorded in the repeat survey were new records for New Zealand waters.

- One species recorded during the second survey of the Gulf Harbour Marina – the club tunicate *Styela clava* - is on the New Zealand Register of Unwanted Organisms.

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

- Approximately 58 % (15 of 26 species) of NIS recorded in the two Gulf Harbour Marina baseline surveys are likely to have been introduced in biofouling assemblages, 2 % (one species) via ballast water and 31 % (eight species) could have been introduced by either ballast water or biofouling vectors and for 2 % (one species) the method of introduction is unknown.

- The predominance of biofouling species in the introduced biota of the Gulf Harbour Marina (as opposed to ballast water introductions) is consistent with findings from similar port baseline studies overseas and 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, marinas 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, an additional 41 non-indigenous species or suspected non-indigenous species (i.e. Cryptogenic type 1 – see "Definitions of species categories", in 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. As part of its comprehensive five-year Biodiversity Strategy package on conservation, environment, fisheries, and biosecurity released in 2000, the New Zealand Government funded a national series of baseline surveys. These surveys aimed to determine the identity, prevalence and distribution of native, cryptogenic and non-indigenous species in New Zealand's major shipping ports and other high risk points of entry for vessels entering New Zealand from overseas. The government department responsible for biosecurity in the marine environment at the time, the New Zealand Ministry of Fisheries (MFish), commissioned NIWA to undertake biological baseline surveys in 13 ports and three marinas that are first ports of entry for vessels entering New Zealand from overseas (Figure 1). Marine biosecurity functions are now vested in MAF Biosecurity New Zealand.

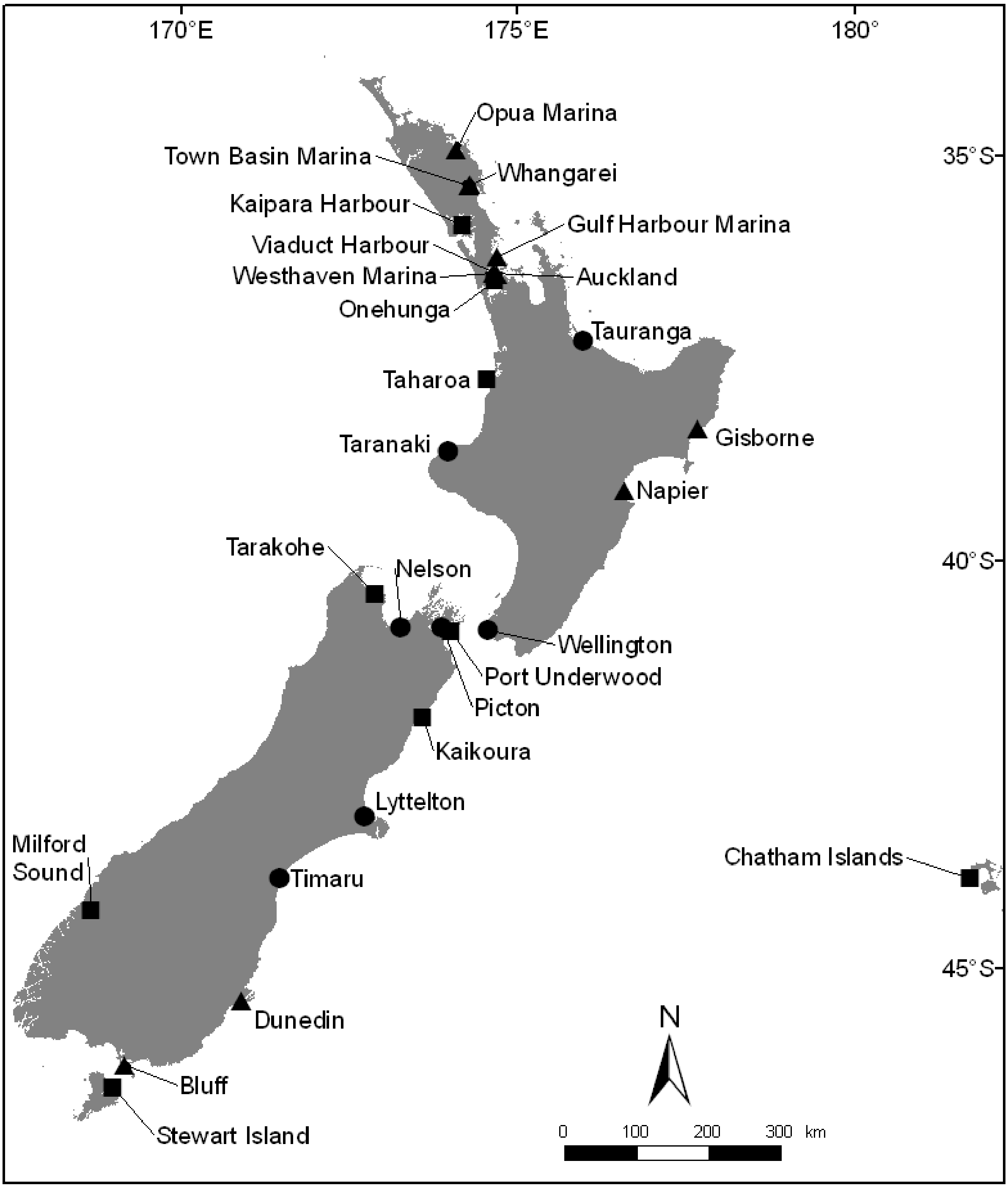

Figure 1: Commercial shipping ports in New Zealand where baseline non- indigenous species surveys have been conducted. Group 1 ports (circles) were surveyed in the summer of 2001/2002 and resurveyed in the summer of 2004/2005, Group 2 ports (triangles) were surveyed in the summer of 2002/2003 and resurveyed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

The New Zealand baseline port surveys were based on protocols developed in Australia by the CSIRO Centre for Research on Introduced Marine Pests (CRIMP) for port surveys of introduced marine species (Hewitt and Martin 1996; Hewitt and Martin 2001). They are best described as "*generalised pest surveys*", as they are broad-based investigations whose primary purpose is to identify and inventory the range of non-indigenous species present in a port (Wittenberg and Cock 2001; Inglis *et al*. 2003).

The surveys have two stated objectives:

i. To provide a baseline assessment of native, non-indigenous and cryptogenic[1] species, and
ii. To determine the distribution and relative abundance of a limited number of target species in shipping ports and other high risk points of entry for non-indigenous marine species (Hewitt and Martin 2001).

Initial surveys were completed in New Zealand's 13 major shipping ports and three marinas of first entry during the summers of 2001/2002 and 2002/2003 (Figure 1). These 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 during the surveys and await more formal taxonomic description. These 16 locations were subsequently resurveyed in the summers of 2004/05 and 2005/06 to establish changes in the number and identity of non-indigenous species present.

In 2005, MAF Biosecurity New Zealand extended the national port baseline surveys to a range of secondary, domestic and international ports and marinas within New Zealand ("Group 3 ports"; Figure 1) to increase our knowledge of the non-indigenous marine species present in regional nodes for shipping.

Worldwide, port surveys based on the CRIMP protocols 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 are underway at 10 sites in the Mediterranean (Raaymakers 2003). Despite their wide use, there have been few evaluations of the survey methods or survey design to determine their sensitivity for individual unwanted species or to determine the completeness of biodiversity inventories based upon them Inglis *et al*. (2007) used a range of biodiversity metrics to evaluate the adequacy of sample effort and distribution during the initial New Zealand survey of the Port of Wellington and compared the results with those from seven Australian port baseline surveys. In general, they concluded that the surveys provided an adequate description of the richness of the assemblage of non-indigenous species present in the ports, but that the total richness of native and cryptogenic taxa present in the survey area was likely to be under estimated. The authors made a number of recommendations for future surveys that included increasing the sample effort for benthic infauna, maximising dispersion of samples throughout the survey area (rather than allocation based on CRIMP priorities) and modification of survey methods or design components which had high complementarity in species composition. Both Inglis *et al*. (2007) and a more recent study by Hayes *et al*. (2005) on the sensitivity of the survey methods concluded that generalised port surveys, such as these, are likely to under-sample species that are very rare or which have restricted distributions within the port environments and, as such, should not be considered surveys for early detection of unwanted species.

Instead, the port surveys are intended to provide a baseline for monitoring the rate of new incursions by non-indigenous marine species in port environments, and to assist international risk profiling of problem species through the sharing of information with other shipping

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

nations (Hewitt and Martin 2001). Despite the large number of ports that have been surveyed using modifications of the CRIMP protocols, no ports have been completely resurveyed. This means that there has been no empirical determination of the background rate of new arrivals or of the surveys‟ ability to detect temporal changes in the composition of native and non-indigenous assemblages.

This report describes the results of a second, repeat survey of the Gulf Harbour Marina undertaken in April 2006, three years after the initial baseline survey. In the manner of the first survey report (Inglis *et al*. 2006g) we provide an inventory of species recorded during the survey and their biogeographic status as either native, introduced ("non-indigenous") or cryptogenic. Organisms that could not be identified to species level are also listed as indeterminate taxa (see "Definitions of species categories", in methods section).

The report is intended as a stand-alone record of the resurvey and, as such, we reiterate background information on the Gulf Harbour Marina, including its history, physical environment and shipping patterns, development and maintenance activities, and biological environment. Where available, this information is updated with new data that have become available in the time between the two surveys.

DESCRIPTION OF THE GULF HARBOUR MARINA

General features

The Gulf Harbour Marina (36° 37‟ S, 174° 47‟ E) (Fig. 2) is situated about 24 km north of Auckland City, on the southern edge of the Whangaparoa Peninsula on New Zealand‟s North Island (Figure 1). At the heart of the Hibiscus Coast, the Whangaparoa Peninsula used to be home largely to holidaymakers, but over the years most of the baches have slowly disappeared, replaced with permanent dwellings. With better roads and amenities an increasing number of people have chosen to commute between Auckland and Whangaparaoa, and this has been reflected in the amount of development going on in the area, of which the Gulf Harbour Marina is one example.

The construction and development of the marina and associated reclamation was permitted through the Rodney County Council (Gulf Harbour) Vesting and Empowering Act 1977 (Rodney District Council 2005). The Act enabled the Rodney District Council to issue a seabed licence with an effective term of 100 years, as well as to issue registered leases for the same term for adjacent reclamation areas (Gulf Harbour Marina 2007). Gulf Harbour Marina Ltd (the "Marina Company") is the owner of all of the assets involved in the marina, including the Hobbs Bay seabed licence, dated 20 September 1988.

Gulf Harbour Marina is approximately 420 m at its widest point and 760 m in length, with the majority of the Marina in approximately 2.4 m of water depth at LWS. The Marina is surrounded by rock sea walls and a breakwater protects the main entrance channel, which is approximately 70 m wide. A wave dissipation beach near the channel entrance reduces wave disturbance. Gulf Harbour Marina is a major hub for recreational and sailing vessels in the northeast of the North Island (Inglis 2001). The Marina currently has 1,028 existing berths for vessels up to 55 metres LOA, and a further 25 super-yacht berths. A 4.2 m SLW channel on the eastern side of the main fairway continues to the deep water berths at O and N piers. Maximum draft on the western side of the marina (piers Z to L) is between 2.1 and 2.4 m (Gulf Harbour Marina 2007).

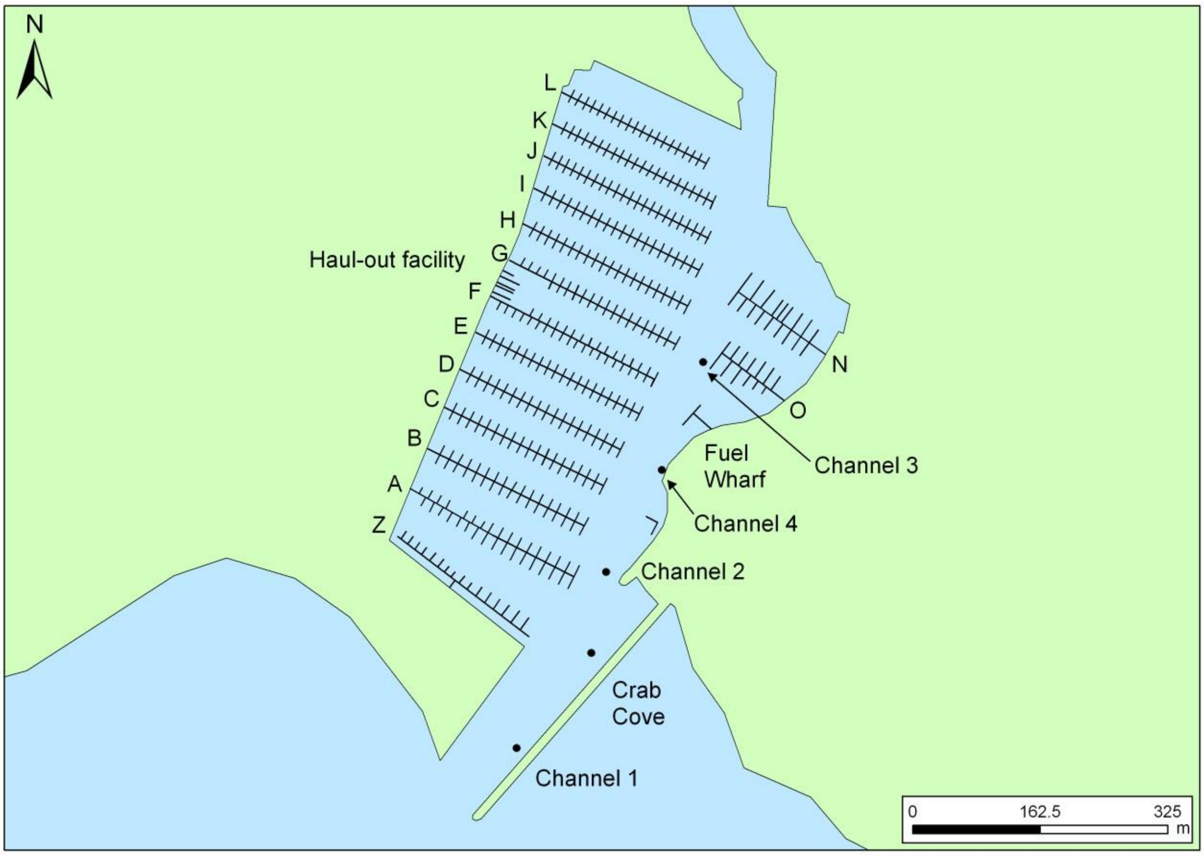

Figure 2: Gulf Harbour Marina map, indicating major features and sampling sites.

Marina operation, development and maintenance activities

Berths in Gulf Harbor Marina are arranged around floating concrete Bellingham-type piers and vary in length from 10.5 to 55.0 m (Gulf Harbour Marina 2007), with predominantly H6-treated pine piles. The majority of the berths are contained on the western side of the Marina where piers A-L, Z, and private berths are located (

Figure 2). The eastern side of the Marina contains a fuel jetty and piers N and O, which are for super-yachts and larger recreational craft. Z and O piers are set up for commercial chartering activities, particularly fishing charters. There is also a commercial ferry service running to and from Auckland four times per day, and a service to Tiritiri Matangi Island (approximately 10 km to the east) runs several times per week. Details of the berthing facilities available in the Marina are provided in Table 1.

Vessels unable to be berthed in the marina immediately may anchor outside the marina either in nearby Army Bay or between Kotonui Island and the entrance way to the marina (Tom Warren, Gulf Harbour Marina, pers. comm.).

No on-going maintenance dredging is conducted within Gulf Harbour Marina. The last dredging occurred in 2000 as capital dredging for the East Marina Extension (EME; Tom Warren, Gulf Harbour Marina, pers. comm.). This involved dredging of approximately 52,000 m^3 of sandstone from the interior channel, 40,000 m^3 of silt and sand from the entrance channel, and 30,000 m^3 from the EME basin. Spoil was disposed of as landfill (Tom Warren, Gulf Harbour Marina, pers. comm.).

Work on the new Eastern Boat Harbour waterfront precinct is currently underway, with the project progressing through the first rounds of resource consent in June 2007. Adjacent to the Gulf Harbour Marina, development plans incorporate around 550 homes, a hotel, office space and a commercial area featuring restaurants and shops. Work is expected to begin on the earthworks around the new boat harbour in the near future, and an access road from Pinecrest Drive has already been formed (Gulf Harbour Marina 2007).

Vessel movements and ballast discharge patterns

New Zealand has strict conditions regarding the discharge of ballast water within its coastal waters. A Ballast Water Import Health Standard, issued under Section 22 of the *Biosecurity Act 1993*, requires all vessels entering New Zealand waters to formally submit their intentions to discharge ballast water at least 48 hours before they arrive (http://www.biosecurity.govt.nz/files/ihs/ballastwater.pdf). Discharge of ballast water is only permitted if the vessel can satisfy an inspector that:

- the ballast water has been exchanged en route to New Zealand in the open-ocean, or the
- ballast water is fresh water.

The number of overseas yachts travelling to New Zealand has increased dramatically over the last three decades. Data from the New Zealand Customs Service show that around 900 international boats visited in 2000, almost three times as many as in 1993 (Inglis and Floerl 2002). The majority of vessels entering New Zealand waters clear customs in Opua, Whangarei and Auckland. The number of pleasure craft entering Opua Marina accounts for almost 70 % of all international recreational craft visits to NZ, and is more than four times that of Auckland, the next busiest location (Campbell 2004). Interviews with marina operators suggest that the majority of overseas vessels entering New Zealand waters spend most of their time in Northland and Auckland and do not travel further south than Tauranga. The peak period for arrivals of international yachts is between October and December as the vessels move south to avoid the austral tropical cyclone season, with most vessels departing in April and May when the cyclone season has ended (Inglis and Floerl 2002). Anecdotal reports indicate that many vessels departing Gulf Harbour Marina for international waters are destined for Fiji (Gulf Harbour Marina 2007).

The majority of international arrivals to New Zealand come from the South Pacific (around 80%) or Australia (16%; O. Floerl, NIWA, pers. comm.). The main points of origin in these areas are Fiji, Tonga, New Caledonia, Australia (Coffs Harbour, Lord Howe Island, Brisbane, Sydney, Norfolk Island, Bundaberg, Gladstone, Southport, Townsville, Launceston), Cook Islands, Vanuatu, Western Samoa, American Samoa, Niue, French Polynesia and the US Pacific Dependency (Inglis and Floerl 2002).

Movements of recreational yatchs (domestic and international) to and from the Gulf Harbour Marina were derived from a questionnaire survey of approximately 1,300 yacht owners (O. Floerl, NIWA, unpublished data). National survey information was used to create an epidemiological model simulating yacht movements between main marinas around NZ. Annual movements of yatchs between marinas were calculated from a 10-year simulation. The calculated average number of recreational vessels departing the Gulf Harbour Marina, and heading to one of 36 domestic destination ports was 1,252 departures annually. The five most common destination ports for vessels travelling from the Gulf Harbour Marina were: Auckland Westhaven Marina (342), Great Barrier Island (199), Opua (187), Waikawa (72) and Tutukaka (71). A similar trend was seen in recreational vessels arriving at the Gulf Harbour Marina (1,262 annual arrivals). The five most common origin ports were Auckland

Westhaven Marina (343), Great Barrier Island (201), Opua (192), Waikawa (72) and Tutukaka (72; O. Floerl, NIWA, unpublished data).

Telephone surveys of marina operators in 2005 were used to gather estimates on annual domestic and international vessel movements from marinas nationwide (O. Floerl, NIWA, unpublished data). Estimates indicate that around 2480 vessels arrive at the Gulf Harbour Marina annually, with around 20 % of these being international arrivals and 80 % domestic arrivals. An estimated 9,000 trips are undertaken by local boats per year from the Gulf Harbour Marina. Of these, the highest portion of trips occur during the summer season (65 %), followed by 15 % of trips undertaken in autumn, 15 % in spring, and 5 % in winter (O. Floerl, NIWA, unpublished data).

EXISTING BIOLOGICAL INFORMATION

There appears to be little published information on biological surveys in the Gulf Harbour Marina or surrounding bays.

An ecological survey of Hobbs Bay was initiated at the request of Parkdale Development Ltd, prior to the development of the Gulf harbour marina complex (Don *et al*. 1974). The report provides information regarding the marine habitat and marine flora and fauna prior to development. Extensive sampling of the marine biota was carried out using line transects in rocky intertidal areas and sand flats, and subtidal benthic sampling was also carried out a regular intervals across the bay. In general, Hobbs Bay was found to support a diverse and natural marine biota, with around 90 different species recorded from the intertidal zones.

Cranfield *et al*. (1998) conducted a desktop review to compile a list of species that are adventive in New Zealand. They reported 151 adventive species and provided an indication of their current ranges within New Zealand, the likely means of introduction, and their probable native ranges. One species, the bivalve *Musculista senhousia*, was reported from the Whangaparaoa Peninsula. Gulf Harbour Marina and the Whangaparaoa Peninsula were not explicitly reported in the ranges of any of the other species, but several were reported to have been recorded from Hauraki Gulf or attributed a general range of the north or north east of the North Island. They were the algae *Colpomenia durvilleae*, the cord grass *Spartina alterniflora*, the sponges *Halichondria panicea, Hymeniacidon perleve* and *Tethya aurantium*, the hydroid *Hoplangia durotrix*, the caryophyllid *Tethocyathus cylindraceus*, the molluscs *Aeolidiella indica, Crassostrea gigas, Eubranchus agrius, Janolus hyalinus, Limaria orientalis, Lyrodus mediolobatus, Okenia plana* and *Polycera hedgpethi*, the barnacle *Balanus trigonus*, the decapods *Dromia wilsoni, Merocryptus lambriformis* and *Plagusia chabrus*, the bryozoan *Electra tenella*, and the ascidians *Asterocarpa cerea*, *Botrylloides magnicoecum, Botryllus schlosseri, Cystodytes dellechiajei, Didemnum "candidum", Diplosoma listerianum* and *Styela plicata*. Several others were reported with widespread distributions throughout New Zealand, including the cord grass *Spartina anglica*, the sponges *Clathrina coriacea, Cliona celata, Dendya poterium, Leucosolenia botryoides, Sycon ciliata* and *Tethya aurantium*, the hydroids *Amphisbetia operculata* and *Plumularia setacea*, the bryozoans *Bugula flabellata, Bugula neritina* and *Cryptosula pallasiana*, and the ascidian *Corella eumyota.*

Gust *et al*. (2006) carried out a delimitation survey on behalf of Biosecurity New Zealand for the invasive tunicate, *Styela clava* in 26 ports, marinas and harbours nationwide. The survey was initiated after the clubbed tunicate was found to be widespread in the Viaduct Basin and Freemans Bay, Auckland in mid October 2005. It is now also known to be widespread throughout the Hauraki Gulf, with higher density populations (tens to hundreds per m^2)

established near Waiheke Island. Although the Gulf Harbour Marina was not chosen by Biosecurity New Zealand as a survey site, opportunistic surveys by NIWA at the Marina on the 24th of November 2005 found *S. clava* present at densities of 1-10 individuals per square metre beneath floating pontoons. *Styela clava* is thought to be native to the coastal waters of Japan, Korea, Northern China and Siberia (Furlani 1996). It is capable of rapid proliferation and has a history of invasive spread in temperate marine environments, establishing many non-indigenous populations worldwide. Overseas incursions of this species have resulted in significant ecological and economic impacts. At very high densities, *S. clava* is capable of smothering other fauna, competing for food resources with other suspension feeders, and causing a nuisance to long-line mussel culture (Bourque *et al.* 2003).

RESULTS OF THE FIRST BASELINE SURVEY

An initial baseline survey of the Gulf Harbour Marina was completed in April 2003 (Inglis *et al*. 2006b). The report identified a total of 124 species or higher taxa. They consisted of 78 native species, 15 non-indigenous species, 12 cryptogenic taxa (those whose geographic origins are uncertain) and 19 indeterminate taxa (taxa for which there is insufficient taxonomic or systematic information available to allow identification to species level). Four taxa of marine organisms collected from the Gulf Harbour Marina had not previously been described from New Zealand waters. Two of these, the the fouling serpulid polychaete *Hydroides ezoensis* and the solitary ascidian *Cnemidocarpa sp.*, were non-indigenous. The other two taxa, the amphipod *Leucothoe* sp. 1 and the ascidian *Microcosmus squamiger* were thought to be cryptogenic.

Since the first survey was completed, six species recorded in it have been re-classified as a result of new information or re-examination of specimens during identification of material from the repeat baseline survey. The Amphipod, *Aora typica*, was identified as native, but has since been reclassified as a Cryptogenic Category 1 species due to it's wide distribution beyond New Zealand. The ascidians, *Microcosmus australis* and *Microcosmus squamiger*, were classified as Native and Cryptogenic Category 2, respectively, in the initial survey but both have since been reclassified as Cryptogenic Category 1 species. The ascidian, *Aplidium phortax*, was originally classified as a Cryptogenic Category 1 species in the initial survey but has since been reclassified as Native. The Arthropods, *Pilumnopeus serratifrons* and *Balanus trigonus*, were regarded as Cryptogenic Category 1 species in the initial survey but have been reclassified as native since the initial report was written. The revised summary statistics for the Gulf Harbour Marina following re-classification were 78 native species, 14 non-indigenous species, 17 cryptogenic taxa and 14 indeterminate taxa. These revisions have been incorporated into the comparison of data from the two surveys below.

The 14 non-indigenous organisms described from the Gulf Harbour Marina included representatives of seven major taxonomic groups. The non-indigenous species detected were: (Annelida) *Hydroides ezoensis, Hydroides elegans*; (Arthropoda) *Apocorophium acutum, Ericthonius pugnax*; (Bryozoa) *Bugula neritina, Schizoporella errata, Watersipora subtorquata, Zoobotryon verticillatum;* (Chordata) *Ascidiella aspersa;* (Mollusca) *Crassostrea gigas, Limaria orientalis, Theora lubrica*; (Porifera) *Vosmaeropsis* cf. *macera* and (Ochrophyta) *Cutleria multifida*. No species on the New Zealand register of unwanted organisms were found in the Gulf Harbour Marina during the initial baseline survey. Approximately 64 % (nine of 14 species) of non-indigenous species recorded in the Gulf Harbour Marina baseline survey were likely to have been introduced in biofouling assemblages, 7 % (one species) via ballast water and 29 % (four species) could have been introduced by either ballast water or biofouling vectors.

Methods

SURVEY METHOD DEVELOPMENT

To allow a direct comparison between the initial baseline survey and the resurvey of the Gulf Harbour Marina, the survey used the same methodologies, occurred in the same season, and sampled the same sites used in the initial baseline survey (as requested by MAF Biosecurity NZ). To improve the description of the biota of the marina, some additional survey sites were added during the repeat survey. These are described below.

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

Baseline survey protocols are intended to sample a variety of habitats within ports and marinas, including epibenthic fouling communities on hard substrata, soft-sediment communities, mobile invertebrates and fishes, and dinoflagellates. Below, we describe the methods and sampling effort used for the resurvey of the Gulf Harbour Marina. The survey was undertaken from 7th -11th April 2006.

DIVER OBSERVATIONS AND COLLECTIONS ON WHARF PILES

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

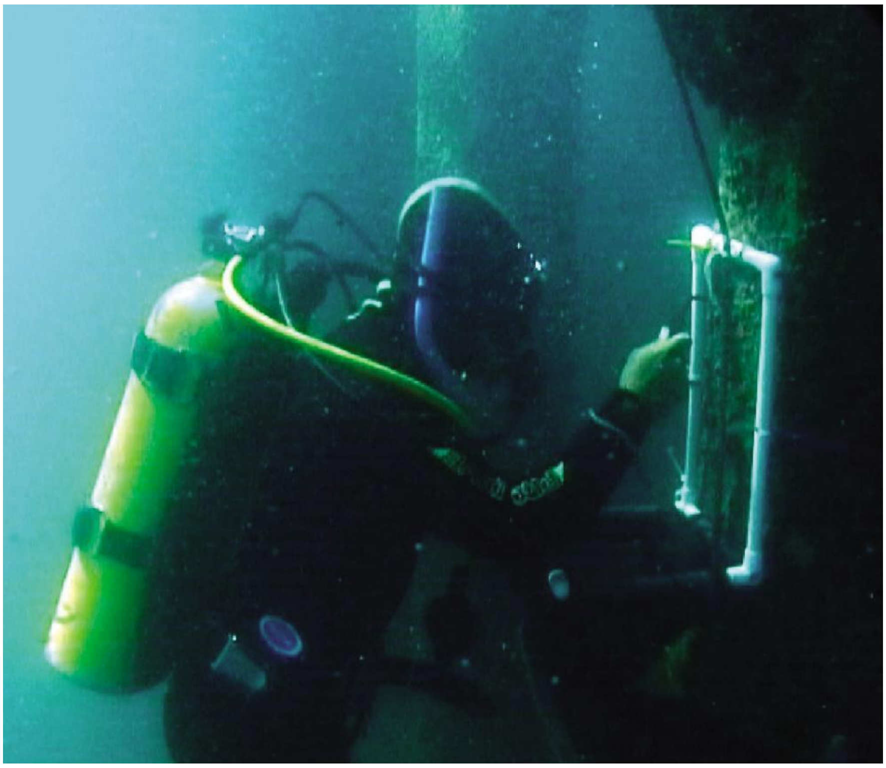

Figure 3: Diver sampling organisms on pier piles.

BENTHIC FAUNA

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

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

EPIBENTHOS

Larger benthic organisms were sampled using an Ocklemann sled (hereafter referred to as a "sled"). The sled is approximately one meter long with an entrance width of ~0.7 m and height of 0.2 m. A short yoke of heavy chain connects the sled to a tow line (Figure 5). The mouth of the sled partially digs into the sediment and collects organisms in the surface layers to a depth of a few centimetres. Runners on each side of the sled prevent it from sinking completely into the sediment so that shallow burrowing organisms and small, epibenthic fauna pass into the exposed mouth. Sediment and other material that enters the sled is passed through a mesh basket that retains organisms larger than about 2 mm. Sleds were towed for a standard time of two minutes at approximately two knots. During this time, the sled typically traversed between 80 – 100 m of seafloor before being retrieved. Two to three sled tows were completed adjacent to each sampled berth within the marina, and the entire contents were sorted.

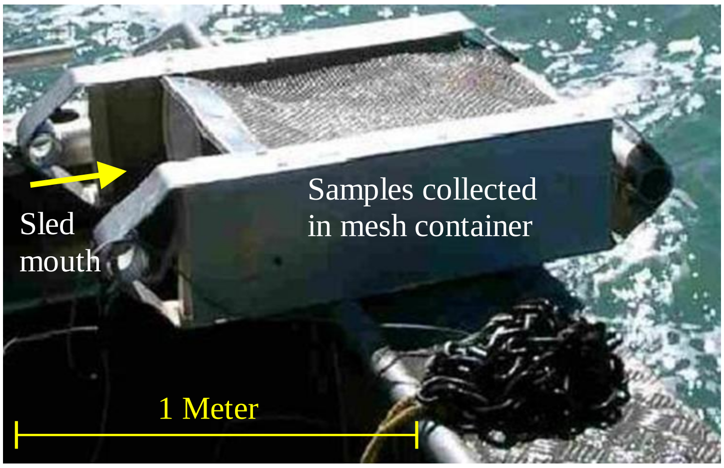

Figure 5: Benthic sled

SEDIMENT SAMPLING FOR CYST-FORMING SPECIES

A TFO gravity corer (hereafter referred to as a “javelin corer”) was used to take small sediment cores for dinoflagellate cysts (Figure 6). The corer consists of a 1.0-m long x 1.5-cm diameter hollow stainless steel shaft with a detachable 0.5-m long head (total length = 1.5 m). Directional fins on the shaft ensure that the javelin travels vertically through the water so that the point of the sampler makes first contact with the seafloor. The detachable tip of the javelin is weighted and tapered to ensure rapid penetration of unconsolidated sediments to a depth of 20 to 30 cm. A thin (1.2 cm diameter) sediment core is retained in a perspex tube within the hollow spearhead. In muddy sediments, the corer preserves the vertical structure of the sediments and fine flocculant material on the sediment surface more effectively than hand-held coring devices (Matsuoka and Fukuyo 2000). The javelin corer is deployed and retrieved from a small research vessel. Cyst sample sites were not constrained to the berths sampled by pile scraping and trapping techniques. Sampling focused on high sedimentation areas within the marina and avoided areas subject to strong tidal flow. On retrieval, the perspex tube was removed from the spearhead and the top 5 cm of sediment retained for analysis. Sediment samples were kept on ice and refrigerated prior to culturing. Culture procedures generally followed those described by Hewitt and Martin (2001).

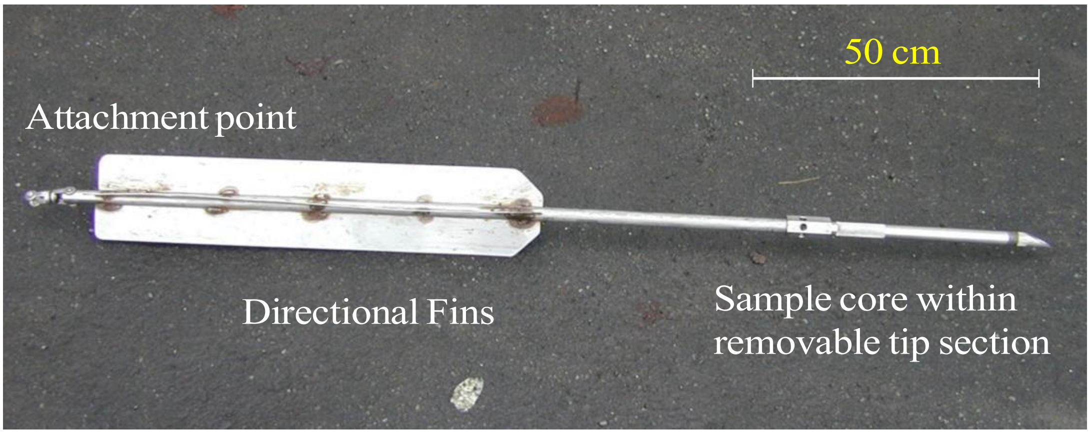

Figure 6: Javelin corer

MOBILE EPIBENTHOS

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

Fish (Opera house) traps

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

Crab (Box) traps

Fukui-designed box traps (63 cm x 42 cm x 20 cm) with a 1.3 cm mesh netting were used to sample mobile crabs and other small epibenthic scavengers (Figure 7). A central mesh bait holder containing two dead pilchards was secured inside the trap. Organisms attracted to the bait enter the traps through slits in inward sloping panels at each end. Two trap lines, each containing two box traps, were set on the sea floor at each site and left to soak overnight before retrieval.

Seastar traps

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

Shrimp traps

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

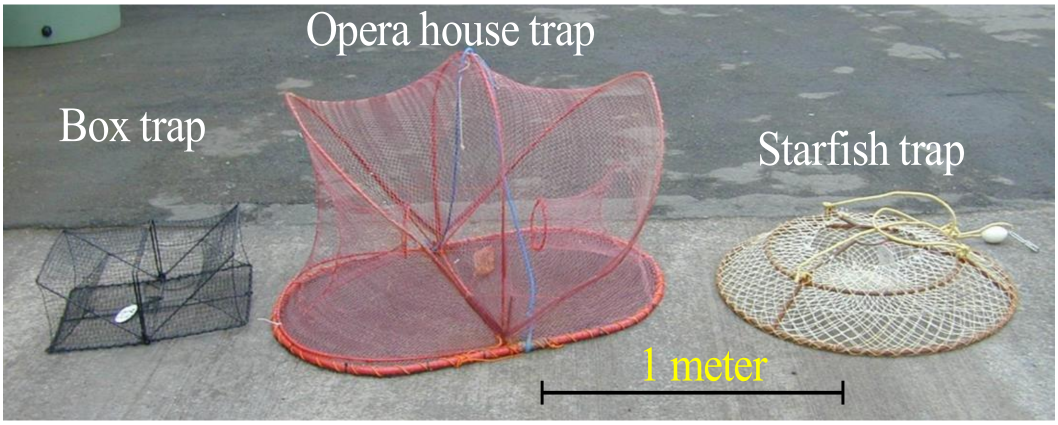

Figure 7: Trap types deployed in the marina.

VISUAL SEARCHES

Qualitative above-water visual searches were conducted at nine sites in the Gulf Harbour Marina. Observers searched for any potential invasive species fouling pontoons, rock facings, breakwalls, berths and associated structures.

SEDIMENT ANALYSIS

Sediment samples were taken for analysis of grain size and organic content from each site that was sampled for benthic infauna, where possible (some sites had stoney substrates with very little sediment, which prohibited the collection of one or both sediment samples). A ~100 g wet weight sample was collected from each of two replicate anchor box dredge or large hand core samples at each site, and frozen prior to analysis. A ~30 g sub-sample was removed for analysis of organic content, while the remainder was used to determine the particle size distribution of the sample using a laser grain size analyser.

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

The distribution of particle sizes at each port and marina 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 and classified into the standard Wentworth size classes, with some extra divisions included in the pebble and fine silt categories (Table 3). Typically, 250,000 to 500,000 particles were counted per sample.
7. The fraction in each size category calculated by the laser analysis was then calculated as a percent of the total net dry weight.

SAMPLING EFFORT

A summary of sampling effort during the second baseline survey of the Gulf Harbour Marina is provided in Table 4, and the exact geographic locations of sample sites are given in Appendix 2. The distribution of effort aimed to maximise spatial coverage and represent the diversity of active berthing sites within the area. Total sampling effort was constrained by the costs of processing and identifying specimens obtained during the survey.

During the initial baseline survey, most sample effort was concentrated around four areas – Jetty C, Jetty J, Jetty L and Jetty N & O. These areas are spread throughout the marina and represented a range of active berths and lay-up areas (

Figure 2, Table 4). Additional benthic sled and grab samples were taken near all other jetties, channels 1, 2 and 4 and in Crab Cove. (Inglis *et al.* 2006b). Similar locations were again sampled during the resurvey of the marina, wherever possible. It was occasionally necessary to shift sampling sites in order to avoid interference with vessel movements. To improve description of the flora and fauna in the resurvey, sampling effort for dinoflagellate cysts, using the javelin corer, was increased and sediment samples and qualitative land visual searches were added to the survey. These additional sampling sites were spread throughout the marina (Table 4). The spatial distribution of sampling effort for each of the sample methods is indicated in the following figures: diver pile scraping and javelin cyst coring (Figure 8), benthic sled and benthic grab sampling (Figure 9), fish, crab, seastar and shrimp trapping (Figure 10), sediment sampling (Figure 11) and above-water visual searches (Figure 12).

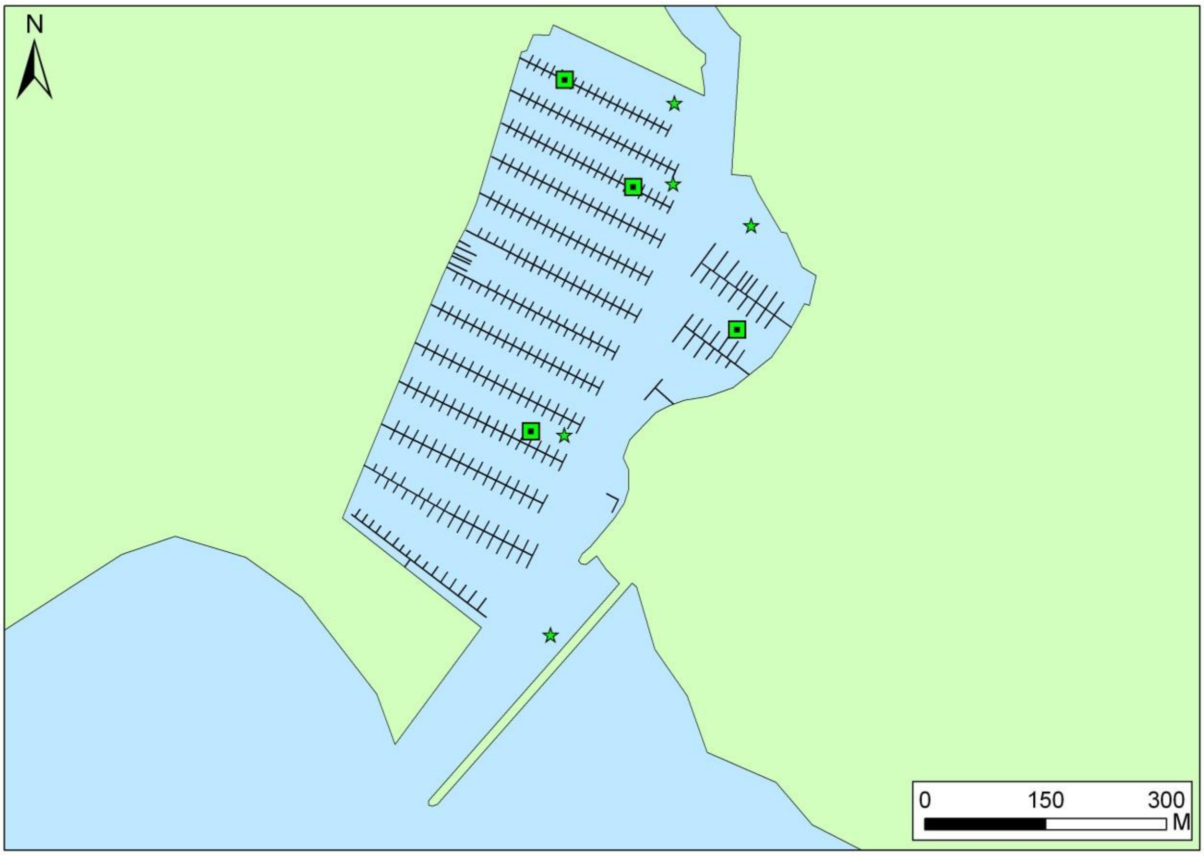

Figure 8: **Diver pile scraping (squares) and dinoflagellate cyst core (stars) sampling sites.**

Figure 9: **Benthic sled (full black circles) and benthic grab (white/black circles) sampling sites.**

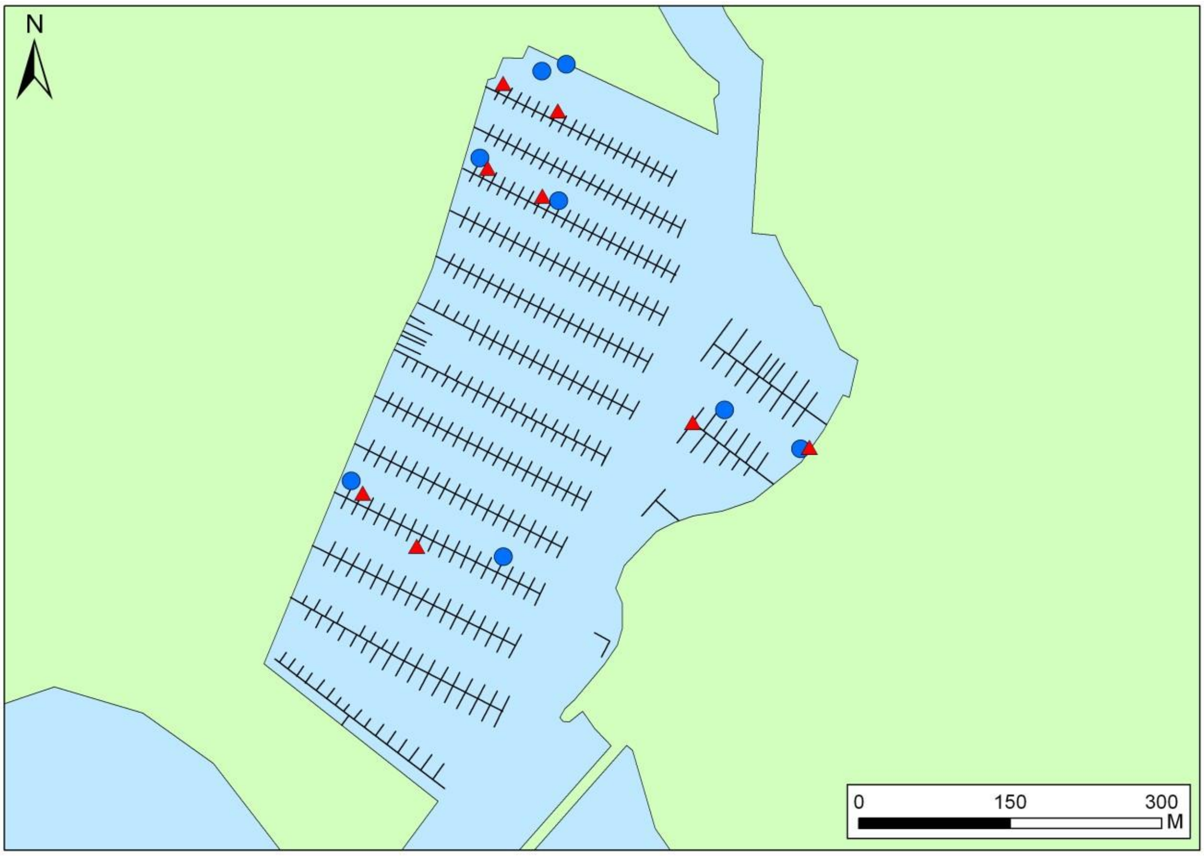

Figure 10: Sites sampled using fish traps (red triangles), and crab, shrimp and seastar traps (blue circles).

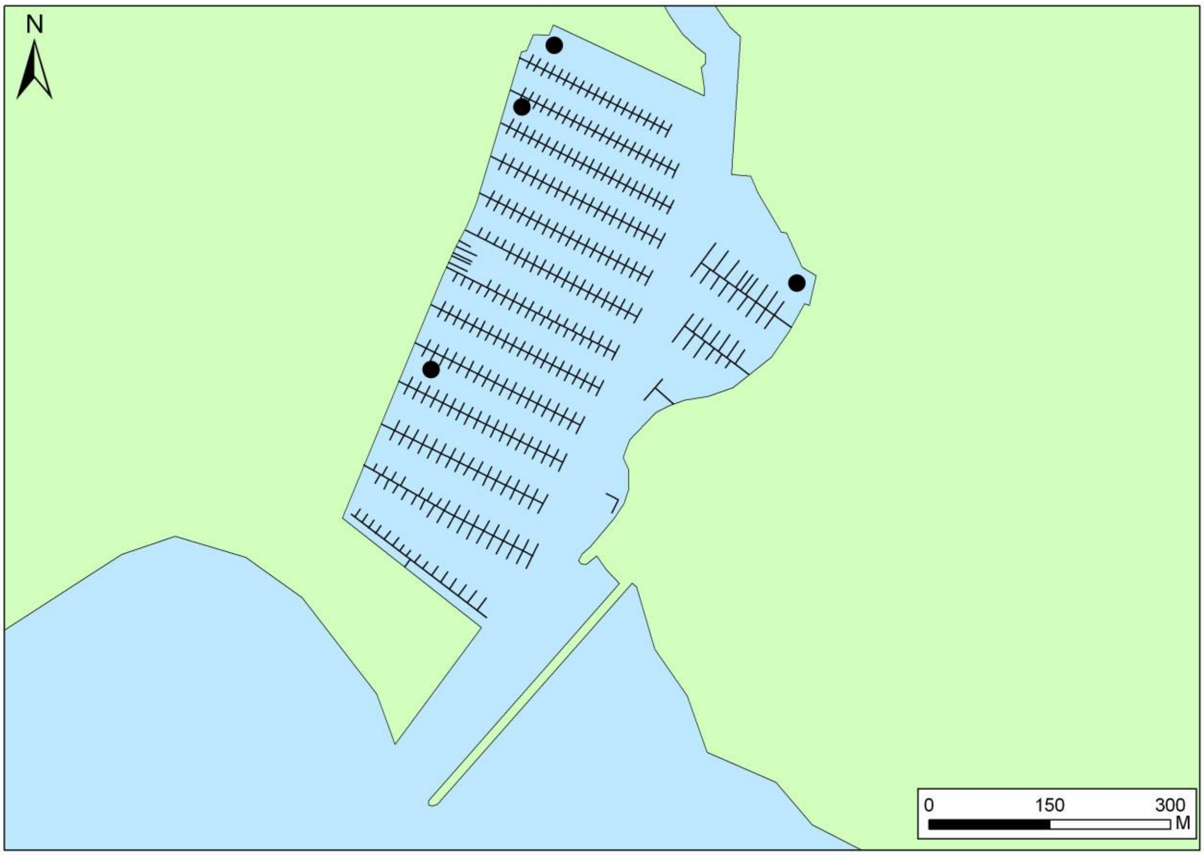

Figure 11: Sediment sampling sites.

Figure 12: Above-water visual search sites

SORTING AND IDENTIFICATION OF SPECIMENS

Each sample collected in the survey was allocated a unique code on waterproof labels and transported to a nearby field laboratory where it was sorted by a team into broad taxonomic groups (e.g. ascidians, barnacles, sponges etc.). These groups were then preserved and individually labelled. Details of the preservation techniques varied for many of the major taxonomic groups collected, and the protocols adopted and preservative solutions used are indicated in Table 5. Specimens were subsequently sent to a range of taxonomic experts (see "Project Team", above) for identification to species or lowest taxonomic unit (LTU). Experts were not available to examine platyhelminths or sipunculids, so these taxa could only be recorded as "indeterminate taxa" (see "Definitions of species categories", below).

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 and marina were compared with the marine species listed on the New Zealand register of unwanted organisms under the Biosecurity Act 1993 (Table 6) and the Australian Consultative Committee on Introduced Marine Pest Emergencies (CCIMPE) Trigger List (Table 7).

DEFINITIONS OF SPECIES CATEGORIES

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

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

Native species

Native species have 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 taxa category 1

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

Cryptogenic taxa category 2

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.

DATA ANALYSIS

Comparison with the initial baseline survey

Several approaches were used to compare the results of the current survey with the earlier baseline survey of the Gulf Harbour Marina, completed in 2003 (Inglis *et al*. 2006b).

Summary statistics were compiled on the total number of species and major taxonomic groups found in each survey and on the numbers of species in each biogeographic category (i.e. native, non-indigenous, etc) recovered by each survey method.

While these summary data give the numbers of species actually observed in each survey they do not, by themselves, provide a robust basis for comparison, since they do not account for differences in sample effort between the surveys, variation in the relative abundance of species at the time of each survey (for a discussion of these issues, see Gotelli and Colwell 2001), or the actual species composition of the recorded assemblages. The latter is important if port surveys are to be used to estimate and monitor the rate of new incursions by non-indigenous species.

In any single survey, the number of species observed will always be less than the actual number present at the site. This is because a proportion of species remain undetected due to bias in the survey methods, local rarity, or insufficient sampling effort. A basic tenet of sampling biological assemblages is that the number of species observed will increase as more samples are taken, but that the rate at which new species are added to the survey tends to decline and gradually approaches an asymptote that represents the total species richness of the assemblage (Colwell and Coddington 1994). In very diverse assemblages, however, where a large proportion of the species are rare, this asymptote is not reached, even when very large numbers of samples are taken. In these circumstances, comparisons between surveys are complicated by the large number of species that remain undetected in each survey. This issue has received considerable attention in recent literature and new statistical methods have been developed to allow better comparisons among surveys (Gotelli and Colwell 2001; Colwell *et al*. 2004; Chao *et al*. 2005). We use several of these new techniques – sample-based rarefaction curves (Colwell *et al*. 2004), non-parametric species richness estimators (Colwell and Coddington 1994), and bias-adjusted similarity indices (Chao *et al*. 2005) - to compare results from the two surveys of the Gulf Harbour Marina.

Sample-based rarefaction curves

Sample-based rarefaction curves depict the number of species that would be expected in a given number of samples (n) taken from the survey area, where $n_{(max)}$ is the total number of samples taken in the field survey. The shape of the curves and the number of species expected for a given *n* can be used as the basis for comparing the surveys and evaluating the benefit of reducing or increasing sample effort in subsequent surveys (Gotelli and Colwell 2001). For each baseline survey we computed separate sample-based rarefaction curves (Gotelli and Colwell 2001) for each survey method. The curves were computed from the presence or absence of each recorded species in each sample unit (i.e. replicated incidence data) using the analytical formula developed by Colwell *et al*. (2004) (the Mau Tau index) and the software EstimateS (Colwell 2005).

Separate curves were computed for each of three methods: pile scraping, benthic sleds and benthic grabs. The remaining methods did not usually recover enough taxa to allow meaningful analyses. For pile scrapes, only quadrat samples were used; specimens collected on qualitative visual searches of piles were not included. Since the purpose of the port surveys is primarily inventory of non-indigenous species, we generated separate curves for native species, cryptogenic category 2 taxa, and the combined species pool of non-indigenous and cryptogenic category 1 taxa, where there were sufficient numbers of taxa to produce meaningful curves (arbitrarily set at > 8 taxa per category). This was only possible for pile scrapes; for the other survey methods, all taxa (excluding indeterminate taxa) were pooled in order to have sufficient numbers of taxa. Even after pooling all taxa, there were usually insufficient numbers of taxa recorded by cyst cores, shrimp traps, seastar traps and fish traps, so analyses were not conducted for these methods. Several taxa (Order Tanaidacea (tanaids), Class Scyphozoa (jellyfish), Phylum Platyhelminthes (flatworms), Phylum Sipuncula (peanut worms) and Class Anthozoa (sea anemones) were specifically excluded from analyses as, at the time the reports were prepared, we had been unable to secure identification of specimens from either the initial survey, the resurvey, or both.

Note that, by generating rarefaction curves we are assuming that the samples can reasonably be considered a random sample from the same universe (Gotelli and Colwell 2001). Strictly, this does not represent the way that sample units were allocated in the survey. For example, quadrat samples were taken from fixed depths on inner and outer pilings at each berth, rather than distributed randomly throughout the "universe" of pilings in the marina. Previously, we showed that there is greater dissimilarity between assemblages in these strata than between replicates taken within each stratum, although the difference is marginal (range of average similarity between strata = 22%-30% and between samples = 25%-35 %, Inglis *et al*. 2003). This stratification is an example of the common tension in biodiversity surveys between optimising the complementarity of samples (i.e. reducing overlap or redundancy in successive samples so that the greatest number of species is included) and adequate description of diversity within a particular stratum (Colwell and Coddington 1994). In practice, no strategy for sampling biodiversity is completely random or unbiased. The effect of the stratification is likely to be an increase in the heterogeneity of the samples, equivalent to increasing the patchiness of species distribution across quadrats. This is likely to mean slower initial rate of accumulation of new species and slower accumulation of rare species (Chazdon *et al*. 1998). Because the same survey strategy was used in both marina surveys, this systematic bias should not unduly affect comparisons between the two surveys. Furthermore, preliminary trials, where we pooled quadrat samples to form more homogenous units (e.g. piles or berths as the sample unit) and compared the curves to total randomisation of the smallest unit (quadrats), had little effect on the rate of accumulation (Inglis *et al*. 2003).

Estimates of total species richness

Estimates of total species richness (or more appropriately total "species density") in each survey were calculated using the Chao 2 estimator. This is a non-parametric estimate of the true number of species in an assemblage that is calculated using the numbers of rare species (those that occur in just one or two sample units) in the sample (Colwell and Coddington

1994). That is, it estimates the total number of species present, including the proportion that was present, but not detected by the survey ("unseen" species). As recommended by Chao (in Colwell 2005), we used the bias-corrected Chao 2 formula, except when the coefficient of variation CV > 0.5, in which case the estimates were recalculated using the Chao 2 classic formula, and the higher of the Chao 2 classic and the ICE (Incidence-based Coverage Estimator) was reported.

Plots of the relationship between the species richness estimates and sample size were compared with the sample-based rarefaction curve for each combination of survey, method, and species category. Convergence of the observed (the rarefaction curve) and estimated (Chao 2 or ICE curve) species richness provides evidence of a relatively thorough inventory (Longino *et al*. 2002).

Similarity analyses

A range of indices is available to measure the compositional similarity of samples from biological assemblages using presence-absence data (Koleff *et al.* 2003). Many of these are based on the relative proportions of species that are common to both samples ("shared species") or which occur in only a single sample. The classic indices typically perform poorly for species rich assemblages and are sensitive to sample size, since they do not account for the detection probabilities of rare ("unseen") species. Chao *et al.* (2005) have recently developed new indices based on the classic Jaccard and Sorenson similarity measures that incorporate the effects of unseen species. We used the routines in EstimateS (Colwell 2005) to compare samples from the two surveys using the new Chao estimators, but also report the classic Jaccard and Sorenson measures. Separate comparisons were done for each combination of survey method and species category where there were sufficient taxa (see above). For each similarity index, values range from zero (completely different) to one (identical).

Survey results

MARINA ENVIRONMENT

Sampling was carried out at 23 different sites throughout the Gulf Harbour Marina (Figure 8 to Figure 12; Table 8). Maximum recorded depths ranged from 11.2 m at Jetty N & O to around 3.9 m at Jetty D & E, Jetty G & H and Jetty L & shore. Turbidity was highest at Jetty J (1.78 m secchi depth) and lowest at Jetty C, Jetty L and Jetty N & O (2.3 m secchi depth). The average salinity across measured sites was 32 ppt and ranged from 30 ppt at Jetty C to 34 ppt at Jetty N & O. Water temperature was relatively consistant with an average of around 20 ± 0.5 °C across all sites. Water temperature was highest at Jetty C (20.4 °C) and lowest at Jetty N & O (19.5 °C). During sampling, sea states ranged from 1-2 on the Beaufort scale (i.e. approximately 0-6 knots wind speed and 0.1-0.3 m wave height).

The organic content of sediments in the Gulf Harbour Marina was low, with a mean LOI (loss on ignition) value across the four analysed samples from four sites of 4.5 % (Figure 13). Organic content was highest at the Jetty N & O site (5.5 %) which is located in a sheltered area (Figure 2). Organic content was similar (4.1 – 4.3 %; Figure 13) at the other sites sampled.

Compared to other sites, sediments collected at site Jetty N & O contained the highest proportion of silt (74.74 %) and clay (0.65 %), and the lowest proportion of sand-sized particles (24.59 %; Table 8). This is a refelection of the sheltered locality of this site. All other sites sampled in the Gulf Harbour Marina were dominated by sand-sized particles (60.03 % – 74.56 %), but also contained significant amount of silt-sized particles (25.32 – 39.67 %) and a low percentage of clay-sized particles (0.12 – 0.3 %; Table 8). Gravel and small pebbles were not present in any sediment samples collected.

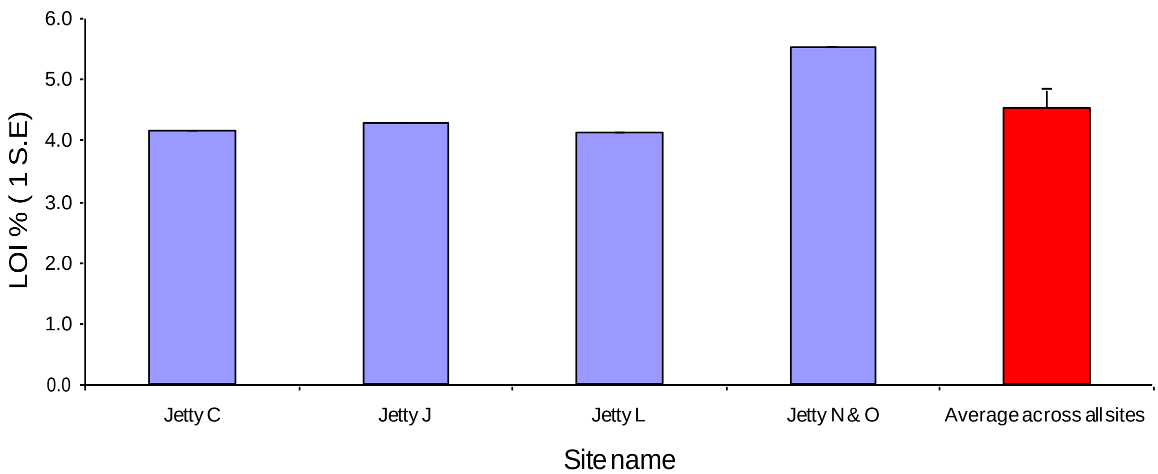

Figure 13: Organic content as determined by loss on ignition analyses of sediments from four sites at Gulf Harbour Marina.

SPECIES RECORDED

A total of 146 species or higher taxa were identified from the resurvey of Gulf Harbour Marina. This collection consisted of 79 native (Table 10), 13 cryptogenic (Table 11), and 23 non-indigenous species (Table 12), with the remaining 31 taxa being made up of indeterminate taxa (Table 13, Figure 14). In comparison, (after revision; see "Results of the first baseline survey" above) 123 taxa were recorded from the initial survey of the port in April 2003, comprising 78 native species (Table 10), 17 cryptogenic taxa (Table 11), 14 non-indigenous species (Table 12) and 14 indeterminate taxa (Table 13).

The biota in the resurvey included a diverse array of organisms from 12 phyla (Figure 15). For general descriptions of phyla encountered during this study refer to Appendix 2, and for detailed species lists collected using each method refer to Appendix 3.

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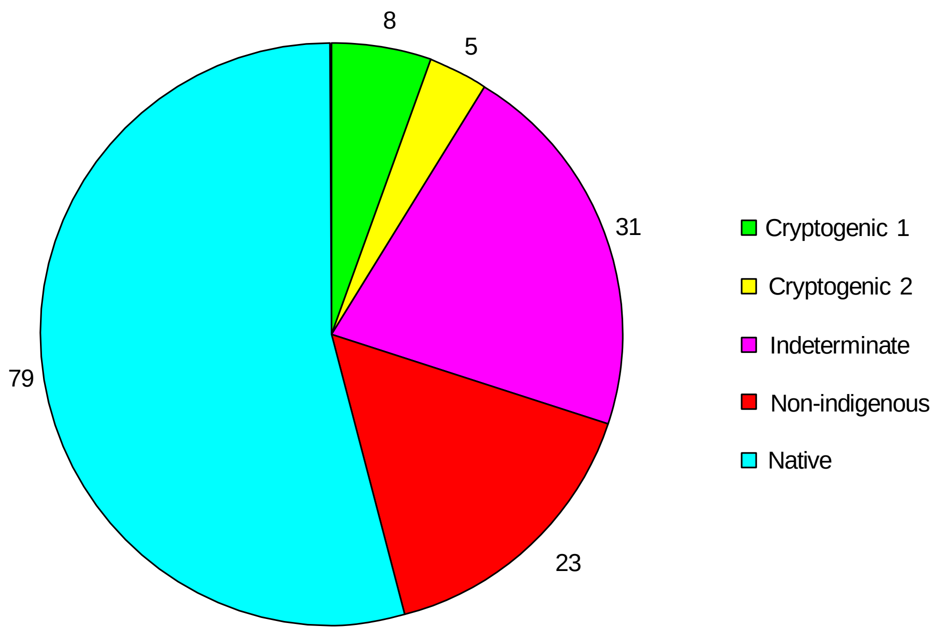

Figure 14: Diversity of marine species sampled in the Gulf Harbour Marina. Values indicate the number of taxa in each category.

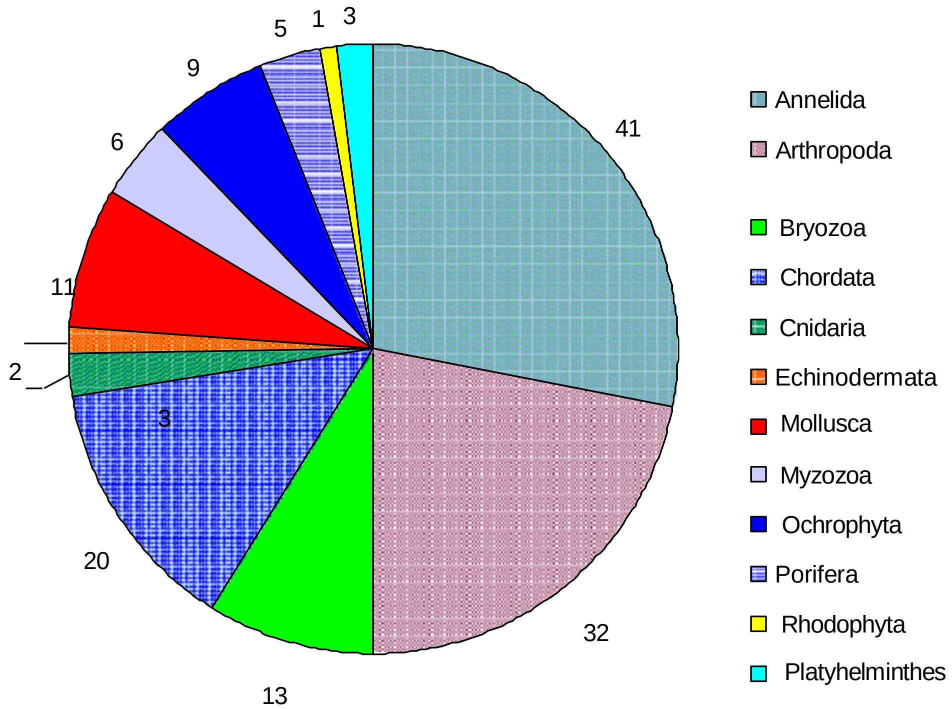

Figure 15: Phyla recorded in the Gulf Harbour Marina. Values indicate the number of taxa in each of the major taxonomic groups.

Native species

The 79 native species recorded during the resurvey of the Gulf Harbour Marina represented 54 % of all species identified from this location (Figure 14) and included diverse assemblages of annelids (31 species), arthropods (20 species), molluscs (7 species) and chordates (7 species). A number of other less diverse major taxonomic groups including bryozoans, cnidarians, echinoderms, myzozoans, ochrophyta and a poriferan were also recorded from the marina (Figure 15).

Cryptogenic taxa

Cryptogenic taxa (n = 13) represented 9 % of all species or higher taxa identified from the Marina. The cryptogenic organisms identified included eight (5.5 %) Category 1 taxa (C1) and five (3.4 %) Category 2 taxa (C2) as defined in "Definitions of species categories" above. These organisms included three annelids, six chordates, one myzozoa, and three sponges (Table 11). Two of the C1 taxa (the chordates *Didemnum* sp. and *Botryllus schlosseri*) and seven of the C2 taxa (the annelids *Eumida Eumida*-C, *Lepidonotus lepidonotus*-C, *Notomastus Notomastus*-A; the chordates *Didemnum* sp., *Botryllus schlosseri*; and the poriferans *Halichondria* new sp. 4 and *Halichondria* new sp. 1) were not recorded in the initial baseline survey of the marina. Four of the 10 C1 taxa (the annelid *Chaetopterus chaetopterus*-A, the chordates *Microcosmus australis* and *Asterocarpa humilis* and the arthropod *Aora typica*) and all seven of the C2 taxa (the annelids *Typosyllis Typosyllis*-B, *Demonax Demonax*-B, *Serpula Serpula*-D, *Cirratulus Cirratulus*-A, *Terebella Terebella*-B; the chordate *Distaplia* sp. and the arthropod *Leucothoe* sp. 1) recorded in the initial baseline survey of the Gulf Harbour Marina were not found during the resurvey. Some of the C1 taxa (e.g the ascidians *Asterocarpa humilis, Botrylloides leachii* and *Corella eumyota*) have been present in New Zealand for more than 100 years but have distributions outside New Zealand that suggest non-native origins (Cranfield *et al*. 1998). The Chapman and Carlton (1994) criteria applicable to each C1 taxon are indicated in Appendix 5.

The *Didemnum* species group, which we have included in cryptogenic category 1, warrants further discussion. This genus includes at least two species that have recently been reported from within New Zealand (*D. vexillum* and *D. incanum*) and two related, but distinct species from Europe (*D. lahillei*) and the north Atlantic (*D. vestum* sp. nov.) that have displayed invasive charactertistics (i.e. sudden appearance and rapid spread, Kott 2004a; Kott 2004b). All can be dominant habitat modifiers. The taxonomy of the Didemnidae is complex and it is difficult to identify specimens to species level. The colonies do not display many distinguishing characters at either species or genus level and are comprised of very small, simplified zooids with few distinguishing characters (Kott 2004a). Six species have been described in New Zealand (Kott 2002) and 241 in Australia (Kott 2004a). Most are recent descriptions and, as a result, there are few experts who can distinguish the species reliably.

Specimens of *Didemnum* obtained during the initial port baseline surveys were examined by the world authority on this group, Dr Patricia Kott (Queensland Museum). She identified *D. vexillum* among specimens taken from the initial baseline surveys of Nelson and Tauranga, and *D. incanum* from the ports of Tauranga, Picton and Bluff. A third species, *D. tuberatum*, which Dr Kott described as native to New Zealand, was also recorded from Bluff. None of these species, or any other *Didemnum* species, were recorded from the initial survey of Gulf Harbour Marina. At the time that this report was prepared, we had been unable to secure Dr Kott‟s services to examine specimens from the repeat-baseline surveys, and all *Didemnum* specimens were identified only to genus level. We have reported these species collectively, as a species group (*Didemnum* sp., Table 11).

Non-indigenous species

The 23 non-indigenous species (NIS) recorded in the resurvey of the Gulf Harbour Marina included four annelid worms, three arthrpods, nine bryozoans, three ascidians, three bivalves, and one poriferan (Table 12). Twelve species found in the resurvey were not recorded during the initial baseline survey in April 2003. These were: the polychaetes *Pseudopolydora corniculata, Pseudopolydora paucibranchiata*; the arthropods *Monocorophium acherusicum* and *Amphibalanus amphitrite*; the bryozoans *Bugula neritina, B. stolonifera, Schizoporella errata, Watersipora subtorquata, Watersipora arcuata, Celleporaria aperta, Bowerbankia gracilis, Scrupocellaria* n. sp. and *Zoobotryon verticillatum*; the ascidians *Diplosoma listerianum* and *Styela clava* and the mollusc *Musculista senhousia*. Only three NIS that were recorded in the first survey (the arthropod) *Ericthonius pugnax*; (the Mollusc) *Limaria orientalis* and (the Ochrophyta) *Cutleria multifida* were not recorded during the repeat survey. Each of these species was present in just a single sample in the initial baseline survey. None of the NIS recorded in this resurvey of the Gulf Harbour Marina are new to New Zealand.

Below we summarise available information on the biology of each of these species, providing images where available, and indicate what is known about their distribution, habitat preferences and impacts. This information was sourced from published literature, the taxonomists in the Project Team and from regional databases on non-indigenous marine species in Australia (National Introduced Marine Pest Information System, Hewitt *et al*. 2002) and the USA (National Exotic Marine and Estuarine Species Information System, Fofonoff *et al*. 2003). Distribution maps for each NIS in the marina are composites of multiple replicate samples and display presence/absence data only for the sampling techniques that could have been expected to collect the particular species. Where overlayed presence and absence symbols occur on the map, this indicates the NIS was found in at least one, but not all replicates at that GPS location. NIS are presented below by major taxonomic groups in the same order as Table 12. The Chapman and Carlton (1994) criteria applicable to each NIS are indicated in Appendix 4 (Chapman and Carlton 1994).

Hydroides ezoensis (Okuda 1934)

Image: CSIRO http://www.science-in salamanca.tas.csiro.au
Information: Hewitt (2002) & http://www.jncc.gov.uk

Hydroides ezoensis is a tube dwelling serpulid worm that is a cosmopolitan fouling species on both natural and artificial structures. It constructs hard, sinuous, calcareous tubes that are cemented to hard surfaces. It is found subtidally where it may form large encrustations (e.g. 30 cm thick) and is highly tolerant of environmental fluctuations. It creates microhabitat for some species and competes with others for food and space.

Hydroides ezoensis originates in Asia, where it is found on the Japanese and Chinese coasts, and the Russian waters of the Sea of Japan (Figure 16). It has been introduced into the north-east Atlantic and Australia. It is a relatively recent introduction to Australia, being recorded there for the first time in 1998, from Sydney Harbour (Australian Faunal Directory 2005). During the New Zealand initial port baseline surveys, *H. ezoensis* was recorded in the Gulf Harbour Marina (Figure 17; (Inglis *et al*. 2006b), which was the first New Zealand record. During the resurveys *H. ezoensis* was recorded in Opua (Inglis *et al.* in press), Westhaven Marina (Inglis *et al*. 2006d) and in this resurvey, where it was found in pile scrape samples taken from Jetty C, Jetty J and Jetty L (Figure 18; Table 14).

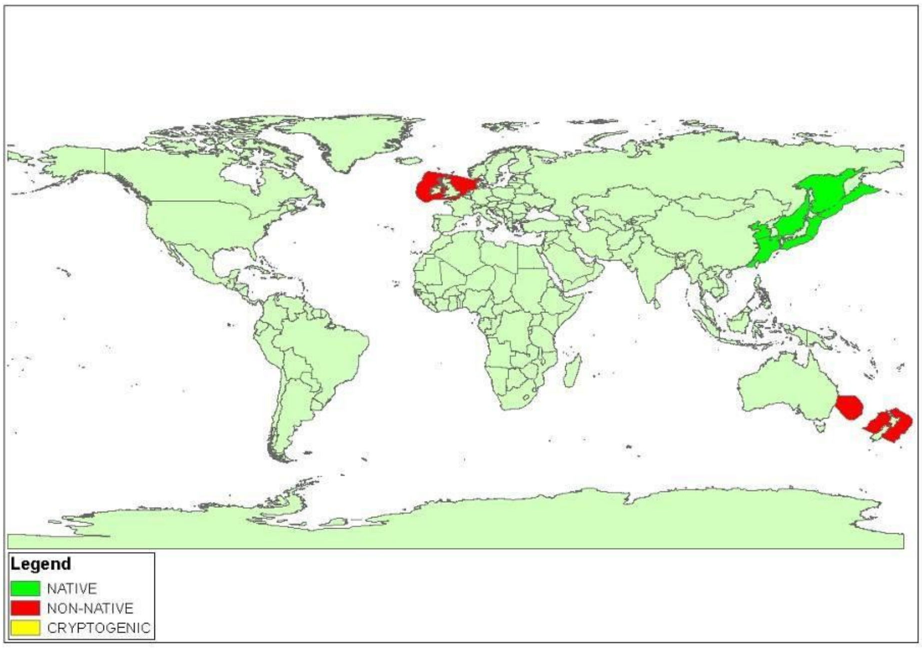

Figure 16: Global distribution of *Hydroides ezoensis*

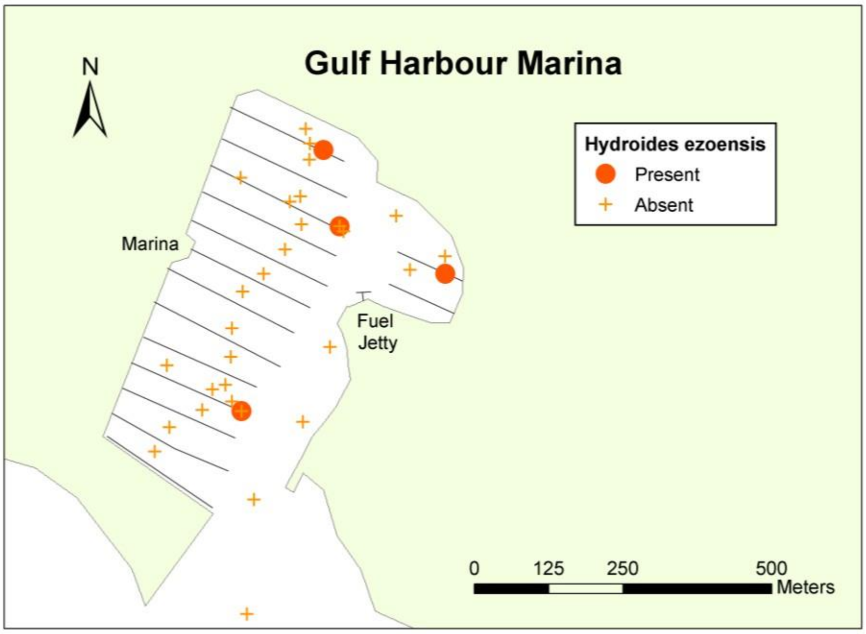

Figure 17: *Hydroides ezoensis* distribution in Gulf Harbour Marina during the initial survey.

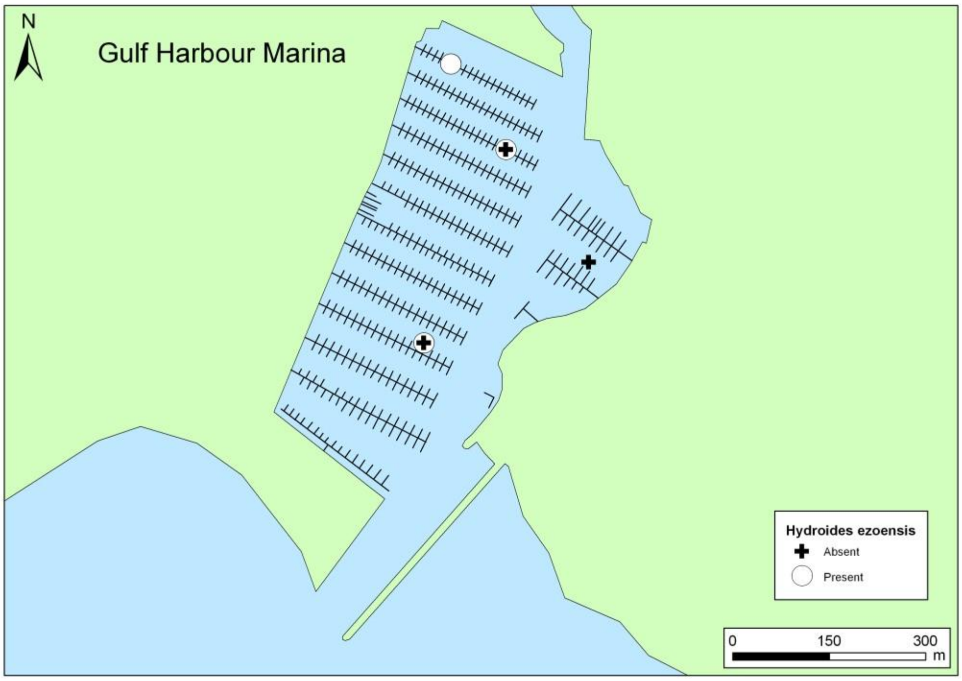

Figure 18: ***Hydroides ezoensis*** **distribution in Gulf Harbour Marina during the resurvey**

Hydroides elegans (Haswell, 1883)

Image and information: NIMPIS (2002d)

Hydroides elegans is a small, tube dwelling polychaete worm that grows to up to 20mm in length. It constructs hard, sinuous, calcareous tubes. The worm has 65-80 body segments, and an opercular crown with 14-17 spines. *Hydroides elegans* is a fouling species on both natural and artificial structures. It is found subtidally and is highly tolerant of contaminated waters. Although the type specimen for this species was described from Sydney Harbour, Australia, the native range of *H. elegans* is unknown, as it is possible it was introduced to Australia prior to 1883 (Australian Faunal Directory 2005). *H. elegans* is present in the Caribbean Sea, Brazil, Argentina, northwest Europe, Japan, the Mediterranean, north-west and south-east Africa, and New Zealand (Figure 19). This species is able to grow in high densities, particularly in tropical and sub- tropical ports, sometimes heavily fouling any newly immersed structure. It creates microhabitat for some species and competes with others for food and space. *H. elegans* has been present in New Zealand since at least 1952 and has been recorded from Waitemata and Lyttelton Harbours (Cranfield *et al*. 1998). During the initial port baseline surveys, *H. elegans* was recorded in Gulf Harbour marina (Figure 20) and the Port of Auckland (Inglis *et al*. 2006b, d). During the second baseline surveys it was recorded from the Ports of Nelson, Auckland, Westhaven Marina, and Viaduct Harbour (Inglis *et al*. 2006w); Inglis *et al.* in press) and in this survey where it was found in pile scrapes taken from Jetty C and Jetty J (Figure 21; Table 14).

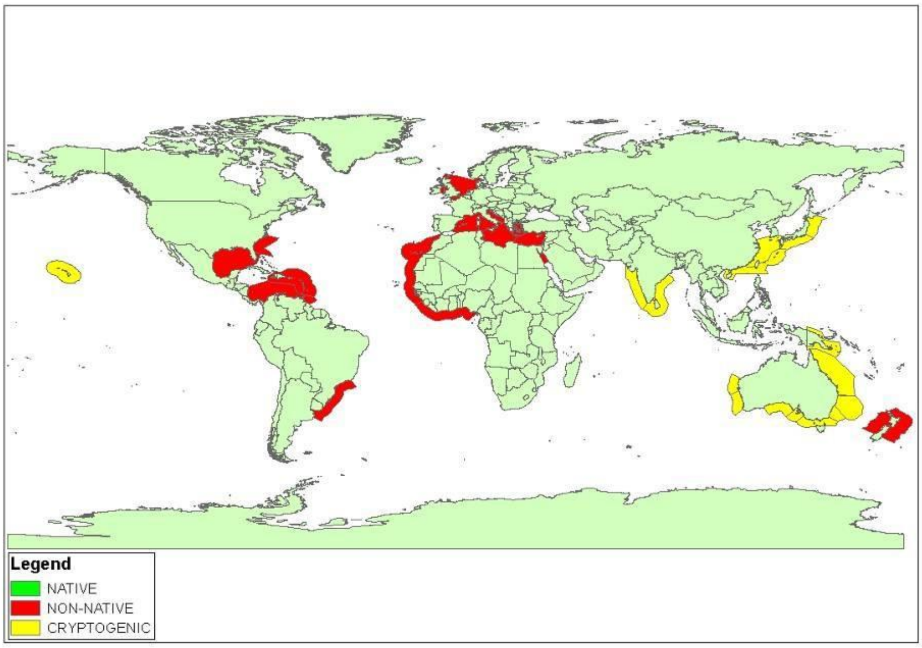

Figure 19: Global distribution of *Hydroides elegans*

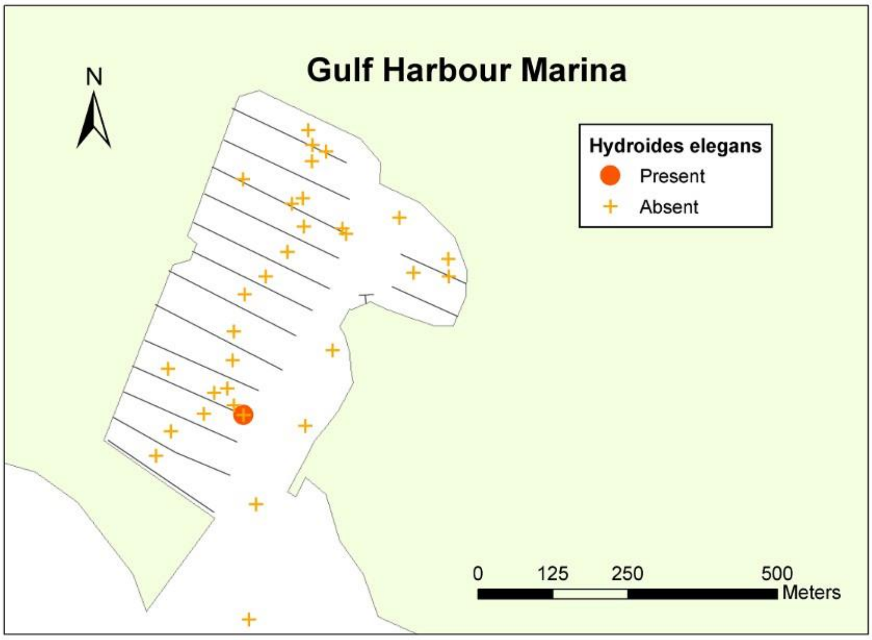

Figure 20: *Hydroides elegans* distribution in Gulf Harbour Marina during the initial survey.

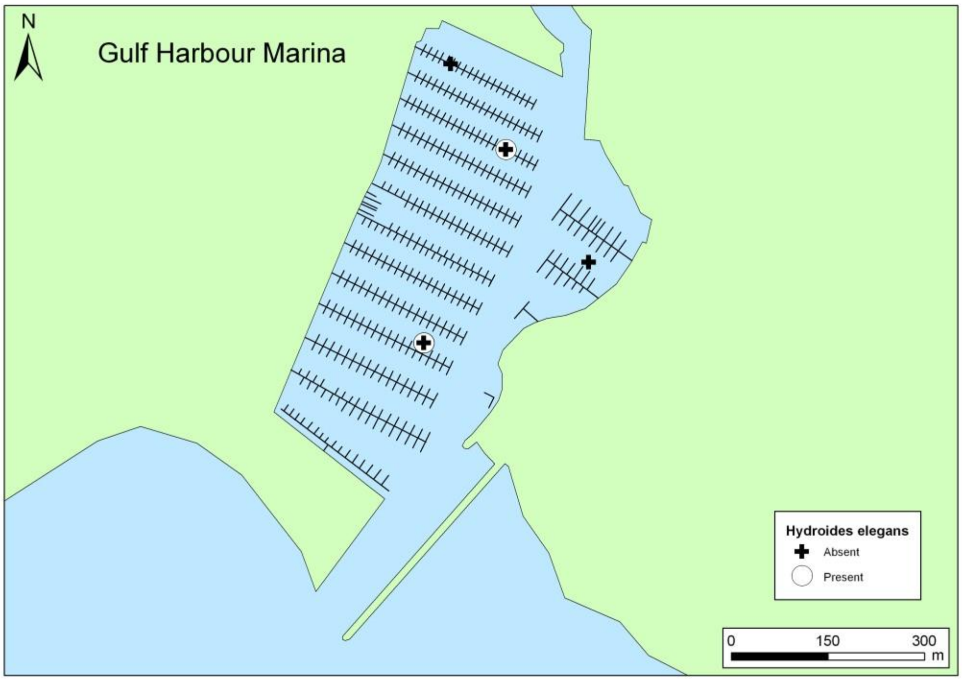

Figure 21: ***Hydroides elegans*** **distribution in the resurvey of the Gulf Harbour Marina.**

Pseudopolydora corniculata (Radashevsky & Hsieh, 2000)

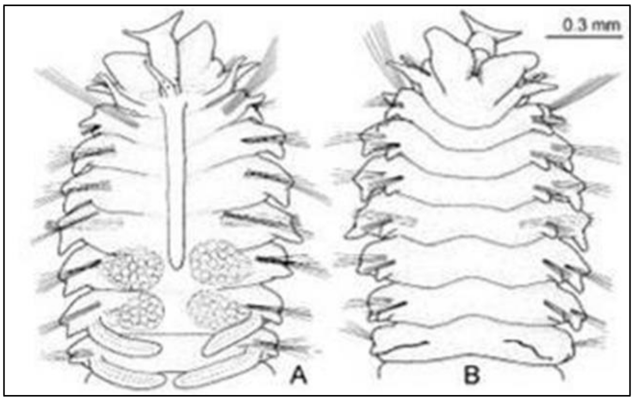

Image modified from Radashevsky and Hsieh (2000).

A: anterior end, dorsal view
B: anterior end, ventral view

Pseudopolydora corniculata is a spionid worm that constructs mud tubes in soft sediments of brackish water environments. *P. corniculata* can be distinguished from other *Pseudopolydora* species by the shape of the prostomium, peristomium, and by the presence of long cirriform postchaetal lamellae on segment 1 (Radashevsky and Hsieh 2000). These structures on the anterior end of the worm give it a horn-like appearance. A full description of the holotype is provided by Radashevsky and Hsieh (2000). Males and females are separate and fertilisation is internal.

Pseudopolydora corniculata inhabits intertidal and subtidal marine and estuarine sandflats. The type specimens were recorded from mud and fine sands at between 11-14 m depth. It lives in mud tubes and is a tentacular surface deposit-feeder.

The impacts of *Pseudopolydora corniculata* are unknown in New Zealand, but a related species, *P. paucibranchiata*, can be a dominant member of infaunal assemblages, with high densities of tubes altering the suitability of benthic habitats for other species (NIMPIS 2002f).

P. corniculata has only recently been described from type material from it"s Taiwan (Radashevsky and Hsieh 2000). New Zealand is the only other extralimital record of this species (Figure 22) although, until recently, it may have been confused with other species of *Pseudopolydora* elsewhere.

The date of introduction of *P. corniculata* to New Zealand is unknown, but it was known to be present prior to the port baseline surveys (as *P. kempi*). It has been recorded from Rangaunu Harbour, Colville Bay, Howick and Manukau Harbour (G. Read, NIWA, pers. comm.). During the port baseline surveys, *P. corniculata* was recorded in a single sample from Marsden Point, Whangarei Harbour (Inglis *et al*. 2006o) and in this resurvey of the Gulf Harbour Marina where it was found in a single benthic sled sample at site Jetty D & E (Figure 23; Table 14).

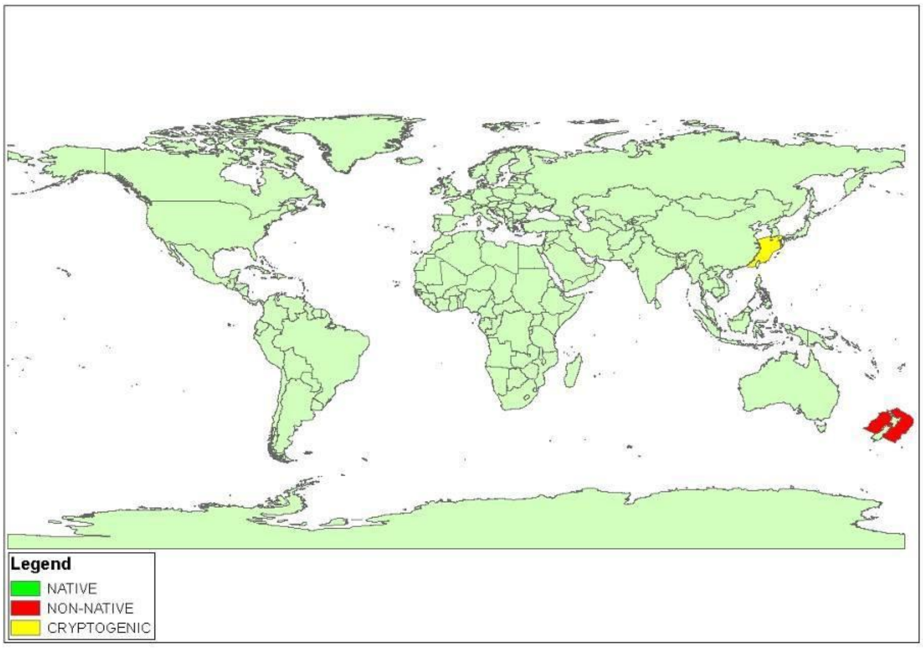

Figure 22: Global distribution of *Pseudopolydora corniculata*

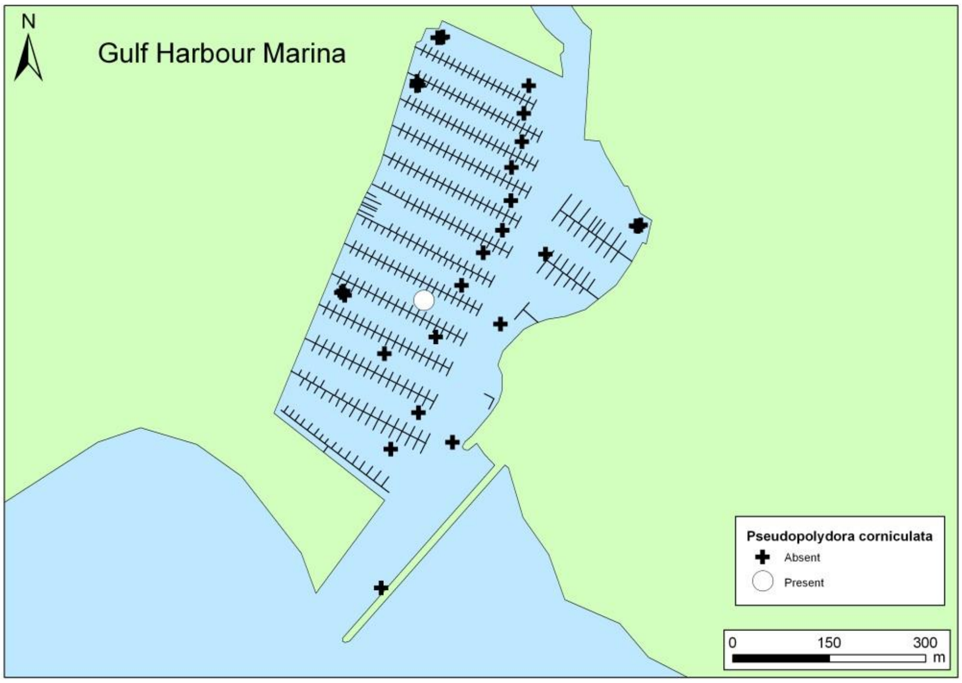

Figure 23: *Pseudopolydora corniculata* distribution in the resurvey of the Gulf Harbour Marina.

Pseudopolydora paucibranchiata (Okuda, 1937)

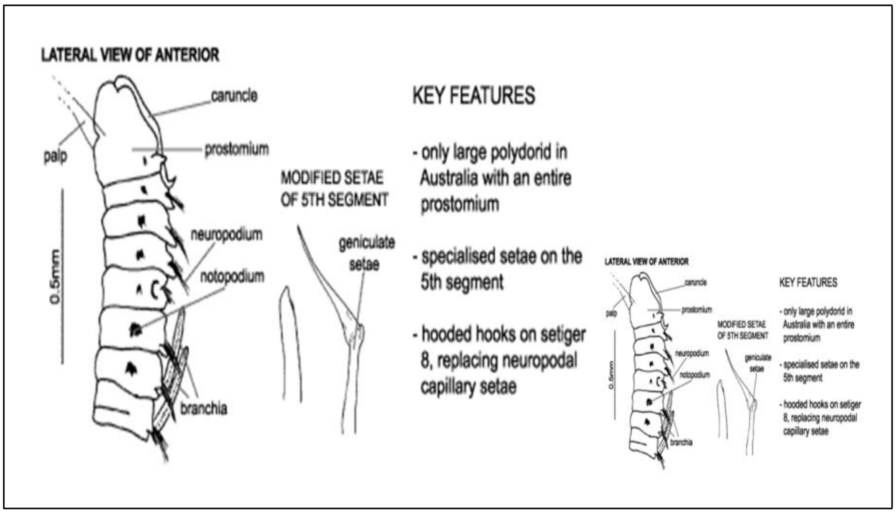

Diagram: Swaleh and Mustaquim, 1993, in NIMPIS (2002f)

Pseudopolydora paucibranchiata (common name Elkhorn slough spionid or Japanese polydorid) is a burrowing, sedentary spionid polychaete worm. It constructs tubes from sand and silt. It is a creamy colour with yellow-white bands. The first segment is reduced, with no notosetae (hairs). The fifth segment is not enlarged or modified, but has distinct parapodial (foot) lobes with major spines placed in a U-shaped line. From the eighth segment, hooded hooks are present which replace the capillary setae (NIMPIS 2002f).

Pseudopolydora paucibranchiata is most abundant in the low tidal zone, but also occurs subtidally. It occurs in sand and mudflats, but prefers fine sediments. It also occurs in fouling communities and is a fouler on oyster shells. It is a deposit/suspension feeder, consuming algae, invertebrate larvae, detritus and other polychaetes (NIMPIS 2002f). *P. paucibranchiata* has been recorded at a maximum depth of 63m, in water temperatures from 8.5 to 21 degrees Celsius, and in salinities from 21.5 to 34.8 ppt (see NIMPIS 2002f and references therein).

Males and females are separate and fertilisation is internal. In a breeding season up to 800 eggs are deposited inside the female‟s tube. Larvae remain in the plankton between 7 and 47 days, after which they settle, metamorphose, begin burrowing and constructing a tube. Sexual maturity is reached by approximately 4 weeks age (see NIMPIS 2002f and references therein). In New Zealand the reproductive season is March to September (Read 1975).

P. paucibranchiata can be a dominant member of the infaunal community; densities of up to 60,000 individuals per square metre have been recorded (Levin 1981, in NIMPIS 2002f). These high densities may alter habitat and bio-geochemical cycles due to the concentration of tubes in the sediment. Faunal composition may also be altered through competition and predation *P. paucibranchiata* loses interspecific interactions against gammarid and caprellid amphipods but dominates interactions with other polychaetes. It has been recorded to negatively affect recruitment of an opheliid polychaete, *Armandia* sp., through predation of larvae. *P. paucibranciata* has been recorded to be inhibited by mats of the invasive mussel *Musculista senhousia* in San Diego (see NIMPIS 2002f and references therein). *M. senhousia* is also non-indigenous in New Zealand, known from several locations in northern New Zealand (Cranfield *et al*. 1998). *P. paucibranchiata* is ranked 33rd of 53 species in terms of its potential impact in a listing of domestic marine priority pests in Australia (Hayes *et al*. 2005a).

P. paucibranchiata may be introduced to new locations and dispersed around New Zealand through attached or free-living fouling individuals on ships, through translocations of fish or shellfish, dredge spoil, ballast water, sea water systems, live wells or other deck basins and by natural planktonic dispersal.

The type locality of *Pseudopolydora paucibranchiata* is Japan (Okuda 1937). It is thought to be native to the north-west Pacific, from China to the coast of Russia, and has been introduced to the north-east Atlantic, the west Coast of the U.S.A., southern Australia and New Zealand (Figure **24**). *P. paucibranchiata* was first recorded in Australia in 1972, where it was possibly introduced with *Crassostrea gigas*, the Pacific oyster (NIMPIS 2002f; Australian Faunal Directory 2005).

P. paucibranchiata has been present in New Zealand since at least 1975, and was known from Wellington prior to the port baseline surveys (Read 1975). During the initial port baseline surveys it was recorded from the Port of Gisborne (Inglis *et al*. 2006f) and also in a single sample from Marsden Point, Whangarei (Inglis *et al*. 2006o). During the repeat surveys it was recorded in the Port of Gisborne, Viaduct Harbour, Westhaven Marina (Inglis *et al*. in press) and in this survey of the Gulf Harbour Marina. *P. paucibranchiata* was recovered in benthic sled and benthic grab samples from Jetty B & C, Jetty C, Jetty D & E, Jetty F & G, Jetty G & H, Jetty I & J, Jetty L & shore and Jetty A & L during this survey (Figure 25; Table 14).

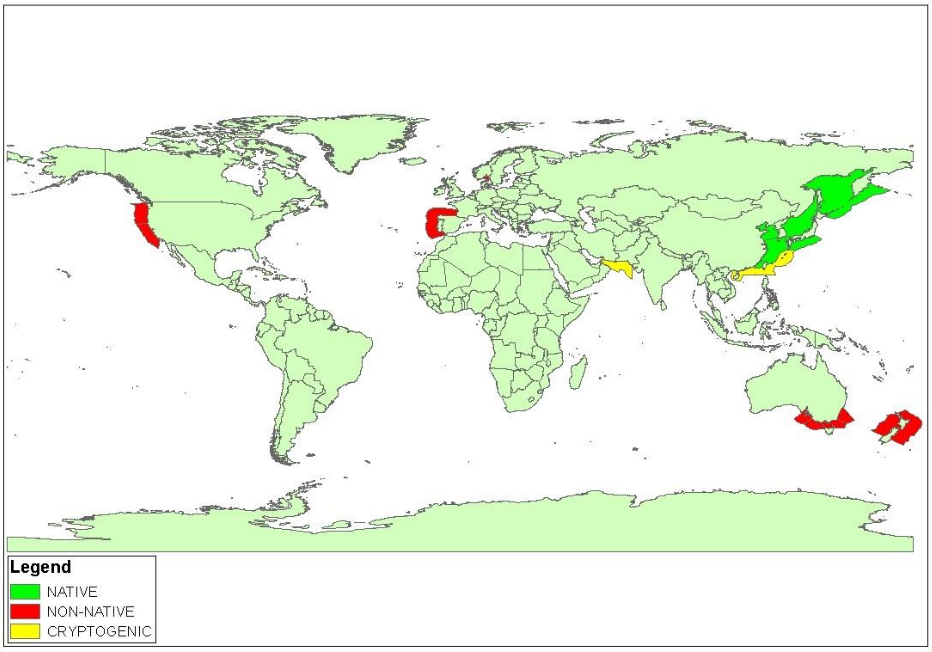

Figure 24: Global distribution of *Pseudopolydora paucibranchiata*

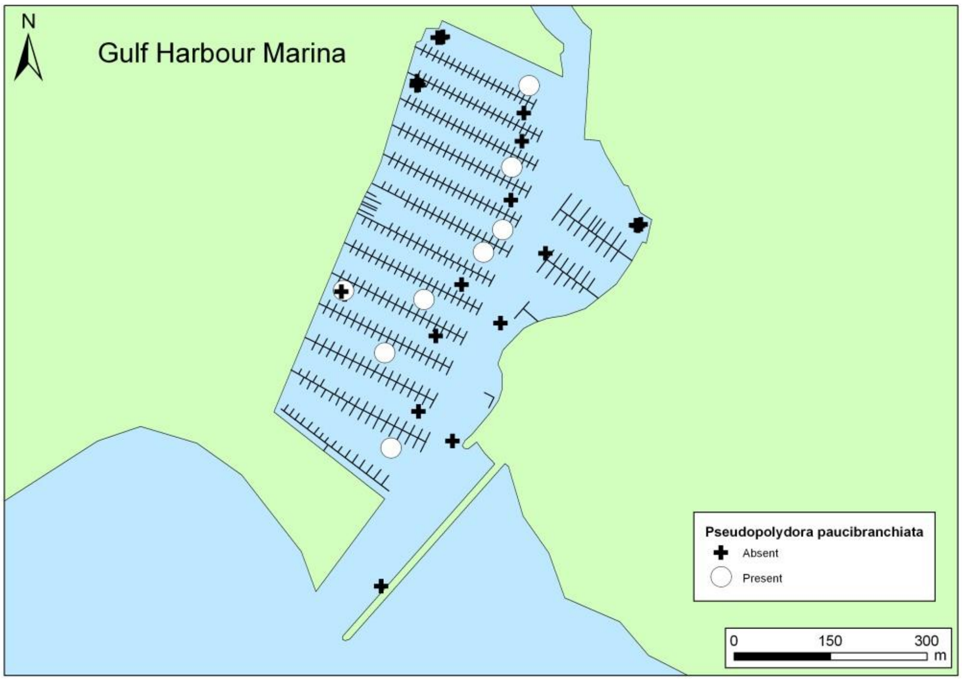

Figure 25: ***Pseudopolydora paucibranchiata*** **distribution in the resurvey of the Gulf Harbour Marina**

Apocorophium acutum (Chevreux, 1908)

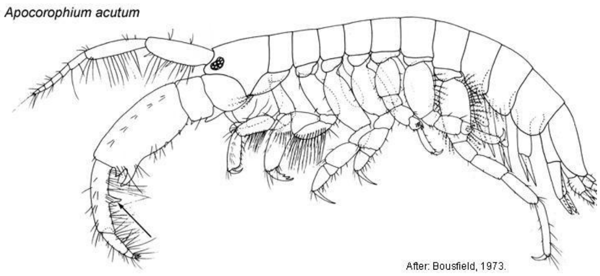

Image and information: Myers *et al*. (2006)

Apocorophium acutum is a corophiid amphipod, known from the Atlantic Ocean (England, France, North America, Brazil, South Africa), Pacific Ocean (New Zealand) and the Mediterranean Sea (

Figure 26). The native range of this species is not known, although the type specimen of this species was described from the southern Mediterranean. *Apocorophium acutum* inhabits marine sediments in estuarine mudflats and brackish water and fouling assemblages where it builds muddy tubes. It has no known documented impacts. During the initial port baseline surveys *A. acutum* was recorded from the ports of Tauranga, Lyttelton, Timaru and Dunedin, and from Gulf Harbour (Figure 27), and Opua marinas (Inglis *et al*. 2006a, b, c; Inglis *et al*. 2006g; Inglis *et al*. 2006l, m, n); Table 14). During the second baseline surveys it was recorded from the ports of Lyttelton, Timaru, Auckland, Bluff, Dunedin, Gisborne, Napier, Whangarei and Opua, Whangarei and Westhaven Marina (Inglis *et al*. 2006m; Inglis *et al*. 2006q, u; Inglis *et al*. in press) and this resurvey of Gulf Harbour Marina. In the resurvey of the Gulf Harbour Marina, *A. acutum* occurred in pile scrape samples taken from the Jetty J, Jetty C, Jetty N & O and Jetty L (Figure 28; Table 14).

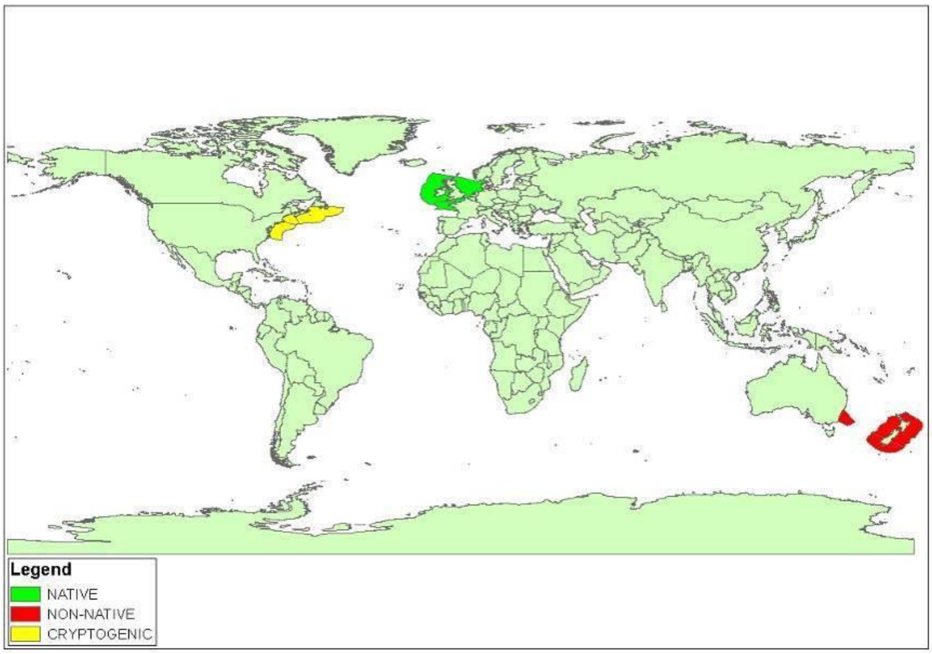

Figure 26: Global distribution of *Apocorophium acutum*

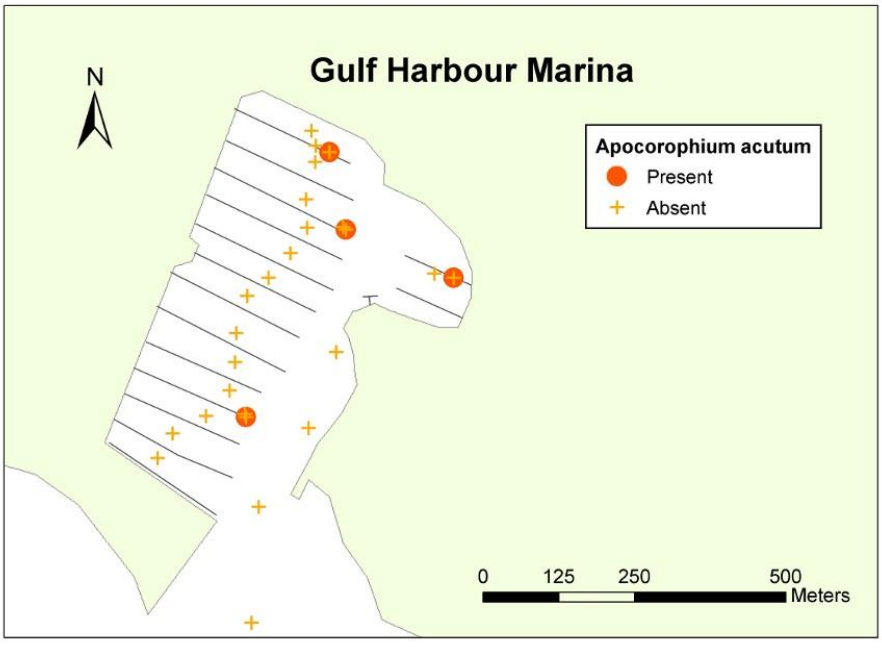

Figure 27: *Apocorophium acutum* distribution in the initial baseline survey of the Gulf Harbour Marina

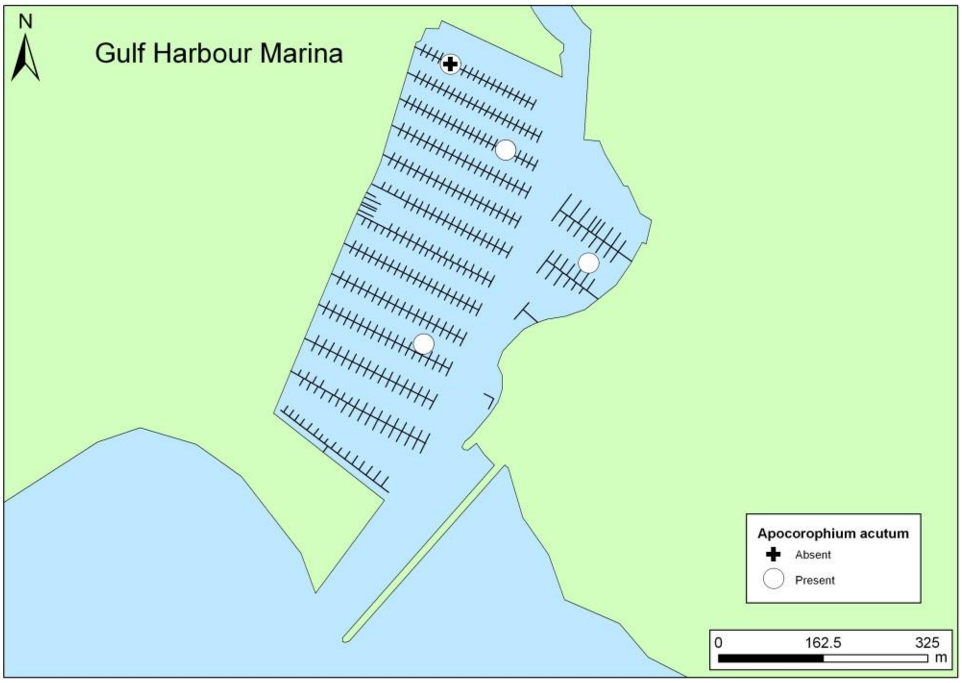

Figure 28: ***Apocorophium acutum*** **distribution in the resurvey of the Gulf Harbour Marina**

***Monocorophium acherusicum* (A. Costa, 1851)**

Image and information: NIMPIS (2002e)

Monocorophium acherusicum is a flat, yellowish-brown amphipod crustacean that lives amongst assemblages of marine invertebrates and plants or in soft-bottom habitats, and feeds by grazing on bacteria on sediment particles or on organic matter suspended in the water column. It is native to the northeast Atlantic, the Mediterranean and the northwest African coast and has been introduced to Brazil, southeast Africa, India, the Japanese and China Seas, Australia and New Zealand (Figure 29). It is cryptogenic in the Baltic Sea, the Caribbean and the east and northwest coasts of the USA.

Monocorophium acherusicum occurs subtidally on sediments or where silt and detritus accumulate among fouling communities such as algae, ascidians and bryozoans, and man-made installations e.g. wharf pylons, rafts and buoys. It is a tube building species constructing conspicuous, fragile U-shaped tubes of silk, mud and sand particles. It can reach high abundances and can tolerate a wide range of salinities. Pilisuctorid ciliates are parasites on this species in the Black Sea, but it is unknown whether these parasites could transfer to native species and cause negative impacts in New Zealand. During the initial port baseline surveys, *M. acheruscium* was recorded from the ports of Tauranga, Gisborne, Lyttelton, Timaru, Dunedin and the Whangarei Town Basin Marina (Inglis *et al*. 2006l); (Inglis *et al*. 2006a, f; Inglis *et al*. 2006g; Inglis *et al*. 2006m, p); Table 14). During the repeat baseline surveys it was recorded in the Port of Timaru, Lyttelton, Wellington (Inglis *et al*. 2006u), (Inglis *et al*. 2006q; Inglis *et al*. 2006v), the Whangarei Marina (Inglis *et al*. in press) and in this survey of the Gulf Harbour Marina. In the Gulf Harbour Marina, it occurred in one pile scrape miscellaneous sample taken from Jetty N & O (Figure 30; Table 14).

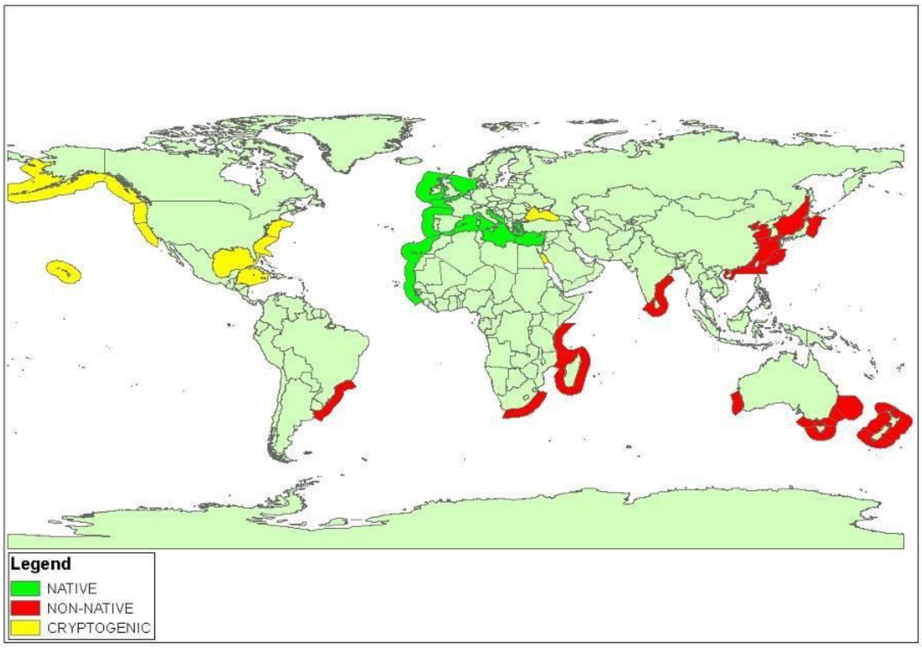

Figure 29: Global distribution of *Monocorophium acherusicum*

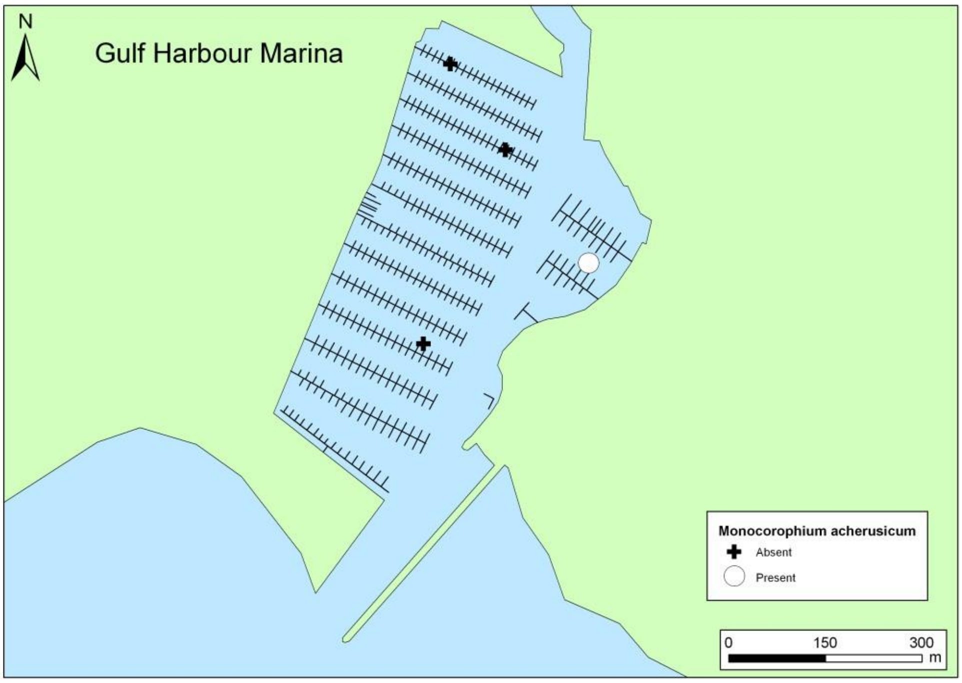

Figure 30: *Monocorophium acherusicum* distribution in the resurvey of the Gulf Harbour Marina

***Amphibalanus amphitrite* (Darwin, 1854)**

Image: (Stafford and Willan 2007)

Amphibalanus amphitrite is distinguished in the field by its vertical purple stripes. It has 6 naupliar stages and one cyprid stage before it settles and metamorphoses into and adult. It is known to spawn throughout the year in India but in temperate areas it is seasonal and spawning coincides with warmer spring and summer months (Daniel 1958).

Amphibalanus amphitrite is distributed world-wide in warm and temperate seas. It is found in the Mediterranean, the West Indies, South Africa, the Philippine Archipelago, New South Wales, Australia and from Florida to as far north as Massachusetts in North America (Zullo 1963).

In New Zealand *A. amphitrite* has been recorded in Auckland, Dunedin, Napier, Nelson, New Plymouth, Opua, Otago, Picton, Tauranga, Wellington (Floerl et al. 2008)and Waitemata Harbour (Cranfield et al. 1998). It was found in the resurvey of the Gulf Harbour Marina in two pile scrape samples taken from Jetty J (
Figure 32; Table 14).

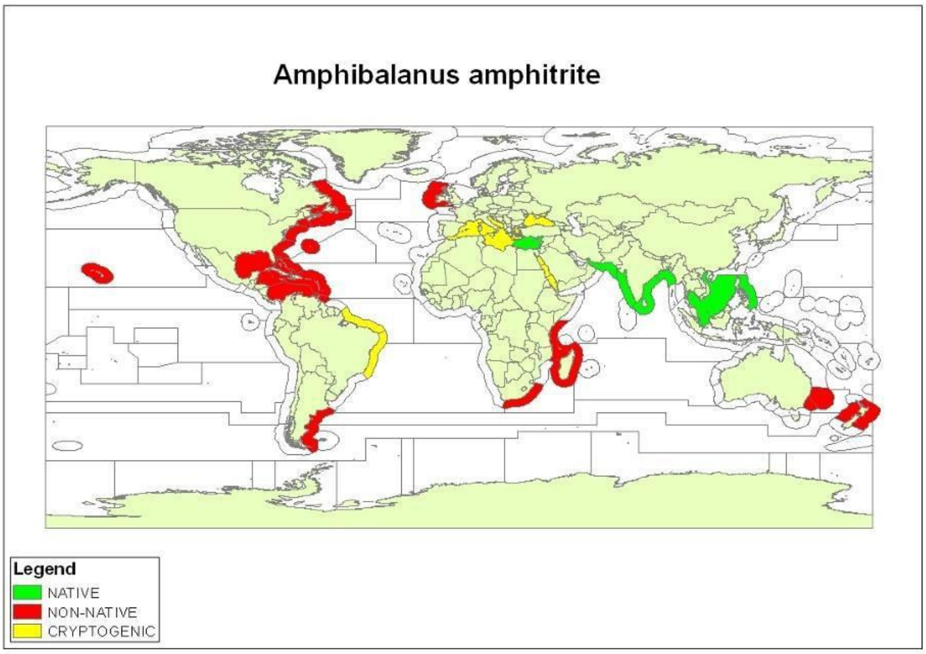

Figure 31: Global distribution of *Amphibalanus amphitrite*

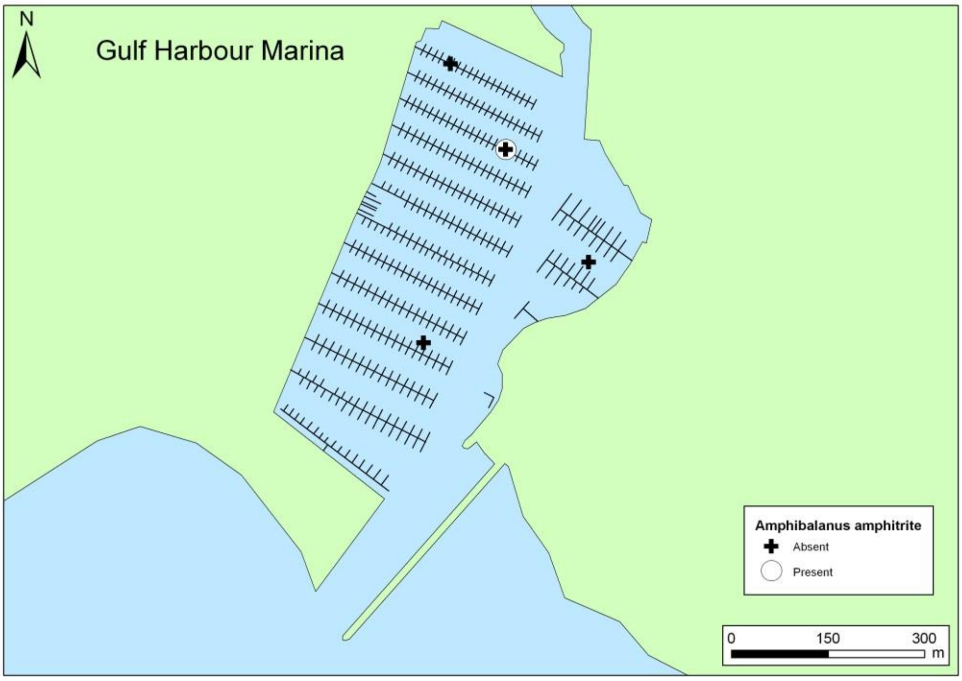

Figure 32: ***Amphibalanus amphitrite*** **distribution in the resurvey of the Gulf Harbour Marina**

***Bugula neritina* (Linnaeus, 1758)**

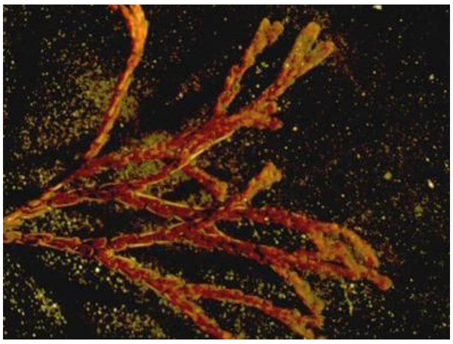

Image and information: NIMPIS (2002b)

Bugula neritina is an erect, bushy, red-purple-brown bryozoan. Branching is dichotomous (in series of two) and zooids alternate in two rows on the branches. Unlike all other species of *Bugula*, *B. neritina* has no avicularia (defensive structures) or spines, but there is a single pointed tip on the outer corner of zooids. Ovicells (reproductive structures) are large, globular and white. They often appear in such high numbers that they resemble small snails or beads.

Bugula neritina is native to the Mediterranean Sea (Figure 33). It has been introduced to most of North America, Hawaii, India, the Japanese and China Seas, Australia and New Zealand. It is cryptogenic in the British Isles. *Bugula neritina* is one of the most abundant bryozoans in ports and harbours and an important member of the fouling community. The species colonises any available substratum and can form extensive monospecific growths. It grows well on pier piles, vessel hulls, buoys and similar submerged surfaces. It even grows heavily in ships" intake pipes and condenser chambers. In North America, *B. neritina* occurs on rocky reefs and seagrass leaves. In Australia, it occurs primarily on artificial substrata. *B. neritina* occurs in all New Zealand ports (Gordon and Mawatari 1992). During the initial port baseline surveys it was recorded from the Opua and Gulf Harbour marinas (Figure 34), Whangarei Harbour (Marsden Point, Whangarei Port and Town Basin marina), and the ports of Auckland, Tauranga, Taranaki, Napier, Gisborne, Lyttelton, Timaru and Dunedin (Table 14; (Inglis *et al*. 2006a, b, c, d, f; Inglis *et al*. 2006g; Inglis *et al*. 2006h, k, l, m, o, p). In the repeat baseline surveys it was recorded from the ports of Tauranga, Whangarei, Taranaki, Napier, Gisborne, Picton, Lyttelton, Dunedin and Timaru and Opua, Whangarei and Westhaven Marinas (Inglis *et al*. 2006q, r, s, t, u; Inglis *et al*. in press) and this survey of The Gulf Harbour Marina. In the Gulf Harbour Marina it occurred in pile scrape samples taken from Jetty C, Jetty J and Jetty N & O (Figure 35; Table 14).

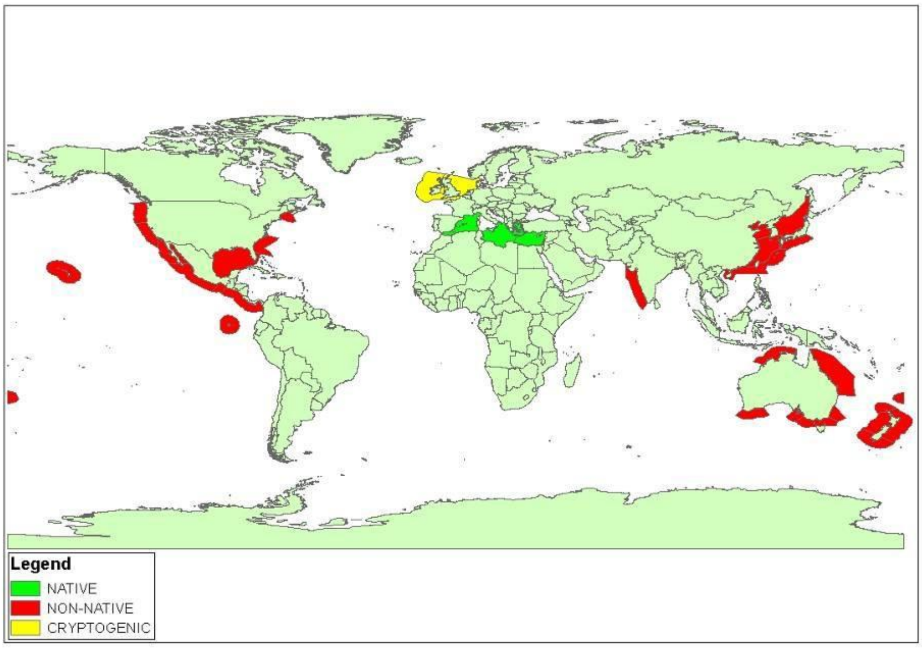

Figure 33: Global distribution of *Bugula neritina*

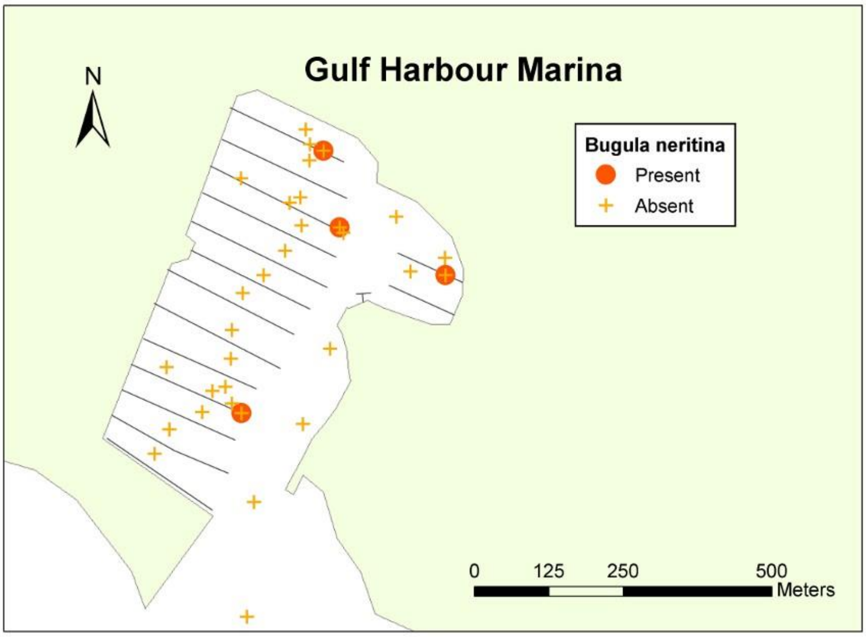

Figure 34: *Bugula neritina* distribution in the initial baseline survey of theGulf Harbour Marina.

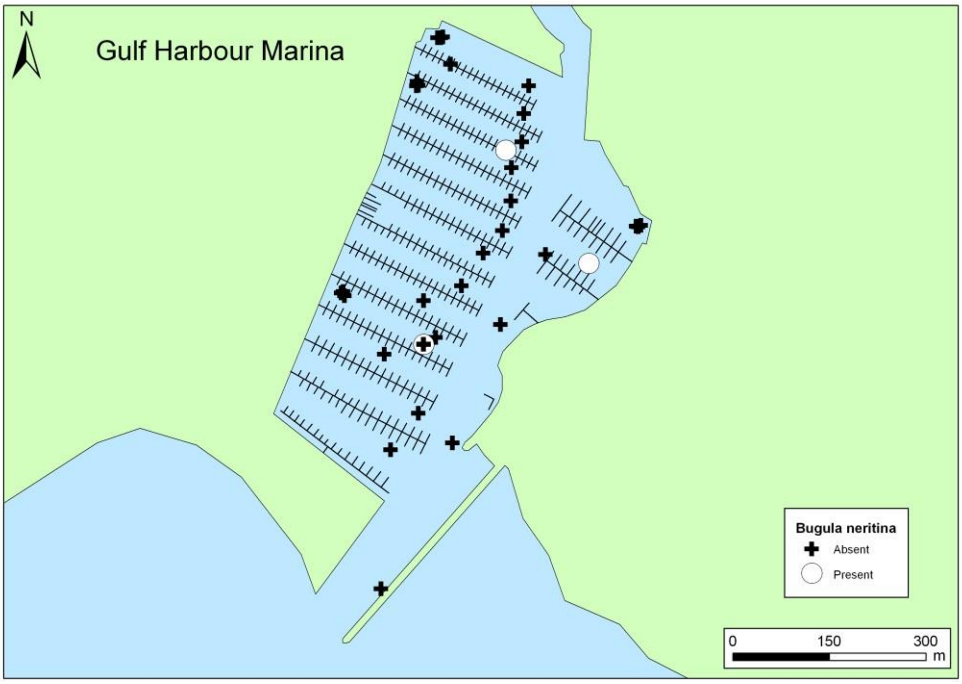

Figure 35: ***Bugula neritina*** **distribution in the resurvey of the Gulf Harbour Marina**

Bugula stolonifera (Ryland, 1960)

Image: California Academy of Sciences (2002)

Bugula stolonifera forms dense tufted colonies of 30-40 mm high. It is a greyish buff colour and lives attached to the substratum by rhizoids. Its basal and lateral walls are lightly calcified. Young colonies take on a fan or funnel shape, while established colonies form dense tufts. The zooids of *B. stolonifera* are smaller than those of *B. neritina*, yet they still taper proximally (Gordon and Mawatari 1992; Hill 2001).

Bugula stolonifera is native to southern Britain. It has been introduced to California, Hawaii, Mexico, Brazil, the Mediterranean and the eastern Atlantic (Gordon and Mawatari 1992; Hill 2001); (Figure 36). In New Zealand it has been recorded from Auckland, Napier, Nelson, Lyttelton, Timaru and Bluff (Gordon and Mawatari 1992). During the initial port baseline surveys, *B. stolonifera* was recorded from the ports of New Plymouth, Whangarei and Whangarei Marina (Inglis *et al*. 2006k, o) and in the second survey of Gisborne, Napier, Opua, Whangarei Harbour, Viaduct, Westhaven and Gulf Harbour Marina (Inglis *et al*. in press). In this survey of the Gulf Harbour Marina *B. stolonifera* was recorded in the pile scrapes taken from Jetty N & O, Jetty J and Jetty L (Figure 37; Table 14).

Like other species within the genus, *B. stolonifera* is a prolific fouling organism that readily occupies available hard substrata, as well as the exposed shells or carapaces of other organisms, or attaches itself onto attached or floating seagrass and algae (Hill 2001). Specimens collected during the surveys were from pile scrapings. *Bugula stolonifera* is a filter feeder.

The impacts of *B. stolonifera* on New Zealand ecosystems have not been documented. As an abundant fouling organism, *B. neritina* colonizes underwater structures and may interfere with vessel performance, aquaculture and potentially out-compete native species. Possible pathways for introductions to new locations and dispersal within New Zealand include attachment to ships as free-living fouling organisms, through translocations of fish, shellfish, and fishery products and packing and through dispersal on biogenic and artifical substrata.

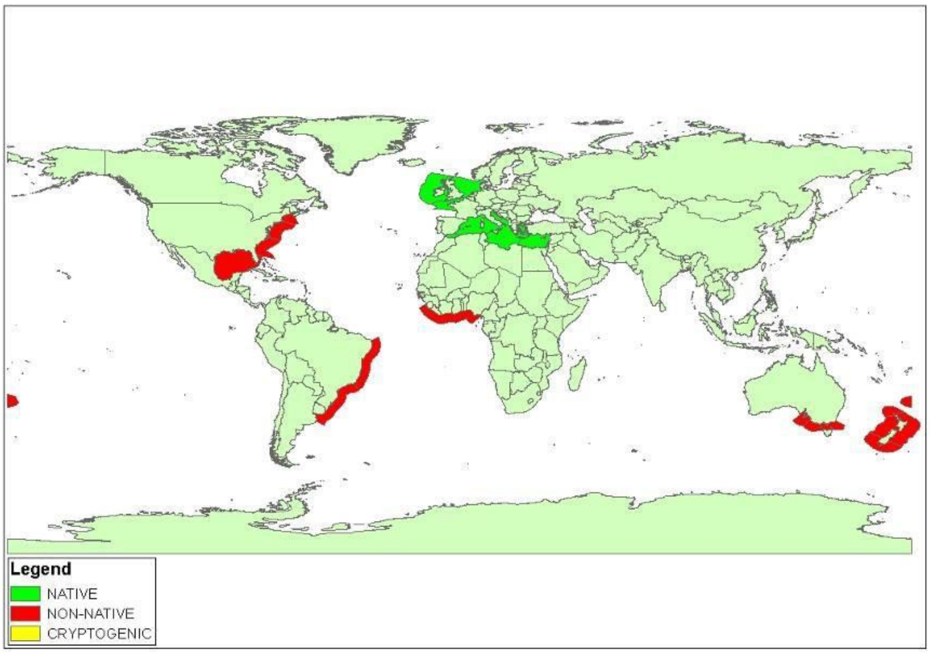

Figure 36: Global distribution of *Bugula stolonifera*

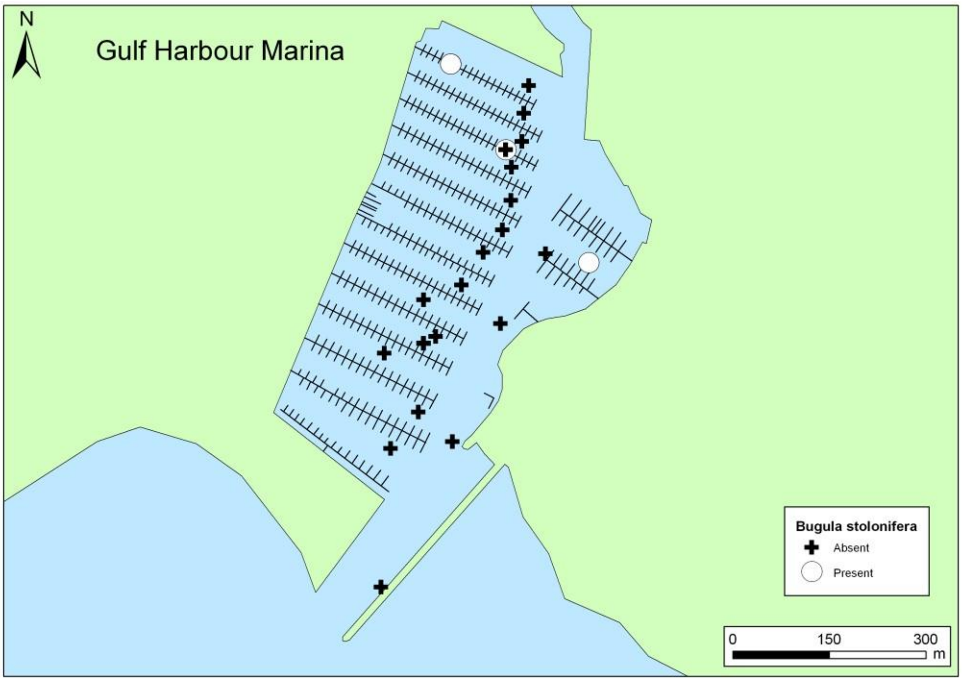

Figure 37: *Bugula stolonifera* distribution in the resurvey of the Gulf Harbour Marina

Schizoporella errata (Waters, 1878)

Image: O. Floerl 2003; information: Eldredge and Smith (2001)

Schizoporella errata is a heavily calcified, encrusting bryozoan that is typically dark brick red with orange-red growing margins. It assumes the shape of whatever it overgrows. This species may form heavy knobbly incrustations on flexible surfaces such as algae or worm tubes, turning them into solid, sometimes erect branching structures. The thickness of the growth is dependent upon the age of the colony. Multilaminar encrustations 1 cm thick are common. The frontal surface of the zoecium (secreted exoskeleton housing of individual zooids) is porous with a wide semicircular aperture and proximal sinus. It also has single avicularia on the right or left side of the aperture sinus.

Schizoporella errata is thought to be native to the Mediterranean. It has been introduced to many worldwide locations in warm temperate-subtropical seas. It has been reported from West Africa, the Red Sea, the Persian Gulf, South Australia, New Zealand, the Hawaiian Islands, the Pacific coast of North America, the east coast of North America through to the Caribbean and Brazil (Figure 38). *S. errata* occurs in shallow water on various hard substrates (pilings, hulls, coral rubble, etc.) in harbours and embayments. It is also occasionally found on rocky or coral reefs. *S. errata* can compete with other fouling organisms for space and large encrustations of this species are known to smother other biota (Cocito *et al*. 2000). It is present in Waitemata Harbour and the Bay of Islands. During the baseline port *surveys S. errata* was also recorded from Nelson, Whangarei Harbour and the Gulf Harbour Marina (Figure 39; Table 14; (Inglis *et al*. 2006i; Inglis *et al*. 2006p; Inglis *et al*. 2006o). During the repeat surveys *S. errata* was recorded in the Viaduct Harbour, Westhaven and Opua Marina, Whangarei Port and in this resurvey (Inglis *et al*. in press). *S. errata* was found in piles scrapes samples taken from Jettty C, Jetty L and Jetty J in the second survey of the Gulf Harbour Marina (Figure 40; Table 14).

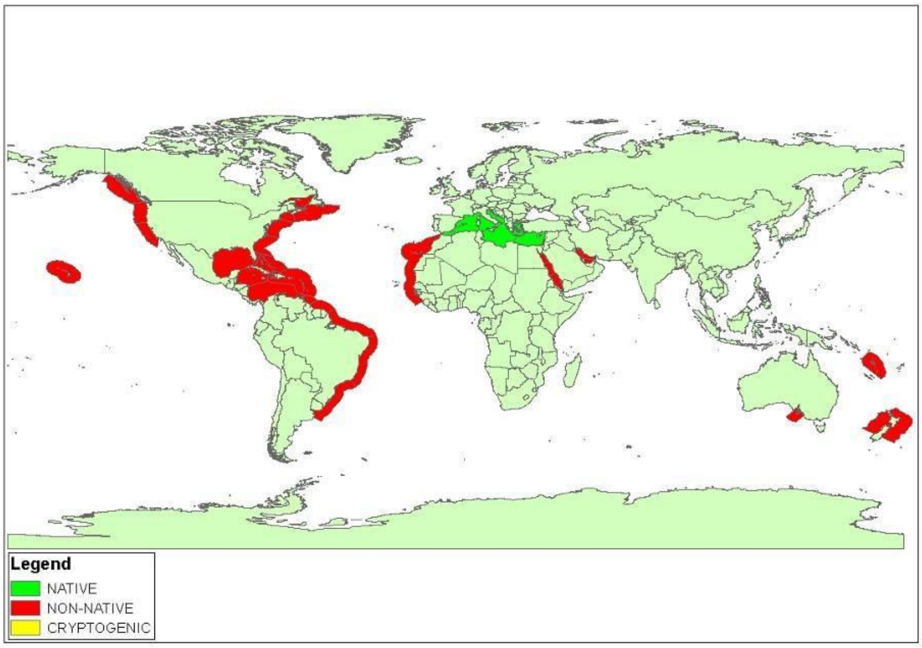

Figure 38: Global distribution of *Schizoporella errata*

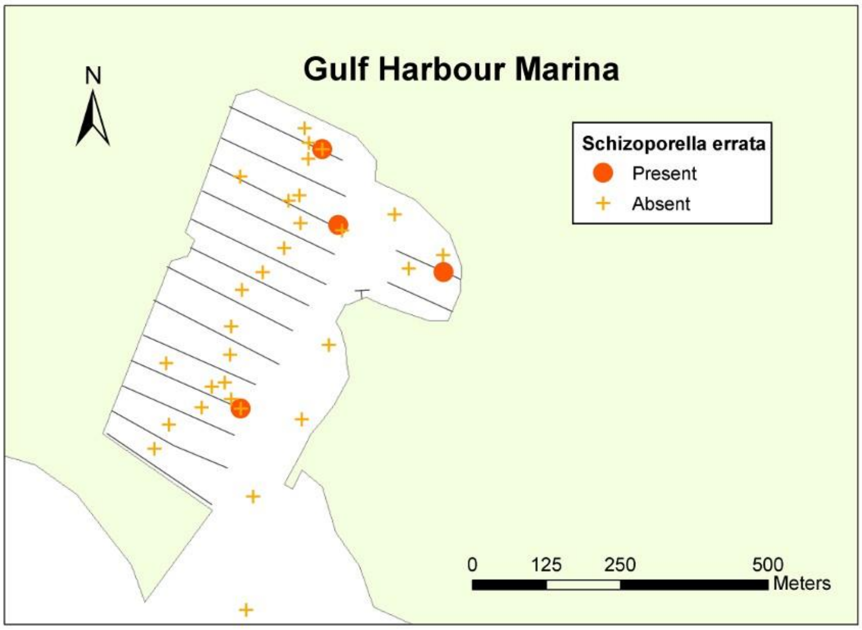

Figure 39: *Schizoporella errata* distribution in the initial baseline survey of theGulf Harbour Marina.

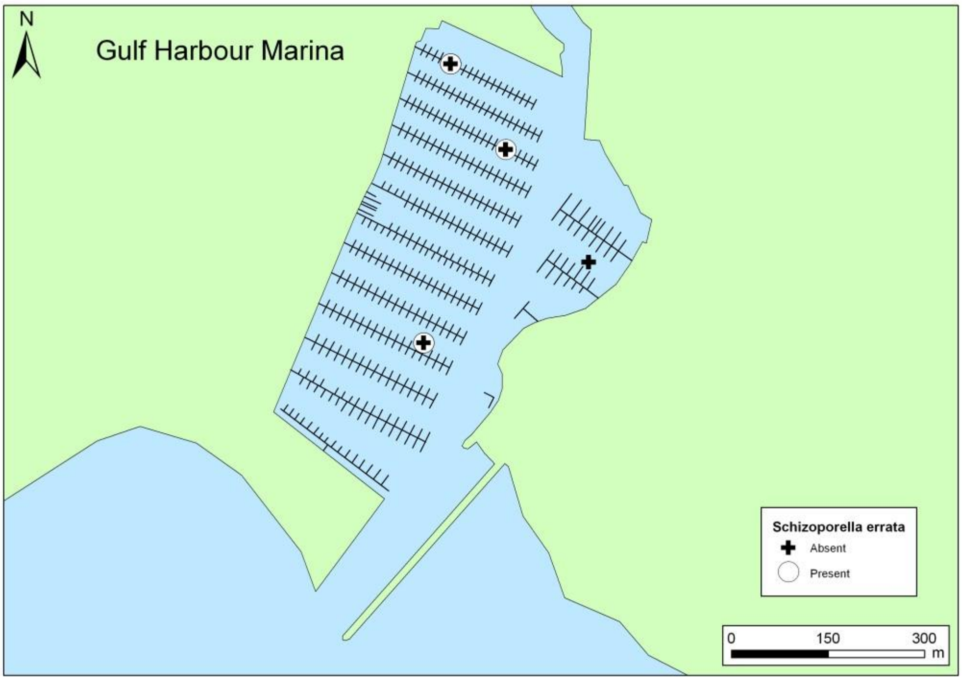

Figure 40: ***Schizoporella errata* distribution in the resurvey of the Gulf Harbour Marina**

***Watersipora subtorquata* (d'Orbigny, 1852)**

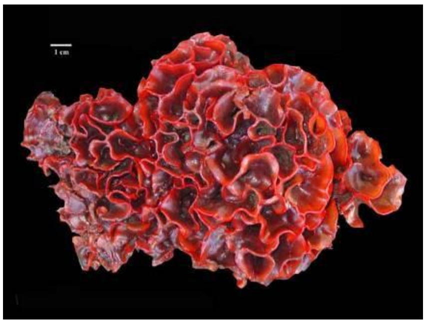

Image: Cohen (2005)
Information: Gordon and Matawari (1992)

Watersipora subtorquata is a loosely encrusting bryozoan capable of forming single or multiple layer colonies. The colonies are usually dark red-brown, with a black centre and a thin, bright red margin. The operculum is dark, with a darker mushroom shaped area centrally. *W. subtorquata* has no spines, avicularia or ovicells. The native range of the species is unknown, but is thought to include the wider Caribbean and South Atlantic (Figure 41). The type specimen was described from Rio de Janeiro, Brazil (Gordon and Mawatari 1992). It also occurs in the northwest Pacific, Torres Strait and northeastern and southern Australia.

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

Watersipora subtorquata has been present in New Zealand since at least 1982 and is now present in most ports from Opua to Bluff (Gordon and Mawatari 1992). During the initial port baseline surveys, it was recorded from the Opua and Gulf Harbour marinas (Figure 42), Whangarei Harbour (Marsden Point and Whangarei Marina) and the ports of Tauranga, Gisborne, Napier, Taranaki, Wellington, Picton, Nelson, Lyttelton, Timaru, Dunedin and Bluff (Table 14; (Inglis *et al*. 2006a, b, c, d, e, f; Inglis *et al*. 2006g; Inglis *et al*. 2006h; Inglis *et al*. 2006i; Inglis *et al*. 2006j, k, l, m, n, o).

During the second baseline surveys *W. subtorquata* was recorded from the ports of Whangarei, Auckland, Tauranga, Gisborne, Taranaki, Napier, Wellington, Picton, Nelson, Lyttelton, Timaru, Dunedin, Bluff and Westhaven and Opua Marinas, and in this survey of the Gulf Harbour Marina (Inglis *et al*. 2006q, r, s, t, u; Inglis *et al*. 2006v; Inglis *et al*. 2006w; Inglis *et al.* in press).) In the Gulf Harbour Marina it occurred in pile scrape samples taken from Jetty A & B, Jetty C, Jetty J, Jetty L and Jetty N & O (Figure 43; Table 14).

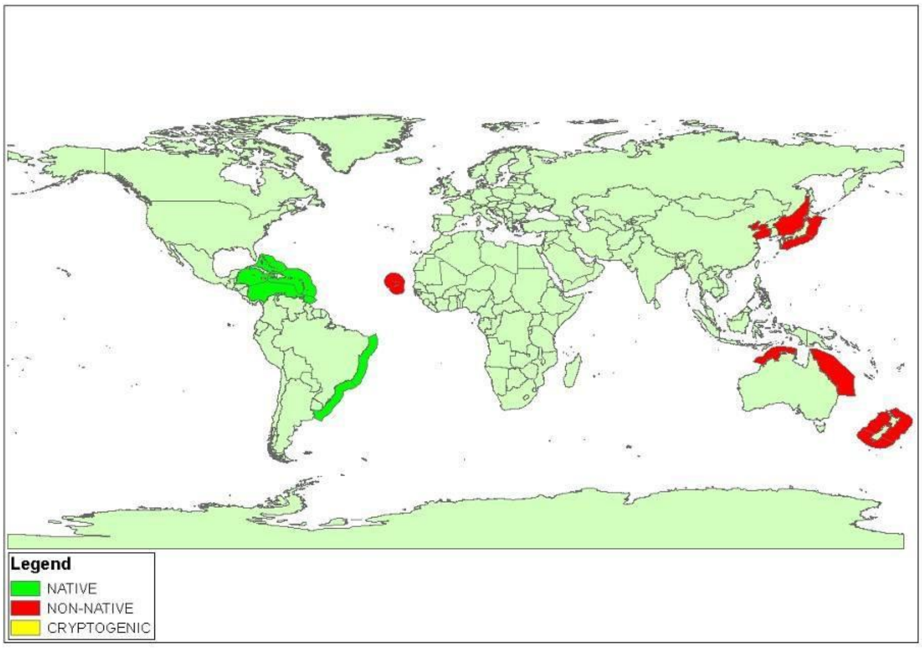

Figure 41: Global distribution of *Watersipora subtorquata*

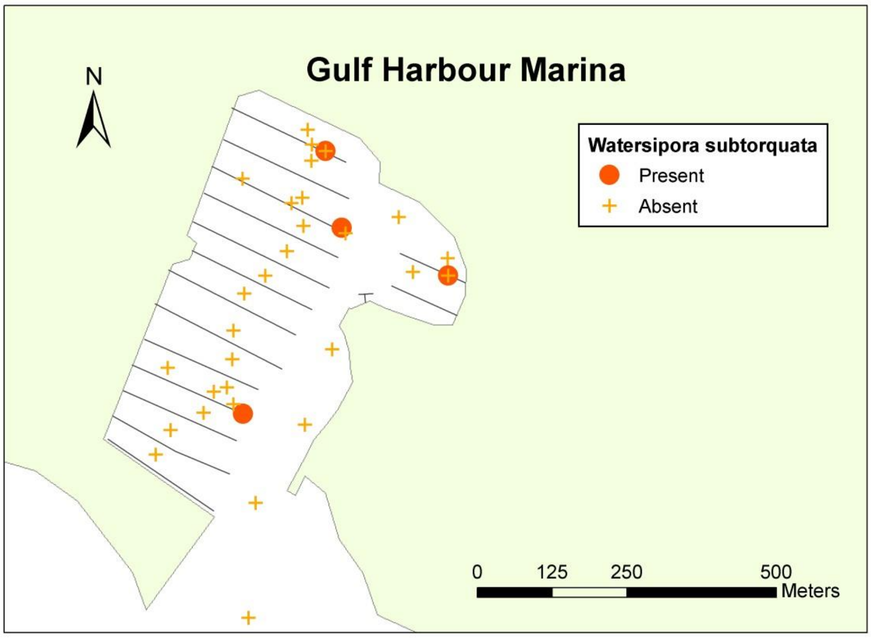

Figure 42: *Watersipora subtorquata* distribution in the initial baseline survey of theGulf Harbour Marina

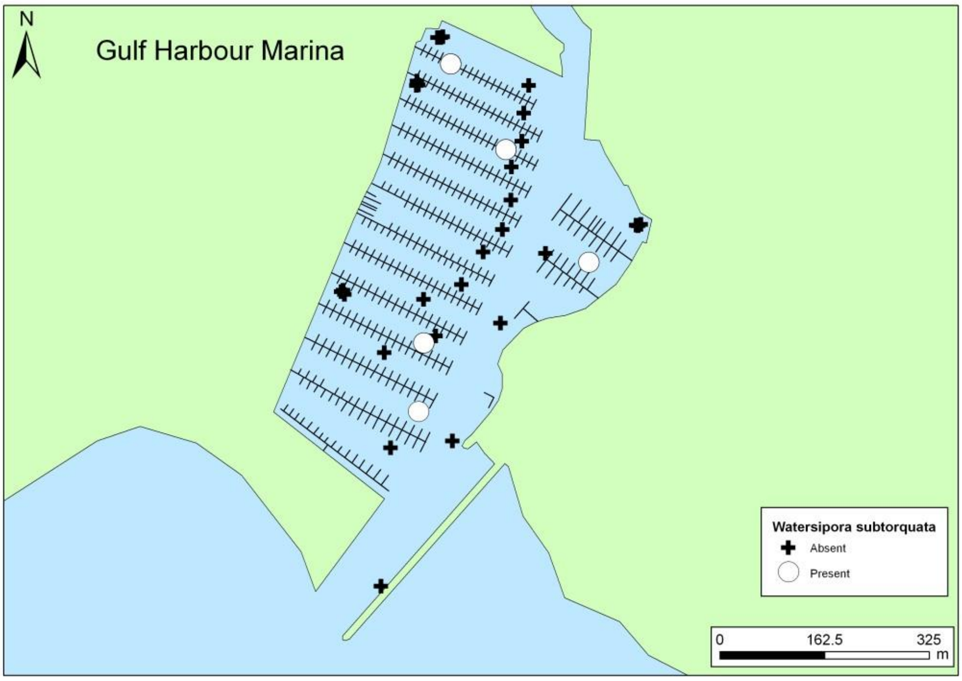

Figure 43: ***Watersipora subtorquata*** **distribution in the resurvey of the Gulf Harbour Marina**

Celleporaria aperta (Hincks, 1882)

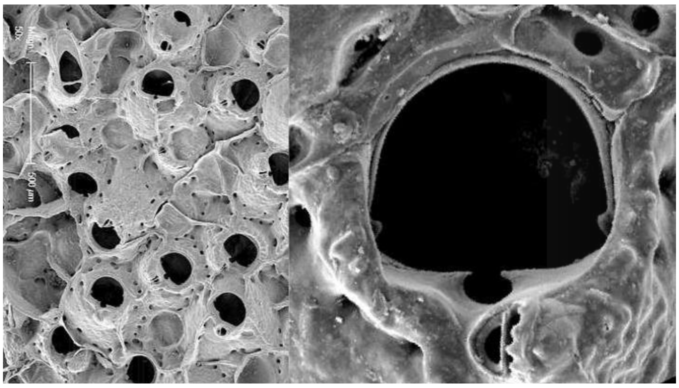

Image: Vanessa Owen (Bock 2006)

Celleporaria aperta is an encrusting bryozoan found on coral rubble in tropical settings and a variety of other substrate throughout its range (Winston 1986). The species has lecithotrophic larva and is not known to be an aggressive alien.

C. *aperta* was first recorded on the Israeli coast and is thought to have migrated from across the Suez Canal from the Red Sea. *C. aperta* was reported on the fouling cages of an oyster farm on Malta Island in 1977 and it was suggested to have been introduced there via shipping (Kocak 2007). *C. aperta* has also been recorded from the Philippines, Singapore, Indonesia, Great Barrier Reef, north-western Australia, India and possibly Mauritius (Figure 44). In New Zealand, *C. aperta* has been recorded fouling ship hulls in Auckland, Nelson, Whangaparaoa and Opua. This is the first record of this species in a port survey. *C. aperta* was recorded in five pile scrape samples taken from Jetty C and Jetty N & O, one pile scrape miscellaneous sample taken from Jetty N & O and one benthic sled taken near Jetty A & B (Figure 45; Table 14).

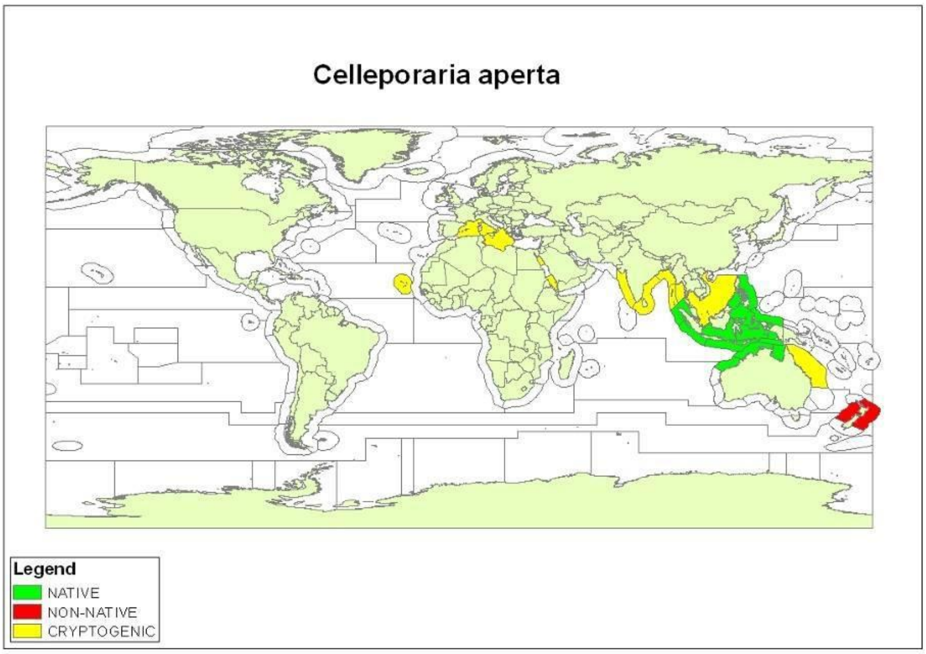

Figure 44: Global distribution of *Celleporaria aperta*

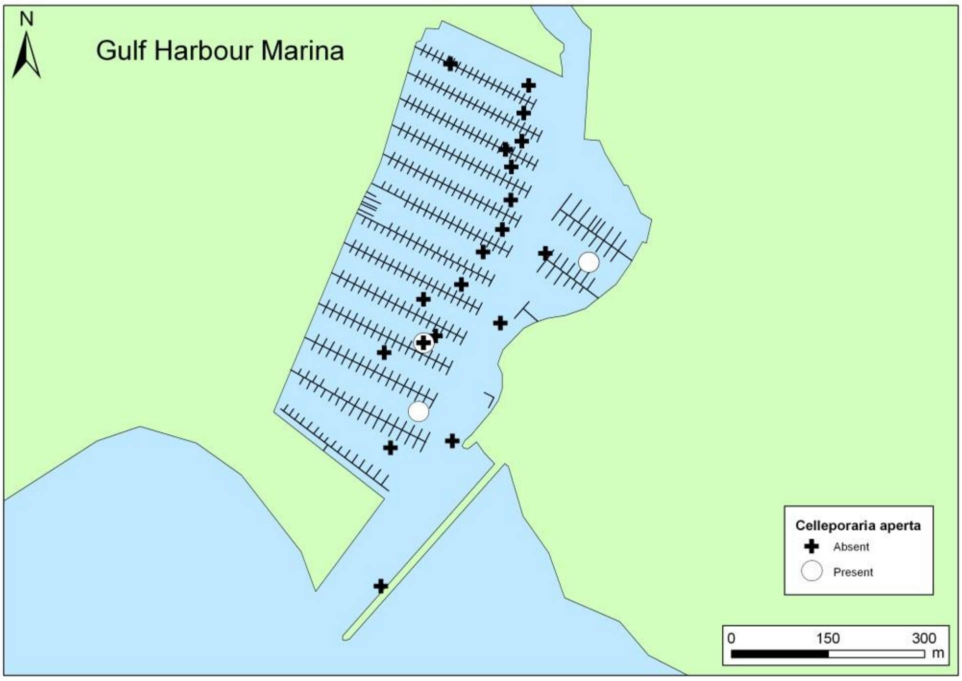

Figure 45: *Celleporaria aperta* distribution in the resurvey of the Gulf Harbour Marina

***Scrupocellaria* n. sp.**

No Image available.

Scrupocellaria n. sp. is a typically biofouling bryozoan which lacks scuta, has frontally directed large sessile avicularia, non-tubular ovicellular pores, and transversely orientated dorsal vibracula (Gordon *et al*. 2007). Although it is considered non-indigenous to New Zealand, the specimens found in New Zealand do not match existing descriptions of species known from this genus overseas (Gordon *et al*. 2007).

Scrupocellaria n. sp was first detected in New Zealand waters in August 2005 on the hull of a recreational vessel at Opua (last port of call Brisbane) and has subsequently been found on the hulls of recreational vessels berthing at Whangarei, Auckland, and Nelson whose last ports-of-call were in Noumea, Tonga, and Fiji, and all of the specimens were alive at the time of collection (Floerl et al. 2005; Gordon et al. 2007). This is the first record of this species in the port surveys. It was recorded in one pile scrape sample taken from Jetty C (Table 14, Figure 46).

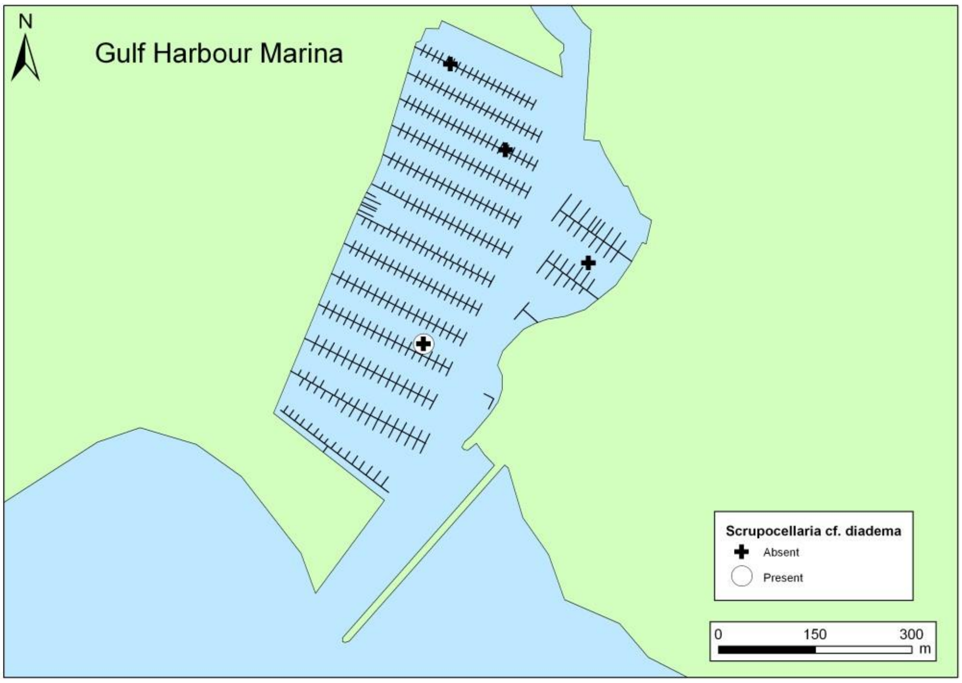

Figure 46: *Scrupocellaria* n. sp. distribution in the resurvey of the Gulf Harbour Marina

***Bowerbankia gracilis* (Leidy, 1855)**

Image: (Hill 2001)

Bowerbankia gracilis is a pale yellow to tan-coloured encrusting bryzoan. Zooids are almost transparent, cylindrical and disjunct (Gordon and Mawatari 1992). Zooids are up to 0.62 mm long when retracted and 1.04 mm long when extended and can be found singulary or clustered in dense groups of various size and age (Gordon and Mawatari 1992). The stolon is considerably narrower than the zooid. The polypide and body wall is flexible. *B. gracilis* is found in the low intertidal to shallow subtidal depths and in estuaries.

The type locality of *B. gracilis* is Point Judith, Rhode Island (Gordon and Mawatari 1992). It has a wide global distribution and has been recorded from Europe, Britain, Greenland, eastern United States, Washington State to Mexico, South Africa, India, Japan, South Australia (Figure 47). *B. gracilis* is regarded as established in New Zealand and has been recorded in Goat Island Bay, Leigh marine Harbour, Onehunga, Port of Napier, Oaonui, Tataraimaka, Totaranui, Oban (Gordon 1986). *B. gracilis* was not found in any initial baseline port surveys but has been recorded in the second baseline survey of Gisborne, Opua, Whangarei (Marina and Port), Napier, Viaduct, Westhaven (Inglis *et al.* in press) and in this survey of the Gulf Harbour Marina where it was recovered in pile scrape samples taken at Jetty C and Jetty L (Figure 48; Table 14).

As well as fouling on structures, *B. gracilis* can settle on cultivated species and consequently have a deleterious impact on the aquaculture industry (Soule 1977). Additionally, this species has the potential to out-compete native species and disrupt species assemblages.

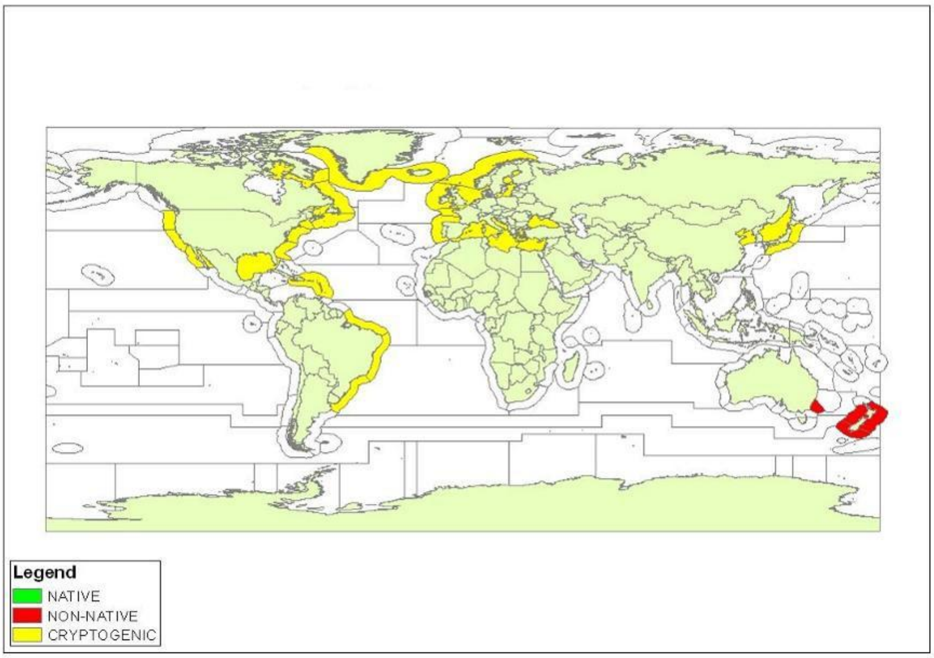

Figure 47: Global distribution of *Bowerbankia gracilis*

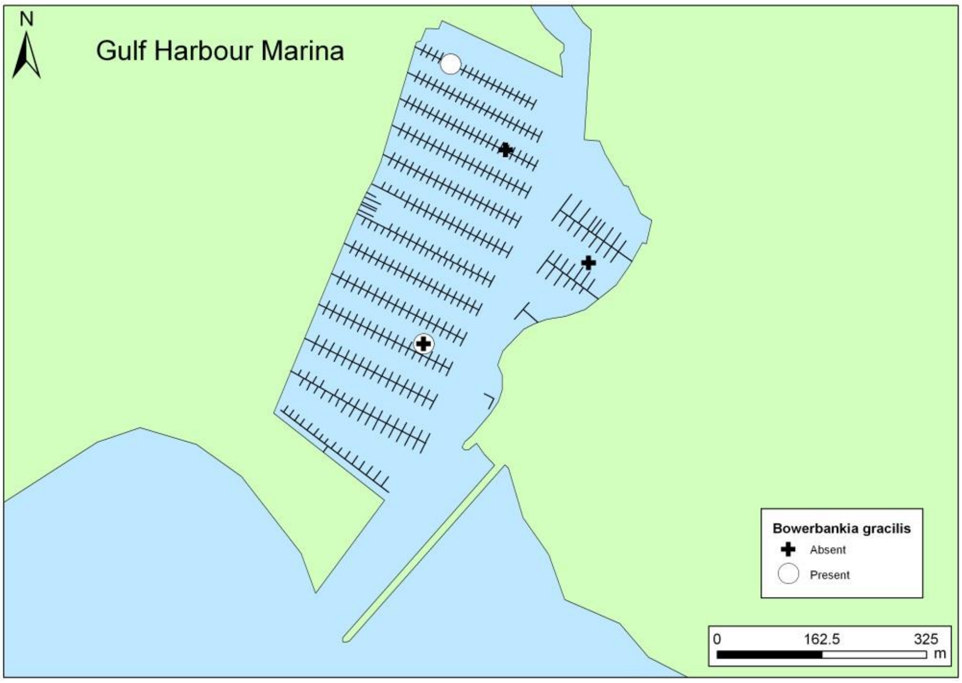

Figure 48: *Bowerbankia gracilis* distribution in the resurvey of the Gulf Harbour Marina

Zoobotryon verticillatum (Delle Chiaje, 1828)

Image and information: Gordon and Matawari (1992)

Zoobotryon verticillatum is a bryozoan that grows into large, bushy colonies often 20-30cm in diameter. They often appear like thin, stringy, gelatinous noodles. The young colonies are usually transparent, while older and larger ones have a dirty white appearance. In contrast to most other bryozoans, calcium carbonate is absent in exoskeletons of this species. *Zoobotryon verticillatum* is a subtidal species and mostly occurs on hard surfaces such as rocks, pontoons, pilings or, boat hulls, or as an epibiont on shells or carapaces.

The type locality of *Z. verticillatum* is Naples, Italy, although the species is now widely distributed in tropical and subtropical seas, including the Caribbean, Indian Ocean, north-west and north-east Pacific, Hawaii, New Caledonia and Australia (Gordon and Mawatari 1992);

Figure 49). It has been present in New Zealand, in the Waitemata and Manukau Harbours, since at least the 1960‟s (Gordon and Matawari, 1992). Under optimal conditions *Z. verticillatum* can form large aggregations that can clog fishing nets and potentially exclude other sessile organisms. Large bushes are formed only when water warms to 22°C and above, although the colonies can overwinter during colder periods. Elevated temperature and salinity has been suggested to enhance outbreaks of this bryozoan. In the initial port surveys *Z. verticillatum* only occurred in the Gulf Harbour Marina (Inglis *et al*. 2006b);

Figure 50). During the repeat surveys it was also found at the Port of Tauranga (Inglis *et al*. 2006t), Viaduct Harbour, Westhaven Marina (Inglis *et al.* in press) and was recorded in pile scrape and benthic sled samples taken at Jetty A & B, Jetty J, Jetty L and Jetty N & O in the Gulf Harbour Marina (Figure 51; Table 14).

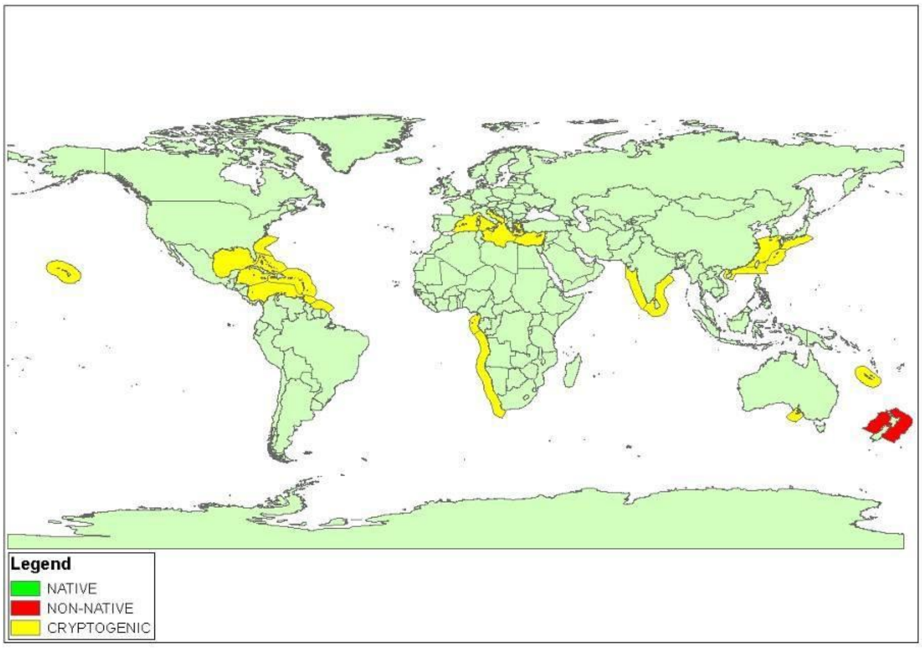

Figure 49: Global distribution of *Zoobotryon verticillatum*

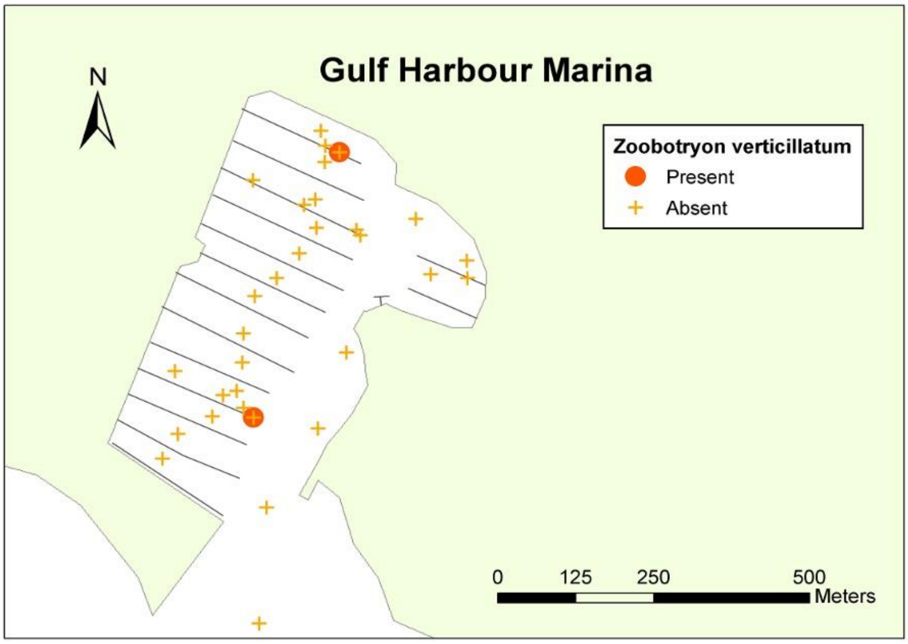

Figure 50: *Zoobotryon verticillatum* distribution in initial survey of Gulf Harbour Marina

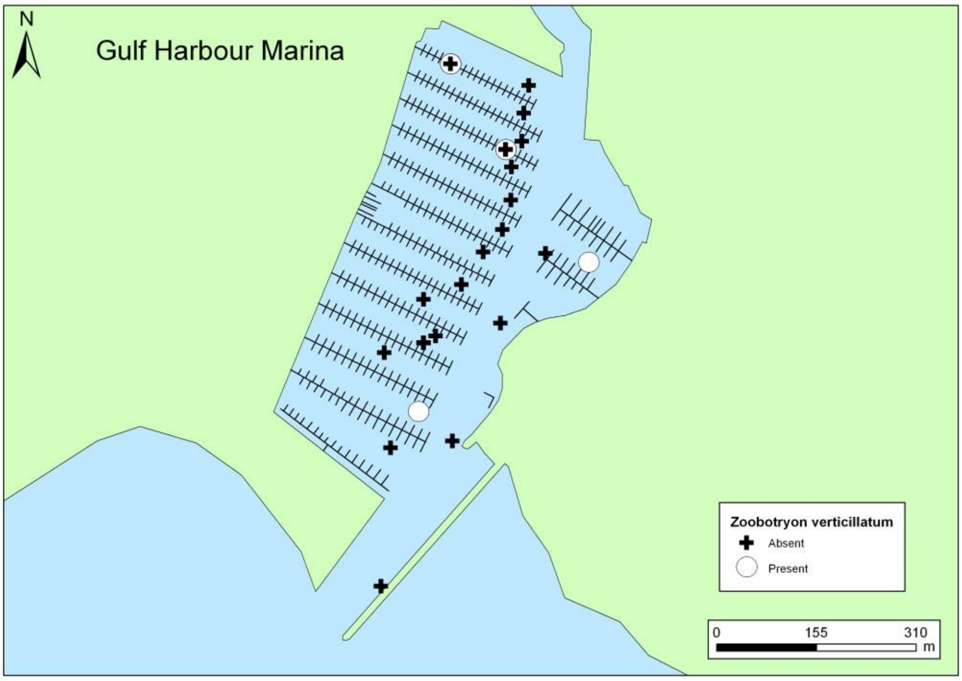

Figure 51: ***Zoobotryon verticillatum*** **distribution in the resurvey of the Gulf Harbour Marina**

***Ascidiella aspersa* (Mueler, 1776)**

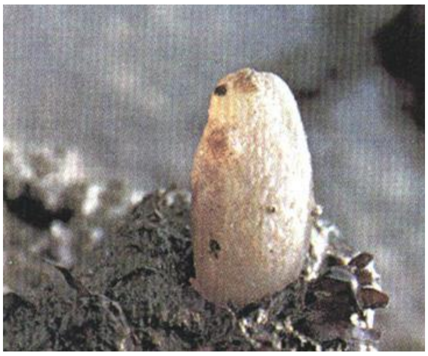

Image and information: NIMPIS (2002a)

Ascidiella aspersa is a solitary ascidian that is native to northwest Europe, the British Isles, the Mediterranean Sea and the northwest African coasts (

Figure 52). It has been introduced to India, Australia and New Zealand, and is cryptogenic to the east coast of the USA. *Ascidiella aspersa* attaches to the substratum by its entire left side and grows up to 130 mm in length. The inhalant (branchial) siphon is positioned at the top of the body and is conical in shape. The exhalent (atrial) siphon is positioned around one third of the way down the body and both siphons are ridged. The body wall (test) is firm and is transparent with numerous papillae scattered over the surface. Small amounts of pink or orange may be visible inside the siphons. *Ascidiella aspersa* is found from intertidal to shallow subtidal waters to 50m depth attached to clay, stones, rocks, algae and wharf piles, where it can be the dominant fouling species. In the southern hemisphere, populations are particularly abundant in the inner-reaches of estuaries and harbours in protected or semi-enclosed marine embayments. Although it is a solitary ascidian (i.e. not colonial) it is often found in dense clumps. It has no known documented impacts.

During the initial baseline surveys it was recorded from Gisborne, Napier and the Gulf Harbour Marina (Figure 53; Table 14; Inglis *et al*. 2006b, f, h). These are likely to be extensions to the range of this species in New Zealand (M. Page, pers. comm.), as published records of its occurrence in New Zealand are for Christchurch, Portobello and Stewart Island (Vervoort and Watson 2003). During the second baseline surveys *A. aspersa* was recorded from the Port of Lyttelton (Inglis *et al*. 2006q), Bluff, Viaduct Harbour, Westhaven Marina (Inglis *et al.* in press) and during this survey of the Gulf Harbour Marina where it occurred in pile scrape samples taken from Jetty C, Jetty J, Jetty L, Jetty N & O (Figure 54; Table 14).

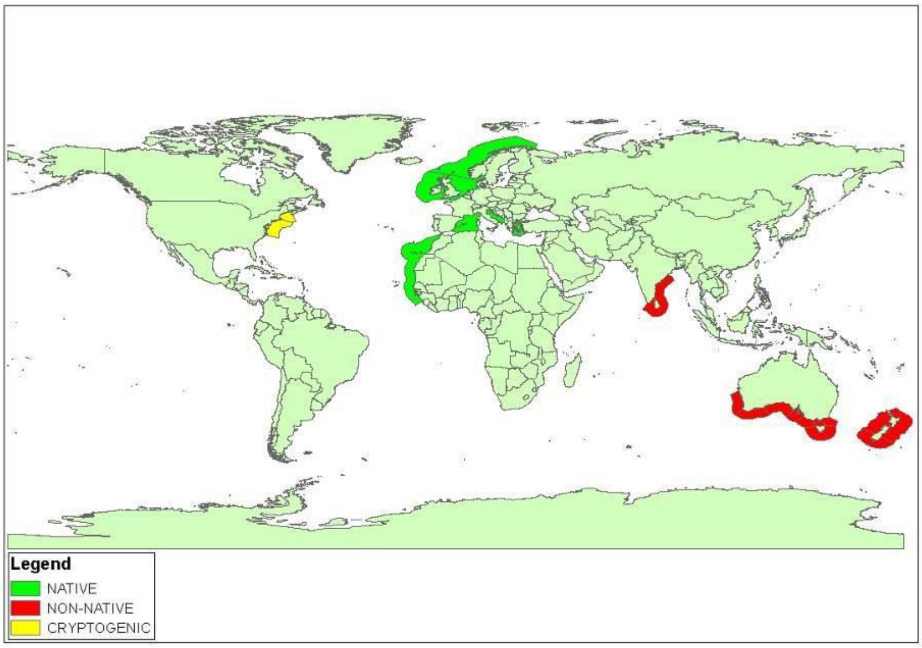

Figure 52: Global distribution of *Ascidiella aspersa*

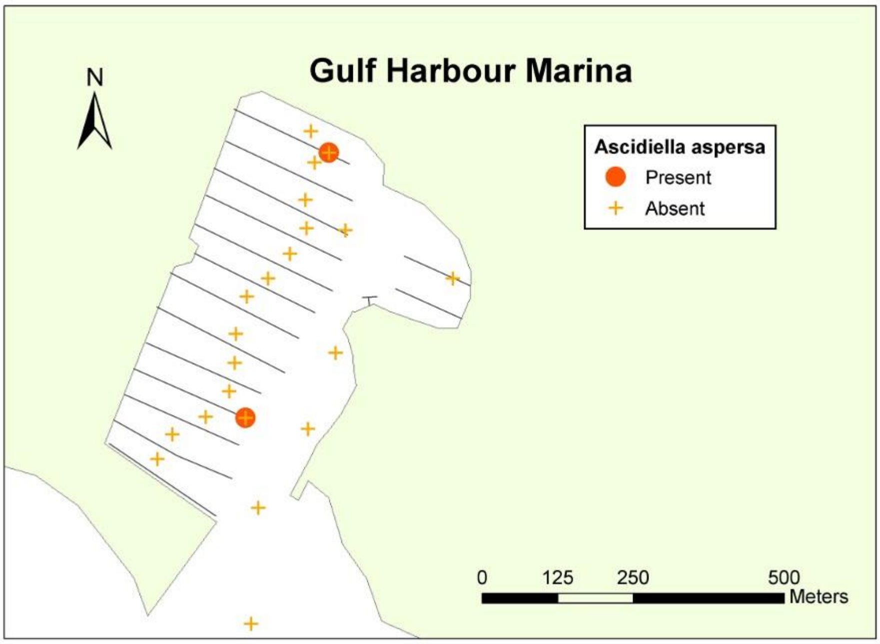

Figure 53: *Ascidiella aspersa* distribution in the initial survey of the Gulf Harbour Marina

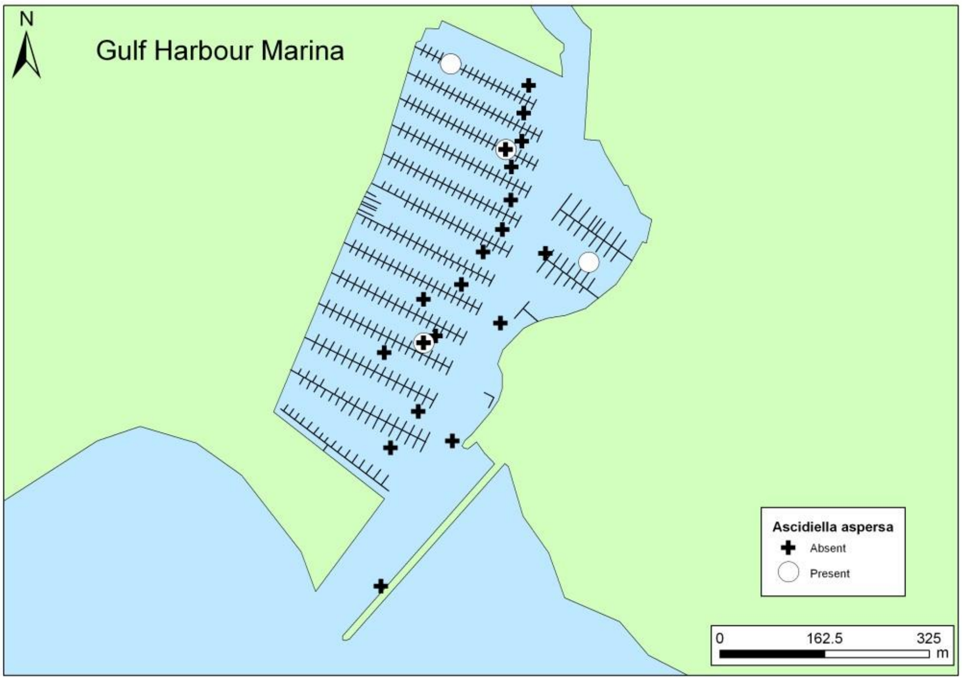

Figure 54: ***Ascidiella aspersa*** **distribution in the resurvey of the Gulf Harbour Marina**

***Diplosoma listerianum* (Milne-Edwards, 1841)**

Image: (Picton 2007)

Diplosoma listerianum is a transparent, gelatinous, ascidian which forms sheets of colonies on algae up to 4 mm thick and 50 mm wide. The zooids are small, colourless and scattered densely throughout the sheet. Each zooid has a small inhalant pore and there are a few larger exhalant openings, but these openings are not conspicuously pigmented. There is a conspicuous pattern of small yellow pigment bodies in the surface layer which can be seen on close inspection (Picton 2007).

D. listerianum is common in shallow water through the British Isles and tropical and subtropical seas (Picton 2007); Figure 55). In New Zealand *D. listerianum* was recorded as a cryptogenic category 1 taxon in the initial baseline surveys of the ports of Auckland, Gisborne, Dunedin, Napier, Tauranga, New Plymouth, Whangarei and Taharoa (Inglis et al. 2006a, d, h, k, l, p). *D. listerianum* has also been recorded in the resurvey of the ports of Lyttelton, Tauranga, Dunedin, Auckland, Bluff, Napier, Whangarei, Westhaven Marina, Viaduct Harbour (Inglis et al. 2006q, t; Inglis et al. in press) and in this survey of the Gulf Harbour Marina, where it was recorded in a single pile scrape sample taken from Jetty L (Figure 56; Table 14).

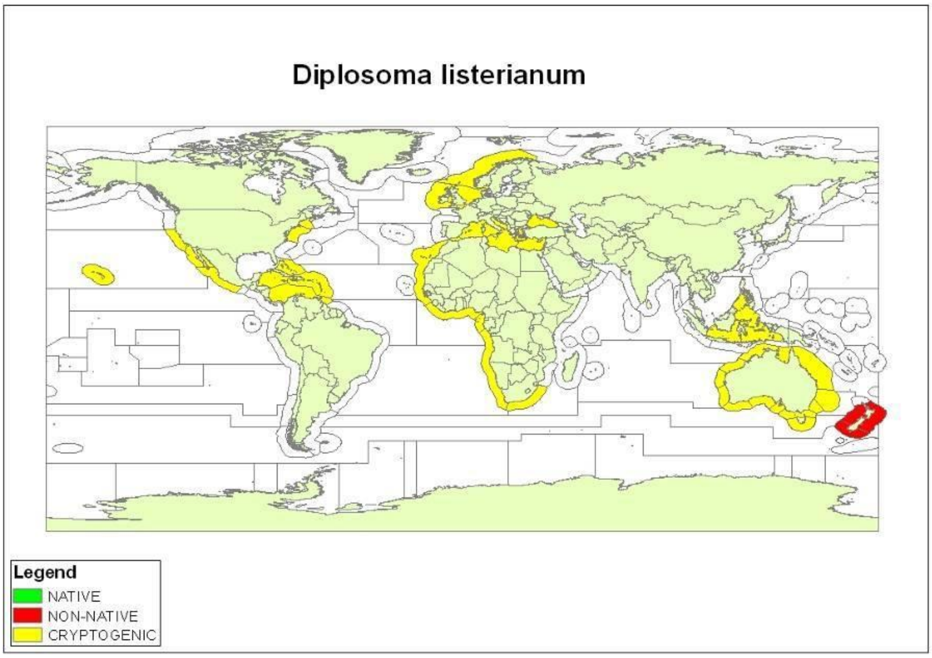

Figure 55: Global distribution of *Diplosoma listerianum*

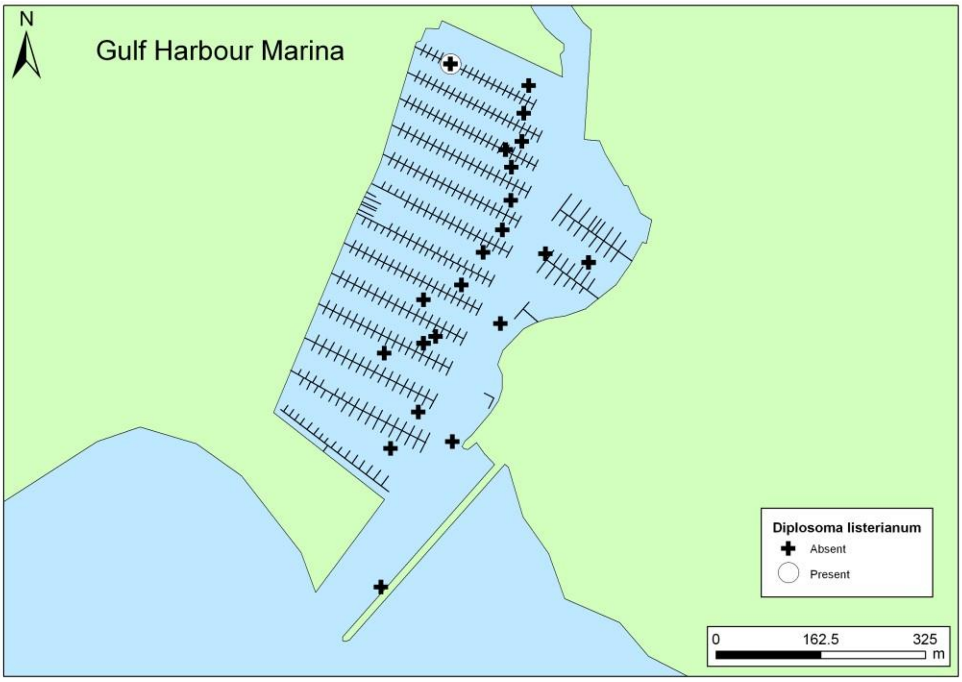

Figure 56: *Diplosoma listerianum* distribution in the resurvey of the Gulf Harbour Marina.

Styela clava (Herdman, 1881)

Image and information: NIWA (2006)

Styela clava is a club-shaped, solitary ascidian with a leathery cylindrical body. It has two short siphons and tapers to a basal stalk, although juveniles may not be stalked. The stalk is shorter than the stalk of the similar native species *Pyura pachydermatina* (Biosecurity New Zealand 2005). Individuals of *S. clava* can grow up to 160 mm long, and are whitish-yellow, yellow-brown or reddish-brown. *S. clava* is native to the northwest Pacific (Japan, Korea, northern China and Siberia;Figure 57). It has been introduced to the eastern and western coasts of North America, Europe, and southern Australia (northern Tasmania, southern New South Wales and Victoria).

S. clava can tolerate a wide range of salinity and temperature, and can breed in water temperatures above 15^{o}C and salinities above 25-26 ppt (NIMPIS 2002g). It is found from low tide to at least 25 m depth and prefers sheltered waters. It settles on rocks, seaweed, shellfish and man-made structures including wharves, docks, boat hulls, mooring lines, buoys and aquaculture structures. *S. clava* is capable of rapid proliferation and can achieve very large densities of 500 to 1,500 individuals per square metre. In Canada, it is having a significant impact on mussel aquaculture through fouling of equipment, overgrowth of mussel lines and competition with mussels for nutrients.

Styela clava was not recorded during the initial baseline surveys of ports. It was first identified in New Zealand in September 2005 from specimens collected in Viaduct Harbour by a visiting scientist. Soon after (October 2005), identification was completed of the ascidians collected during the repeat baseline survey of Lyttelton in November 2004. Subsequent delimitation surveys commissioned by MAF Biosecurity New Zealand have shown that *S. clava* is widely distributed in the Hauraki Gulf and is present in Tutukaka marina (Northland) and Magazine Bay Marina in Lyttelton Harbour (Inglis 2003). Re- examination of stored ascidian specimens collected by other researchers prior to this survey confirm that it has been present in Lyttelton since at least 2002 and may have been present in the Hauraki Gulf for ten years or more. *S. clava* was recorded in the repeat surveys of Lyttelton, Auckland, Viaduct Harbour, Westhaven Marina (Inglis *et al*. 2006q); Inglis *et al.* in press) and in this survey of the Gulf Harbour Marina, where it was recorded in a pile scrape miscellaneous sample at Jetty C and Jetty N & O (Figure 58; Table 14).

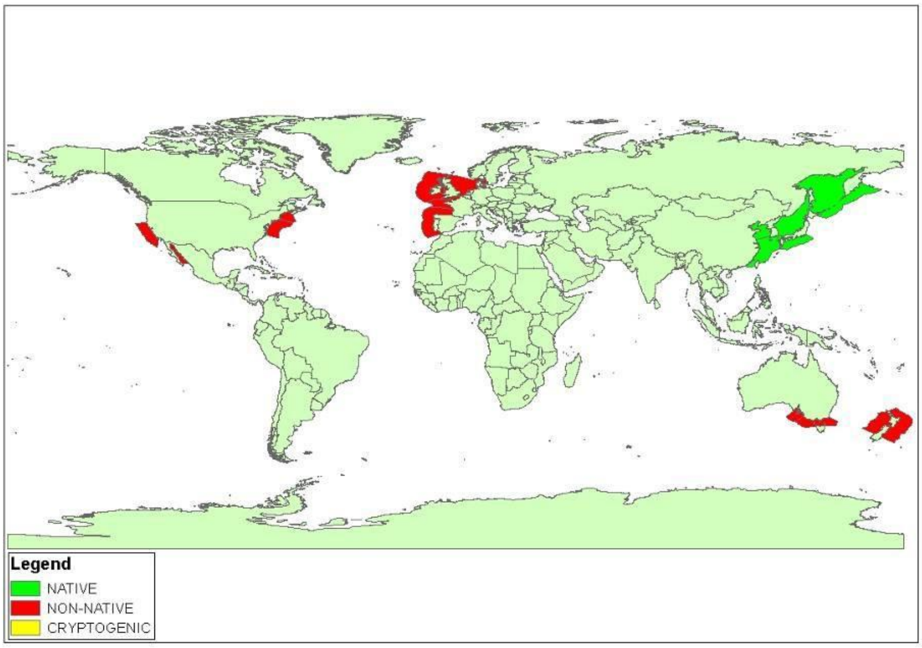

Figure 57: Global distribution of *Styela clava*

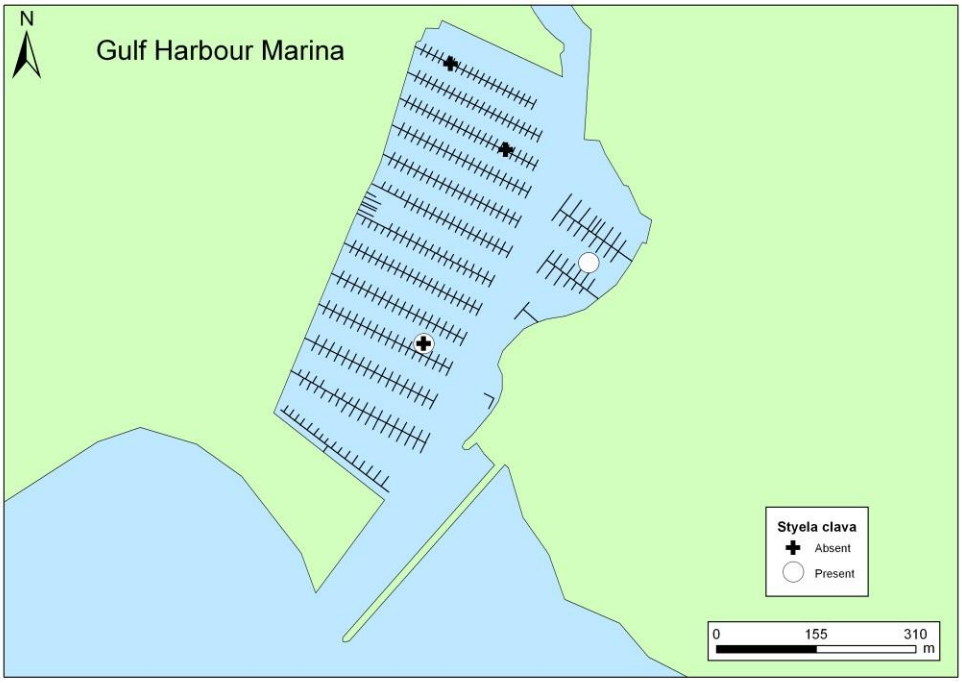

Figure 58: *Styela clava* distribution in the resurvey of the Gulf Harbour Marina

Musculista senhousia (Benson in Cantor, 1842)

Image and information: NIMPIS (2002d)

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

Musculista senhousia is native to the Japan and north China Seas (Figure 59). It has been introduced to the west coast of the USA, the Mediterranean, Australia and New Zealand. It is cryptogenic in the Red Sea, the eastern Indian Ocean, South China Sea, Indonesia and Papua New Guinea. It has been present in New Zealand since at least 1978 and has spread to a range of estuaries in north-east New Zealand, from the East Cape to Parengarenga Harbour. It was recorded in the initial port survey of Opua and Whangarei Marina (Inglis *et al*. 2006c, p). During the repeat surveys *M. senhousia* was reported in Whangarei Marina and Port, Westhaven Marina (Inglis *et al*. in press) and in this survey of the Gulf Harbour Marina where it was found in benthic sled samples in Channel 1 and Jetty J & K (Figure 60; Table 14).

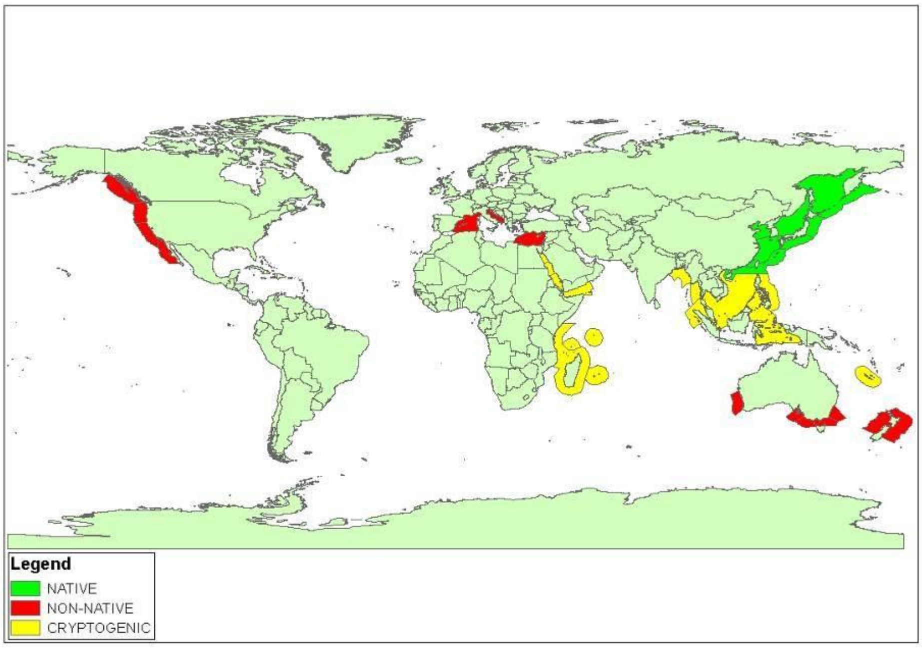

Figure 59: Global distribution of *Musculista senhousia*

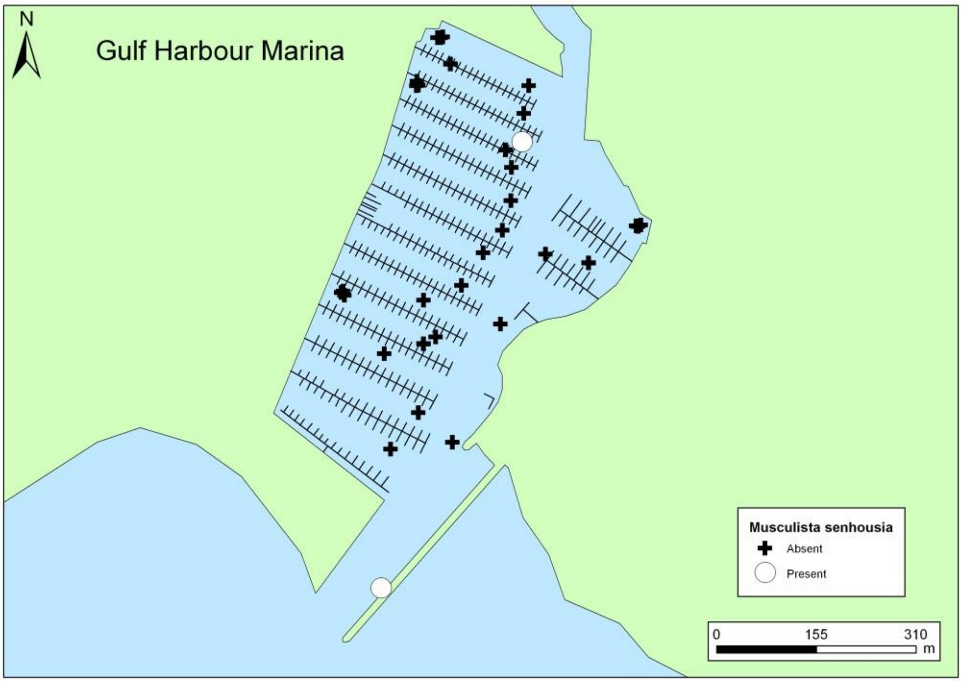

Figure 60: *Musculista senhousia* distribution in the resurvey of the Gulf Harbour Marina

Crassostrea gigas (Thunberg, 1793)

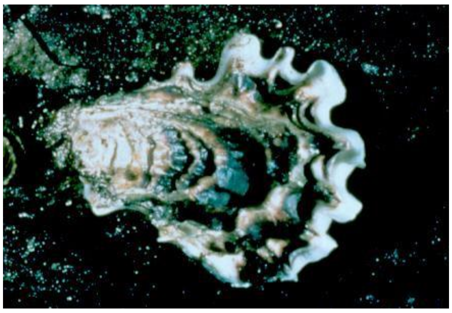

Image and information: NIMPIS (2002c)

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

Crassostrea gigas is native to the Japan and China Seas and the northwest Pacific (Figure 61). It has been introduced to the west coast of both North and South America, the West African coast, the northeast Atlantic, the Mediterranean, Australia, New Zealand, Polynesia and Micronesia. It is cryptogenic in Alaska. *Crassostrea gigas* will attach to almost any hard surface in sheltered waters. Whilst they usually attach to rocks, the oysters can also be found in muddy or sandy areas. Oysters will also settle on adult oysters of the same or other species. They prefer sheltered waters in estuaries where they are found in the intertidal and shallow subtidal zones, to a depth of about 3 m. *Crassostrea gigas* settles in dense aggregations in the intertidal zone, resulting in the limitation of food and space available for other intertidal species.

C. gigas has been present in New Zealand since the early 1960s. Little is known about the impacts of this species in New Zealand, but it is now a dominant structural component of fouling assemblages and intertidal shorelines in northern harbours of New Zealand and the upper South Island. *C. gigas* is now the basis of New Zealand's oyster aquaculture industry, having displaced the native rock oyster, *Saccostrea glomerata*. During the initial port baseline surveys *C. gigas* was recorded from the Opua and Gulf Harbour marinas (Figure 62), Whangarei Harbour (Whangarei Port and Town Basin marina), and the ports of Auckland, Taranaki, Nelson and Dunedin (Inglis *et al*. 2006a, d; Inglis *et al*. 2006i; Inglis *et al*. 2006k); (Inglis *et al*. 2006d). During the second baseline surveys *C. gigas* was recorded from the ports of Taranaki and Nelson, Auckland and Whangarei Harbour (Whangarei Port and Town Basin Marina), Opua, Westhaven and Gulf Harbour Marinas (Inglis *et al*. 2006s; Inglis *et al*. 2006w). In the Gulf Harbour Marina it occurred in pile scrape samples taken from Jetty C, Jetty J and Jetty L (Figure 63; Table 14).

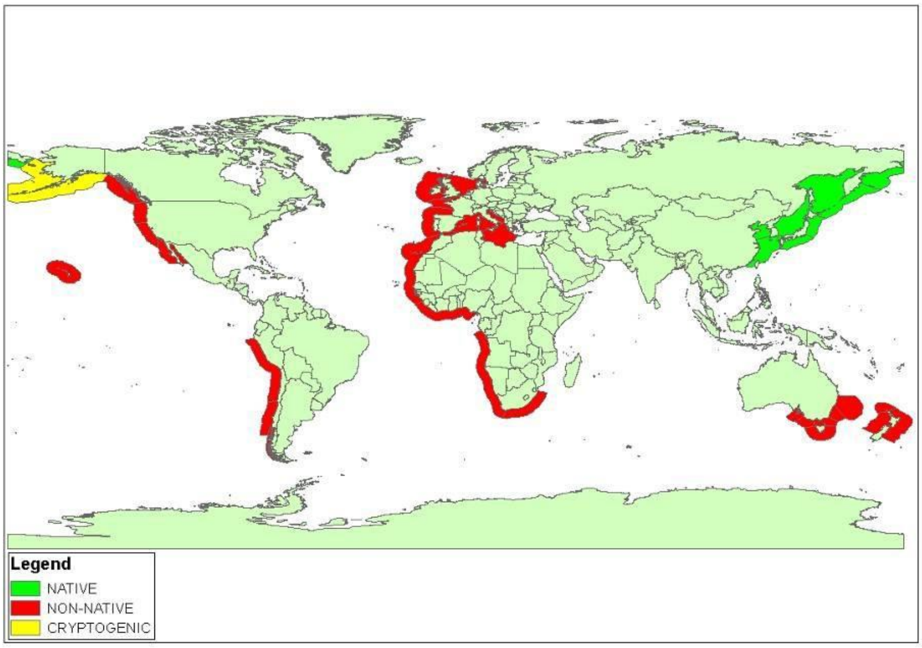

Figure 61: Global distribution of *Crassostrea gigas*

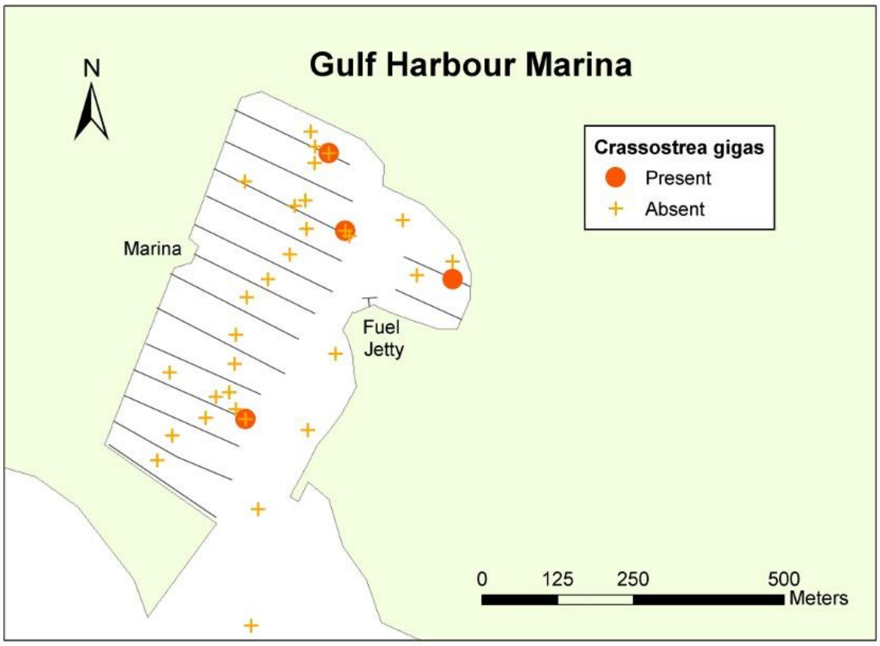

Figure 62: *Crassostrea gigas* distribution in the initial baseline survey of the Gulf Harbour Marina

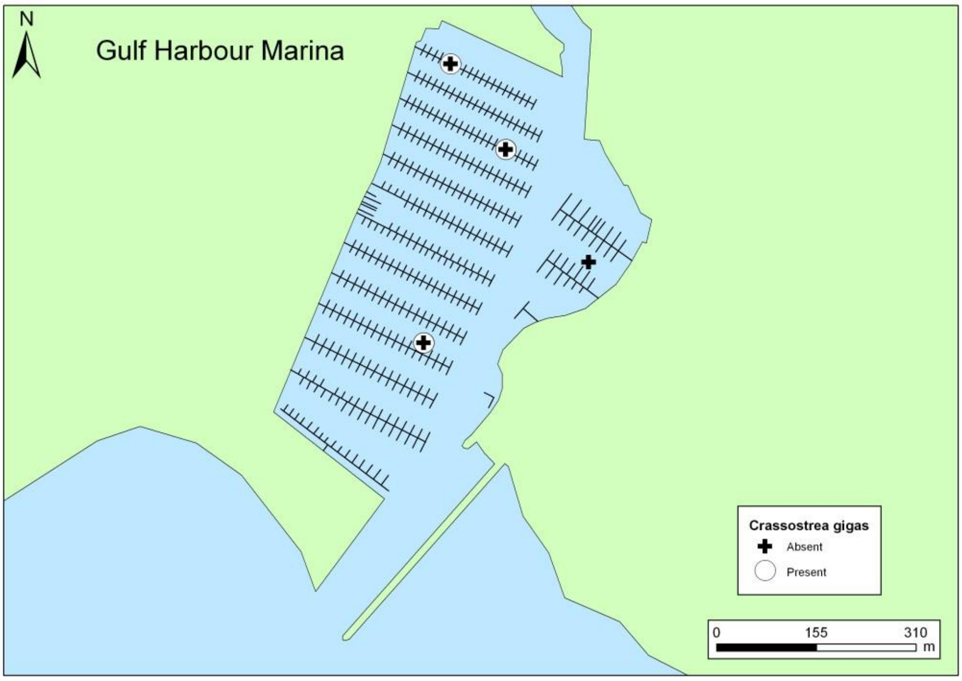

Figure 63: ***Crassostrea gigas*** **distribution in the resurvey of the Gulf Harbour Marina**

Theora lubrica (Gould, 1861)

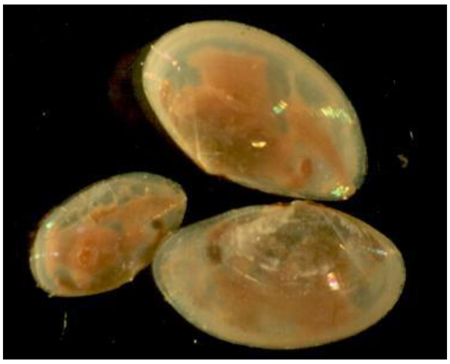

Image and information: NIMPIS (2002h)

Theora lubrica is a small bivalve with an almost transparent shell. The shell is very thin, elongated and has fine concentric ridges. *T. lubrica* grows to about 15 mm in size, and is characterised by a fine elongate rib extending obliquely across the internal surface of the shell. *Theora lubrica* is native to the Japanese and China Seas. It has been introduced to the west coast of the USA, Australia and New Zealand. *Theora lubrica* typically lives in muddy sediments from the low tide mark to 50 m, however it has been found at 100 m. In many localities, *T. lubrica* is an indicator species for eutrophic and anoxic areas. *T. lubrica* has been present in New Zealand since at least 1971 (Cranfield *et al*. 1998). It occurs in estuaries of the northeast coast of the North Island, including the Bay of Islands, Whangarei Harbour, Waitemata Harbour, Wellington and Pelorus Sound. During the initial port baseline surveys, it was recorded from Opua marina, Whangarei port and marina, Gulf Harbour marina (Figure 65), and the ports of Auckland, Gisborne, Napier, Taranaki, Wellington, Nelson, and Lyttelton (Table 14; (Inglis *et al*. 2006b, c, d, f; Inglis *et al*. 2006g; Inglis *et al*. 2006h; Inglis *et al*. 2006i; Inglis *et al*. 2006k, n, o, p). During the second baseline surveys of Group *T. lubrica* was recorded from the ports of Auckland, Gisborne, Napier, Opua, Whangarei Harbour (Marina and Port), Taranaki, Wellington, Picton, Nelson Lyttelton, Viaduct Harbour, Westhaven Marina and in this survey of the Gulf Harbour Marina (Inglis *et al*. 2006r, s; Inglis *et al*. 2006v; Inglis *et al*. 2006w; Inglis *et al.* in press). In the Gulf Harbour Marina it occurred in benthic sled, benthic grab and pile scrape samples taken near Jetty A & B, Jetty B & C, Jetty C, Jetty C & D, Channel 1, Channel 2, Channel 3, Channel 4, Jetty D & E, Jetty E & F, Jetty F & G, Jetty G & H, Jetty H & I, Jetty I & J, Jetty J & K, Jetty K & L, Jetty L (Figure 66; Table 14).

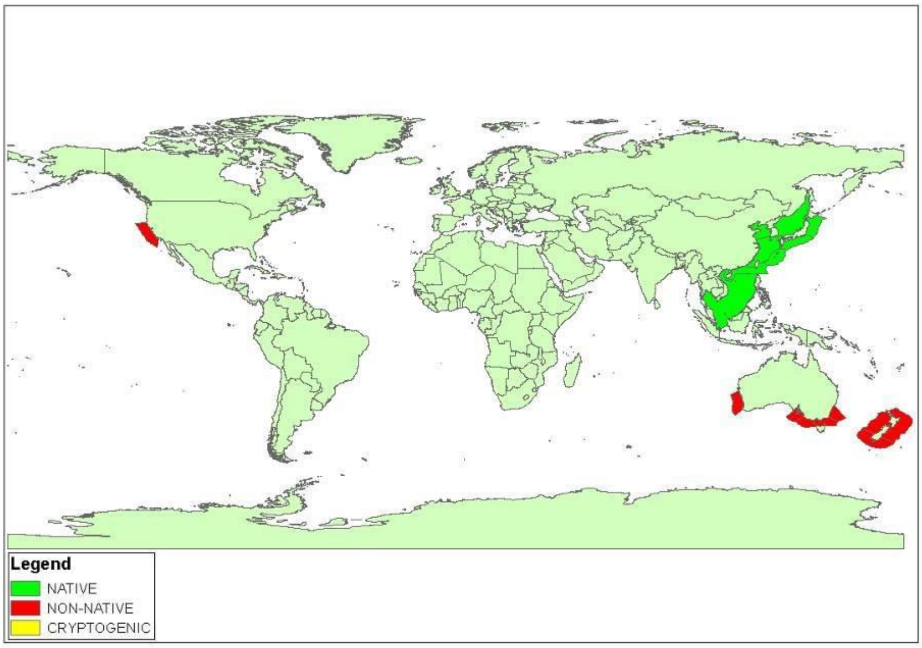

Figure 64: Global distribution of *Theora lubrica*

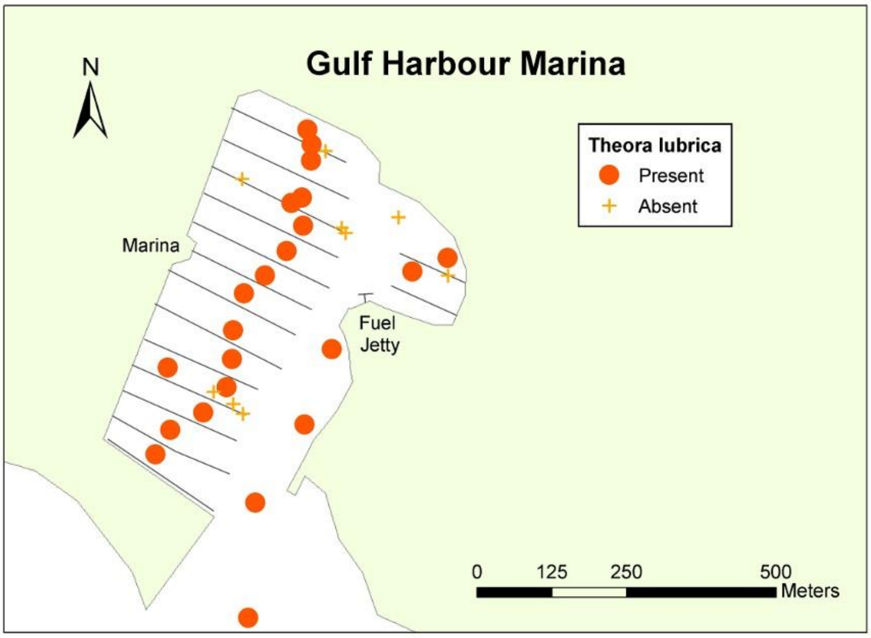

Figure 65: *Theora lubrica* distribution in the initial baseline survey of Gulf Harbour Marina

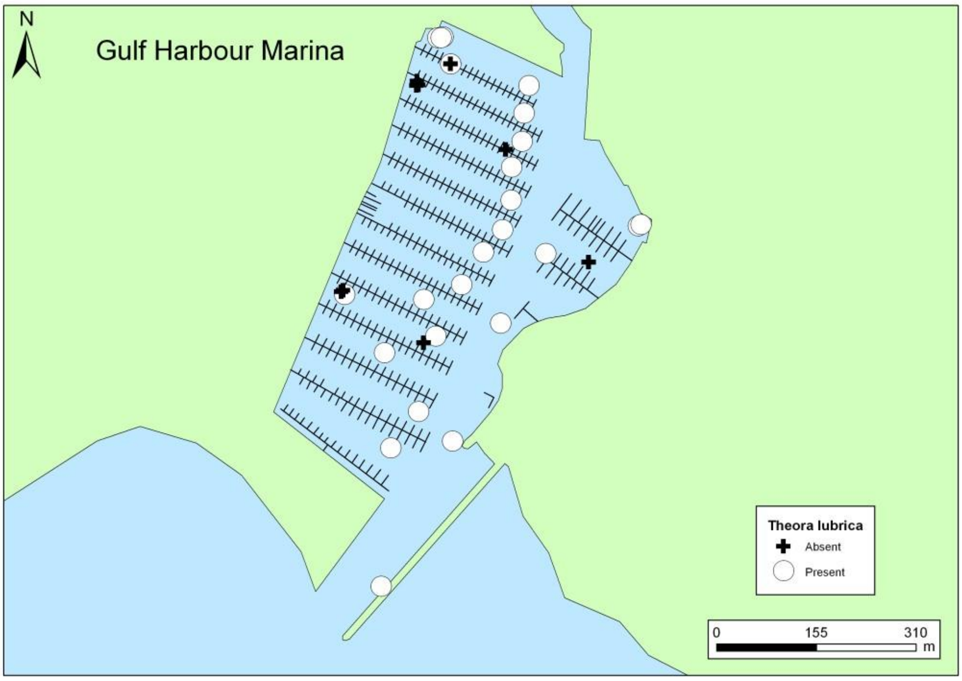

Figure 66: ***Theora lubrica*** **distribution in the resurvey of the Gulf Harbour Marina**

Vosmaeropsis cf. *macera* (Carter, 1886)

No image available

Vosmaeropsis cf *macera* is a sponge in the family Heteropiidae. The type locality for this species is Port Phillip Heads, Australia (Carter 1886; Figure 67). It has previously been reported from Lyall Bay, in Wellington (Michelle Kelly- Shanks, pers. com), but was not known from other New Zealand locations. Calcareous sponges, like *V.* cf. *macera* are notorious hull foulers that grow best in sheltered, dark places, and proliferate in pipes and inlets in marine infrastructure. During the initial port baseline surveys *V.* cf. *macera* was recorded in Whangarei Harbour and Gulf Harbour Marina (Inglis *et al*. 2006b, o); (Figure 68). During the second surveys it was only recorded in this survey of the Gulf Harbour Marina in a pile scrape sample at Jetty C.

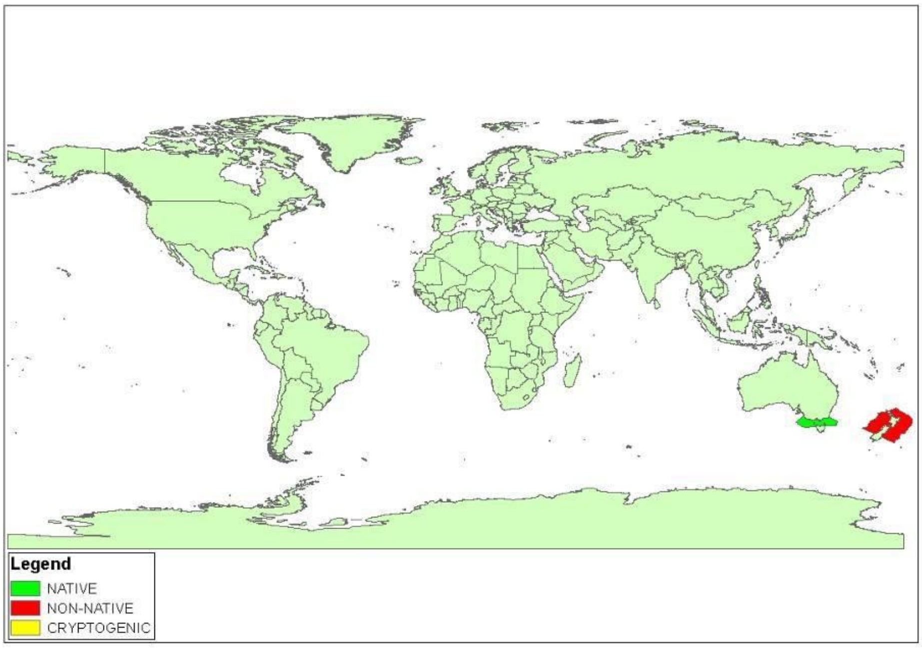

Figure 67: Global distribution of *Vosmaeropsis* cf. *macera*

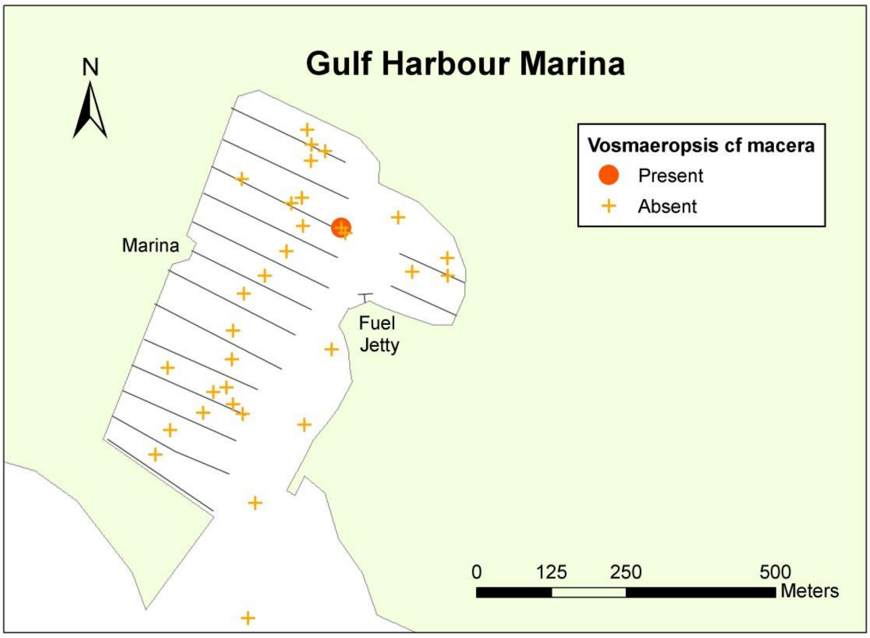

Figure 68: *Vosmaeropsis* cf. *macera* distribution in the initial survey of the Gulf Harbour Marina

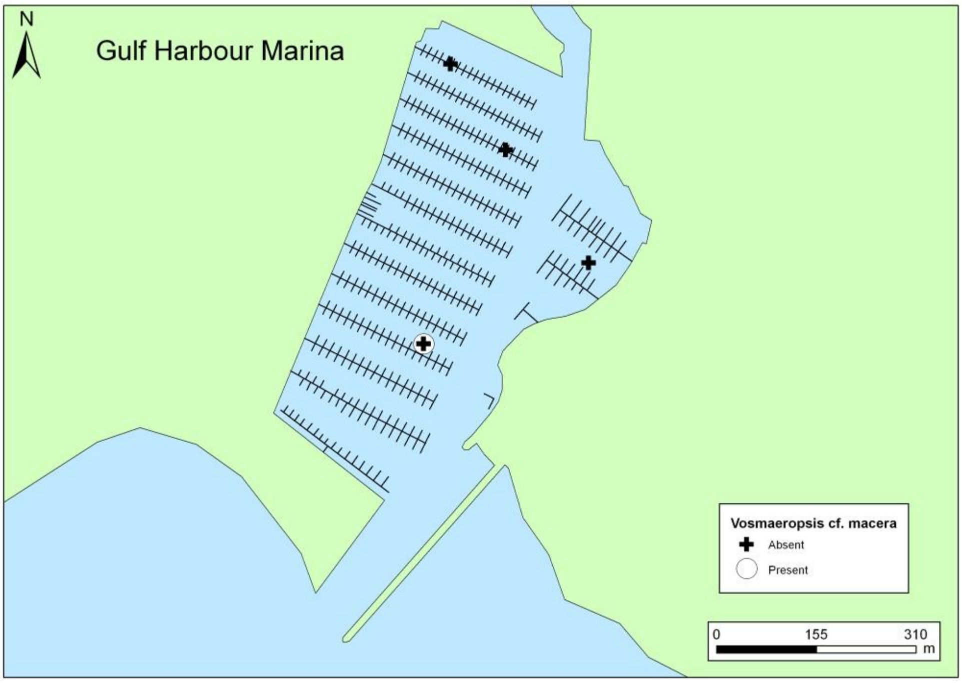

Figure 69: *Vosmaeropsis* cf. *macera* distribution in the resurvey of the Gulf Harbour Marina

Indeterminate taxa

Thirty-two organisms from the Gulf Harbour Marina were classified as indeterminate taxa. If each of these organisms is considered a species of unresolved identity, then together they represent 22 % of all species collected from this survey (Figure 14). Indeterminate taxa from the Gulf Harbour Marina included seven arthropods, four chordates, three annelids, three bryozoans, three myzozoans, three ochropyta, three platyhelminthes one mollusc, one rhodophyta and one cnidarian (Table 13).

Notifiable and unwanted species

One species recorded during the second survey of the Gulf Harbour Marina – the club tunicate *Styela clava* - is on the New Zealand Register of Unwanted Organisms (Table 6).

The Australian Consultative Committee on Introduced Marine Pest Emergencies (CCIMPE) has endorsed a Trigger List of marine pest species (CCIMPE 2006). One species, the bivalve *Musculista senhousia,* listed as established but not widespread in Australia, is considered non-indigenous in New Zealand and was recorded from the Gulf Harbour Marina.

Australia has 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. Fourteen of the 53 Australian priority domestic pests (ie. those already present in Australia) are present in the Gulf Harbour Marina. These are listed in descending order of the impact potential ranking attributed to them by Hayes *et al.* (2005a): *Gymnodinium catenatum, Crassostrea gigas, Bugula neritina, Schizoporella errata, Musculista senhousia, Watersipora subtorquata, Styela clava, Hydroides ezoensis, Zoobotryon verticillatum, Watersipora arcuata, Theora lubrica, Apocorophium acutum, Pseudopolydora paucibranchiata* and *Monocorophium acherusicum.* None of the 37 priority international pests (ie. those not yet in Australia) identified by Hayes *et al.* (2005a) were present in the survey of the Gulf Harbour Marina.

Species not previously recorded in New Zealand

No species recorded from the resurvey of the Gulf Harbour Marina are new records from New Zealand waters.

Range extensions

The occurrence of two species in samples from the resurvey of the Gulf Harbour Marina was highlighted by taxonomists to represent extensions to the known range of these species in New Zealand. These species are the polychaete *Notomastus Notomastus*-A (C2, previously known from Waiheke Island) and the bryozoan *Celleporaria aperta* (NIS, previously known from Opua).

Cyst-forming species

Cysts of six species of dinoflagellate were collected during this survey. Two of these are considered native species (Table 10), three are indeterminate (Table 13) and one is Cryptogenic category 1 taxa (Table 11). Two of these - the C1 species *Gymnodinium catenatum* and the native species *Lingulodinium polyedrum* are known to produce toxins, as described below.

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

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).

Depth stratification trends

The greatest proportion of NIS, C1 taxa and native taxa occurred in samples from zero to six metres depth (Figure 70). This was due to the large proportion of taxa, both NIS and C1 (80 %) and native (62.8 %), that were recorded in pile scrapings, which were only conducted in the top six metres of water (Table 15, Table 16). This demonstrates that the pile scraping method is an effective method for sampling many organisms.

The lower depths (depth classes >6 m to 9 m, and >9 m to 12 m) were largely sampled by several other methods (benthic sleds, benthic grabs, and crab, fish and seastar traps and wharf piling miscellaneous searches). Of the few samples that were collected at these lower depths, none were NIS or C1 taxa. All 30 NIS and C1 taxa were collected between 0 m and 6 m depth and in both the 0-3 m and the >3-6 m depth classes there were more NIS and C1 taxa collected than native taxa (Figure 70). This reflects the high proportion of fouling organisms amongst the NIS and C1 taxa recorded from the port, which are less likely to be recorded by these other methods than by the pile scraping method, which targets fouling organisms.

Native taxa were recorded from the top three depth classes, ranging from two native taxa at >6 - 9m depth, to 72 taxa at > 3 – 6 m depth (Table 16). A large majority of the native taxa were recorded in each of the top two depth classes (24.4 % in 0-3 m, and 92.3 % in >3-6 m depth), but the range of taxa varied between depth classes. Of the 78 native taxa recorded, five (6.4 %) were recorded from only the 0-3 m depth class, 57 (73.1 %) were recorded only from the >3-6 m depth class and one (1.3 %; *Scrippsiella trochoidea*) was recorded only from the >6-9 m depth class. The variation of taxa recorded from different depth classes highlights the importance of sampling a range of depths in order to gain as complete an inventory of organisms as possible.

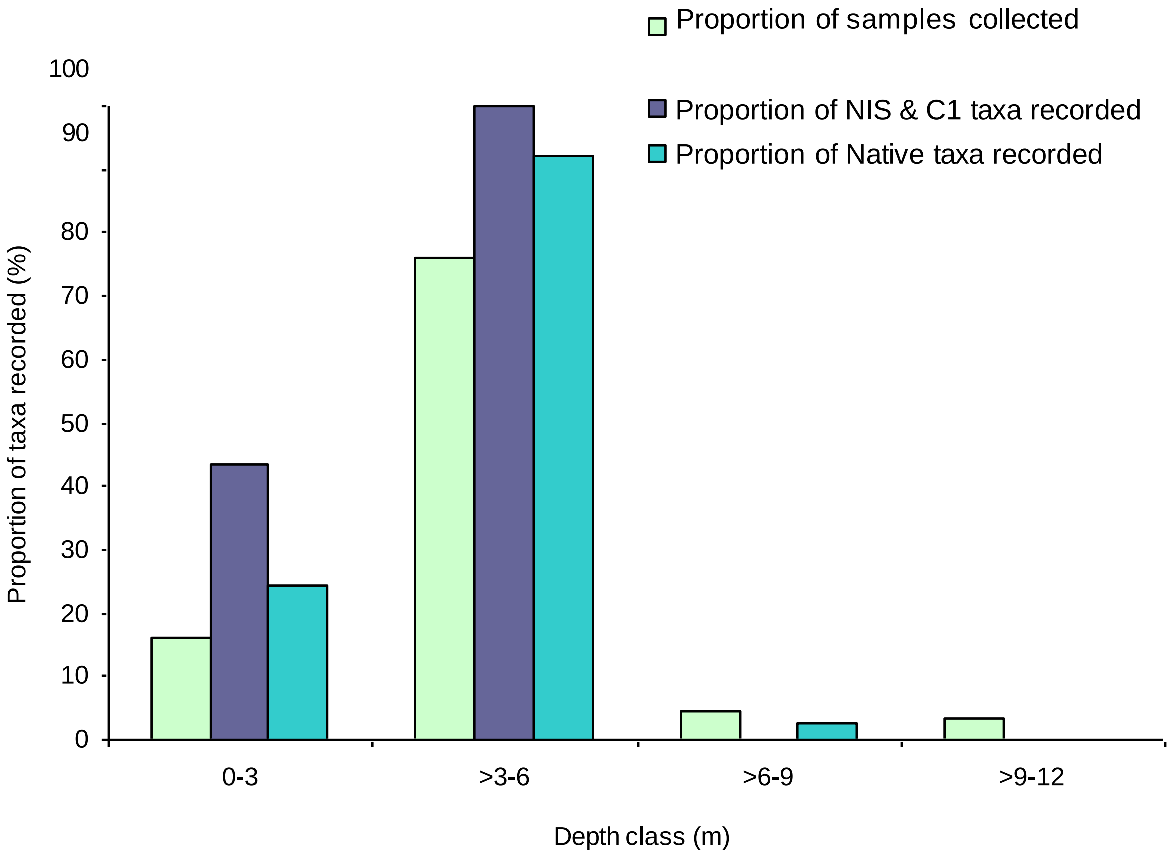

Figure 70: **Proportion of taxa recorded from four depth classes during the second survey of Gulf Harbour Marina. The proportion of taxa sums to a total of >100% across depth classes, as some taxa were recorded from more than one depth class.**

COMPARISON OF RESULTS FROM THE INITIAL AND REPEAT BASELINE SURVEYS OF THE GULF HARBOUR MARINA

Pile scrape samples

Native species

Rarefaction curves and estimates of total species richness in pile scrape samples taken from the two baseline surveys of the Gulf Harbour Marina are presented in Figure 71. Curves for the native species assemblage were similar in each survey, with comparable rates of species accumulation relative to sampling effort (Figure 71). In each case, the observed richness increased as more samples were taken and did not approach an asymptote. Sampling effort was the same for each survey (n = 64) with the second survey recovering 10 fewer species (46) compared to the initial survey (56; Table 17). Although estimates of total species richness in each survey appeared to have plateaued, they did not converge with observed richness, indicating a number of unsampled species in the assemblages. This could be due to the large proportion of uniques (i.e. species that occurred in only one sample) present in the assemblages. Thirty-eight percent and 37 % of the native species observed in each survey occurred in just a single sample (Table 17). The large number of uniques had a strong influence on the estimated number of unsampled species in the assemblage, which varied between 44 % in the first survey (i.e. 25 unsampled species out of 56 observed) and 46 % in the resurvey (i.e. 21 unsampled species of 46 observed).

Despite the correspondence between the rarefaction curves for the two surveys, the species compositions of these assemblages were quite different. Only 30 species (42 % of the total number) were recorded in both surveys (Table 17). Again, this reflects the large number of comparatively rare species in the assemblage, with non-detection of many of these probably accounting for much of the difference observed between the two surveys. For example, the classic Jaccard and Sorenson measures of compositional similarity indicate a reasonably low similarity between the assemblages recorded in the initial and repeat baseline surveys of the Gulf Harbour Marina (0.417 and 0.588, respectively). In contrast, the new Chao similarity indices, which adjust for the effects of non-detection of rare species, suggest much closer resemblance of the two samples (Chao bias-adjusted Jaccard = 0.874; Chao bias-adjusted Sorenson = 0.933; Table 17).

Cryptogenic category 2 taxa

Very few cryptogenic category 2 taxa were recorded in either survey (10 taxa in total; Table 17). This is particularly true for the second survey which only recovered three taxa. The observed richness of cryptogenic category two taxa did not reach an asymptote in either survey, however, in the second survey the curve did converge with the estimated richness, suggesting relatively complete inventory of this group (Figure 71). The observed and estimated richness failed to converge in the initial survey suggesting an incomplete inventory of this group. Indeed, a high proportion of the taxa were uniques (initial survey = 57 %, second survey = 67 %). This resulted in a high and unstable estimate of taxa richness in the first survey (Chao 2 estimate = 13 taxa).

There was a high turn-over in cryptogenic category 2 taxa composition between the two surveys. No taxa were common to both surveys (Table 17). This is reflected by similarity indices which show no similarity between the assemblages, even when adjustment is made for undetected rare species (Chao bias-adjusted Jaccard = 0; Chao bias-adjusted Sorenson = 0; Table 17). It is unclear what caused the differences in taxa composition between surveys, but they may be associated with temporal variation in the abundance of taxa within the assemblage or immigration of new taxa into it.

Non-indigenous and cryptogenic category 1 species

A similar number of NIS and C1 species were recorded in the first (22 species) and the second (25 species) surveys (Table 17). The observed species richness curves, for both surveys, appeared to have almost plateued after approximately 50 quadrats. In the second survey, at 65 quadrat samples, the observed richness curve approached the estimated total richness of 29 species (Figure 71). The modest difference between the observed and estimated richness in the second survey (four species) suggested a relatively complete inventory of this group. The proportion of uniques was reasonably low (24 %) and therefore, few species were undetected (Table 17). In the initial survey, the estimated number of species did not approach an asymptote and continued to increase steeply with increasing sample effort (Figure 71). Although the observed species richness plateued after about 50 samples (at around 22 species), it remained substantially lower than the estimated species density (50 species). This is most likely due to the high proportion of uniques in the first survey (36 %; Table 17) causing a higher estimation of species richness compared to the second survey. Only seven of the 22 species (32 %) found in the first survey were not detected in the repeat survey (Table 17). As a result, the compositional similarity of the two assemblages was reasonably high, once undetected species had been adjusted for (Chao bias-adjusted Jaccard = 0.848; Chao bias-adjusted Sorenson = 0.918; Table 17).

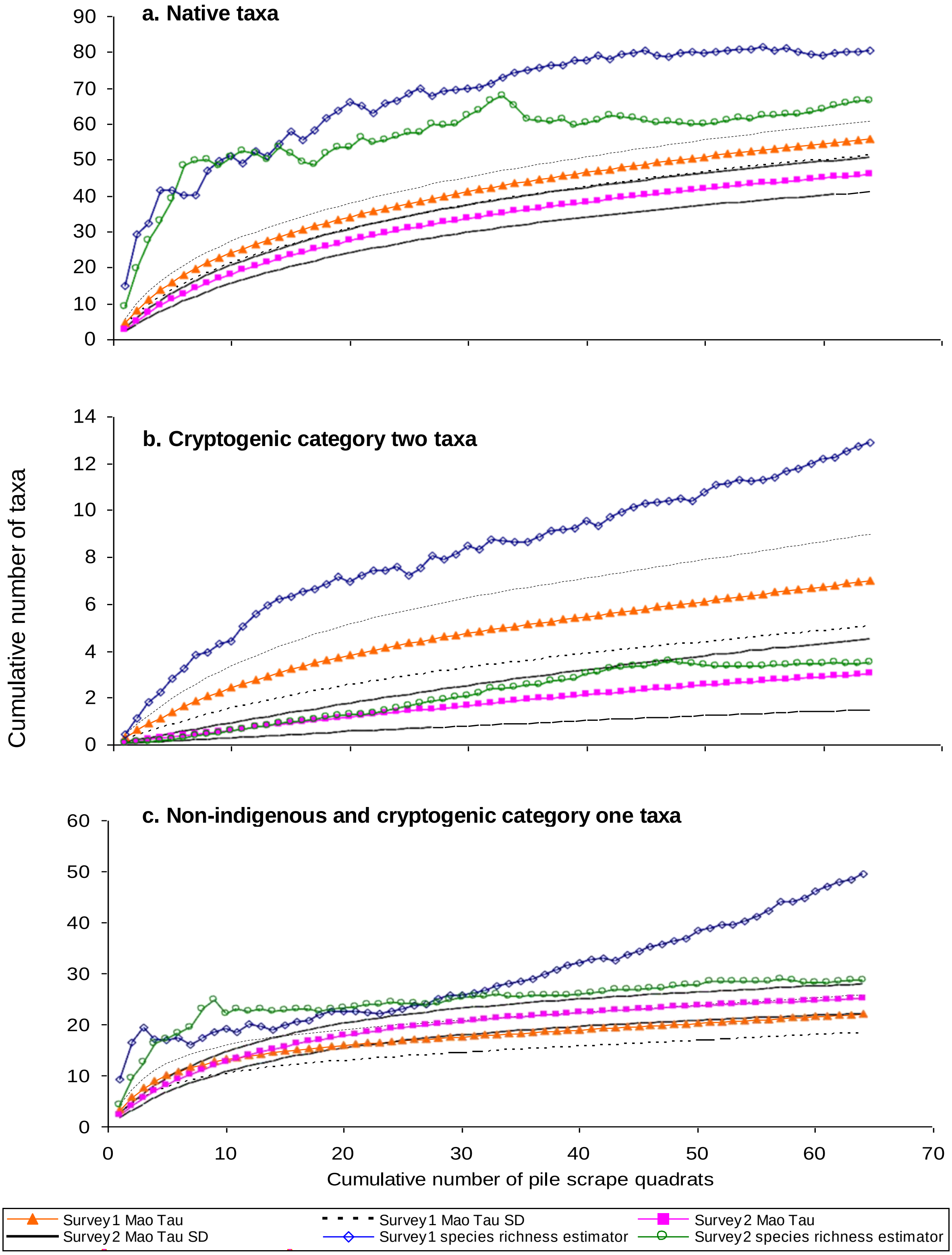

Figure 71: Mean (± 1 standard deviation (SD)) rarefaction (Mao Tau) for native (a), cryptogenic category two (b) and non-indigenous and cryptogenic category one (c) taxa collected from pile scrape quadrats for the first survey (full triangles, ± SD (dashed lines)) and second survey (full squares, ± SD (solid lines)). Species richness estimators are also shown for the first survey (empty diamonds) and second survey (empty circles); the Chao 2 bias-corrected formula was used for NIS & C1 taxa in the second survey and C2 taxa in the second survey. The Chao 2 classic formula was used in all other instances.

Benthic sled samples

Samples taken with the benthic sled contained relatively few non-indigenous and cryptogenic category 1 species (seven species in total) or cryptogenic category 2 taxa (two taxa) in either survey (Table 17). For this reason, analysis was done on the pooled species assemblage. Seventeen benthic sleds were taken in both the initial and resurvey of the Gulf Harbour Marina. However, the second survey recovered a greater number of taxa (41) compared to the initial survey (16; Table 17; Figure 73). Consequently, only 21 % of taxa were shared between the two surveys.

A high proportion of taxa collected were uniques (Table 17). Sixty-six percent of taxa in the second survey were uniques, resulting in a high and unstable estimate of species richness. This estimate failed to converge with the observed richness (Figure 72) suggesting an incomplete inventory and a number of undetected rare taxa present in this assemblage.

Although the estimate and observed richness in the initial survey were much closer, these curves also failed to converge, again suggesting an incomplete inventory of this group. This may be due to the high proportion of uniques (44 % of taxa) again indicating a high number of rare and patchily distributed species in this assemblage.

The similarity between the initial and second survey assemblages was moderate, even after adjustment had been made for non-detection of rare species (Chao bias-adjusted Jaccard = 0.599; Chao bias-adjusted Sorenson = 0.75; Table 17).

Benthic grab samples

Samples taken with the benthic grab contained relatively few non-indigenous and cryptogenic category 1 species (two species in total) and no cryptogenic category 2 taxa in either survey (Table 17). For this reason, analysis was done on the pooled species assemblage.

As with the benthic sled samples, survey effort was consistent between the initial and second surveys of the Gulf Harbour Marina (Figure 73; Table 17). Both surveys recovered a very similar number of taxa (initial survey = eight taxa, second survey = seven taxa; Table 17), however, species composition was quite different. Only 36 % (4 of 11) of taxa were shared between the two surveys. Indeed, a high proportion of uniques were recovered in each survey (initial = 63 % of taxa; second survey = 43 %; Table 17), which suggested a number of „rare‟ and patchily distributed taxa were present and may account for much of the observed difference between the two surveys. When adjustment is made for non-detection of rare species similarity indices show moderate similarity between the two assemblages (Chao bias- adjusted Jaccard = 0.631; Chao bias-adjusted Sorenson = 0.773; Table 17).

The high proportion of uniques was reflected in the high and unstable estimate of species richness shown for the initial survey (Figure 73). The estimate of 20.5 species after twelve benthic grabs was much greater than the observed richness of eight species (Figure 73). The difference again suggests there was a comparatively large number of rare species in this assemblage with non-detection of many of these probably accounting for much of this difference. In comparison the estimated richness in the second survey was much lower, at eight species, and converged with the observed richness of seven species, suggesting a complete inventory of this group had been made.

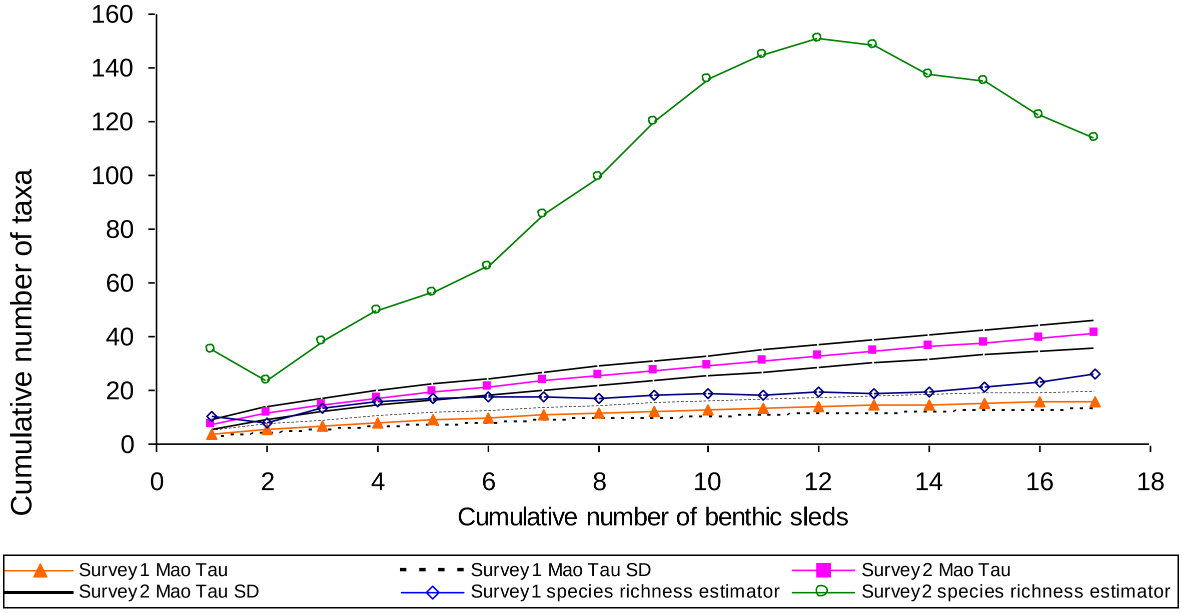

Figure 72: Mean (± 1 standard deviation (SD)) rarefaction curves (Mao Tau) for native, cryptogenic and non-indigenous taxa combined collected in benthic sleds for the first survey (full triangles, ± SD (dashed lines)) and second survey (full squares, ± SD (solid lines)). Species richness estimators are also shown for the first survey (empty diamonds, Chao 2 Bias-corrected formula) and second survey (empty circles, Chao 2 Classic formula).

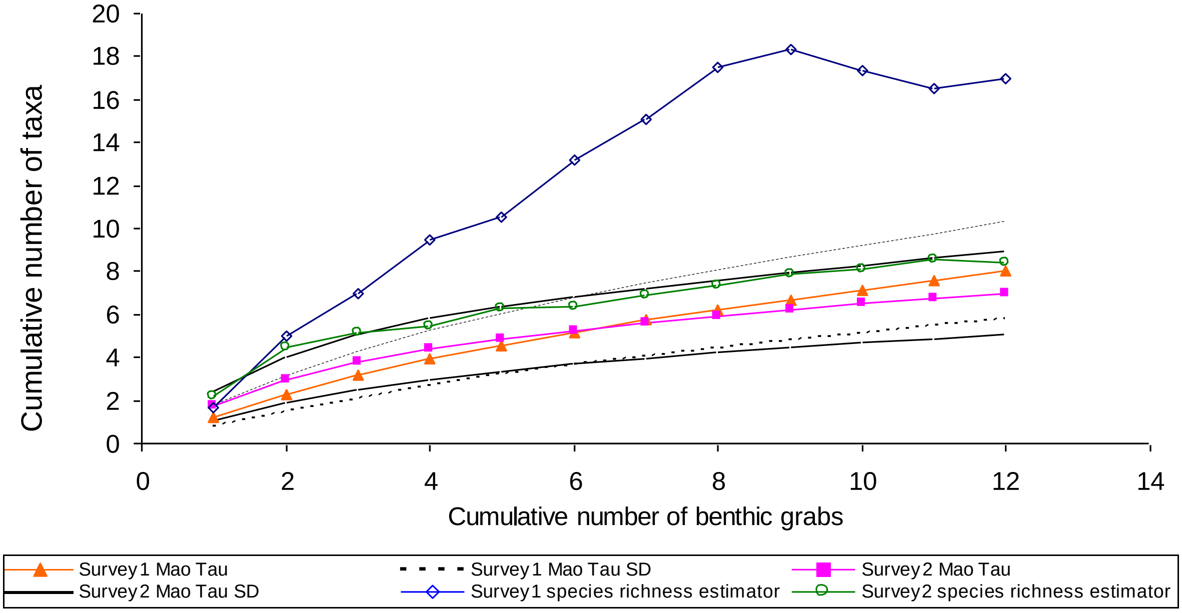

Figure 73: Mean (± 1 standard deviation (SD)) rarefaction curves (Mao Tau) for native, cryptogenic and non-indigenous taxa combined collected in benthic grabs for the first survey (full triangles, ± SD (dashed lines)) and second survey (full squares, ± SD (solid lines)). Species richness estimators are also shown for the first survey (empty diamonds, ICE formula) and second survey (empty circles, Chao 2 bias-corrected formula).

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

The non-indigenous species located in the Gulf Harbour Marina are thought to have arrived in New Zealand via international shipping. They may have reached the Gulf Harbour Marina directly from overseas or through domestic spread (natural and/or anthropogenic) from other New Zealand ports. Table 12 indicates the possible vectors for the introduction of each NIS recorded from the Gulf Harbour Marina during the baseline port surveys. Likely vectors of introduction are largely derived from Cranfield *et al*. (1998) and expert opinion. They suggest that only one of the 26 NIS (2 %) probably arrived via ballast water, 16 species (58 %) were most likely to be associated with biofouling and eight species (31 %) could have arrived via either of these mechanisms and for one species (2 %) the method of introduction is unknown.

Assessment of the risk of new introductions to the marina

Many non-indigenous species introduced to New Zealand ports and marinas by movement of recreational and commercial vessels 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).

Estimates indicate that approximately 2480 vessels enter the Gulf Harbour Marina annually (Inglis and Floerl 2002) with around 20 % of these being international and 80 % domestic arrivals. The majority of international vessels arriving in New Zealand come from the South Pacific (around 80 %) or Australia (16.5 %; O. Floerl, NIWA, pers. Comm. Feb 2007; see Vessel movements and ballast discharge patterns, above). These vessels commonly arrive from Fiji, Tonga, New Caledonia, Australia (Coffs Harbour, Lord Howe Island, Brisbane, Sydney, Norfolk Island, Bundaberg, Gladstone, Southport, Townsville, Launceston), Cook Islands, Vanuatu, Western Samoa, American Samoa, Niue, French Polynesia and the US Pacific Dependency (Inglis and Floerl 2002). Almost all of these are tropical locations with coastal environments dissimilar to those of New Zealand, except possibly for the northern-most waters of the North Island. However, southern Australian locations, such as Sydney, are in temperate regions that have coastal environments similar to New Zealand's. Due to the environmental similarities and relatively short transit times and similarity of the marine environment, vessels arriving from Sydney and southern Australia present perhaps the greatest risk of introducing new non-indigenous species to the Gulf Harbour Marina. Furthermore, six of the eight marine pests on the New Zealand Register of Unwanted Organisms (Table 6) are already present in southern Australia (*Carcinus maenas*, *Asterias amurensis*, *Undaria pinnatifida*, *Sabella spallanzanii*, *Caulerpa taxifolia*, and *Styela clava*).

Assessment of translocation risk for introduced species found in the marina

An estimated 1,252 recreational vessels depart the Gulf Harbour Marina annually and travel predominantly to Auckland Westhaven Marina (342), Great Barrier Island (199), Opua (187), Waikawa (72) and Tutukaka Marina (71) (O. Floerl, NIWA, unpublished data). Although the majority of the non-indigenous species found in the resurvey of Gulf Harbour Marina have been recorded in other locations throughout New Zealand (Table 14), they were not detected in all of the other ports surveyed. There is, therefore, a risk that species established in Gulf Harbour Marina could be spread to other New Zealand locations. Of particular note is the species present in Gulf Harbour Marina that is on the New Zealand Register of Unwanted Species: the club-shaped ascidian, *Styela clava.*

Outside the Hauraki Gulf *Styela clava* has only been recorded in Tutukaka Marina and the Port of Lyttelton (Inglis 2003; Inglis *et al*. 2006g). This species is considered a significant pest of aquaculture (particularly long-line mussel culture) and there is concern about the potential for it to spread to important mussel growing areas in the Marlborough Sounds and Coromandel. Because they are fouling organisms, the risk of translocating *S. clava* is highest for slow-moving vessels, such as yachts, and vessels that have long residence times in the marina. In the Gulf Harbour Marina, recreational craft that are laid up for significant periods of time pose a particular risk for the spread of this species.

Several non-indigenous species recorded during the baseline resurvey have relatively restricted distributions nationwide and could, therefore, be spread from the Gulf Harbour Marina to other locations. NIS with limited distribution include the annelids *Hydroides ezoensis, Hydroides elegans, Pseudopolydora corniculata* and *Pseudopolydora. paucibranchiata*; the bryozoans *Schizoporella errata, Watersipora arcuata, Celleporaria aperta* and *Zoobotryon verticillatum*; the molluscs *Musculista senhousia* and *Limaria orientalis;* the Poriferan *Vosmaeropsis* cf. *macera* and the Orchrophyta *Cutleria mulifda*.

Management of existing non-indigenous species in the marina

Approximately half of the NIS detected in this survey appear to be well established in the marina. However, there were five NIS recorded in this survey that were recorded from only one site in this survey (Table 14). They included species that were not recorded during the initial baseline survey of the Gulf Harbour Marina (the polychaete worm *Pseudopolydora corniculata*, the arthropods *Monocorophium acherusicum* and *Amphibalanus amphitrite*, and the ascidian *Diplosoma listerianum*) and one that was present in only one sample in the initial baseline survey of the Gulf Harbour Marina (the poriferan *Vosmaeropsis* cf. *macera*). Furthermore, four of these five species were recorded from only a single sample and the remaining species, *A. amphitrite*, was recorded in only two samples. These species may not be well established in the Gulf Harbour Marina, and two of them (*P. corniculata* and *V.* cf. *macera*) have been recorded in a few other New Zealand ports, and thus, based on survey results, do not appear to be well established in New Zealand, either

For most marine NIS, eradication by physical removal or chemical treatment is not yet a cost-effective option. Local population controls are unlikely to be effective for species that are widespread in the Gulf Harbour Marina. They may be worth considering for the more restricted species noted above, but 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. It is recommended that management activity be directed toward mitigating the spread of species established in the port to locations where they do not presently occur.

This is particularly important for the unwanted species *Styela clava*. MAF Biosecurity New Zealand is currently undergoing research that may assist in the future management of *S. clava*. MAF Biosecurity NZ is also running public education programmes, encouraging marine users to keep their vessels and equipment clean and anti-fouled to help prevent the spread of the ascidian to non-infected areas (MAF 2003).

Prevention of new introductions

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

Options are currently lacking, however, for effective in-situ treatment of biofouling and sea-chests. MAF Biosecurity New Zealand has recently embarked on a national survey of biofouling on vessels entering New Zealand from overseas. The study will characterise risks from this pathway (including high risk source regions and vessel types) and identify predictors of risk that may be used to manage problem vessels. Shipping companies and vessel owners can reduce the risk of transporting NIS in biofouling or sea chests through regular maintenance and antifouling of their vessels. Until effective risk mitigation options are developed, it is recommended that local authorities and port companies assess the risk of activities such as in-water cleaning of vessel hulls and sea-chests. These activities can increase the likelihood of non-indigenous fouling species being released and potentially becoming established within the marina. They should be discouraged where the risk is considered unacceptable. Slow moving barges or vessels that are laid up in overseas ports for long periods before travelling to New Zealand can carry large densities of non-indigenous marine organisms with them. Cleaning and maintenance of these vessels should be encouraged by marina authorities and shipping companies prior to their departure for New Zealand waters.

Studies of historical patterns of invasion have suggested that changes in trade routes can herald an influx of new NIS from regions that have not traditionally had major shipping links with the country or port (Carlton 1987; Hayden *et al.* 2009). The growing number of baseline port surveys internationally and an associated increase in published literature on marine NIS means that information is becoming available that will allow more robust risk assessments to be carried out for new shipping routes. We recommend that port companies consider undertaking such assessments for their ports when new import or export markets are forecast to develop. The assessment would allow potential problem species to be identified and appropriate management and monitoring requirements to be put in place.

Conclusions and recommendations

The national biological baseline surveys have significantly increased our understanding of the identity, prevalence and distribution of introduced and native species in New Zealand's shipping ports and marinas. They represent a first step towards a comprehensive assessment of the risks posed to native coastal marine ecosystems from non-indigenous marine species. Although measures are being taken by the New Zealand government to reduce the rate of new incursions, foreign species are likely to continue to be introduced to New Zealand waters by shipping. There is a need for continued monitoring of non-indigenous marine species in port and marina 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 repeat survey of the Gulf Harbour Marina recorded 146 species or higher taxa, including 23 non-indigenous species. Although many of these species also occurred in the initial April 2003 baseline survey of the marina, the degree of overlap was not high. Around 46 % of the native species, 52 % of non-indigenous species, and 46 % of cryptogenic taxa recorded during the repeat survey were not found in the earlier survey. This is not simply attributable to the sampling effort since it was almost identical in both surveys. The species assemblage in each survey was characterised by high diversity, a comparatively large proportion of uncommon species, and patchy local distributions that are typical of marine biota. As a consequence, the estimated numbers of undetected species were comparatively high. In the initial baseline survey, for example, five of the 14 non-indigenous species (36 %; *Limaria orientalis*, *Vosmaeropsis* cf. *macera*, *Hydroides elegans*, *Ericthonius pugnax*, *Cutleria multifida*) were each found in just a single sample. In the second survey *V.* cf. *macera* was recorded in one sample and *H. elegans* in five samples and the remaining three species (*L. orientalis*, *E. pugnax* and *C. multifida*) were undetected in the resurvey. Furthermore, of the 11 non-indigenous species that were detected in the second survey but not in the first, four were recorded in just a single sample (*Diplosoma listerianum*, *Monocorophium acherusicum*, *Pseudopolydora corniculata*), two were recorded from just two samples (*Amphibalanus amphitrite* and *Musculista senhousia*), one was recorded from three samples (*Styela clava*) and the remaining species were recorded in four to eight samples (*Watersipora arcuata*, *Bowerbankia gracilis*, *Bugula stolonifera*, *Celleporaria aperta* and *Pseudopolydora paucibranchiata*). This makes it difficult to determine if some of the new records in the second survey represent incursions that occurred after the first survey or, rather, are species that were present, but undetected during the first survey due to their sparse densities or distribution. Similarly, the absence in the resurvey of three NIS that were recorded in the initial survey (Table 12) could be explained either by an aftefact of sampling as a consequence of very small population denstities or because the initial populations that were discovered were not viable.

In each case, additional information can be used to address this problem. Seven of the non-indigenous species recorded in the second survey but not in the first – the annelid *Pseudopolydora paucibranchiata*, the arthropods *Monocorophium acherusicum* and *Amphibalanus amphitrite*, the bryozoans *Bugula stolonifera*, *Watersipora arcuata*, and *Bowerbankia gracilis*, the mollusc *Musculista senhousia* – have been present in New Zealand for at least 30 years. The ascidian *Diplosoma listerianum* was first recorded in New Zealand in 1996 (Cranfield *et al*. 1998; Kospartov 2008). And a further two of these NIS recorded in the second Gulf Harbour Marina survey but not the first (the bryzoan *Celleporaria aperta* and the ascidian *Styela clava*) are recent arrivals in New Zealand (2004 – 2006). The date of introduction of one NIS, *Pseudopolydora corniculata*, is unknown, but it is thought to be present prior to the port baseline surveys (as *P. kempi*; G. Read, NIWA, pers. comm.). The occurrence of the bryozoan, *Celleporaria aperta*, in the second survey of Gulf Harbour Marina represent an extension of the known range of this species, and thus may not be expected to have been present in the marina during the time of the initial survey. Thus, although the evidence is only circumstantial, this species may represent new incursions to the Gulf Harbour Marina.

Similarly, for the three NIS that were recorded in the first survey but not in the second, their distributions throughout New Zealand, the period of time they have been in the country, and the number of samples they were recorded from, provide clues as to whether they were likely to have been overlooked during the resurvey, or whether local extinction may have taken place.

The mollusc, *Limaria orientalis*, has been known in New Zealand since at least 1972 and has been recorded in the northern North Island (Waitemata Harbour, Hauraki Gulf, Bay of Islands, Coromandel Peninsula and Opua; (Cranfield *et al*. 1998)). As well as being recorded in the initial survey of the Gulf Harbour Marina, it has been recorded in port surveys in Auckland (second survey); (Inglis *et al*. 2006d); Viaduct Harbour (first survey) Inglis, in press.), Whangarei Port (second survey; Inglis in press.) and Opua (initial survey, (Inglis *et al*. 2006c)). *L. orientalis* was only found in a single sample in three of these port surveys, and in two samples in the other two surveys. Because *L. orientalis* was only found in a single sample in the initial survey of Gulf Harbour Marina and was absent from the resurvey suggests that it failed to establish in the Gulf Harbour Marina. However, due to its widespread distribution in surrounding areas, it seems likely that it could be re-introduced.

The amphipod, *Ericthonius pugnax*, has been in New Zealand for almost a century (since at least 1914). It is not widespread and has only been recorded around the Gulf Harbour region of New Zealand. The initial survey of the Gulf Harbour Marina was the first port survey to record this amphipod, where it was found in a single sample. Its absence from this resurvey suggests that it either failed to establish at this location or was undetected due to its sparse distribution.

Similarly, the Ochrophyta, *Cutleria multifida* was also found only in one sample in the intial survey of the Gulf Harbour Marina. Although it has been present in New Zealand for over a century (since at least 1870) and has been recorded in many locations from Auckland to Stewart Island (Cranfield *et al*. 1998), *C. multifida* has only been recorded in one other port survey in Dunedin (the initial survey; (Inglis *et al*. 2006a). Two possiblities could explain the absence of *C. multifida* from the second Gulf Harbour survey. This species may have failed to establish at this location or a sampling error could have occurred as it has been recorded in many New Zealand locations (Cranfield *et al*. 1998), but only detected in two port surveys and found in just a single sample in this survey. More detailed studies of the distribution and abundance of these NIS would be required to confirm whether they are still present in the Gulf Harbour Marina.

As several recent analyses have shown, the large area of habitat available for marine organisms within shipping ports and marinas and the logistic difficulties of sampling in these environments mean 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*. 2005b; Gust *et al*. 2006). In generalised pest surveys, such as the baseline port 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; 49 % of native species recorded in the Gulf Harbour Marina resurvey also occurred in just a single sample. Nor is it unique to marine assemblages. These results reflect the spatial and temporal variability that are features of marine biological assemblages (Morrisey *et al*. 1992a, b) 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 marinas 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.

This survey, alone, cannot determine the threat to New Zealand's native ecosystems that is presented by the non-indigenous species encountered in this marina. It does, however, provide a starting point for further investigations of the distribution, abundance and ecology of the species described within it. 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 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 Taxa	Species that are neither clearly indigenous nor non-indigenous.	
Endemic	An organism restricted to a specified region or locality.	
Environment†	(a) Ecosystems and their constituent parts, including people and their communities; and (b) All natural and physical resources; and (c) Amenity values; and (d) The aesthetic, cultural, economic, and social conditions that affect or are affected by any matter referred to in paragraphs (a) to (c) of this definition	
Established	A non-indigenous organism that has formed self-sustaining populations within the new area of introduction, but is not necessarily an invasive species.	Naturalised
Generalised pest survey	A survey to identify and inventory the range of non-indigenous species present in an area	Blitz survey
Introduction	Direct or indirect movement by a human agency of an organism across a major geographical barrier to a region or locality that is beyond its natural distribution potential.	Translocation (*usually applied to secondary movement of the organism within a new region*)
Indeterminate taxa	Specimens that could not be identified to species level reliably because they were damaged, incomplete or immature, or because there was insufficient taxonomic or systematic information to allow identification to species level.	*(referred to as "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 species	An organism occurring within its natural past or present range and dispersal potential (organisms whose dispersal potential is independent of human intervention).	Native
Non-indigenous species	Any organism (including its seeds, eggs, spores, or other biological material capable of propagating that species) occurring outside its natural past or present range and dispersal potential (organisms whose dispersal is caused by human action).	Adventive Alien, Allochthonous, Exotic, Introduced, Non-native
Pathway	Used interchangeably with *vector*, but can also include the purpose (the reason why a species is moved), and route (the geographic corridor) by which a species is moved from one point to another (Carlton 2001).	Vector
Pest†	(1) A non-indigenous organism that is considered harmful to the environment, where "*environment*" has the broad definition described above. (2) An organism specified as a pest in a pest management strategy that has been approved under Part V of Biosecurity Act 1993.	
Prevalence	The ratio of the number of recorded occurrences of a species relative to the total number of observations.	
Species richness	The number of species present in an area.	

Term	Definition	Terms with the same or similar meaning
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: Biosecurity Council (2003), Carlton (2001), Cohen and Carlton (1998), Colautii and MacIsaac (2004), Falk-Petersen *et al*. (2006), Gotelli and Colwell (2001), Gray (2000) and Occhipinti-Ambrogi and Galil (2004).

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Tables

Table 1: Berthage facilities in the Gulf Harbour Marina

Berth	Berth No.	Purpose	Construction	Length of Berth (m)	Depth (m below chart datum)
A	68	Recreational vessels	Floating concrete pier/wood pile	240	2.4
B	67	Recreational vessels	Floating concrete pier/wood pile	225	2.4
C	73	Recreational vessels	Floating concrete pier/wood pile	225	2.4
D	73	Recreational vessels	Floating concrete pier/wood pile	230	2.4
E	81	Recreational vessels	Floating concrete pier/wood pile	235	2.4
F	84	Recreational vessels	Floating concrete pier/wood pile	235	2.4
G	84	Recreational vessels	Floating concrete pier/wood pile	240	2.4
H	84	Recreational vessels	Floating concrete pier/wood pile	240	2.4
I	84	Recreational vessels	Floating concrete pier/wood pile	240	2.4
J	91	Recreational vessels	Floating concrete pier/wood pile	240	2.4
K	88	Recreational vessels	Floating concrete pier/wood pile	235	2.4
L	80	Recreational vessels	Floating concrete pier/wood pile	205	2.4
N	33	Recreational vessels	Floating concrete pier/wood pile + some steel piles	135	4
O	28	Commercial charters/recreational	Floating concrete pier/wood pile + some steel piles	95	4
Z	32	Commercial charters/recreational	Floating concrete pier/wood pile + some steel piles	210	2.4

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

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

	CRIMP Protocol		NIWA Method		
Taxa sampled	**Survey method**	**Sample procedure**	**Survey method**	**Sample procedure**	**Notes**
		target species		target species	
Sedentary / encrusting biota	Quadrat scraping	0.10 m^2 quadrats sampled at -0.5 m, -3.0 m and -7.0 m on 3 outer piles per berth	Quadrat scraping	0.10 m^2 quadrats sampled at -0.5 m, -1.5 m, -3.0 m and -7 m on 2 inner and 2 outer piles per berth	Workshop recommended extra quadrat in high diversity algal zone (-1.5 m) and to sample inner pilings for shade tolerant species
Sedentary / encrusting biota	Video / photo transect	Video transect of pile/rockwall facing. Still images taken of the three 0.10 m^2 quadrats	Video / photo transect	Video transect of pile/rockwall facing. Still images taken of the four 0.10 m^2 quadrats	
Mobile epifauna	Beam trawl or benthic sled	1 x 100 m or timed trawl at each site	Benthic sled	2 x 100 m (or 2 min.) tows at each site	
Fish	Poison station	Divers & snorkelers collect fish from poison stations	Opera house fish traps	4 traps (2 lines x 2 traps) left for min. 1 hr at each site	Poor capture rates anticipated from poison stations because of low visibility in NZ ports. Some poisons also an OS&H risk to personnel and may require resource consent.
Fish/mobile epifauna	Beach seine	25 m seine haul on sand or mud flat sites	Opera house fish traps / Whayman Holdsworth seastar traps	4 traps (2 lines x 2 traps) of left at each site (Whayman Holdworth seastar traps left overnight)	Few NZ ports have suitable intertidal areas to beach seine.

Table 3. Particle size classes used in grain size analyses of sediment samples from the baseline port surveys.

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

Table 4: **Summary of sampling effort in the Gulf Harbour Marina. Exact geographic locations of survey sites are provided in Appendix 2**

	Sampling method and survey (T1: first survey; T2: second survey)																									
	FSHTP		CRBTP		SHRTP		STFTP		BGRB		BSLD		CYST		PSC		Photo stills & video		Qualitative visual searches (on pilings)		Sediment		Opportunistic diver visual search (PSCM)		Opportunistic land visual search (VISS)	
Site name	**T1**	**T2**	**T1**	**T2**	**T1**	**T2**	**T1**	**T2**	**T1**	**T2**	**T1**	**T2**	**T1**	**T2**	**T1**	**T2**	**T1**	**T2**	**T1**	**T2**	**T1**	**T2**	**T1**	**T2**	**T1**	**T2**
Channel 1											1	1														
Channel 2											1	1														
Channel 3											1	1														
Channel 4											1	1														
Crab Cove													2	2												
Jetty A & B											1	1														
Jetty B																										1
Jetty B & C											1	1														
Jetty C	4	4	4	4	4	4	4	4	3	3				2	16	16	64	64	4	4		1		1		1
Jetty C & D											1	1														
Jetty D & E											1	1														
Jetty E & F											1	1														
Jetty F																										1
Jetty F & G											1	1														
Jetty G & H											1	1														
Jetty H & I											1	1														
Jetty I & J											1	1														
Jetty J	4	4	4	4	4	4	4	4	3	3			2	2	16	16	64	64	4	4		1	1			1
Jetty J & K											1	1														
Jetty K & L											1	1														
Jetty L	4	4	4	4	4	4	4	4	3	3				2	16	16	64	64	4	4		1	1			1
Jetty L & shore											1	1														
Jetty N & O		4		4		4		4		3				2		16		64		4		1		2		
Jetty Z & A											1	1														
MISC													2													
SY	4		4		4		4		3				2		16		64		4							
Total	**16**	**16**	**16**	**16**	**16**	**16**	**16**	**16**	**12**	**12**	**17**	**17**	**8**	**10**	**64**	**64**	**256**	**256**	**16**	**16**	**0**	**4**	**2**	**3**	**0**	**5**

Table 5: 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 6: 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*[1]

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

Table 7: Consultative Committee on Introduced Marine Pest Emergencies (CCIMPE) Trigger List (Endorsed by the National Introduced Marine Pest Coordinating Group, 2006).

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

* Species on Interim CCIMPE Trigger List

Table 8: Physical characteristics of the sites sampled during the resurvey of Gulf Harbour Marina. Sites not sampled for a given characteristic are indicated with a dash (-).

Site name	Maximum recorded depth (m)	Secchi depth (m)	Salinity (ppt)	Water temperature (°C)	Sea state (Beaufort scale)
Channel 1	4.3	-	-	-	-
Channel 2	4	-	-	-	-
Channel 3	5	-	-	-	-
Channel 4	5	-	-	-	-
Crab Cove	4.9	-	-	-	-
Jetty A & B	4.8	-	-	-	-
Jetty B & C	4.1	-	-	-	-
Jetty C	4.8	2.3	30	20.4	1-2
Jetty C & D	4	-	-	-	-
Jetty D & E	3.9	-	-	-	-
Jetty E & F	4	-	-	-	-
Jetty F	-	-	-	-	-
Jetty F & G	4.1	-	-	-	-
Jetty G & H	3.9	-	-	-	-
Jetty H & I	4.1	-	-	-	-
Jetty I & J	4.1	-	-	-	-
Jetty J	4.2	1.78	32	19.8	1-2
Jetty J & K	4.2	-	-	-	-
Jetty K & L	3.9	-	-	-	-
Jetty L	4.3	2.3	32	20.2	1-2
Jetty L & shore	3.9	-	-	-	-
Jetty N & O	11.2	2.3	34	19.5	1-2
Jetty Z & A	5	-	-	-	-
Average across all sites	**4.29**	**2.17**	**32.00**	**19.98**	**1.5**
SE of average across all sites	**0.09**	**0.13**	**0.82**	**0.20**	**0.50**

Table 9: Percentage of five sediment particle sizes at four sites sampled during the second baseline survey of Gulf Harbour Marina. Data are percent net dry weight in each size class.

Site name	Clay <3.9um, >2um	Silt <62.5um, >3.9um	Sand >62.5um, <2mm	Gravel >2mm, <4mm	Small pebbles >4mm, <8mm
Jetty C	0.20	39.31	60.50	0.00	0.00
Jetty J	0.30	39.67	60.03	0.00	0.00
Jetty L	0.12	25.32	74.56	0.00	0.00
Jetty N & O	0.65	74.74	24.59	0.00	0.00

Table 10: Native species recorded from the Gulf Harbour Marina in the first (T1) and second (T2) surveys.

Major taxonomic group, Class	Order	Family	Taxon name	T1*	T2*
Annelida					
Polychaeta	Eunicida	Lumbrineridae	*Abyssoninoe galatheae*	1	
Polychaeta	Eunicida	Lumbrineridae	*Lumbrineris sphaerocephala*	1	1
Polychaeta	Eunicida	Eunicidae	*Marphysa unibranchiata*	1	
Polychaeta	Phyllodocida	Glyceridae	*Glycera lamelliformis*	1	1
Polychaeta	Phyllodocida	Hesionidae	*Ophiodromus angustifrons*	1	1
Polychaeta	Phyllodocida	Nephtyidae	*Aglaophamus verrilli*		1
Polychaeta	Phyllodocida	Nereididae	*Neanthes kerguelensis*	1	1
Polychaeta	Phyllodocida	Nereididae	*Nereis falcaria*	1	1
Polychaeta	Phyllodocida	Nereididae	*Platynereis Platynereis_australis_*group	1	1
Polychaeta	Phyllodocida	Nereididae	*Neanthes cricognatha*		1
Polychaeta	Phyllodocida	Nereididae	*Perinereis camiguinoides*	1	1
Polychaeta	Phyllodocida	Nereididae	*Perinereis pseudocamiguina*		1
Polychaeta	Phyllodocida	Phyllodocidae	*Eulalia* NIWA-2		1
Polychaeta	Phyllodocida	Polynoidae	*Harmothoe macrolepidota*	1	1
Polychaeta	Phyllodocida	Polynoidae	*Lepidastheniella comma*		1
Polychaeta	Phyllodocida	Polynoidae	*Lepidonotus polychromus*	1	1
Polychaeta	Phyllodocida	Sigalionidae	*Labiosthenolepis laevis*	1	1
Polychaeta	Phyllodocida	Goniadidae	*Glycinde trifida*		1
Polychaeta	Sabellida	Sabellidae	*Megalomma suspiciens*	1	
Polychaeta	Sabellida	Sabellidae	*Branchiomma curtum*		1
Polychaeta	Sabellida	Sabellidae	*Demonax aberrans*	1	1
Polychaeta	Sabellida	Sabellidae	*Pseudopotamilla laciniosa*	1	1
Polychaeta	Sabellida	Serpulidae	*Galeolaria hystrix*	1	
Polychaeta	Sabellida	Serpulidae	*Spirobranchus cariniferus*	1	1
Polychaeta	Sabellida	Serpulidae	*Filograna implexa*	1	
Polychaeta	Sabellida	Serpulidae	*Salmacina australis*		1
Polychaeta	Scolecida	Maldanidae	*Euclymene insecta*		1
Polychaeta	Scolecida	Orbiniidae	*Phylo novazealandiae*	1	1
Polychaeta	Scolecida	Scalibregmatidae	*Hyboscolex longiseta*		1
Polychaeta	Spionida	Spionidae	*Boccardia syrtis*	1	1
Polychaeta	Terebellida	Cirratulidae	*Protocirrineris nuchalis*		1
Polychaeta	Terebellida	Flabelligeridae	*Flabelligera affinis*		1
Polychaeta	Terebellida	Flabelligeridae	*Pherusa parmata*	1	
Polychaeta	Terebellida	Pectinariidae	*Pectinaria australis*	1	1
Polychaeta	Terebellida	Terebellidae	*Pseudopista rostrata*	1	1
Polychaeta	Terebellida	Terebellidae	*Streblosoma toddae*	1	1
Polychaeta	Terebellida	Terebellidae	*Terebella plagiostoma*		1
Polychaeta	Terebellida	Acrocirridae	*Acrocirrus trisectus*	1	
Arthropoda					
Malacostraca	Amphipoda	Phoxocephalidae	*Torridoharpinia hurleyi*		1
Malacostraca	Amphipoda	Aoridae	*Aora maculata*		1
Malacostraca	Amphipoda	Leucothoidae	*Leucothoe trailli*		1
Malacostraca	Decapoda	Alpheidae	*Alpheus richardsoni*	1	1
Malacostraca	Decapoda	Crangonidae	*Philocheras australis*		1
Malacostraca	Decapoda	Crangonidae	*Pontophilus australis*	1	
Malacostraca	Decapoda	Crangonidae	*Philocheras* cf. *australis*		1
Malacostraca	Decapoda	Crangonidae	*Pontophilus hamiltoni*	1	
Malacostraca	Decapoda	Diogenidae	*Paguristes pilosus*		1
Malacostraca	Decapoda	Diogenidae	*Paguristes setosus*		1
Malacostraca	Decapoda	Hymenosomatidae	*Halicarcinus cookii*	1	1
Malacostraca	Decapoda	Hymenosomatidae	*Halicarcinus varius*	1	1
Malacostraca	Decapoda	Hymenosomatidae	*Neohymenicus pubescens*		1
Malacostraca	Decapoda	Hymenosomatidae	*Halicarcinus whitei*		1

Major taxonomic group, Class	Order	Family	Taxon name	T1*	T2*
Malacostraca	Decapoda	Majidae	*Notomithrax minor*	1	1
Malacostraca	Decapoda	Ocypodidae	*Macrophthalmus hirtipes*	1	
Malacostraca	Decapoda	Palemonidae	*Periclimenes yaldwyni*	1	1
Malacostraca	Decapoda	Palemonidae	*Palaemon affinis*	1	
Malacostraca	Decapoda	Pilumnidae	*Pilumnopeus serratifrons*	1	1
Malacostraca	Decapoda	Pinnotheridae	*Pinnotheres atrinocola*	1	
Malacostraca	Decapoda	Porcellanidae	*Petrolisthes novaezelandiae*		1
Malacostraca	Decapoda	Hippolytidae	*Hippolyte bifidirostris*	1	1
Malacostraca	Decapoda	Xanthidae	*Pilumnus lumpinus*	1	
Malacostraca	Decapoda	Xanthidae	*Pilumnus novaezelandiae*		1
Malacostraca	Tanaidacea	Tanaididae	*Zeuxo* n. sp. NZ 1		1
Maxillopoda	Sessilia	Archaeobalanidae	*Austrominius modestus*	1	
Maxillopoda	Sessilia	Balanidae	*Balanus trigonus*	1	1
Bryozoa					
Gymnolaemata	Cheilostomata	Candidae	*Caberea rostrata*	1	
Gymnolaemata	Cheilostomata	Aeteidae	*Aetea truncata*		1
Chordata					
Actinopterygii	Mugiliformes	Mugilidae	*Aldrichetta forsteri*	1	1
Actinopterygii	Perciformes	Gobiidae	*Favonigobius exquisitus*	1	
Actinopterygii	Perciformes	Labridae	*Notolabrus celidotus*	1	
Actinopterygii	Perciformes	Sparidae	*Pagrus auratus*	1	1
Actinopterygii	Perciformes	Carangidae	*Decapterus koheru*	1	
Actinopterygii	Perciformes	Carangidae	*Trachurus novaezelandiae*		1
Ascidiacea	Enterogona	Polyclinidae	*Aplidium adamsi*	1	
Ascidiacea	Enterogona	Polyclinidae	*Aplidium phortax*	1	1
Ascidiacea	Pleurogona	Molgulidae	*Molgula mortenseni*	1	1
Ascidiacea	Pleurogona	Molgulidae	*Molgula amokurae*	1	
Ascidiacea	Pleurogona	Pyuridae	*Pyura rugata*	1	1
Ascidiacea	Pleurogona	Pyuridae	*Pyura subuculata*	1	
Ascidiacea	Pleurogona	Pyuridae	*Pyura picta*	1	
Ascidiacea	Pleurogona	Styelidae	*Cnemidocarpa nisiotis*	1	1
Cnidaria					
Anthozoa	Actiniaria	Sagartiidae	*Actinothoe albens*		1
Anthozoa	Scleractinia	Rhizangiidae	*Culicia rubeola*		1
Echinodermata					
Asteroidea	Valvatida	Asterinidae	*Patiriella mortenseni*	1	
Asteroidea	Valvatida	Asterinidae	*Patiriella regularis*	1	1
Echinoidea	Spatangoida	Loveniidae	*Echinocardium cordatum*	1	1
Mollusca					
Bivalvia	Myoida	Hiatellidae	*Hiatella arctica*	1	
Bivalvia	Mytiloida	Mytilidae	*Modiolarca impacta*	1	1
Bivalvia	Mytiloida	Mytilidae	*Perna canaliculus*	1	1
Bivalvia	Ostreoida	Ostreidae	*Ostrea chilensis*	1	
Bivalvia	Veneroida	Semelidae	*Leptomya retiaria*	1	
Bivalvia	Veneroida	Veneridae	*Irus reflexus*	1	1
Bivalvia	Veneroida	Kelliidae	*Kellia cycladiformis*	1	
Bivalvia	Nuculoida	Nuculidae	*Nucula hartvigiana*	1	1
Bivalvia	Nuculoida	Nuculidae	*Nucula nitidula*	1	
Gastropoda	Neogastropoda	Buccinidae	*Cominella adspersa*	1	1
Gastropoda	Neotaenioglossa	Calyptraeidae	*Maoricrypta costata*	1	
Gastropoda	Neotaenioglossa	Calyptraeidae	*Sigapatella novaezelandiae*	1	1
Gastropoda	Neotaenioglossa	Calyptraeidae	*Crepidula costata*		1
Major taxonomic	**Order**	**Family**	**Taxon name**	**T1***	**T2***

Major taxonomic group, Class	Order	Family	Taxon name	T1*	T2*
group, Class					
Gastropoda	Nudibranchia	Dorididae	*Alloiodoris lanuginata*	1	
Polyplacophora	Acanthochitonina	Acanthochitonidae	*Cryptoconchus porosus*	1	
Polyplacophora	Ischnochitonina	Chitonidae	*Sypharochiton pelliserpentis*	1	
Myzozoa					
Dinophyceae	Peridiniales	Gonyaulacaceae	*Gonyaulax grindleyi*	1	
Dinophyceae	Peridiniales	Gonyaulacaceae	*Lingulodinium polyedrum*		1
Dinophyceae	Peridiniales	Peridiniaceae	*Scrippsiella trochoidea*		1
Ochrophyta					
Phaeophyceae	Fucales	Sargassaceae	*Carpophyllum maschalocarpum*		1
Phaeophyceae	Fucales	Sargassaceae	*Sargassum scabridum*	1	1
Phaeophyceae	Fucales	Sargassaceae	*Sargassum sinclairii*	1	
Phaeophyceae	Fucales	Cystoseiraceae	*Cystophora scalaris*		1
Phaeophyceae	Cutleriales	Cutleriaceae	*Microzonia velutina*	1	
Phaeophyceae	Laminariales	Alariaceae	*Ecklonia radiata*		1
Dictyochophyceae	Dictyochales	Dictyochaceae	*Dictyota dichotoma*	1	1
Dictyochophyceae	Dictyochales	Dictyochaceae	*Dictyota papenfussii*		1
Porifera					
Calcarea	Leucosolenida	Sycettidae	*Sycon* cf. *ornatum*	1	1

[*] 1 = Present, Blank = Absent

Table 11: Cryptogenic category 1 (C1) and category 2 (C2) marine taxa recorded from the Gulf Harbour Marina in the first (T1) and second (T2) surveys.

Major taxonomic group, Class	Order	Family	Taxon name	Status	T1*	T2*
Annelida						
Polychaeta	Phyllodocida	Phyllodocidae	*Eumida Eumida-C*	C2		1
Polychaeta	Phyllodocida	Syllidae	*Typosyllis Typosyllis-B*	C2	1	
Polychaeta	Phyllodocida	Polynoidae	*Lepidonotus lepidonotus-C*	C2		1
Polychaeta	Sabellida	Sabellidae	*Demonax Demonax-B*	C2	1	
Polychaeta	Sabellida	Serpulidae	*Serpula Serpula-D*	C2	1	
Polychaeta	Scolecida	Capitellidae	*Notomastus Notomastus-A*	C2		1
Polychaeta	Spionida	Chaetopteridae	*Chaetopterus chaetopterus-A*	C1	1	
Polychaeta	Terebellida	Cirratulidae	*Cirratulus Cirratulus-A*	C2	1	
Polychaeta	Terebellida	Terebellidae	*Terebella Terebella-B*	C2	1	
Arthropoda						
Malacostraca	Amphipoda	Aoridae	*Aora typical*	C1	1	
Malacostraca	Amphipoda	Leucothoidae	*Leucothoe* sp. 1	C2	1	
Chordata						
Ascidiacea	Enterogona	Rhodosomatidae	*Corella eumyota*	C1	1	1
Ascidiacea	Enterogona	Didemnidae	*Didemnum* sp.	C1		1
Ascidiacea	Enterogona	Holozoidae	*Distaplia* sp.	C2	1	
Ascidiacea	Pleurogona	Botryllinae	*Botrylloides leachi*	C1	1	1
Ascidiacea	Pleurogona	Pyuridae	*Microcosmus australis*	C1	1	
Ascidiacea	Pleurogona	Pyuridae	*Microcosmus squamiger*	C1	1	1
Ascidiacea	Pleurogona	Styelidae	*Asterocarpa humilis*	C1	1	
Ascidiacea	Pleurogona	Styelidae	*Styela plicata*	C1	1	1
Ascidiacea	Pleurogona	Styelidae	*Botryllus schlosseri*	C1		1
Myzozoa						
Dinophyceae	Gymnodiniales	Gymnodiniaceae	*Gymnodinium catenatum*	C1	1	1
Porifera						
Demospongiae	Halichondrida	Halichondriidae	*Halichondria new* sp. 4	C2		1
Demospongiae	Halichondrida	Halichondriidae	*Halichondria new* sp. 1	C2		1
Demospongiae	Haplosclerida	Chalinidae	*Haliclona heterofibrosa*	C1	1	1

* 1 = Present, Blank = Absent

Table 12: Non-indigenous marine species recorded from the Gulf Harbour Marina during the first (T1) and second (T2) baseline surveys. Likely vectors of introduction are largely derived from Cranfield *et al*. (1998), where H = Hull fouling and B = Ballast water transport. For those species for which information is scarce, we provide dates of first detection rather than probable dates of introduction.

Phylum, Class	Order	Family	Taxon name	Date of first record or introduction	Method of intro	T1*	T2*
Annelida							
Polychaeta	Sabellida	Serpulidae	*Hydroides ezoensis*	April 2003	H	1	1
Polychaeta	Sabellida	Serpulidae	*Hydroides elegans*	Pre-1952	H or B	1	1
Polychaeta	Spionida	Spionidae	*Pseudopolydora corniculata*	Unknown[1]	H or B		1
Polychaeta	Spionida	Spionidae	*Pseudopolydora paucibranchiata*	Pre-1975	H or B		1
Arthropoda							
Malacostraca	Amphipoda	Corophiidae	*Apocorophium acutum*	Pre-1921	H	1	1
Malacostraca	Amphipoda	Corophiidae	*Monocorophium acherusicum*	Pre-1921	H		1
Malacostraca	Amphipoda	Ischyroceridae	*Ericthonius pugnax*	1914	H	1	
Maxillopoda	Sessilia	Balanidae	*Amphibalanus amphitrite*	1960	H		1
Bryozoa							
Gymnolaemata	Cheilostomata	Bugulidae	*Bugula neritina*	Probably 1949	H	1	1
Gymnolaemata	Cheilostomata	Bugulidae	*Bugula stolonifera*	1962	H		1
Gymnolaemata	Cheilostomata	Schizoporellidae	*Schizoporella errata*	Pre-1960	H	1	1
Gymnolaemata	Cheilostomata	Watersiporidae	*Watersipora subtorquata*	Pre-1982	H or B	1	1
Gymnolaemata	Cheilostomata	Watersiporidae	*Watersipora arcuata*	Pre-1957	H		1
Gymnolaemata	Cheilostomata	Lepraliellidae	*Celleporaria aperta*	August 2005	unknown		1
Gymnolaemata	Cheilostomata	Scrupocellariidae	*Scrupocellaria* n. sp.	2006	H		1
Gymnolaemata	Ctenostomata	Vesiculariidae	*Bowerbankia gracilis*	Pre-1965	H or B		1
Gymnolaemata	Ctenostomata	Vesiculariidae	*Zoobotryon verticillatum*	1960	H or B	1	1
Chordata							
Ascidiacea	Enterogona	Ascidiidae	*Ascidiella aspersa*	1900s	H	1	1
Ascidiacea	Enterogona	Didemnidae	*Diplosoma listerianum*	Pre-1996	H		1

Phylum, Class	Order	Family	Taxon name	Date of first record or introduction	Method of intro	T1*	T2*
Ascidiacea	Pleurogona	Styelidae	*Styela clava*	November 2004	H		1
Mollusca							
Bivalvia	Mytiloida	Mytilidae	*Musculista senhousia*	1978	H or B		1
Bivalvia	Ostreoida	Ostreidae	*Crassostrea gigas*	1961	H	1	1
Bivalvia	Pterioida	Limidae	*Limaria orientalis*	Pre-1972	H or B	1	
Bivalvia	Veneroida	Semelidae	*Theora lubrica*	1971	B	1	1
Porifera							
Calcarea	Leucosolenida	Heteropiidae	*Vosmaeropsis* cf. *macera*	Unknown[1]	H	1	1
Ochrophyta							
Phaeophyceae	Cutleriales	Cutleriaceae	*Cutleria multifida*	Pre-1870	H	1	

* 1 = Present, Blank = Absent

[1] Date of introduction currently unknown but species had been encountered in New Zealand prior to the present survey.

Table 13: Indeterminate taxa recorded from the Gulf Harbour Marina in the first (T1) and second (T2) surveys. This group includes either organisms that were damaged or juvenile and lacked crucial morphological characteristics, or taxa for which there is not sufficient taxonomic or systematic information available to allow positive identification to species level.

Phylum, Class	Order	Family	Taxon name	T1*	T2*
Annelida					
Polychaeta	Phyllodocida	Polynoidae	*Harmothoe* Indet.	1	
Polychaeta	Phyllodocida	Syllidae	*Syllin*-unknown indet.	1	
Polychaeta	Sabellida	Sabellidae	Sabellidae Indet.	1	
Polychaeta	Sabellida	Serpulidae	Serpulidae Indet.	1	
Polychaeta	Sabellida	Serpulidae	*Hydroides* sp.		1
Polychaeta	Spionida	Spionidae	*Pseudopolydora* Indet.	1	
Polychaeta	Terebellida	Cirratulidae	Cirratulidae Indet.		1
Polychaeta	Terebellida	Terebellidae	Terebellidae Indet.	1	1
Arthropoda					
			Crustacea		1
Malacostraca	Amphipoda		Amphipoda Indet.		1
Malacostraca	Amphipoda	Aoridae	*Aora* sp.		1
Malacostraca	Decapoda		Decapoda Indet.		1
Malacostraca	Isopoda		Isopoda		1
Malacostraca	Isopoda	Cymothoidae	*Ceratothoa* sp.		1
Malacostraca	Tanaidacea		Tanaidacea		1
Maxillopoda	Tanaidacea		Maxillopoda Indet.		1
Ostracoda	Myodocopida		Myodocopida		1
Bryozoa					
			Bryozoa Indet.		1
Gymnolaemata	Cheilostomata	Crepidacanthidae	Crepidacanthidae		1
Gymnolaemata	Cheilostomata	Lepraliellidae	*Celleporaria* sp.		1
Chordata					
Actinopterygii			Actinopterygii		1
Actinopterygii	Perciformes	Gobiidae	*Eviota* sp.		1
Actinopterygii	Perciformes	Gobiidae	*Favonigobius* sp.	1	
Ascidiacea	Enterogona	Polyclinidae	*Synoicum* sp.		1
Ascidiacea	Enterogona	Didemnidae	*Diplosoma* sp.		1
Cnidaria					
Hydrozoa			Hydrozoa		1
Mollusca					
Gastropoda	Opisthobranchia		Opisthobranchia		1
Myzozoa					
Dinophyceae			Unidentifiable cyst		1
Dinophyceae	Gymnodiniales	Polykrikaceae	*Pheopolykrikos* sp.	1	
Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium* sp.	1	

Phylum, Class	Order	Family	Taxon name	T1*	T2*
Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium* sp. 1		1
Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium* sp. 22		1
Ochrophyta					
Phaeophyceae	Fucales	Sargassaceae	*Carpophyllum* sp.	1	
Phaeophyceae	Fucales	Sargassaceae	*Sargassum* sp.	1	
Phaeophyceae	Fucales	Cystoseiraceae	*Cystophora* sp.	1	1
Phaeophyceae	Ectocarpales	Scytosiphonaceae	*Colpomenia* sp.	1	1
Dictyochophyceae	Dictyochales	Dictyochaceae	*Dictyota* sp.		1
Rhodophyta					
Florideophyceae	Ceramiales	Rhodomelaceae	*Polysiphonia* sp.	1	1
Platyhelminthes					
			Platyhelminthes		1
Turbellaria	Polycladida	Leptoplanidae	*Stylochoplana* sp.		1
Turbellaria	Polycladida	Pseudoceritidae	*Pseudoceros* sp.		1

* 1 = Present, Blank = Absent

Table 14: Non-indigenous marine organisms recorded from the Gulf Harbour Marina survey and the techniques used to capture each species. Species distributions throughout the port and in other ports and marinas around New Zealand are indicated.

Taxon name	Capture techniques in the Gulf Harbour Marina	Locations detected in the Gulf Harbour Marina		Detected in other locations surveyed in ZBS2000_04, ZBS2005_18 & ZBS 2005_19
		First Survey	Second Survey	
Annelida				
Hydroides ezoensis	Pile scrape	Jetty C, Jetty J, Jetty L, SY	Jetty C, Jetty J, Jetty L	Opua, Westhaven Marina
Hydroides elegans	Pile scrape	Jetty C	Jetty C, Jetty J	Auckland, Viaduct Harbour, Westhaven Marina, Nelson
Pseudopolydora corniculata	Benthic sled		Jetty D & E	Whangarei Port
Pseudopolydora paucibranchiata	Benthic sled, benthic grab		Jetty F & G, Jetty I & J, Jetty G & H, Jetty Z & A, Jetty D & E, Jetty L & shore, Jetty C, Jetty B & C	Whangarei Port, Viaduct Harbour, Westhaven Marina, Gisborne
Arthropoda				
Apocorophium acutum	Pile scrape	Jetty C, Jetty L, Jetty J, SY	Jetty C, Jetty J, Jetty L, Jetty N & O	Opua, Whangarei Marina, Whangarei Port, Westhaven Marina, Auckland, Tauranga, Gisborne, Napier, Lyttelton, Timaru, Dunedin, Bluff
Monocorophium acherusicum	Pile scrape miscellaneous		Jetty N & O	Whangarei Marina, Tauranga, Gisborne, Wellington, Lyttelton, Timaru, Dunedin
Ericthonius pugnax	Pile scrape	Jetty C		
Amphibalanus amphitrite	Pile scrape		Jetty J	Westhaven Marina
Bryozoa				
Bugula neritina	Pile scrape, pile scrape miscellaneous	Jetty C, Jetty J, Jetty L, SY	Jetty C, Jetty J, Jetty N & O	Opua, Whangarei Marina, Whangarie Port, Auckland, Westhaven Marina, Tauranga, Gisborne, New Plymouth, Napier, Picton, Lyttelton, Timaru, Dunedin
Bugula stolonifera	Pile scrape, pile scrape miscellaneous		Jetty L, Jetty J, Jetty N & O	Opua, Whangarei Marina, Whangarei Port, Viaduct Harbour, Westhaven Marina, Gisborne, New Plymouth, Napier, Bluff
Schizoporella errata	Pile scrape, pile scrape miscellaneous	Jetty C, Jetty J, Jetty L, SY	Jetty C, Jetty J, Jetty L	Opua, Whangarei Port, Viaduct Marina, Westhaven Marina, Nelson,
Watersipora subtorquata	Pile scrape, benthic sled	Jetty C, Jetty J, Jetty L, SY	Jetty A & B, Jetty C, Jetty J, Jetty L, Jetty N & O	Opua, Whangarei Port, Westhaven Marina, Auckland, Tauranga, Gisborne, New Plymouth, Napier, Wellington,Picton, Nelson, Lyttelton,Timaru, Dunedin, Bluff
Watersipora arcuata	Pile scrape		Jetty C, Jetty N & O	Viaduct Harbour, New Plymouth, Napier
Celleporaria aperta	Pile scrape, pile scrape miscellaneous,		Jetty A & B, Jetty C, Jetty N & O	

Taxon name	Capture techniques in the Gulf Harbour Marina	Locations detected in the Gulf Harbour Marina		Detected in other locations surveyed in ZBS2000_04
		First Survey	Second Survey	ZBS2005_18 & ZBS 2005_19
	benthic sled			
Bowerbankia gracilis	Pile scrape		Jetty C, Jetty L	Opua, Whangarei Marina, Whangarei Port, Viaduct Harbour, Westhaven Marina, Gisborne, Napier
Zoobotryon verticillatum	Pile scrape, pile scrape miscellaneous, benthic sled	Jetty C, Jetty L	Jetty A & B, Jetty J, Jetty L, Jetty N & O	Whangarei Marina, Viaduct Harbour, Tauranga,
Chordata				
Ascidiella aspersa	Pile scrape, pile scrape miscellaneous	Jetty C, Jetty L	Jetty C, Jetty J, Jetty L, Jetty N & O	Viaduct Harbour, Westhaven Marina, Gisborne, Napier, Lyttelton, Dunedin, Bluff
Diplosoma listerianum	Pile scrape		Jetty L	Whangarei Port, Viaduct Harbour, Westhaven Marina, Auckland, Tauranga, Taharoa, Gisborne, New Plymouth, Napier, Lyttelton, Dunedin, Bluff
Styela clava	Pile scrape miscellaneous		Jetty C, Jetty N & O	Viaduct Harbour, Westhaven Marina, Auckland, Lyttelton
Mollusca				
Musculista senhousia	Benthic sled		Channel 1, Jetty J & K	Opua, Whangarei Marina, Whangarei Port, Westhaven Marina
Crassostrea gigas	Pile scrape	Jetty C, Jetty L, Jetty J, SY	Jetty C, Jetty J, Jetty L	Opua, Whangarei Marina, Whangarei Port, Westhaven Marina, Auckland, New Plymouth, Nelson, Dunedin
Limaria orientalis	Pile scrape	Jetty C		Opua, Whangarei Port, Viaduct Harbour, Auckland
Theora lubrica	Pile scrape, benthic sled, benthic grab	Jetty A & B, Jetty B & C, Jetty C, Jetty C & D, Channel 1, Channel 2, Channel 3, Channel 4, Jetty D & E, Jetty E & F, Jetty F & G, Jetty G & H, Jetty H & I, Jetty I & J, Jetty J & K, Jetty K & L, Jetty L & shore	Jetty A & B, Jetty B & C, Jetty C, Jetty C & D, Channel 1, Channel 2, Channel 3, Channel 4, Jetty D & E, Jetty E & F, Jetty F & G, Jetty G & H, Jetty H & I, Jetty I & J, Jetty J & K, Jetty K & L, Jetty L	Opua, Whangarei Marina, Whangarei Port, Viaduct Harbour, Westhaven Marina, Auckland, Gisborne, New Plymouth, Napier, Wellington, Picton, Nelson, Lyttelton
Porifera				
Vosmaeropsis cf. macera	Pile scrape	Jetty J	Jetty C	Whangarei Port
Ochrophyta				
Cutleria multifida	Pile scrape	Jetty J		Dunedin

Table 15: Depth class and method of collection for each NIS and C1 taxon collected during the second Gulf Harbour Marina survey. Data are numbers of samples each species occurred in.

Species	Biosecurity Status	Method *	0 - 3 m	> 3 - 6 m	> 6 - 9 m	> 9 - 12 m	Total
Apocorophium acutum	NIS	PSC	2	5			**7**
Botrylloides leachi	C1	PSC	1	4			**5**
Bowerbankia gracilis	NIS	PSC		5			**5**
Bugula neritina	NIS	PSC	2	1			**3**
		PSCM		1			**1**
Bugula stolonifera	NIS	PSC	1	4			**5**
		PSCM		1			**1**
Corella eumyota	C1	PSC		1			**1**
Crassostrea gigas	NIS	PSC	2	7			**9**
Hydroides ezoensis	NIS	PSC		7			**7**
Microcosmus squamiger	C1	PSC	2	14			**16**
Schizoporella errata	NIS	PSC	1	7			**8**
Styela plicata	C1	PSC		8			**8**
		PSCM		1			**1**
Theora lubrica	NIS	BSLD		17			**17**
		PSC		1			**1**
		BGRB	3	3			**6**
Watersipora subtorquata	NIS	BSLD		1			**1**
		PSC	7	17			**24**
Ascidiella aspersa	NIS	PSC	2	3			**5**
		PSCM		1			**1**
Didemnum sp.	C1	PSC		1			**1**
Diplosoma listerianum	NIS	PSC		1			**1**
Amphibalanus amphitrite	NIS	PSC	1	1			**2**
Botryllus schlosseri	C1	PSC		2			**2**
Celleporaria aperta	NIS	BSLD		1			**1**
		PSC		5			**5**
		PSCM		1			**1**
Gymnodinium catenatum	C1	CYST		2			**2**
Haliclona heterofibrosa	C1	PSC		2			**2**
Hydroides elegans	NIS	PSC		5			**5**
Monocorophium acherusicum	NIS	PSCM		1			**1**
Musculista senhousia	NIS	BSLD		2			**2**
Pseudopolydora corniculata	NIS	BSLD		1			**1**
Pseudopolydora paucibranchiata	NIS	BSLD		7			**7**
		BGRB	1				**1**
Styela clava	NIS	PSCM		3			**3**
Vosmaeropsis cf. macera	NIS	PSC		1			**1**
Watersipora arcuata	NIS	PSC		4			**4**
Zoobotryon verticillatum	NIS	BSLD		1			**1**
		PSC	1	4			**5**
		PSCM		1			**1**
Total number of NIS & C1 specimens			**26**	**156**	**0**	**0**	**182**
Proportion of all NIS & C1 specimens (%)			**14.3**	**85.7**	**0**	**0**	**100**
Total number of NIS & C1 taxa			**13**	**30**	**0**	**0**	**30**
Proportion of all NIS & C1 taxa (%)			**43.3**	**100.0**	**0**	**0**	**#**

* Survey methods: BGRB = benthic grab; BSLD = benthic sled; CYST = dinoflagellate cyst core; CRBTP = crab trap; FSHTP = fish trap; SHRTP = shrimp trap; STFTP = seastar trap; PSC = piling quadrat scrapings; VISS = opportunistic visual search.

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

Table 16: Depth class and method of collection for each native species collected during the second Gulf Harbour Marina survey. Data are numbers of samples each species occurred in.

Species	Method *	0 - 3 m	> 3 - 6 m	> 6 - 9 m	> 9 - 12 m	Total
Actinothoe albens	PSC		3			**3**
Aglaophamus verrilli	BGRB	1				**1**
	BSLD		1			**1**
Aldrichetta forsteri	FSHTP		1			**1**
Alpheus richardsoni	BGRB		1			**1**
	BSLD		1			**1**
Aora maculata	PSC		1			**1**
Aplidium phortax	PSC		3			**3**
Balanus trigonus	PSC	4	14			**18**
	PSCM		1			**1**
Boccardia syrtis	BGRB	4	1			**5**
	BSLD		5			**5**
Branchiomma curtum	BSLD		1			**1**
Carpophyllum maschalocarpum	BSLD		1			**1**
Cnemidocarpa nisiotis	PSC	2	3			**5**
Cominella adspersa	BSLD		2			**2**
Crepidula costata	PSC		8			**8**
Culicia rubeola	PSC		2			**2**
Cystophora scalaris	BSLD		1			**1**
Demonax aberrans	PSC	1	3			**4**
Dictyota dichotoma	PSC		1			**1**
Dictyota papenfussii	PSC		1			**1**
Echinocardium cordatum	BSLD		10			**10**
Ecklonia radiata	BSLD		1			**1**
Euclymene insecta	BSLD		1			**1**
Eulalia NIWA-2	PSC	1				**1**
Flabelligera affinis	PSC		1			**1**
Glycera lamelliformis	BSLD		1			**1**
Glycinde trifida	BSLD		2			**2**
Halicarcinus cookii	PSC		1			**1**
Halicarcinus varius	BSLD		7			**7**
	PSC		5			**5**
Halicarcinus whitei	BSLD		1			**1**
Harmothoe macrolepidota	PSC	4	10			**14**
Hippolyte bifidirostris	BSLD		1			**1**
Hyboscolex longiseta	BSLD		1			**1**
	PSC		1			**1**
Irus reflexus	PSC	1				**1**
Labiosthenolepis laevis	BSLD		10			**10**
Lepidastheniella comma	PSC	2				**2**
Lepidonotus polychromus	BSLD		1			**1**
	PSC		2			**2**
Leucothoe trailli	PSC	1	1			**2**
Lingulodinium polyedrum	CYST		2	1		**3**
Lumbrineris sphaerocephala	PSC	2	4			**6**
Modiolarca impacta	PSC		1			**1**
Molgula mortenseni	PSC		5			**5**
	PSCM		1			**1**
Neanthes cricognatha	BSLD		1			**1**
Neanthes kerguelensis	PSC	3	7			**10**
Neohymenicus pubescens	PSC		2			**2**
Nereis falcaria	PSC		3			**3**
Notomithrax minor	BSLD		1			**1**
	PSC	1	3			**4**

Species	Method *	0 - 3 m	> 3 - 6 m	> 6 - 9 m	> 9 - 12 m	Total
	PSCM		1			**1**
Nucula hartvigiana	BGRB	2				**2**
	BSLD		13			**13**
Ophiodromus angustifrons	BSLD		1			**1**
	PSC	1				**1**
Pagrus auratus	CRBTP		1			**1**
Paguristes pilosus	BSLD		1			**1**
Paguristes setosus	BSLD		1			**1**
Patiriella regularis	BSLD		2			**2**
	CRBTP		1			**1**
	PSC		3			**3**
	STFTP		3			**3**
Pectinaria australis	BSLD		13			**13**
Periclimenes yaldwyni	BSLD		1			**1**
Perinereis camiguinoides	PSC		4			**4**
Perinereis pseudocamiguina	PSC		1			**1**
Perna canaliculus	PSC	1	5			**6**
	PSCM		1			**1**
Petrolisthes novaezelandiae	PSC		2			**2**
Philocheras australis	BSLD		2			**2**
Philocheras cf. *australis*	BSLD		1			**1**
Phylo novazealandiae	BGRB	4	1			**5**
	BSLD		1			**1**
Pilumnopeus serratifrons	PSC	4	5			**9**
Pilumnus novaezelandiae	PSC		1			**1**
	PSC		2			**2**
Platynereis Platynereis_australis_group	PSCM		1			**1**
Protocirrineris nuchalis	PSC		1			**1**
Pseudopista rostrata	PSC		4			**4**
Pseudopotamilla laciniosa	PSC		1			**1**
Pyura rugata	PSC	5	18			**23**
Salmacina australis	PSC		1			**1**
Sargassum scabridum	BSLD		1			**1**
	PSC		2			**2**
Scrippsiella trochoidea	CYST			1		**1**
Sigapatella novaezelandiae	PSC		1			**1**
Spirobranchus cariniferus	PSC		3			**3**
Streblosoma toddae	PSC		3			**3**
	PSCM		1			**1**
Sycon cf. ornatum	PSC	1	2			**3**
Terebella plagiostoma	PSC	4	3			**7**
	PSCM		1			**1**
Torridoharpinia hurleyi	BSLD		7			**7**
Trachurus novaezelandiae	FSHTP		1			**1**
Zeuxo n. sp. NZ 1	PSC		2			**2**
Total number of native specimens		**49**	**264**	**2**	**0**	**315**
Proportion of all native specimens (%)		**15.6**	**83.8**	**0.6**	**0**	**100**
Total number of native taxa		**19**	**72**	**2**	**0**	**78**
Proportion of all native taxa (%)		**24.4**	**92.3**	**2.6**	**0.0**	**#**

* Survey methods: BGRB = benthic grab; BSLD = benthic sled; CYST = dinoflagellate cyst core; CRBTP = crab trap; FSHTP = fish trap; SHRTP = shrimp trap; STFTP = seastar trap; PSC = piling quadrat scrapings; VISS = opportunistic visual search.
\# The proportion of taxa in each depth class sums to greater than 100%, as some taxa were recorded from more than one depth class

Table 17: Summary statistics for taxon assemblages collected in Gulf Harbour Marina using three different methods, and similarity indices comparing assemblages between the first and second surveys. See "Definitions of species categories" for definitions of Native, C1, C2 and NIS taxa.

	No. of samples in first survey	No. of samples in second survey	No. of taxa in first survey	No. of taxa in second survey	No. (%) of taxa shared between surveys	No. of taxa in first survey only	No. of taxa in second survey only	No. (%) of taxa in only one sample in first survey	No. (%) of taxa in only one sample in second survey	Chao Shared Estimated	Jaccard Classic	Sorensen Classic	Chao-Jaccard-Est Incidence -based	Chao-Sorensen -Est Incidence -based
Pile scrape quadrats														
Native	64	64	56	46	30 (42 %)	26	16	21 (38 %)	17 (37 %)	42.358	0.417	0.588	0.874	0.933
C2	64	64	7	3	0 (0 %)	7	3	4 (57 %)	2 (67 %)	0	0	0	0	0
NIS & C1	64	64	22	25	15 (47 %)	7	10	8 (36 %)	6 (24 %)	20.644	0.469	0.638	0.848	0.918
Benthic sleds														
Native, C2, NIS & C1 taxa combined	17	17	16	41	10 (21 %)	6	31	7 (44 %)	27 (66 %)	29.65	0.213	0.351	0.599	0.75
Benthic grabs														
Native, C2, NIS & C1 taxa combined	12	12	8	7	4 (36 %)	4	3	5 (63 %)	3 (43 %)	5.893	0.364	0.533	0.631	0.773

Appendices

Appendix 1: Geographic locations of sample sites in the Gulf Harbour Marina second baseline survey (NZGD49)

Site	Easting	Northing	Survey Method*	Number of sample units
Jetty L	2670425	6507695	STFTP	2
Jetty L	2670425	6507695	CRBTP	2
Jetty L	2670425	6507695	SHRTP	2
Jetty L	2670449	6507702	STFTP	2
Jetty L	2670449	6507702	CRBTP	2
Jetty L	2670449	6507702	SHRTP	2
Jetty J	2670363	6507609	STFTP	2
Jetty J	2670363	6507609	CRBTP	2
Jetty J	2670363	6507609	SHRTP	2
Jetty J	2670441	6507567	STFTP	2
Jetty J	2670441	6507567	CRBTP	2
Jetty J	2670441	6507567	SHRTP	2
Jetty N & O	2670681	6507322	STFTP	2
Jetty N & O	2670681	6507322	CRBTP	2
Jetty N & O	2670681	6507322	SHRTP	2
Jetty N & O	2670606	6507360	STFTP	2
Jetty N & O	2670606	6507360	CRBTP	2
Jetty N & O	2670606	6507360	SHRTP	2
Jetty C	2670236	6507290	STFTP	2
Jetty C	2670236	6507290	CRBTP	2
Jetty C	2670236	6507290	SHRTP	2
Jetty C	2670386	6507215	STFTP	2
Jetty C	2670386	6507215	CRBTP	2
Jetty C	2670386	6507215	SHRTP	2
Jetty J	2670371	6507599	FSHTP	2
Jetty J	2670425	6507572	FSHTP	2
Jetty L	2670387	6507684	FSHTP	2
Jetty L	2670441	6507656	FSHTP	2
Jetty C	2670247	6507278	FSHTP	2
Jetty C	2670301	6507226	FSHTP	2
Jetty N & O	2670690	6507323	FSHTP	2
Jetty N & O	2670574	6507348	FSHTP	2
Channel 1	2670317	6506837	BSLD	1
Channel 2	2670428	6507064	BSLD	1
Channel 4	2670503	6507248	BSLD	1
Channel 3	2670573	6507357	BSLD	1
Jetty B & C	2670322	6507202	BSLD	1
Jetty C & D	2670402	6507228	BSLD	1
Jetty D & E	2670383	6507285	BSLD	1
Jetty E & F	2670442	6507308	BSLD	1
Jetty F & G	2670476	6507359	BSLD	1
Jetty G & H	2670506	6507394	BSLD	1
Jetty H & I	2670519	6507440	BSLD	1
Jetty I & J	2670520	6507492	BSLD	1
Jetty J & K	2670536	6507532	BSLD	1

Site	Easting	Northing	Survey Method*	Number of sample units
Jetty K & L	2670539	6507576	BSLD	1
Jetty L & shore	2670547	6507619	BSLD	1
Jetty A & B	2670375	6507110	BSLD	1
Jetty Z & A	2670332	6507053	BSLD	1
Jetty C	2670260	6507293	BGRB	1
Jetty C	2670258	6507299	BGRB	1
Jetty C	2670255	6507297	BGRB	1
Jetty J	2670372	6507619	BGRB	1
Jetty J	2670373	6507626	BGRB	1
Jetty J	2670375	6507620	BGRB	1
Jetty L	2670413	6507695	BGRB	1
Jetty L	2670405	6507694	BGRB	1
Jetty L	2670410	6507694	BGRB	1
Jetty N & O	2670714	6507401	BGRB	1
Jetty N & O	2670717	6507400	BGRB	1
Jetty N & O	2670721	6507402	BGRB	1
Jetty C	2670383	6507217	PSC	16
Jetty C	2670383	6507217	PSCM	1
Jetty J	2670511	6507519	PSC	16
Jetty L	2670425	6507653	PSC	16
Jetty N & O	2670640	6507343	PSC	16
Jetty N & O	2670640	6507343	PSCM	2
Crab Cove	2670408	6506965	CYST	2
Jetty C	2670425	6507212	CYST	2
Jetty N & O	2670657	6507472	CYST	2
Jetty J	2670560	6507524	CYST	2
Jetty L	2670562	6507624	CYST	2
Jetty C	2670260	6507293	SEDIMENT	1
Jetty J	2670372	6507619	SEDIMENT	1
Jetty L	2670413	6507695	SEDIMENT	1
Jetty N & O	2670714	6507401	SEDIMENT	1
Jetty L	2670425	6507653	VISS	1
Jetty B	2670322	6507202	VISS	1
Jetty C	2670383	6507217	VISS	1
Jetty F	2670442	6507308	VISS	1
Jetty J	2670511	6507519	VISS	1

*Survey methods: PSC = pile scrape quadrats and diver observations on wharf pilings, BSLD = benthic sled, BGRB = benthic grab, CYST = dinoflagellate cyst core, CRBTP = crab trap, FSHTP = fish trap, STFTP = seastar trap, SHRTP = shrimp trap, PSCM = pile scrape miscellaneous, VISS = opportunistic land visual search, SEDIMENT = sediment sample

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

Phylum Annelida

Polychaetes: The polychaetes are the largest group of marine worms and are closely related to the earthworms and leeches found on land. Polychaetes are widely distributed in the marine environment and are commonly found under stones and rocks, buried in the sediment or attached to submerged natural and artificial surfaces including rocks, pilings, ropes and the shells or carapaces of other species. All polychaete worms have visible legs or bristles 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.

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

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

Appendix 3a: **Results from the pile scraping quadrats.**

Appendix 3b: **Results from the benthic grab samples.**

Appendix 3c: **Results from the benthic sled samples.**

Appendix 3d: **Results from the dinoflagellate cyst core samples.**

Appendix 3e: **Results from the fish trap samples.**

Appendix 3f: **Results from the crab trap samples.**

Appendix 3g: **Results from the seastar trap samples.**

Appendix 3h: **Results from the miscellaneous qualitative search samples.**

Appendix 4: Chapman and Carlton criteria applicable to each non-indigenous and C1 taxon recorded from the Gulf Harbour Marina.

Chapman and Carlton's (1994) nine criteria (C1 – C9) were assessed for each non-indigenous and cryptogenic category 1 taxon recorded from the Gulf Harbour Marina. Criteria that apply to each species are indicated with a "Yes" or another comment. Cranfield *et al*'s (1998) analysis was used for species previously known from New Zealand waters. For non-indigenous species that were first detected in New Zealand since the publication of that report, criteria were assigned using advice from the taxonomists that identified them.

Taxon name	Bio-security Status	C1: Has the species suddenly appeared locally where it has not been found before?	C2: Has the species spread subsequently?	C3: Is the species' distribution associated with human mechanisms of dispersal?	C4: Is the species associated with, or dependent on, other introduced species?	C5: Is the species prevalent in, or restricted to, new or artificial environments?	C6: Is the species' distribution restricted compared to natives?	C7: Does the species have a disjunct worldwide distribution?	C8: Are dispersal mechanisms of the species inadequate to reach New Zealand, and is passive dispersal in ocean currents unlikely to bridge ocean gaps to reach NZ?	C9: Is the species isolated from the genetically and morphologically most similar species elsewhere in the world?
Annelida										
Hydroides ezoensis	NIS	Yes		Yes		Yes	Yes	Yes	Yes	Yes
Hydroides elegans	NIS	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudopolydora corniculata	NIS	Yes		Yes		Yes	Yes	Yes	Yes	Yes
Pseudopolydora paucibranchiata	NIS	Yes		Yes		Yes	Yes	Yes	Yes	Yes
Arthropoda										
Apocorophium acutum	NIS			Yes			Yes		Yes	Yes
Monocorophium acherusicum	NIS			Yes		Yes	Yes		Yes	Yes
Amphibalanus amphitrite	NIS	Yes		Yes		Yes	Yes	Yes	Yes	

Taxon name	Bio-security Status	C1: Has the species suddenly appeared locally where it has not been found before?	C2: Has the species spread subsequently?	C3: Is the species' distribution associated with human mechanisms of dispersal?	C4: Is the species associated with, or dependent on, other introduced species?	C5: Is the species prevalent in, or restricted to, new or artificial environments?	C6: Is the species' distribution restricted compared to natives?	C7: Does the species have a disjunct worldwide distribution?	C8: Are dispersal mechanisms of the species inadequate to reach New Zealand, and is passive dispersal in ocean currents unlikely to bridge ocean gaps to reach NZ?	C9: Is the species isolated from the genetically and morphologically most similar species elsewhere in the world?
Bryozoa										
Bugula neritina	NIS	Yes		Yes		Yes	Yes	Yes	Yes	Yes
Bugula stolonifera	NIS	Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes
Schizoporella errata	NIS	Yes	Yes	Yes			Yes	Yes	Yes	
Watersipora subtorquata	NIS	Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes
Watersipora arcuata	NIS	Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes
Celleporaria aperta	NIS	Yes		Yes		Yes	Yes	Yes	Yes	Yes
Bowerbankia gracilis	NIS	Yes	Yes	Yes		Yes	Yes	Yes	Yes	
Zoobotryon verticillatum	NIS	Yes	Yes			Yes	Yes	Yes	Yes	Yes
Chordata										
Ascidiella aspersa	NIS	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Botrylloides leachi	C1	Yes	Yes	Yes		Yes	Yes	Yes	Yes	

Taxon name	Bio-security Status	C1: Has the species suddenly appeared locally where it has not been found before?	C2: Has the species spread subsequently?	C3: Is the species' distribution associated with human mechanisms of dispersal?	C4: Is the species associated with, or dependent on, other introduced species?	C5: Is the species prevalent in, or restricted to, new or artificial environments?	C6: Is the species' distribution restricted compared to natives?	C7: Does the species have a disjunct worldwide distribution?	C8: Are dispersal mechanisms of the species inadequate to reach New Zealand, and is passive dispersal in ocean currents unlikely to bridge ocean gaps to reach NZ?	C9: Is the species isolated from the genetically and morphologically most similar species elsewhere in the world?
Botryllus schlosseri	C1		Unknown, there is no published data to support subsequent spread or indeed time of introduction.	Possibly because it is particularly associated with artificial structures and boat hulls, but no published studies to support a 'Yes ' answer	Perhaps	Yes	The information on biogeograp-hy of NZ ascidians is fragmented at best, it is impossible to answer this question	Yes	Yes	
Corella eumyota	C1	Yes	Yes	Yes		Yes		Yes	Yes	
Didemnum sp.	C1	Unable to assess criteria for the genus as a whole.								
Diplosoma listerianum	NIS	Yes	Yes	Yes		Yes	Yes	Yes	Yes	
Microcosmus squamiger	C1	Unknown	Unknown, there is no published data to support subsequent spread or indeed time of introduction.	Associated with artificial structures and boat hulls, but insufficient information to be certain			Unknown	Yes	Unknown	Unknown

Taxon name	Bio-security Status	C1: Has the species suddenly appeared locally where it has not been found before?	C2: Has the species spread subsequently?	C3: Is the species' distribution associated with human mechanisms of dispersal?	C4: Is the species associated with, or dependent on, other introduced species?	C5: Is the species prevalent in, or restricted to, new or artificial environments?	C6: Is the species' distribution restricted compared to natives?	C7: Does the species have a disjunct worldwide distribution?	C8: Are dispersal mechanisms of the species inadequate to reach New Zealand, and is passive dispersal in ocean currents unlikely to bridge ocean gaps to reach NZ?	C9: Is the species isolated from the genetically and morphologica lly most similar species elsewhere in the world?
Styela clava	NIS	Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes
Styela plicata	C1	Yes	Yes	Yes		Yes	Yes	Yes	Yes	
Mollusca										
Musculista senhousia	NIS	Yes	Yes	Yes			Yes	Yes	Yes	Yes
Crassostrea gigas	NIS	Yes	Yes	Yes			Yes	Yes	Yes	Yes
Theora lubrica	NIS	Yes	Yes			Yes	Yes	Yes	Yes	Yes
Myzozoa										
Gymnodinium catenatum	C1	Yes	Yes							
Porifera										
Haliclona heterofibrosa	C1		Early collections in these locaitons were not at all comprehensive and the species could have been overlooked	Perhaps				Yes	unlikely (short-lived viviparous larvae)	unknown
Vosmaeropsis cf. macera	NIS	Yes				Yes		Yes	Yes	Yes