Westhaven Marina

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

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Executive summary

- This report describes the results of a baseline survey of the Westhaven Marina undertaken in March 2006. The survey provides an inventory of native, non indigenous and cryptogenic marine species within the marina.

- 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.

- Sampling methods used in the survey 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 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 Westhaven 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 Westhaven 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.

- During the survey, 203 species or higher taxa were recorded, including 109 native species, 27 non-indigenous species, 20 cryptogenic taxa and 47 indeterminate taxa.

- The 27 non-indigenous species found in the survey of Westhaven Marina included representatives of 16 phyla. The non-indigenous species detected were: (Annelida) *Pseudopolydora paucibranchiata*; *Hydroides ezoensis, Hydroides elegans, Polydora hoplura, Pseudopolydora paucibranchiata* and *Paralepidonotus ampulliferus* (Arthropoda) *Apocorophium acutum, Charybdis japonica* and *Amphibalanus amphitrite*; (Bryozoa) *Bugula flabellata, B. neritina, B. stolonifera, Bowerbankia gracilis, Schizoporella errata, Watersipora subtorquata, Tricellaria catalinensis, and Zoobotryon verticillatum*, (Chordata) *Ascidiella aspersa, Diplosoma listerianum, Botryllus tuberatus and Styela clava* (Cnidaria) *Pennaria disticha*, (Mollusca) *Musculista senhousia*, *Crassostrea gigas, Theora lubrica*; (Ochrophyta) *Undaria pinnatifida*, and (Porifera) *Vosmaeropsis* cf. *macera* and *Amphilectus fucorum*.

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

- Two species recorded during the survey of Westhaven Marina – the Asian kelp *Undaria pinnatifida* and the clubbed ascidian *Styela clava* - were 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 56 % (15 of 27 species) of NIS recorded in the Westhaven baseline surveys are likely to have been introduced in biofouling assemblages on vessels, 4 % (one species) via ballast water, 33 % (9 species) could have been introduced by either ballast water or biofouling vectors and the method of introduction for 7 % (two species) is currently unknown.

- The predominance of species likely to have been introduced as biofouling in the introduced biota of the Westhaven baseline (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 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.

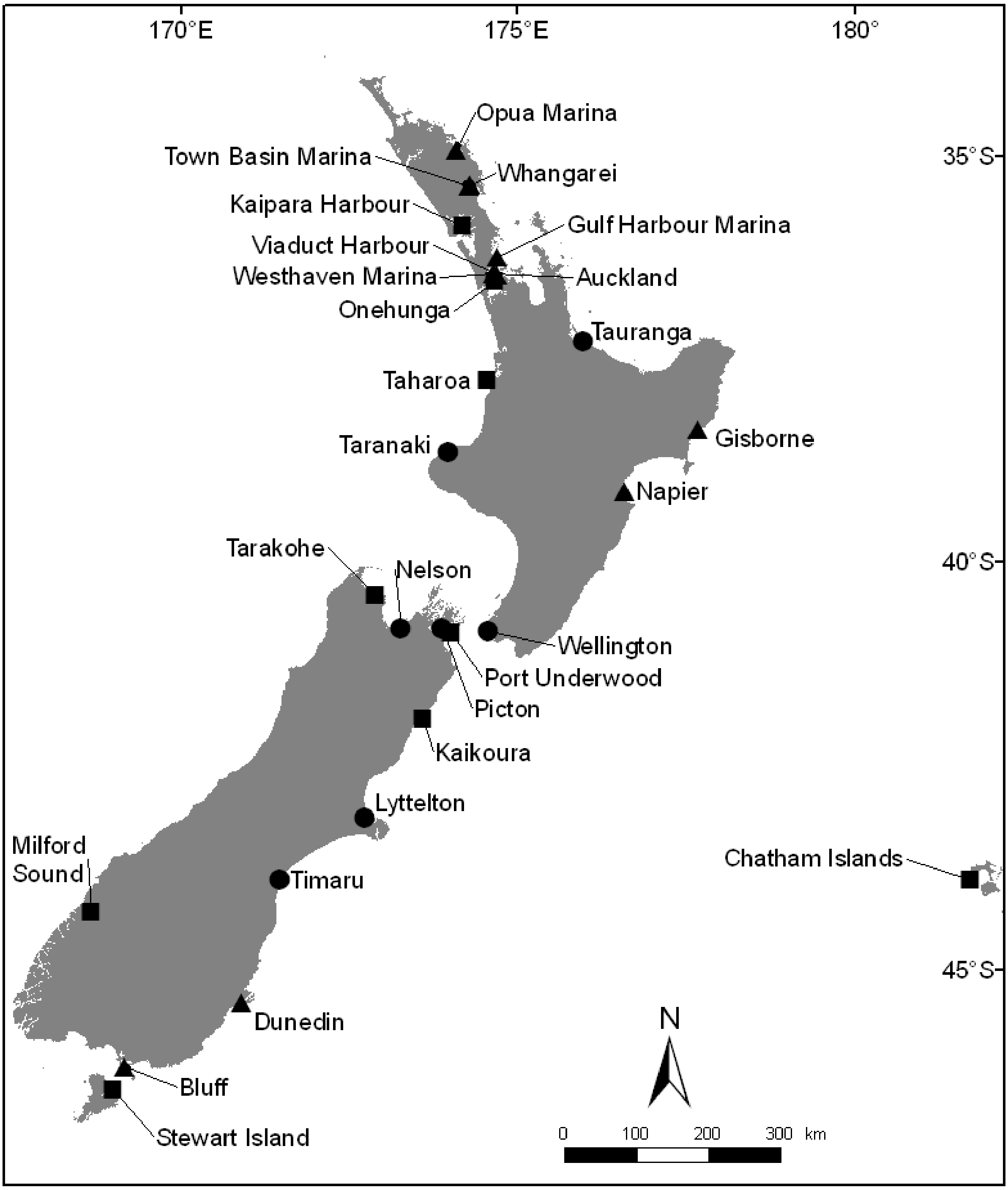

Figure 1: **Commercial shipping ports in New Zealand where baseline non-indigenous species surveys have been conducted. Group 1 ports (circles) were surveyed in the summer of 2001/2002 and resurveyed in the summer of 2004/2005, Group 2 ports (triangles) were surveyed in the summer of 2002/2003 and resurveyed 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 3 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 underestimated. 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 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.

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

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 nations (Hewitt and Martin 2001).

This report describes the results of the first baseline survey of the Westhaven Marina undertaken during March 2006. It provides an inventory of species recorded during the survey and their biogeographic status as either native, introduced ("non-indigenous") and cryptogenic. Organisms that could not be identified to species level are also listed as "indeterminate taxa" (see section "Definitions of species sctegories")

DESCRIPTION OF THE WESTHAVEN MARINA

General features

Westhaven Marina is one of the largest marinas in the southern hemisphere (Westhaven Marina 2007). Owned by the Auckland City Council, it is located on the southern shore of Waitemata Harbour (

Figure 2), a deeply embayed inlet of Hauraki Gulf (Thompson 1981) on the east coast of the North Island (Figure 1). Auckland city extends along the southern shoreline of Waitemata Harbour, and the cities of Takapuna, Birkenhead and Waitemata occupy the north shore. Waitemata Harbour occupies a drowned valley system with numerous ancillary tidal rivers and is connected to the Hauraki Gulf via the Rangitoto channel. The harbour is approximately 20 km long from North Head to the upper harbour bridge and varies in width from around 2 to 15 km. The Rangitoto channel curves south-west to enter the mouth of the harbour and then runs west for the length of Waitemata Harbour. Tidal currents help maintain water depths of around 15 m in this central channel.

The vast majority of the harbour area outside the Rangitoto channel is less than 5 m deep, with extensive areas such as Shoal Bay and Ngataringa Bay and most of the upper harbour being less than 2 m deep. The majority of the subtidal habitat in Waitemata Harbour is composed of mud and fine sand, with a few small areas of coarse sandy or shelly gravel near the centre of the harbour (Hayward 1997a). Muddy intertidal flats are common around the harbour with mangroves present on the flats towards the northwest end of the harbour. Rocky coastline exists on the northern entrance to the harbour around north head, and patches of rocky reef exist in the upper harbour extending north from Point Chevalier.

The waterspace at Westhaven Marina is bordered to the west, south and part of the north by reclaimed land (

Figure 3). Breakwaters are located to the north to protect the mooring sites (Westhaven Marina 2007). The marina has a total of 1,901 berths, with 1,517 fixed berths, 331 pile moorings and 53 swing moorings. Berths range in length from 8 to 30 m and draft within the marina averages 3 m MLWS (Russell Mathieson, Auckland City Marinas, pers. comm.). At the eastern end of Westhaven Marina is 'Z Pier', consisting of 40 marina berths used for the loading and unloading of commercial and charter vessels. Opposite this is the Z Pier Office Retail Development, built in 2002 (Westhaven Marina 2007). The remainder of the marina is used mainly by private recreational vessels. Details of the major berthing facilities are provided in

Table 1.

Also located within Waitemata Harbour is the Port of Auckland, the largest in the country with continuous wharves and jetties spanning over 2.5 km of coastline. The Royal New

Zealand Navy Dockyard is located immediately opposite the port, and Hobson West Marina and the Viaduct Harbour Marina are located adjacently.

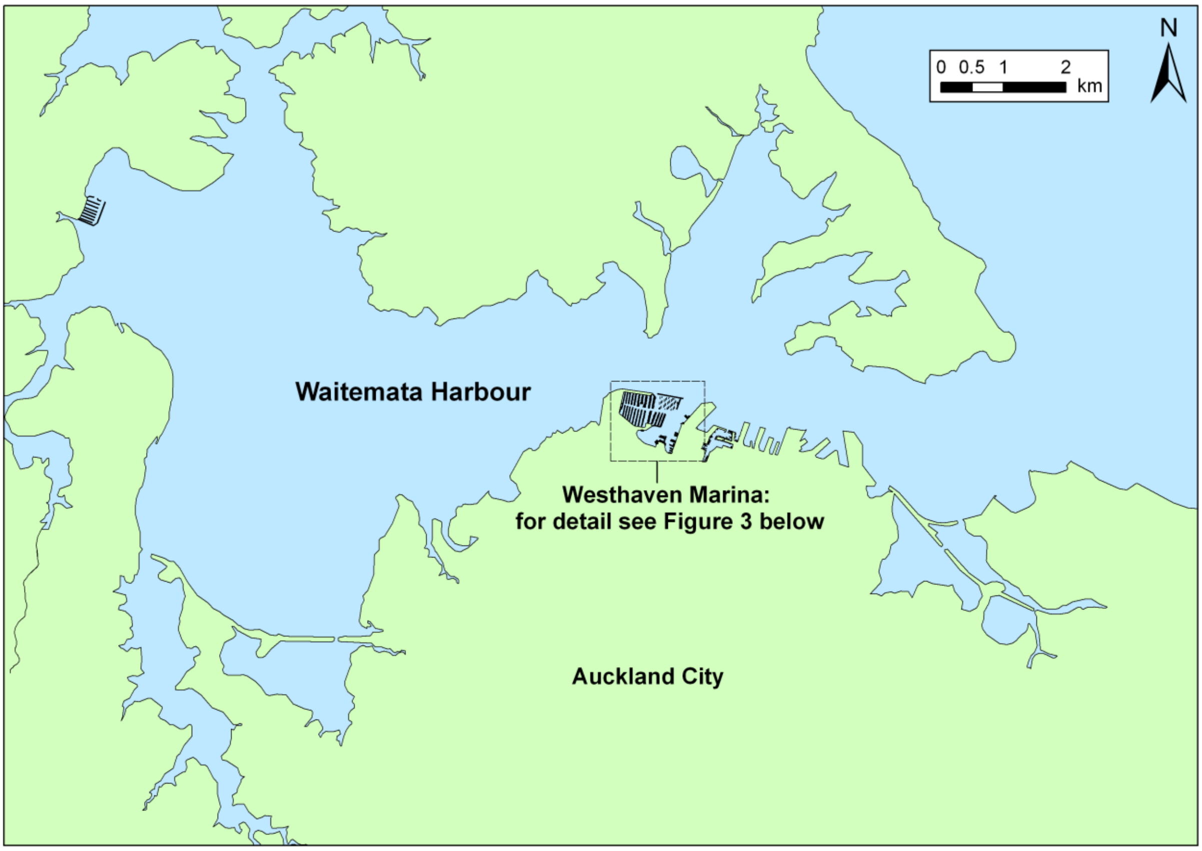

Figure 2: Waitemata Harbour showing the location of Westhaven Marina

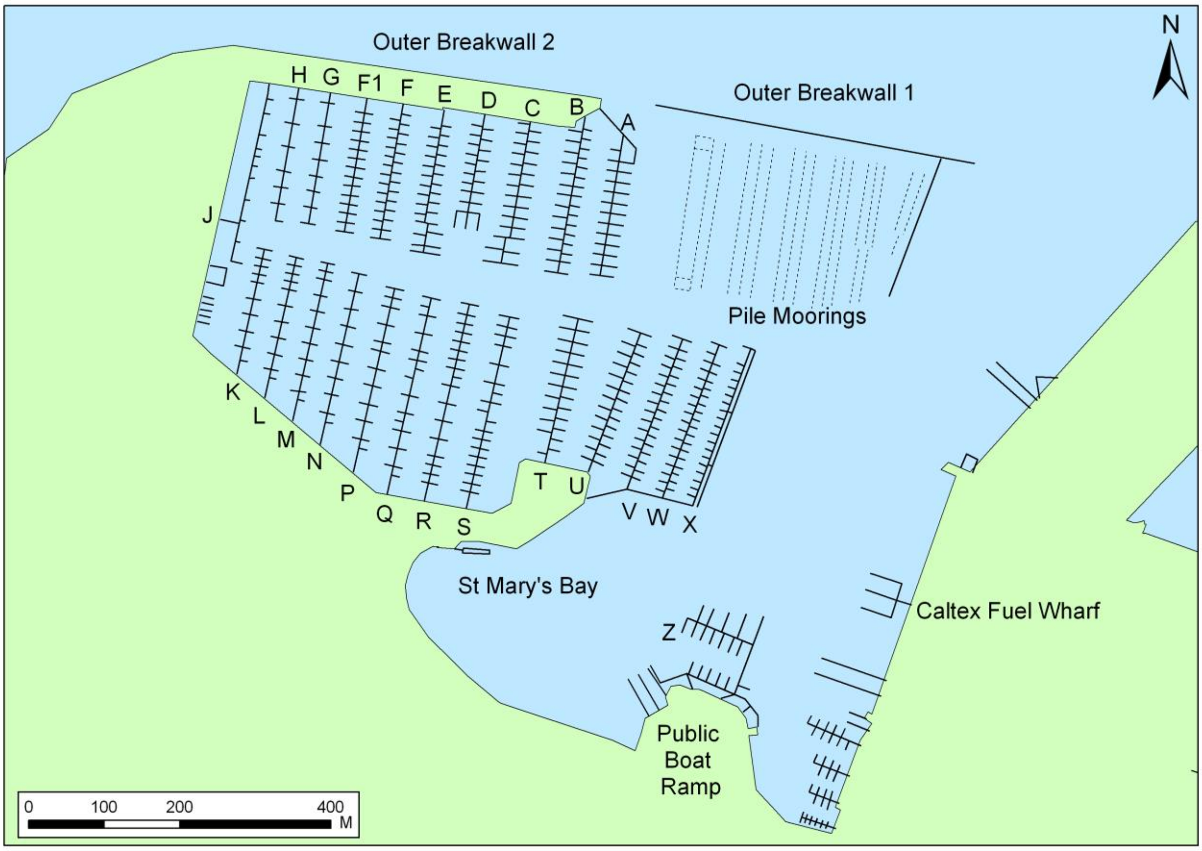

Figure 3: Westhaven Marina showing the location of the main jetties

Marina operation, development and maintenance activities

The Westhaven Marina basin was dredged to a depth of approximately 2-3 m in 1996 to deepen the main fairway. No on-going maintenance dredging is conducted and at present no further dredging works are being planned (Russell Mathieson, Auckland City Marinas, pers. comm.). The 1996 dredging resulted in 10,000 m^3 of spoil being removed. This was disposed of within the Ports of Auckland Axis terminal reclamation (Russell Mathieson, Auckland City Marinas, pers. comm.). The reclamation project carried out by Ports of Auckland involved 9.4 ha reclamation at the southeast corner of the Axis Fergussen container terminal to allow for increasing container handling and storage. This site is located approximately 4 km to the east of Westhaven Marina. Dredgings added to this reclamation were ‘mudcreted’ (mixed with concrete) before addition to the site.

Development plans currently include the replacement of pier ‘X’, which is located on the southern side of the Marina adjacent to the swing moorings. The pier, measuring 200 m by 5 m, will be replaced with a floating pontoon structure (Russell Mathieson, Auckland City Marinas, pers. comm.). A board walk has also been planned for improved public access, part of a series of future marina developments outlined by the Auckland City.

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.

Westhaven Marina, the largest marina in the southern hemisphere, is a major centre for international recreational vessels such as sailing yachts and motor launches. Vessels entering New Zealand waters at Auckland must first clear the Customs/MAF facility in Waitemata Harbour, after which many boats travel to a local marina for a few days (mainly Westhaven, Bayswater or the Viaduct Harbour marinas; O. Floerl, NIWA, pers. comm.). Most of the recreational vessels entering Westhaven Marina have no or little stored sea water on board. Therefore, discharge of international ballast water does generally not occur at the Westhaven Marina. The entire marina is a no-discharge area, including sewage, bilge and ballast water. However, the marina's proximity to the Port of Auckland means that propagules discharged in ballast water at the Port may be dispersed to the marina via local current.

The number of overseas yachts travelling to New Zealand has increased dramatically over the last three decades (Inglis and Floerl 2002). In 1998 and 2006, between 472 and 797 international yachts entered New Zealand per year (Floerl *et al*. 2008). 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. Most vessels entering New Zealand waters clear customs in Opua (annual average 1998-2007: 405 vessels), Whangarei (48 vessels) and Auckland (107 vessels) (Floerl *et al*. 2008). 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 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 vessels (domestic and international) to and from the Westhaven Marina occur mainly during the summer season (60 %), followed by 15 % in autumn, 15 % in spring and 10 % in winter (O. Floerl, NIWA, unpublished data). A simulation model developed by NIWA and based on a questionnaire survey of approximately 1,300 yacht owners estimated the average number of recreational vessel arrivals to Westhaven Marina at 2,185 per year. Most domestic yacht arrivals to the Westhaven Marina originate from Gulf Harbour Marina (16 % of annual arrivals), Auckland Westpark Marina (13 %), Opua Marina (13 %), Great Barrier Island (9 %) and Tauranga (7 %). A similar trend was seen in recreational vessels departing from the Westhaven Marina, with the five most common destinations being Gulf Harbour (16 %), Auckland Westpark Marina (14 %), Opua Marina (13 %) Great Barrier Island (9 %) and Tauranga (7 %; O. Floerl, NIWA, unpublished data).

EXISTING BIOLOGICAL INFORMATION

Over the last two decades, a variety of biological surveys have been carried out in the Waitemata Harbour, some of which (e.g. Hayward 1997a) contain information on non-indigenous species present within the area. We briefly review these studies and their major findings below.

Dromgoole and Foster (1983) reviewed studies of the marine biota of Waitemata Harbour. They noted some marked biological changes as a result of reclamation around the port, namely the loss of mangrove and saltmarsh communities, and also suggested that *Zostera* seagrass beds and the abundance of the green-lipped mussel *Perna canaliculus* were in decline. They concluded, however, that there was a lack of information to make quantitative assessments of the changes that may have occurred with the development of the Port of Auckland.

Read and Gordon (1991) reported the occurrence of the adventive fouling serpulid worm *Ficopomatus enigmaticus* in the Auckland and Whangarei harbours. It was first recorded in New Zealand around 1967, where it appeared suddenly and extensively on piles, pontoons and pleasure craft in the Town Basin Marina, Whangarei. In 1980 it caused fouling problems on the intake pipes of the Otahuhu Power station in the upper reaches of the Tamaki estuary in Waitemata Harbour. The fouling bryozoan *Conopeum seurati*, of European origin, was also noted as an opportunistic associate of *F. enigmaticus*, and was recorded in the Auckland region as early as 1969 (Gordon and Mawatari 1992).

Hayward *et al*. (1997) undertook a resurvey of Powell's (1937) study of subtidal, soft-bottom communities in the Waitemata harbour to determine the nature of faunal change over a 60-year period and the impacts of invasive species on the natural fauna. Dredge samples were collected from 152 stations between 1993 and 1995. The authors concluded that the soft-bottom fauna was still diverse away from the wharves and marinas, and retained a similar spatial distribution pattern to that described in Powell's 1930's study. However they noted that fourteen mollusc species (predominantly carnivorous gastropods) seemed to have disappeared or significantly declined in abundance within the harbour. The gastropod *Maoricolpus roseus* and several species associated with the shelly channel sediments in the harbour showed a reduction in abundance. Furthermore, since the 1930's at least nine native New Zealand mollusc species and one crab appeared to have colonised the harbour, and nine others had increased in relative abundance. The establishment of extensive horse mussel (*Atrina zelandica*) beds was thought to be the most significant of these changes in native abundance over this 60 year period. It was also noted that three non-indigenous bivalves (*Limaria orientalis, Theora lubrica, Musculista senhousia*) became established in Waitemata harbour in the 1960's and 1970's. By the late 1990's these molluscs had become so abundant they were dominant components of six of the eight fauna associations recognised in the harbour benthos by Hayward *et al*. (1997).

Hayward (1997a) identified 39 non-indigenous marine or intertidal species that had established populations in Waitemata Harbour. These were the foraminiferan *Siphogenerina raphanus*, the sea anemone *Sagartia luciae*, the polychaetes *Ficopomatus enigmaticus*, *Hydroides norvegicus* and *Polydora cornuta*, the gastropods *Microtralia occidentalis*, *Okenia plana*, *Phytia myosotis* and *Thecacera pennigera*, the bivalves *Crassostrea gigas*, *Musculista senhousia*, *Limaria orientalis* and *Theora lubrica*, the Californian majid crab *Pyromaia tuberculata*, the barnacle *Balanus amphitrite*, the isopod *Limnoria tripunctata*, the bryozoans *Anguinella palmata, Aeverrillia armata, Amathia distans, Bowerbankia gracilis, Bowerbankia imbricata, Bugula flabellata, Bugula neritina, Bugula simplex, Bugula stolonifera, Buskia socialis, Conopeum seurati, Cryptosula pallasiana, Electra tenella, Schizoporella errata, Tricellaria occidentalis, Watersipora arcuata, Watersipora subtorquata* and *Zoobotryon verticillatum*, the ascidian *Ciona intestinalis*, the green alga *Codium fragile tomentosoides*, the brown algae *Cutleria multifida* and *Hydroclathrus clathratus*, the red alga "Solieriaceae indet." and the cord grasses *Spartina alterniflora* and *Spartina* x *townsendii*. Many of these species have become dominant components of biotic assemblages in different parts of the harbour and appear to have had major (but unquantified) impacts on native assemblages. For example, the Pacific oyster *Crassostrea gigas*, now forms large reefs of shell that dominate areas of the intertidal shoreline and which blanket rocky reefs, wharf piles and other hard substrata (Hayward 1997). Other habitat-modifiers, such as the bivalves *M. senhousia* and *T. lubrica*, the bryozoan *W. subtorquata*, and the cord grasses, *Spartina* sp. are dominant components of the flora and fauna in some areas of the harbour.

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. Those listed as having been recorded from Auckland, Waitemata Harbour, the Hauraki Gulf or attributed the general range of the east coast of the North Island were the algae *Cutleria multifida*, *Hydroclathrus clathratus* and an unidentified species of the Solieriacae, the cord grass *Spartina x townsendi*, the protozoans *Elphidium vellai* and *Siphogenerina raphanus*, the sponges *Halichondria panicea, Halisarca dujardini,* and *Tethya aurantium*, the cnidarians *Coryne pusilla, Diadumene liniata, Ectopleura crocea, Eudendrium ritchiei* and *Pennaria disticha*, the polychaetes *Ficopomatus enigmaticus, Hydroides elegans* and *Polydora cornuta*, the molluscs *Cuthona beta, Eubranchus agrius, Limaria orientalis, Lyrodus mediolobatus, Lyrodus pedicellatus, Microtralia* sp. (= *M. insularis*), *Musculista senhousia, Okenia pellucida, Polycera hedgpethi, Theora lubrica* and *Thecacera pennigera,* the Xiphosuran *Carcinoscopius rotundicauda*, the barnacles *Balanus amphritrite*, *Balanus trigonus* and *Balanus variegatus*, the isopod *Limnoria tripunctata*, the amphipods *Chelura terebrans* and *Corophium acutum*, the decapods *Dromia wilsoni, Merocryptus lambriformis, Pilumnopeus serratifrons, Plagusia chabrus* and *Pyromaia tuberculata*, the bryozoans *Amathia distans, Anguinella palmata, Bowerbankia gracilis, Bowerbankia imbricata, Bugula flabellata, Bugula neritina, Bugula stolonifera, Buskia nitens, Conopeum seurati, Cryptosula pallasiana, Electra tenella, Schizoporella errata, Tricellaria porteri, Watersipora arcuata, Watersipora subtorquata* and *Zoobotryon verticillatum*, and the ascidians *Asterocarpa cerea, Botrylloides leachi, Botrylloides magnicoecum, Botryllus schlosseri, Cystodytes dellechiajei, Didemnum "candidum", Diplosoma listerianum* and *Styela plicata*. Several others were reported to occur 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*, and the ascidian *Corella eumyota.*

Taylor and MacKenzie (2001) examined the Waitemata Harbour for the presence of the toxic blooming dinoflagellate *Gymnodinium catenatum*, and did not detect any resting cysts in sediment samples or motile cells in phytoplankton samples.

In view of the plans for increased urban development in the upper Waitemata Harbour, Cummings *et al*. (2002) reported on a study designed to define the benthic ecological values of the area's intertidal and subtidal habitats (74 sites). Based on information on the distribution and densities of taxa postulated as being sensitive to long term habitat change (e.g. the bivalve *Paphies australis*), they provided a qualitative assessment of the potential effect on benthic communities to long-term habitat change, and identified specific ecologically important areas of the upper Waitemata Harbour. They found the intertidal and subtidal benthic communities in the area to be generally in good condition, and although the sediment organic content was notably high in some areas that communities at these sites did not show characteristics of highly organically enriched areas.

Nicholls *et al*. (2002) reported on a long-term State of the Environment monitoring programme established in 2000 in the Waitemata Harbour. This programme was set up to monitor the ecological status and trends in marine macrobenthic species representative of the region, and to monitor habitats that have the potential to be affected by sedimentation, pollution and other anthropogenic impacts. Common taxa (e.g. the bivalve *Nucula hartvigiana*) and sediments at five monitored intertidal sites showed considerable temporal variability. There was suggestion of cyclic patterns and trends in abundance for some taxa at some sites, caused by natural fluctuations related to recruitment events and storm disturbance, although the data series was not long enough to confirm these trends. The results from continued monitoring of the macrobenthic communities in the Central Waitemata during October 2000 to February 2006 were reported by Halliday *et al*. (2006). A number of changes in abundance of the monitored taxa were observed, but none of these trends were consistent with either increased sedimentation or contamination. Of the list of invasive species found in the Waitemata Harbour four, the bivalves *Musculista senhousia* and *Theora lubrica* and polychaetes *Chaetopterus sp*. and *Pseudopolydora corniculata* were commonly recorded during sampling.

The large (100 mm carapace width) non-indigenous portunid crab, *Charybdis japonica* was discovered in Waitemata Harbour, by commercial fishermen in September 2000 (Webber 2001). Trapping surveys, undertaken in 2002 and 2003 revealed that *Charybdis* was abundant throughout the Waitemata Harbour and in two nearby estuaries (Tamaki and Weiti), but there was no evidence it had spread outside the Hauraki Gulf or to other New Zealand shipping ports (Gust and Inglis 2006). Like other large portunids, *C. japonica* is a generalist predator and scavenger and may have significant impacts on estuarine populations of epibenthic and shallow-burrowing bivalves such as cockles (*Austrovenus stutchburyi*), pipi (*Paphies australis*), scallops (*Pecten novaezelandiae*), and mussels (*Perna canaliculus*) (Gust and Inglis 2006). Miller *et al*.(2006) compared the parasite fauna of *C. japonica* from Waitemata Harbour with sympatric populations of the native paddle crab, *Ovalipes catharus*. They reported an unidentified juvenile ascaridoid nematode from the hindgut of *C. japonica* that was not present in sympatric populations of *O. catharus*. Melanised lesions were also observed in the muscle tissue of almost half (46.6%) of the *C. japonica* examined, but the provenance of both the nematode and lesion-causing agent could not be determined.

Read (2006) reported on the presence of the scale-worm *Paralepidonotus ampulliferus* in the Waitemata harbour. This Indo-Pacific species was first described from Bohol Island in the Philippines. Scale worms of the genus *Paralepidonotus* have no prior New Zealand records. *P. ampulliferus* was found to be widespread around the soft shores of Waitemata Harbour and were also found subtidally in Whangarei Harbour. Earliest records date from late 1998, although no surveys carried out around New Zealand prior to 2003 detected the species. Read (2006) concluded that human mediated transport is the most likely mechanism of introduction of *P. ampulliferus* in northern New Zealand, and further monitoring and study of this species in New Zealand is warranted.

Two non-native gobies, the Asian goby *Acentrogobius pflaumii* and the bridled goby *Arenigobius bifrenatus*, have both been found in the Waitemata harbour (Francis *et al*. 2003). These species are thought to have been introduced by release of ballast water from passing ships. *A. pflaumii* appears to be a relatively recent introduction, being found only in the Waitemata and Whangapoa harbours, whereas *A. bifrenatus* is more widespread, its current recorded range spanning around 150 km of coastline. The exotic species overlap in both range and habitat with two native New Zealand gobies, *Favonigobius lentiginosus* and *F. exquisitus.* Further research is required to determine the ecological impact of the invasive gobies (Francis *et al*. 2003). Another small non-indigenous fish, the Australian oyster blenny, *Omobranchus* *anolius*, was reported from Waitemata Harbour in 2003. (Francis *et al*. 2004). The oyster blenny lives predominantly inside the shells of dead oysters (*Crassostrea gigas*) and in, or under, submerged objects such as large boulders in lower intertidal habitats.

The Asian kelp, *Undaria pinnatifida*, was discovered in Waitemata harbour in 2004 (Stuart and McClary 2004). Is is widely distributed throughout the harbour and well established in the Westhaven Marina. Colonisation of floating structures at Westhaven Marina was extensive, with maximum densities equating to 105 ± 8 sporophytes per m^2. The density and distribution of *U. pinnatifida* suggests that translocation of the invasive kelp to Auckland by fouled barge or associated vessel is the most likely mode of introduction. *Undaria pinnatifida* appears to have been present in the Waitemata harbour and Westhaven Marina since roughly 2000.

The clubbed tunicate, *Styela clava*, was discovered in Viaduct Harbour in Waitemata Harbour, in September 2005. An initial delimitation survey showed that the species was widespread throughout the Westhaven Marina and other areas of Waitemata harbour (Gust *et al*. 2005). It was detected at six of the seven finger wharves surveyed at the Westhaven Marina, and was most prevalent on the sides of floating pontoons and on submerged ropes. *S. 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. 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).

Inglis *et al*. (2006x) and Morrisey *et al*. (2007) presented the results of a surveillance program to detect marine pest species on the New Zealand register of unwanted marine organisms (*Undaria pinnatifida, Caulerpa taxifolia, Asterias amurensis, Sabella spallanzanii, Carcinus maenas, Eriocheir sinensis* and *Potamocorbula amurensis*; Table 13) in eight major ports and Marinas (Whangarei, Waitemata, Tauranga, Wellington, Nelson, Lyttelton, Otago and Bluff).

The introduced portunid crab, *Charybdis japonica*, was captured in Waitemata Harbour during each of the targeted surveillance surveys. Although it was widely distributed throughout Waitemata Harbour, these data showed a general decline in Catch Per Unit Effort (CPUE) between 2002 and 2005 (Inglis *et al*. 2006x).

The cryptogenic parchment tubeworm, *Chaetopterus* sp. was recorded in the Waitemata Harbour on the breakwater off Orakei/Hobson Bay and on pontoons in Bayswater Marina (Morrisey 2007). Few living *Chaetopterus* sp. were captured during the survey of Waitemata Harbour. Samples obtained through epibenthic sledding and intertidal visual searches often consisted of empty tubes (Inglis *et al*. 2006x).

The Asian date mussel, *Musculista senhousia* had been found previously in Waitemata Harbour. *M. senhousia* was first reported from Waitemata Harbour in 1980 (Willan 1987). Although it had previously been a dominant component of the fauna of intertidal and subtidal sediments in Waitemata Harbour and the nearby Tamaki Estuary (Hayward 1997b), specimens were found in only seven of the >200 sled tows in the targeted surveillance of the harbour by Morrisey *et al* (2007). During the four previous surveys of Waitemata Harbour (2002-2004), *M. senhousia* was found in a total of 4 sled tows (<1% of the total), over muddy subtidal and intertidal sediments between Orakei Basin and Point Chevalier in April 2003 and April 2004. The high fecundity, rapid growth and short life span of this species mean that its distribution and abundance is notoriously patchy in space and time (Crooks 1996; Creese *et al*. 1997).

The small Indo-Pacific bivalve *Limaria orientalis* was recorded from shelly gravel in the upper and middle Waitemata Harbour. It was widespread in the harbour, from the upper harbour, off Hobsonville, to the port area. In October 2003 three specimens were recorded from a single sled tow near the Bledisloe Terminal in the commercial port of Waitemata Harbour (Inglis *et al*. 2006x; Morrisey 2007).

The introduced majid crab *Pyromaia tuberculata* was also recorded during the surveys. A single specimen was collected in a sled sample east of the Harbour Bridge.

Methods

SURVEY METHOD DEVELOPMENT

The sampling methods used in this survey were based on the CSIRO Centre for Research on Introduced Marine Pests (CRIMP) protocols developed for baseline port surveys in Australia (Hewitt and Martin 1996; 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 Table 2. Further details are provided in Gust *et al*. (2001).

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 survey of Westhaven Marina. The survey occured from the 24^{th} to 30^{th} March 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 -0.5 m, -1.5 m, -3.0 m and -7 m. A diver descended slowly down the outer surface of each pile and filmed a vertical transect from approximately high water to the base of the pile, using a digital video camera in an underwater housing. On reaching the sea floor, the diver then ascended slowly and captured high-resolution still images of each quadrat using the photo capture mechanism on the video camera. Because of limited visibility, four overlapping still images, each covering approximately ¼ of the area of the quadrat were taken for each quadrat. A second diver then removed fouling organisms from the piling by scraping the organisms inside each quadrat into a 1-mm mesh collection bag, attached to the base of the quadrat (Figure 4). 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. Additional visual transect searches were made at pre-allocated sites. Ten pilings, or 50 metres of breakwall, were searched by divers for any potential invasive species, with a specific focus on species listed on the New Zealand Register of Unwanted Organisms. Of the eight marine pests on the register, the ones most likely to occur on hard substrata were the macroalga, *Undaria pinnatifida*, the tunicate, *Styela clava* (both known to be present in New Zealand), the polychaete, *Sabella spallanzanii*, the shore crab, *Carcinus maenas*, and the seastar, *Asterias amurensis* (not known from New Zealand) Unusual species that could not be identified reliably in the field were also collected and returned for formal identification. Searches were done to 4-5 m depth on each piling, or breakwall, where possible. Opportunistic visual searches were also made of breakwalls and rock facings within the commercial port area. Divers swam vertical profiles of the structures and collected specimens that could not be identified reliably in the field.

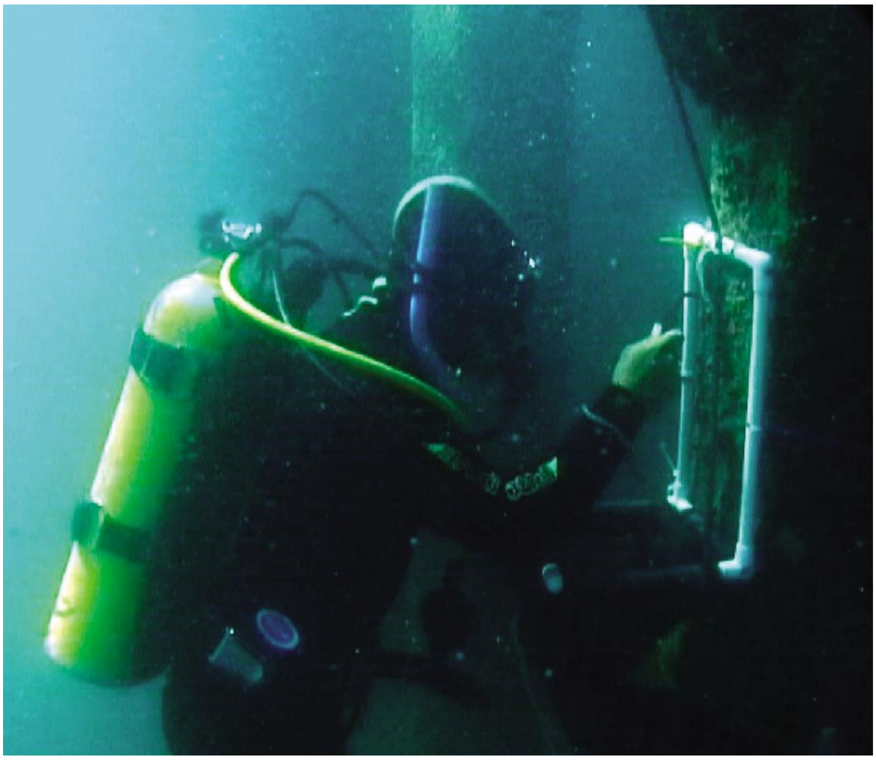

Figure 4: Diver sampling organisms on pier piles.

BENTHIC FAUNA

Benthic infauna was sampled using a Shipek grab sampler deployed from a research vessel moored adjacent to the berth (Figure 5), 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 5: 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 6). 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 port, and the entire contents were sorted.

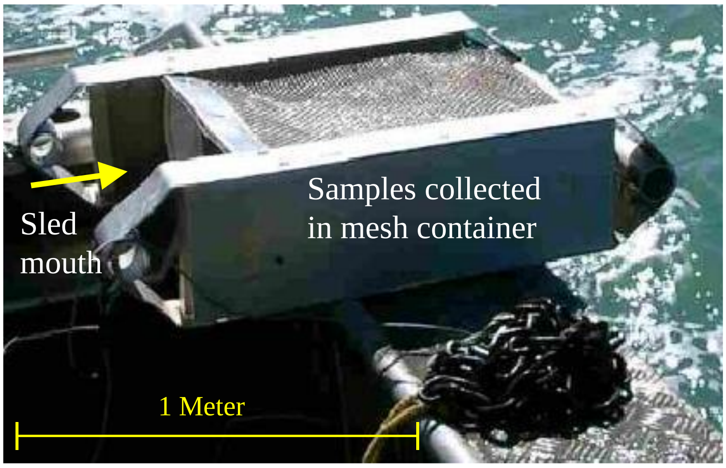

Figure 6: Benthic sled

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 7). 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 Port 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).

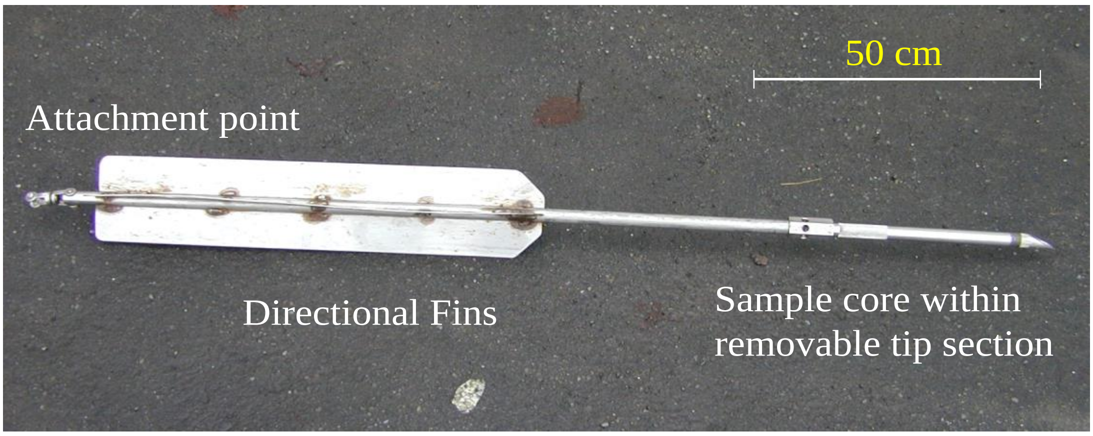

Figure 7: Javelin corer

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 8). 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 8). 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 8). 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.

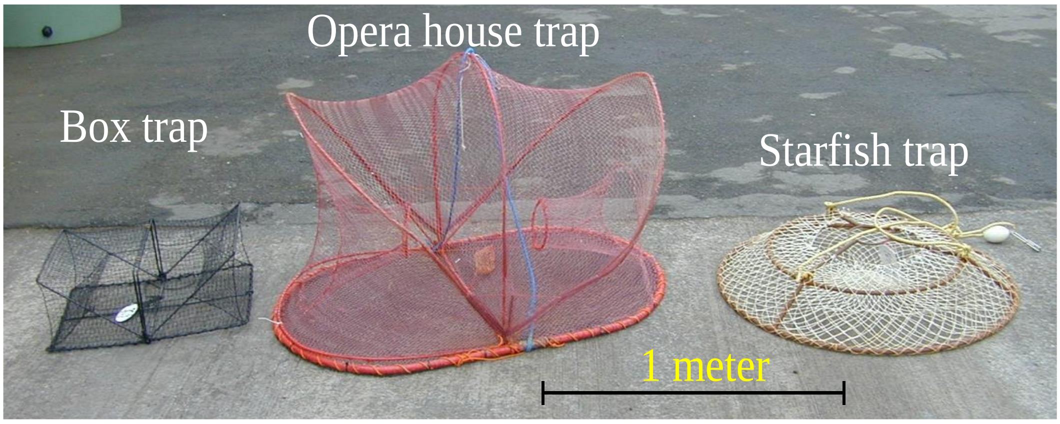

Figure 8: Trap types deployed in the port.

VISUAL SEARCHES

Qualitative above-water visual searches were conducted at in the Westhaven 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 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 baseline survey of Westhaven Marina is provided in Table 4, and the exact geographic locations of sample sites are given in Appendix 1. 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.

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During the baseline survey, most sampling effort was spread throughout the marina and represented a range of active berths and lay-up areas (

Figure 3, Table 4). The spatial distribution of sampling effort for each of the sample methods is indicated in the following figures: diver pile scraping, visual diver transect searches and javelin cyst coring (

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Figure 9), benthic sled and benthic grab sampling (Figure 10), fish, crab, seastar and shrimp trapping (

Figure 11), sediment sampling (

Figure 12), and above-water visual searches (

Figure 13).

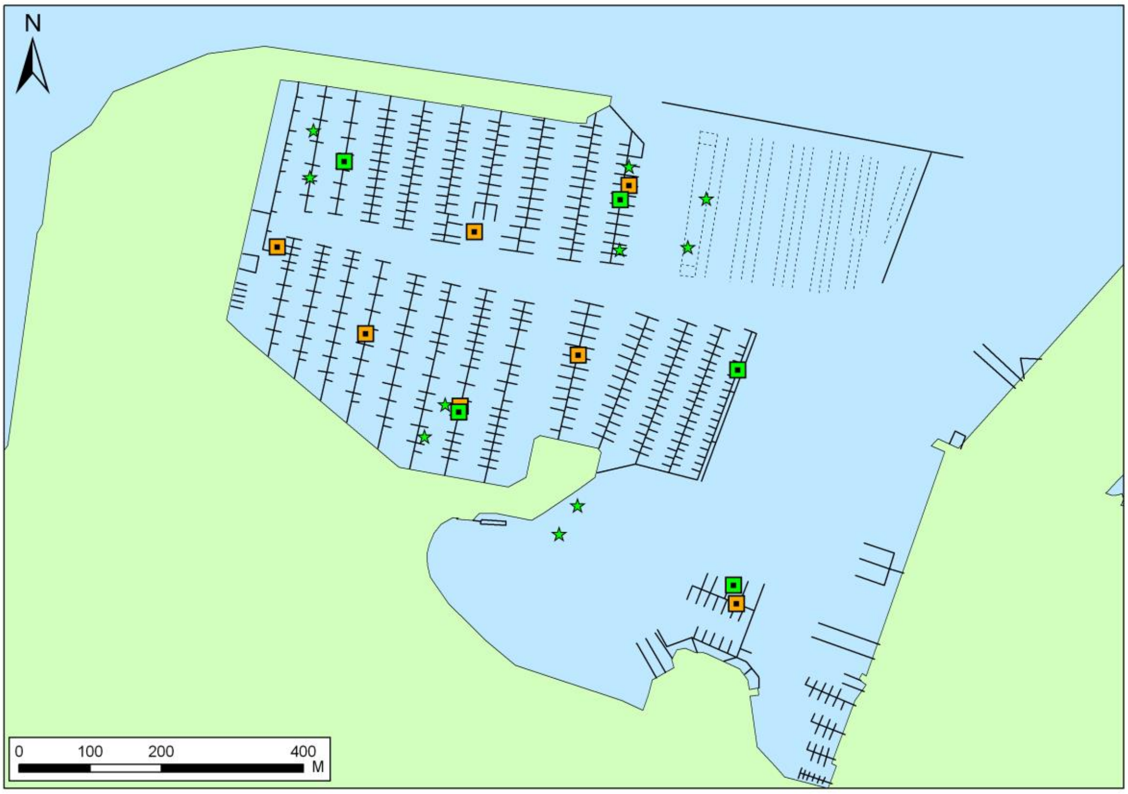

Figure 9: Diver pile scraping (green squares), visual diver transect searches (orange squares) and dinoflagellate cyst core (stars) sampling sites.

Figure 10: Benthic sled (full black circles) and benthic grab (white/black circles) sampling sites.

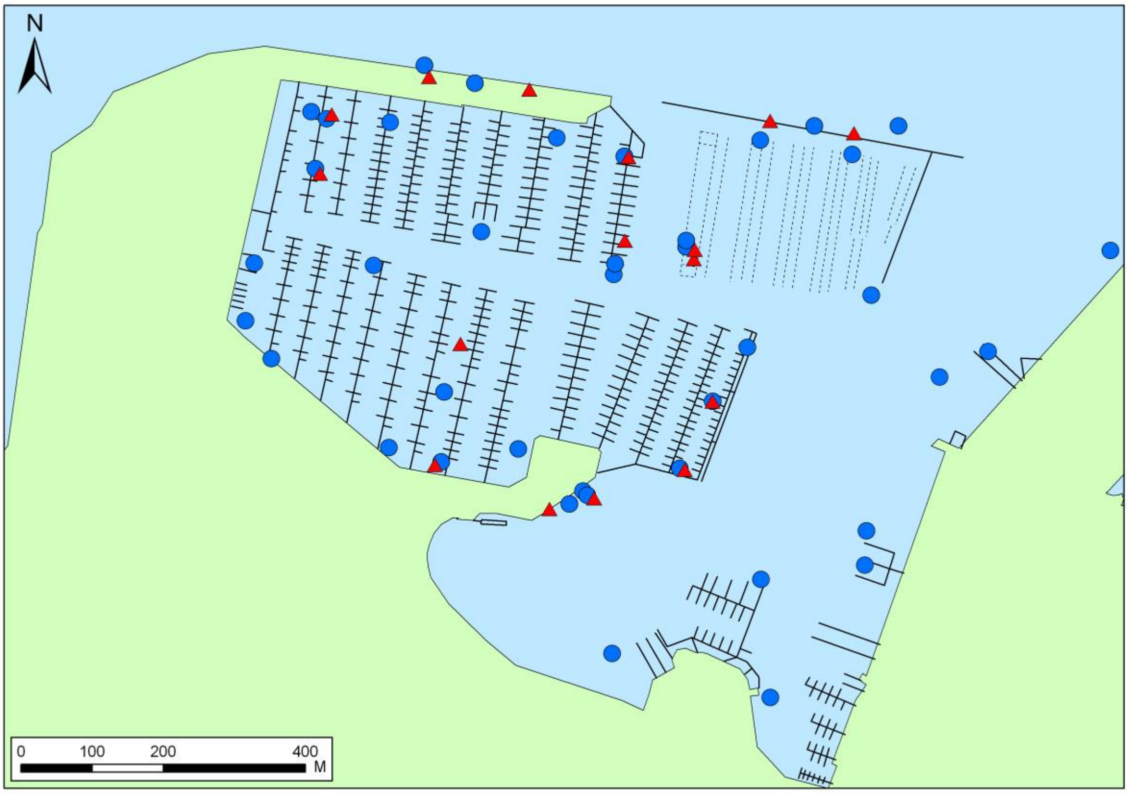

Figure 11: **Sites sampled using fish traps (red triangles), and crab, shrimp and seastar traps (blue circles).**

Figure 12: **Sediment sampling sites.**

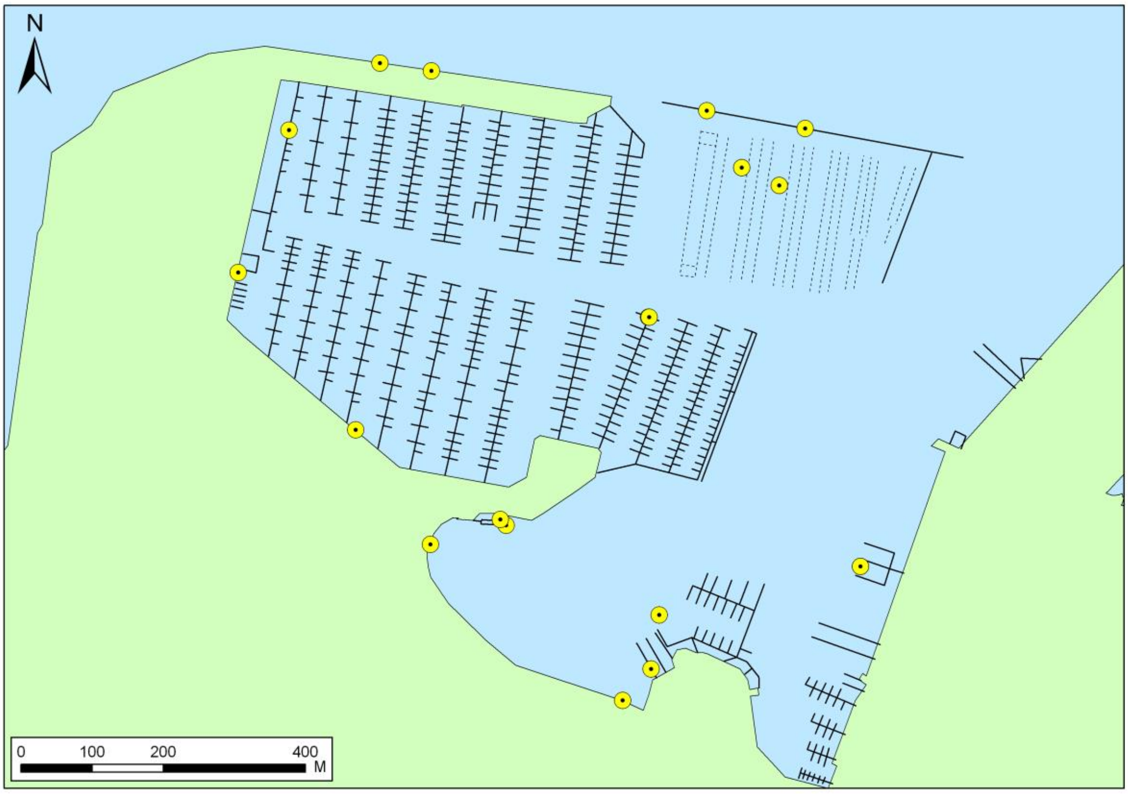

Figure 13: Above-water visual search sites

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 so this taxon could only be recorded as "indeterminate taxa" (see section "Definitions of species categories" below).

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

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 evaluating the benefit of reducing or increasing sample effort in subsequent surveys (Gotelli and Colwell 2001). For the baseline survey we computed 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 four methods: pile scraping, benthic sleds, benthic grabs and crab traps. 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 possible for pile scrapes and benthic sleds; 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 baseline survey.

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). 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") 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) was > 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 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).

Survey results

PORT ENVIRONMENT

Sampling was carried out at 15 different sites throughout Westhaven Marina (
Figure 9 to
Figure 13; Table 4). Maximum recorded depths ranged from 8.8 m at Jetty A to around 1.2 m at St Marys Bay Breakwall. (Table 6). Turbidity was relatively low at all sites sampled (1.75 m ± 0.25) with the lowest turbidity being recorded at Jetty G (2 m secchi depth), whilst it was highest at Jetty A (1.5 m secchi depth). Salinity was reasonably consistent at all sites measurements were taken inside Westhaven Marina (average of 29.8 ppt), and ranged from 28 ppt Jetty G to 32 ppt at Jetty Z. Water temperature was also lowest at Jetty R (20.5 °C) and highest at Jetty G. (21.3 °C). The average water temperature across all sites was 20.76 ± 0.2 °C. During sampling, sea states ranged from 0-1 on the Beaufort scale (i.e. approximately 0-3 knots wind speed and 0-0.1 m wave height).

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Sediments at the sampling sites at Westhaven Marina were dominated by sand-sized particles (77.35-94.49 %), with a smaller proportion of silt-sized particles (5.04-22.48 %; Table 7). Clay-sized particles were present in all sites but only made up a small proportion of the sample (0.03-0.34 %). Gravel was only found in one sample at the Outer Breakwall 1 site (0.42 %) and pebble-sized particles were not present in any samples (Table 7). The Outer Breakwall 1 site contained the highest proportion of large particles. This site, situated on the outside of the marina, was the most exposed sampled in this survey (
Figure 3). In comparison, the samples collected from the Jetty R, Jetty G and Jetty Z sites contained the highest proportions of small particles. These sites were located in the sheltered inner marina.

The organic content of sediments in the Westhaven Marina was moderate, with a mean LOI (loss on ignition) value across the eight analysed samples from eight sites of 5.7 % (Figure 14). Organic content was highest at Jetty R (7.6 %) and highest at the St Mary’s Bay (2.4 %) and Outer Breakwall 1 (3.2 %) sites (Figure 14;
Figure 3).

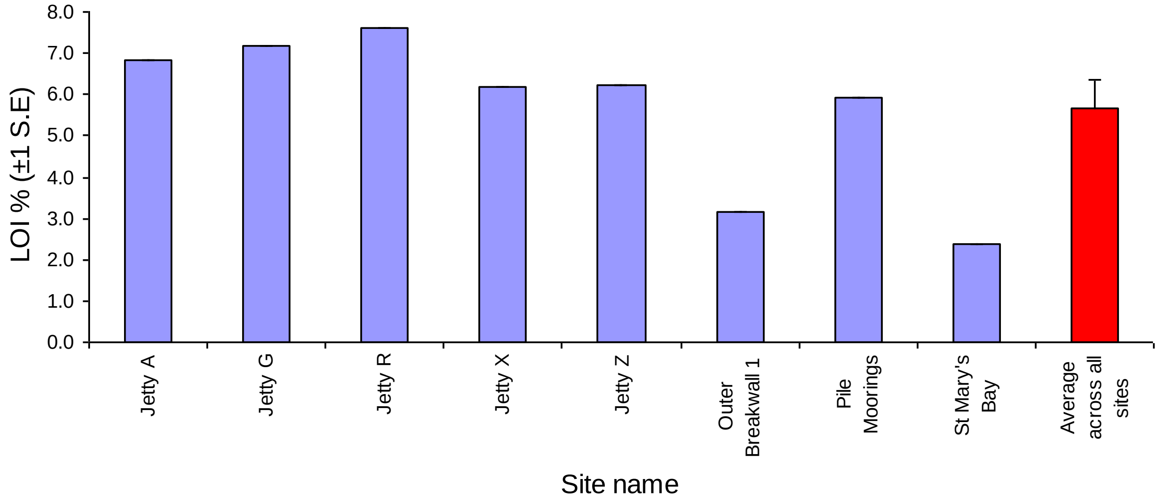

Figure 14: **Organic content as determined by loss on ignition analyses of sediments from eight sites at and around Westhaven Marina.**

Species recorded

A total of 203 species or higher taxa were identified from the survey of Westhaven Marina. This collection consisted of 109 native (Table 8), 20 cryptogenic (Table 9), and 27 non-indigenous species (Table 10), with the remaining 47 taxa being made up of indeterminate taxa (Table 11, Figure 15).

The biota in the survey included a diverse array of organisms from 17 phyla (Figure 16). 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.

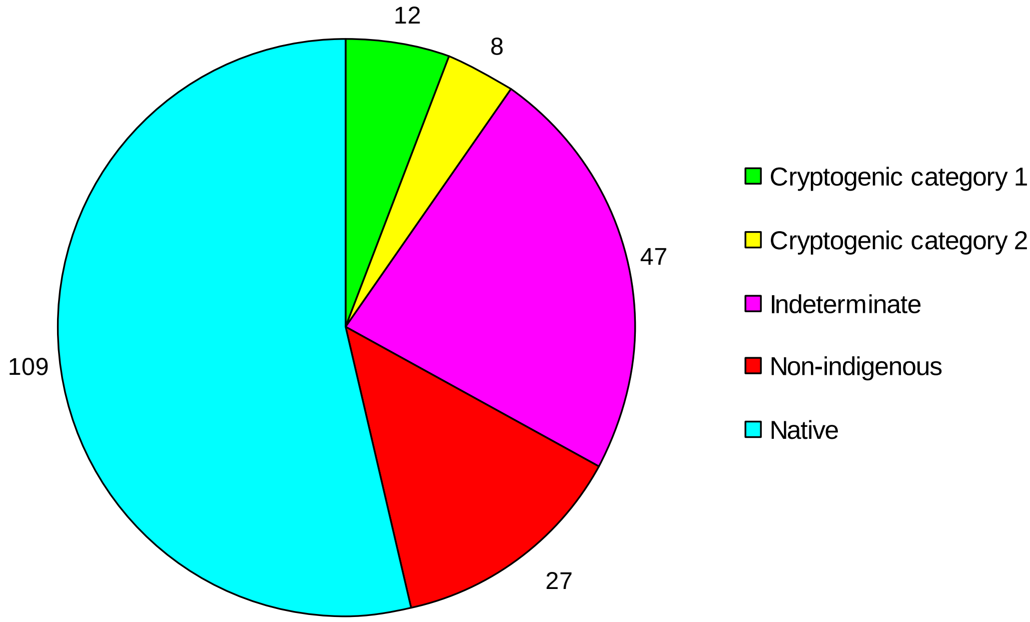

Figure 15: **Diversity of marine species sampled in Westhaven Marina. Values indicate the number of taxa in each category.**

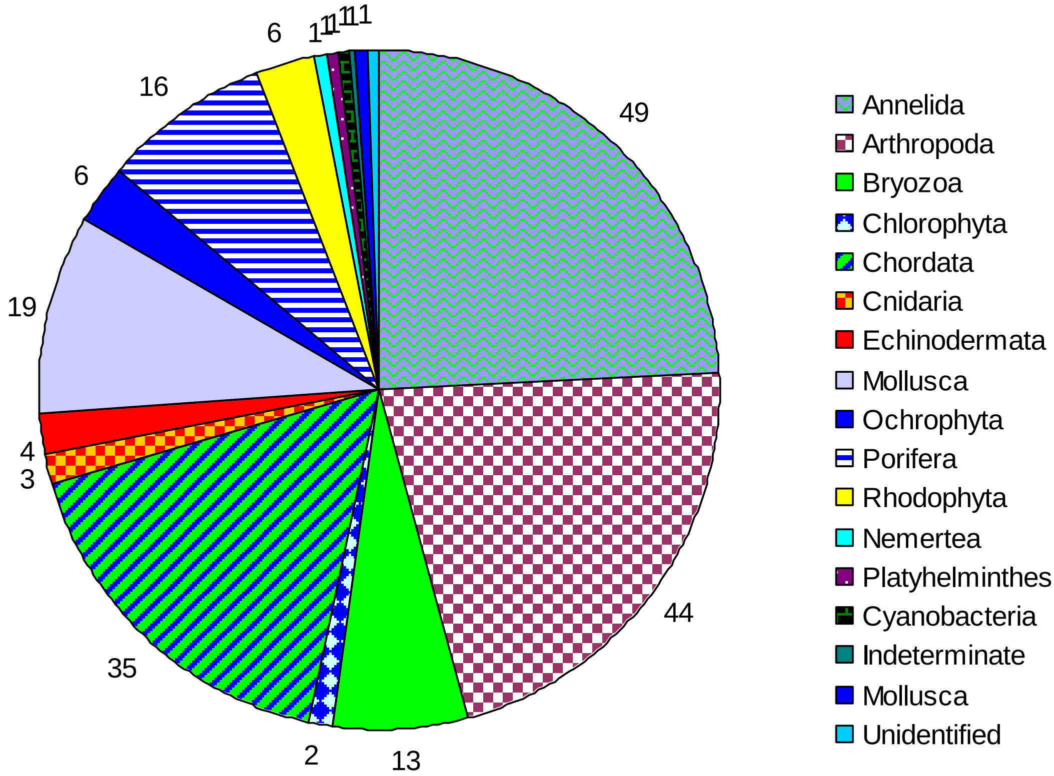

Figure 16: Phyla recorded in Westhaven Marina. Values indicate the number of taxa in each of the major taxonomic groups.

Native species

The 109 native species recorded during the survey of Westhaven Marina represented 54 % of all species identified from this location (Figure 15) and included diverse assemblages of annelids (32 species), crustaceans (32 species), molluscs (13 species), fish (11 species), ascidians (seven species), sponges (five species) and brown algae (three species). A number of other less diverse major taxonomic groups including echinoderms, rhodophyta, porifera, cnidarians and a bryozoan were also recorded from the Marina (Table 8).

Cryptogenic taxa

Cryptogenic taxa (n = 20) represented 13 % of all species or higher taxa identified from the Marina. The cryptogenic organisms identified included 12 Category 1 and eight Category 2 species as defined in the section "Definitions of species categories". These organisms included nine sponges, six ascidians, three annelids, one bryozoan and one crustacean (Table 9).

Several of the Category 1 cryptogenic taxa (e.g the annelids *Heteromastus filiformis* and *Scruparia ambigua* and ascidians *Botrylloides leachi* 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 4.

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 characteristics (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. Several specimens of *Didemnum* were recovered from Lyttelton during the initial survey, but these did not fit any of the existing descriptions and were identified only to genus level. At the time that this report was prepared, we had been unable to secure Dr Kott's services to examine specimens from the Westhaven Marina baseline survey, and all *Didemnum* specimens were identified only to genus level. We have reported these species collectively, as a species group (*Didemnum* sp., Table 9).

Non-indigenous species

The 27 non-indigenous species (NIS) recorded in the survey of Westhaven Marina included eight bryozoans, five annelids, four ascidians, three crustaceans, three molluscs, two sponges, one cnidarian and one brown alga (Table 10; Table 12).

None of the NIS are new records for New Zealand. A list of Chapman and Carlton's (1994) criteria (see section "Definitions of species categories") that were met by the non-indigenous species sampled in this survey is given in Appendix 4.

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 they appear in Table 10. The Chapman and Carlton (1994) criteria applicable to each NIS are indicated in Appendix 4 (Chapman and Carlton 1994).

Hydroides elegans (Haswell, 1883)

Image and information: NIMPIS (2002e)

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 17). 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 and the Port of Auckland ((Inglis *et al*. 2006b, d)). During the second baseline surveys of it was recorded from the Ports of Nelson, Auckland and Viaduct Harbour (Inglis *et al*. 2006w), Inglis *et al.* in press) and in this survey of Westhaven Marina (Table 10; Table 12).

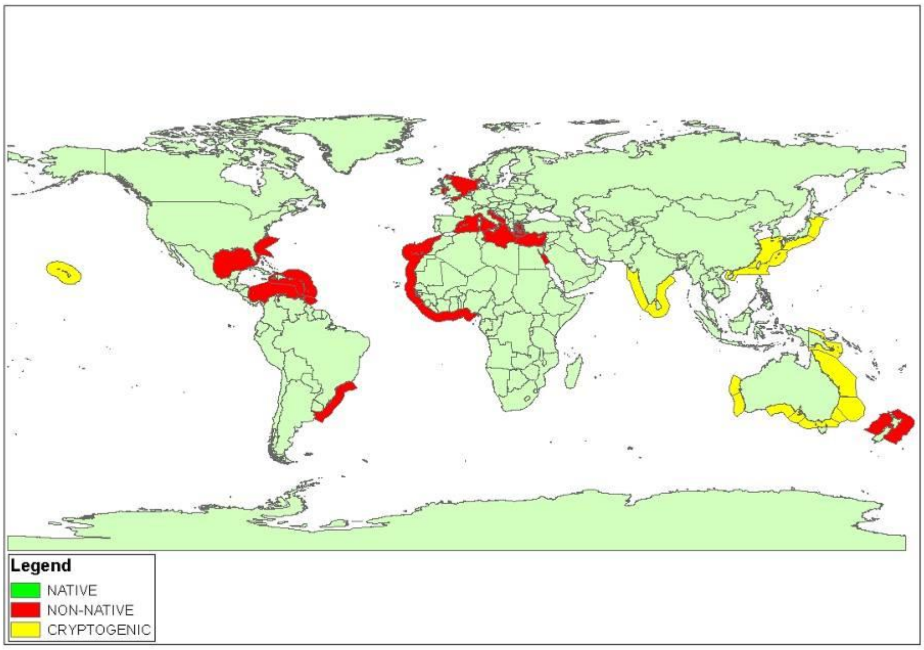

Figure 17: Global distribution of *Hydroides elegans*

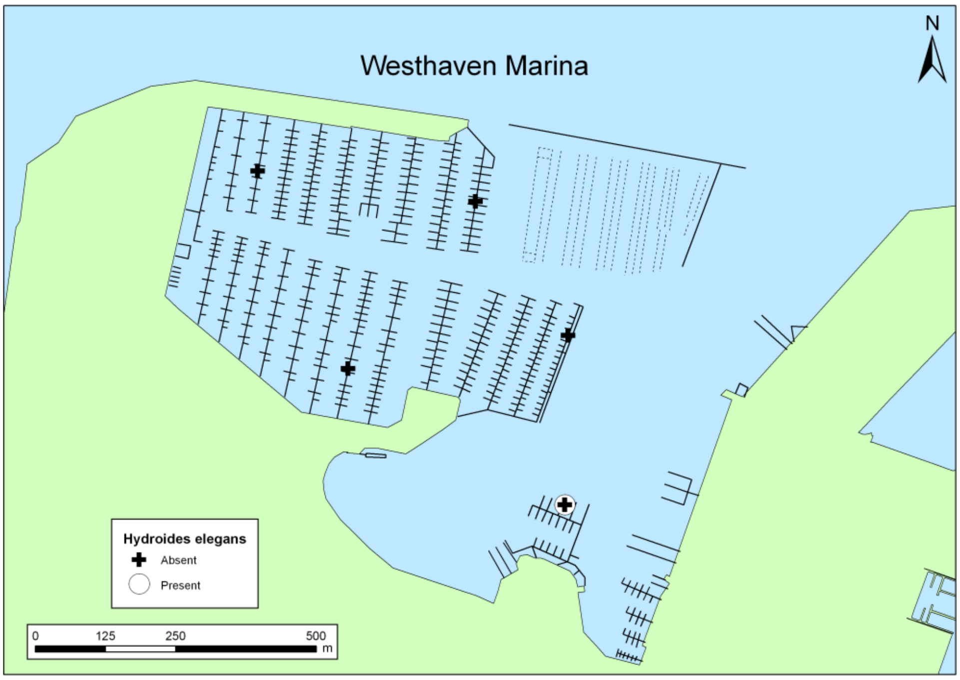

Figure 18: *Hydroides elegans* distribution in the baseline survey of the Westhaven Marina.

***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 19). 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 20; (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), again in Gulf Harbour Marina and in this survey of Westhaven Marina (Inglis *et al*. 2006d) (

Figure 19; Table 10; Table 12).

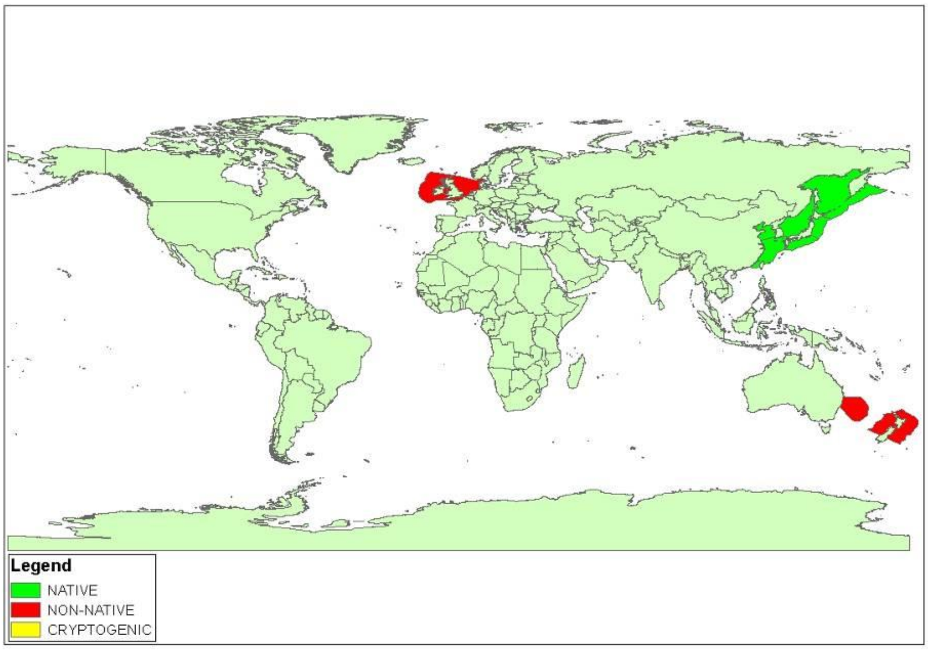

Figure 19: Global distribution of *Hydroides ezoensis*

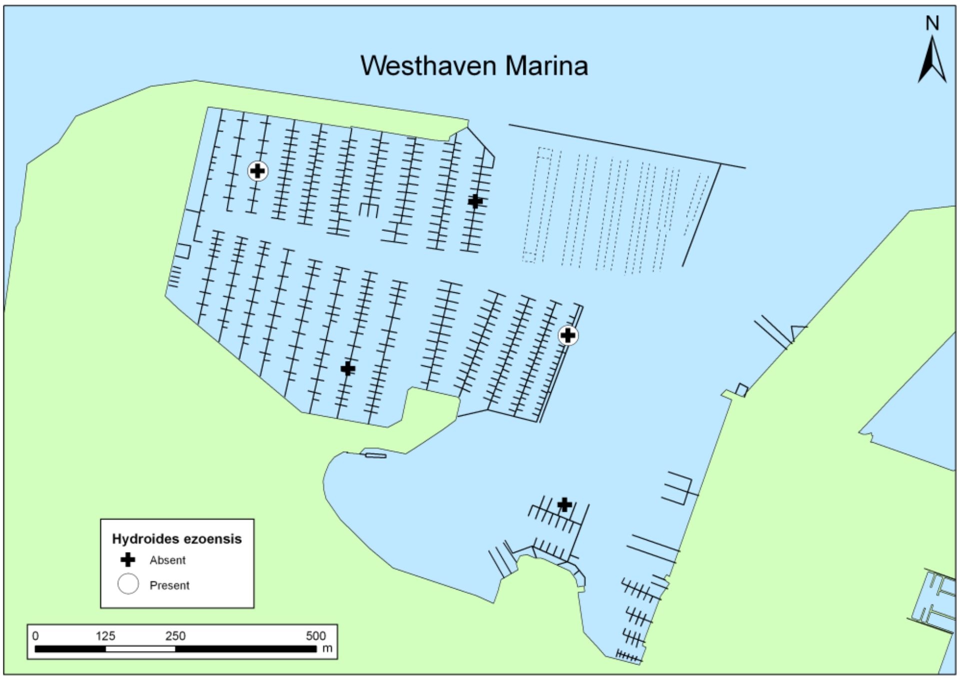

Figure 20: *Hydroides ezoensis* distribution in the baseline survey of the Westhaven Marina

Polydora hoplura (Claparède, 1870)

Image: Read (2004)

(Left) with eggmass in an opened blister; (top R) posterior; (bottom R) lateral head

Polydora hoplura is a spionid polychaete worm that bores into the shells of molluscs. It is a common pest of shellfish mariculture as its burrows cause blisters in the shells of farmed oysters, mussels and abalone (Pregenzer 1983; Handley 1995; Read 2001; Lleonart *et al*. 2003). It is considered one of New Zealand's worst pest worms (Read 2004). It is often found below the tide mark on jetty piles (Australian Faunal Directory 2005). The type specimen for this species was recorded from the Gulf of Naples, Italy (Claparède, E. 1870). Its native range is thought to be the Atlantic coast of Europe and the Mediterranean (Cranfield *et al*. 1998). *P. hoplura* has also been recorded from South Africa, southeast Australia (Bass Strait and Victoria, Central East Coast, southern Gulf Coast, and Tasmania) and New Zealand where it is thought to have been introduced (Australian Faunal Directory 2005; Figure 21). It is not known when *P. hoplura* first arrived in New Zealand (Read 2001). In Europe and New Zealand, *P. hoplura* is often associated with shells of the introduced Pacific oyster *Crassostrea gigas* (Handley 1995; Read 2004).

Polydora hoplura had previously been recorded from Wellington and the Marlborough Sounds (Cranfield *et al*. 1998). In the initial port surveys *P. hoplura* was recorded in Dunedin, Whanagrei, Nelson, Wellington, Tauranga, Picton and Viaduct Harbour (Inglis *et al*. 2006a, d; Inglis *et al*. 2006i; Inglis *et al*. 2006j, l, n, p). In the repeat surveys *P. hoplura* was recorded in Whangarei, Napier, Wellington, Lyttelton, Timaru, Dunedin, Bluff, and in this initial survey of Westhaven Marina (
Figure 22; Table 10; Table 12) (Inglis *et al*. 2006q, u; Inglis *et al*. 2006v).

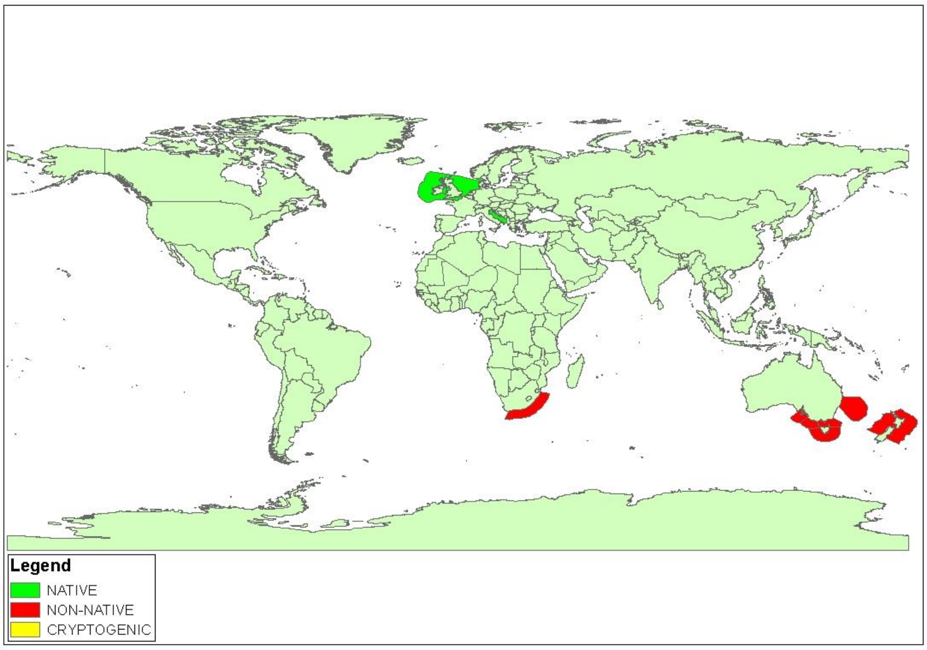

Figure 21: Global distribution of *Polydora Hoplura*

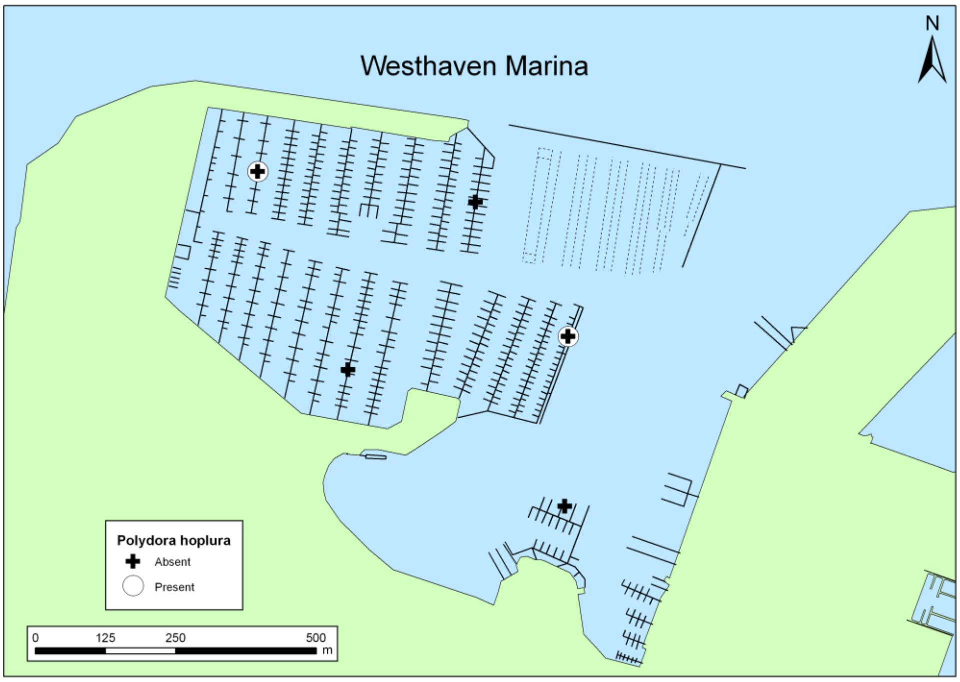

Figure 22: *Polydora hoplura* distribution in the survey of the Westhaven Marina

Pseudopolydora paucibranchiata **(Okuda, 1937)**

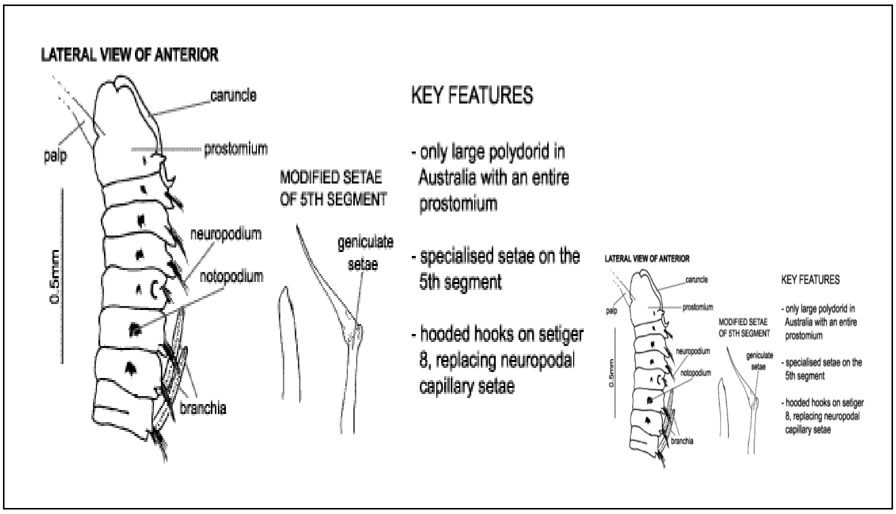

Diagram: Swaleh and Mustaquim, 1993, in NIMPIS (2002f)

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 is 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 23). *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 and Gulf Harbour Marina (Inglis *et al*. 2006o). During the repeat surveys it was recorded in the Port of Gisborne, Viaduct Harbour, (Inglis *et al*. in press) and in this survey of Westhaven Marina (
Figure 24; Table 10; Table 12).

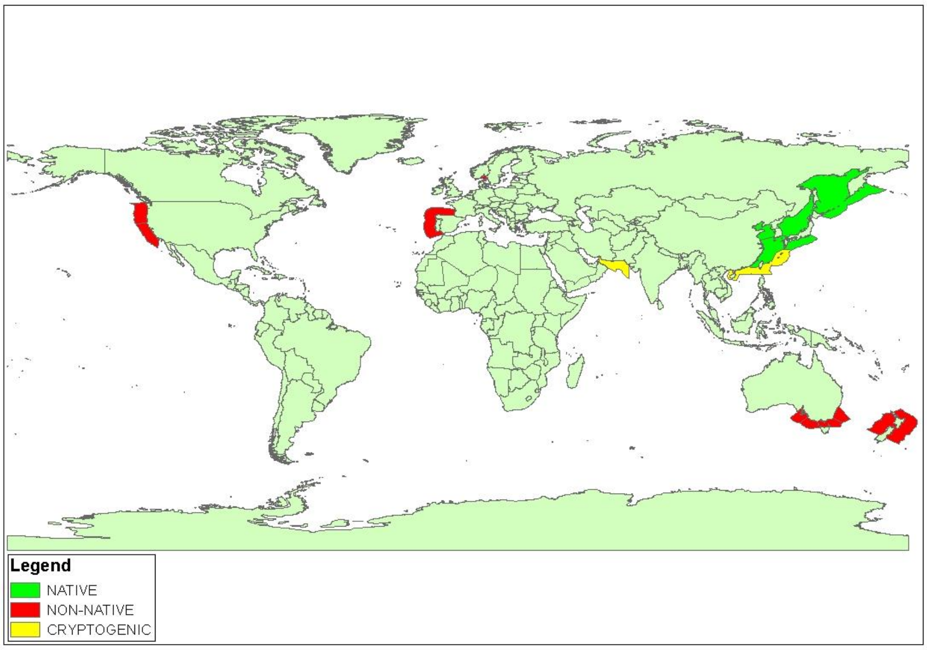

Figure 23: Global distribution of *Pseudopolydora paucibranchiata*

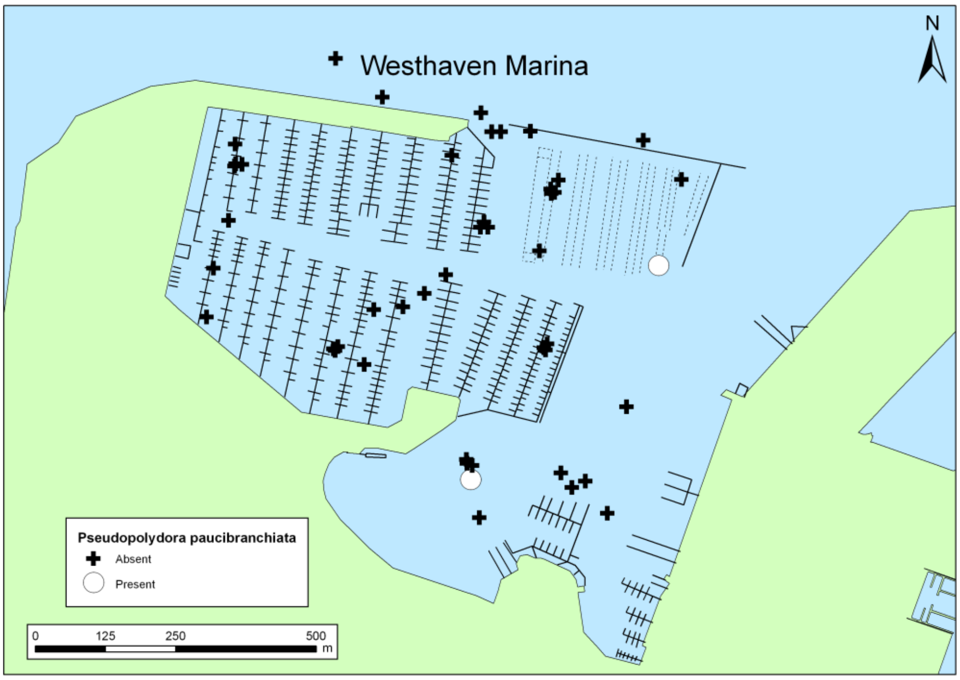

Figure 24: ***Pseudopolydora paucibranchiata*** **distribution in the baseline survey of the Westhaven Marina**

***Paralepidonotus ampulliferus* (Horst, 1915)**

No Image Available.

Paralepidonotus ampulliferus is a smallish (adult size approximately 100mm) soft-shore polynoid (scale-worm) which has a broad body and can grow to have up to 40 segments. *P. ampulliferus* is widely distributed across the Indian Ocean and the western Pacific Ocean, and is present around much of the Australian coast (
Figure **25**). The scale worm most likely arrived in New Zealand via ship ballast water, vessel hull fouling, or shipments of live shellfish. *Paralepidonotus ampulliferus* appears to be habitat-flexible and has been found as epifauna in environments other than soft sediment. No restrictive associations with other species have yet been detected (Read 2006).

P. ampulliferus has been found subtidally in Whangarei Harbour, and is widespread around the soft-shores of Waitemata Harbour (Auckland) and nearby Hauraki Gulf inlets, with the earliest record dating from late 1998 and seems to have a restricted but expanding national distribution (Read 2006). *P. ampulliferus* was recorded in the second baseline surveys of the ports of Whangarei and Auckland, and also in the initial survey of Viaduct Harbour Marina and in this survey of Westhaven Marina (
Figure **26**; Table 10; Table 12).

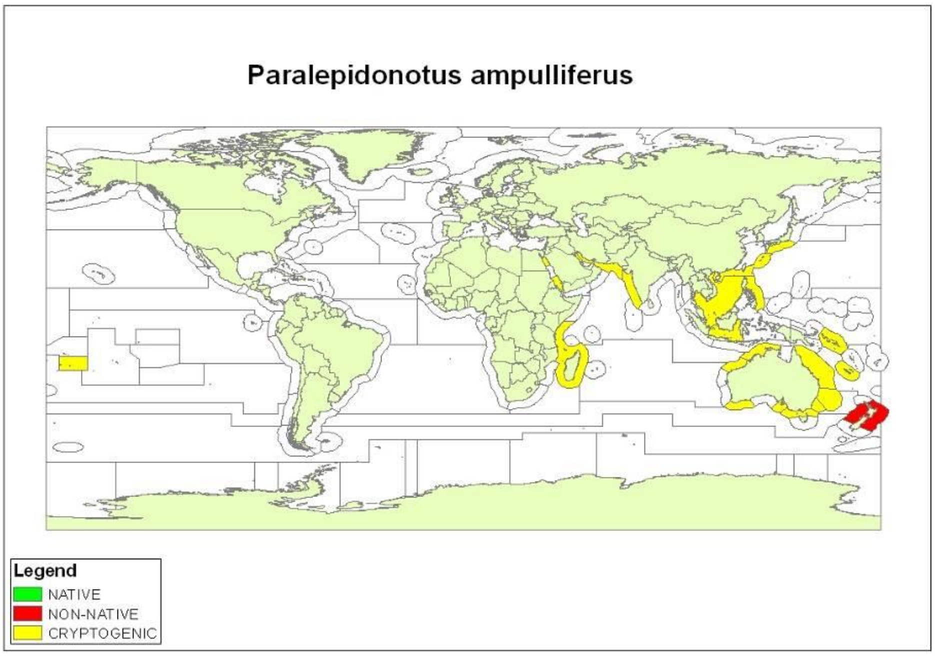

Figure 25: Global distribution of *Paralepidonotus ampulliferus*

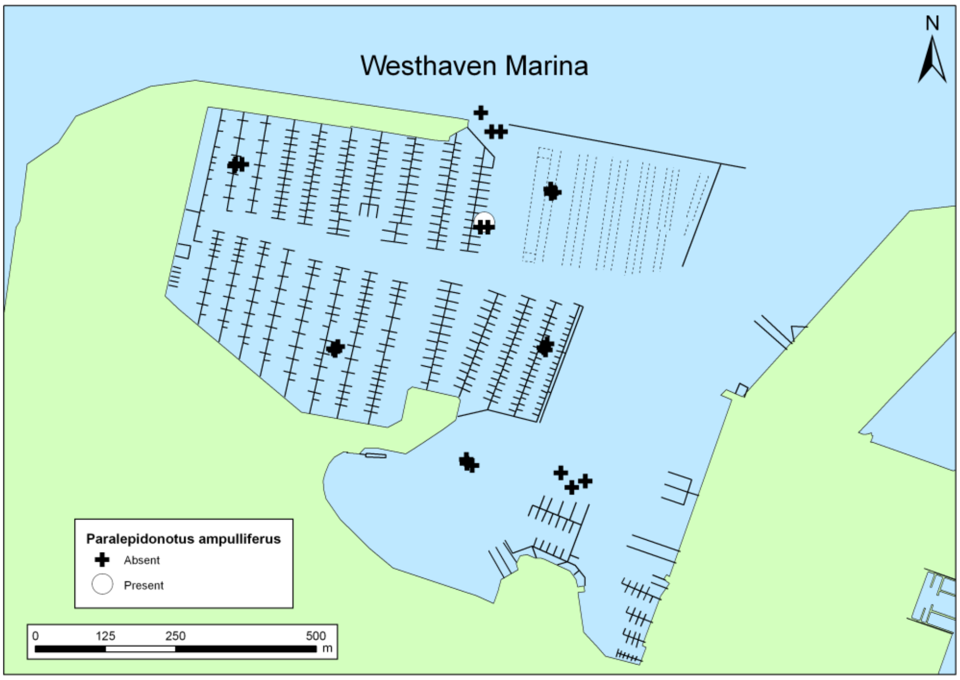

Figure 26: ***Paralepidonotus ampulliferus*** **distribution in the baseline survey of the Westhaven Marina**

Apocorophium acutum (Chevreux, 1908)

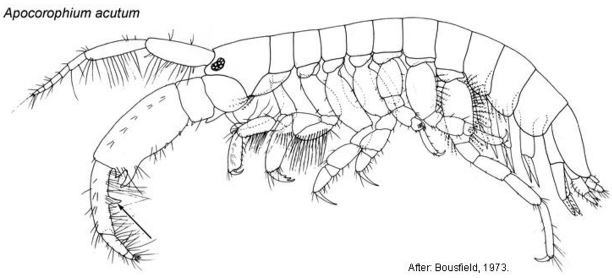

Image and information: Myers *et al*. (2006)

Apocorophium acutum is a corophiid amphipod, known from the Atlantic Ocean (England, France, North America, Brazil, and South Africa), Pacific Ocean (New Zealand) and the Mediterranean Sea (
Figure 27). 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 28), and Opua marinas (Inglis *et al*. 2006a, b, c; Inglis *et al*. 2006g; Inglis *et al*. 2006l, m, n)(Table 12). During the second baseline surveys it was recorded from the ports of Lyttelton, Timaru, Auckland, Bluff, Dunedin, Gisborne, Napier, Whangarei and the Opua, Gulf Harbour and Whangarei Marinas (Inglis *et al*. 2006m; Inglis *et al*. 2006q, u; Inglis *et al*. in press) and this resurvey of Westhaven Marina (

Figure 28; Table 10; Table 12).

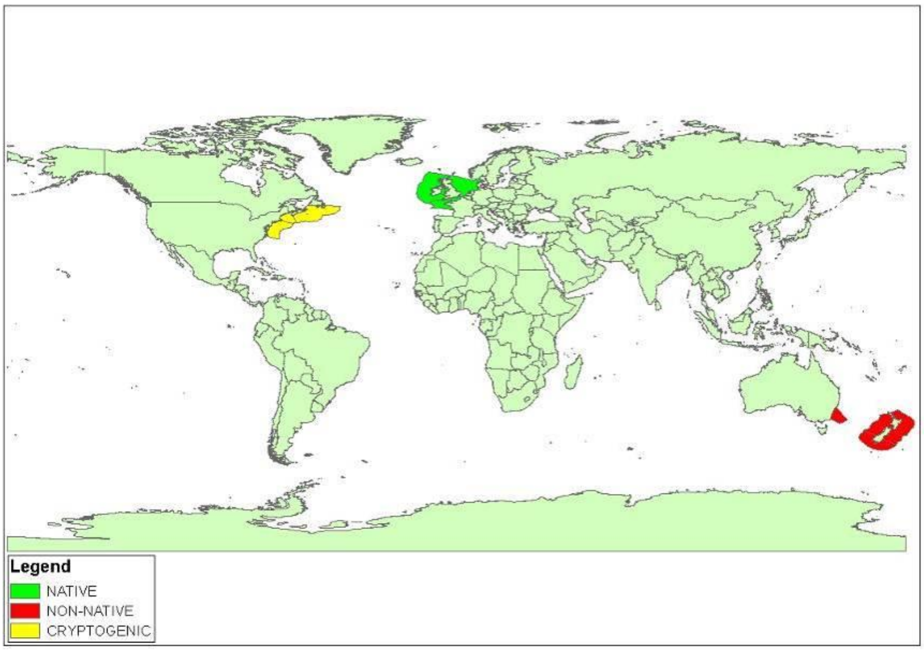

Figure 27: Global distribution of *Apocorophium acutum*

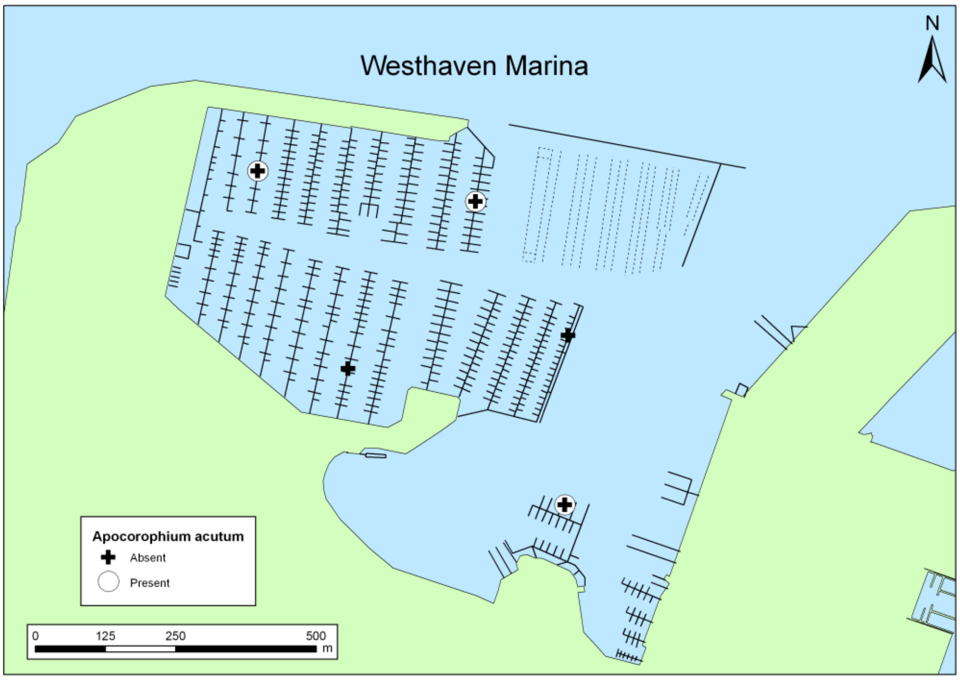

Figure 28: *Apocorophium acutum* distribution in the baseline survey of the Westhaven Marina

***Charybdis japonica* (A. Milne-Edwards, 1861)**

Image and information:
Gust and Inglis (In Press)

Charybdis japonica is a large (max. carapace width ~ 10 cm) portunid (paddle) crab that was first discovered in New Zealand, in Waitemata Harbour in September 2000. It is native to the north-west Pacific, including coastal regions of China, Malaysia, Korea, Taiwan and Japan (Figure 29). Carapace colouration is variable, but can include a yellow-brown marbled shell or a dark shell with blue and red flashes on the ventral surfaces and legs. Adult crabs occupy a range of habitats in sub-tidal coastal areas and estuaries. In its native range, juvenile *C. japonica* are commonly found in tide pools in the rocky intertidal zone. Trapping surveys of the Waitemata population showed that *C. japonica* had spread widely throughout a range of habitats in the Harbour (Gust and Inglis *In press*). Delimitation surveys undertaken in late 2002 showed that it was abundant in the Waitemata Harbour and two nearby estuaries (the Tamaki and Weiti), but there was no evidence of its spread to other shipping ports nationwide. As a key estuarine predator, *C. japonica* is likely to have significant impacts on native estuarine benthic assemblages, particularly small bivalves.

C. japonica was recorded in the Port of Auckland in both the initial and resurvey (Inglis *et al*. 2005), and in this survey of Westhaven Marina (Figure **30**; Table 10; Table 12).

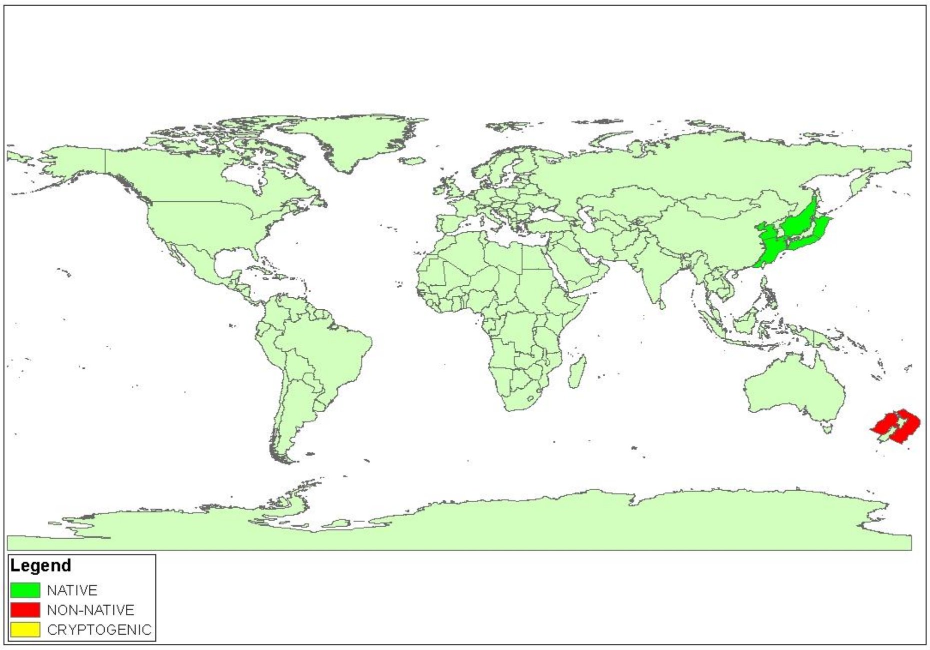

Figure 29: Global distribution of *Charybdis japonica*

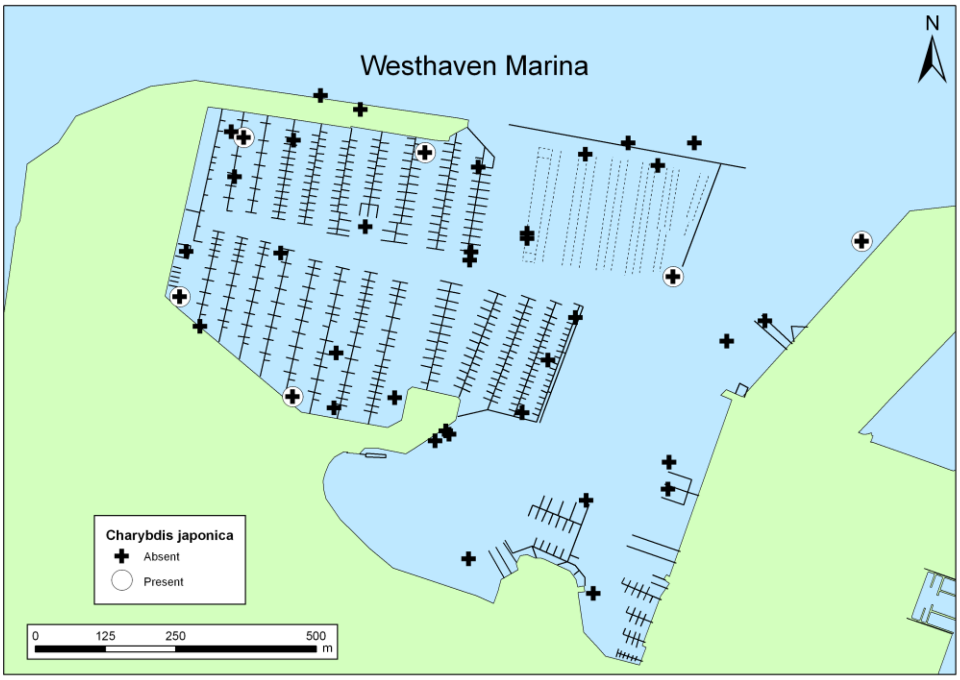

Figure 30: *Charybdis japonica* distribution in the baseline survey of the Westhaven Marina

***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 (

Figure 31). 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, Taranaki, Opua, Otago, Picton, Tauranga, Wellington, Waitemata Harbour (Floerl *et al*. 2008) and in the survey of Westhaven Marina (
Figure 32; Table 10; Table 12).

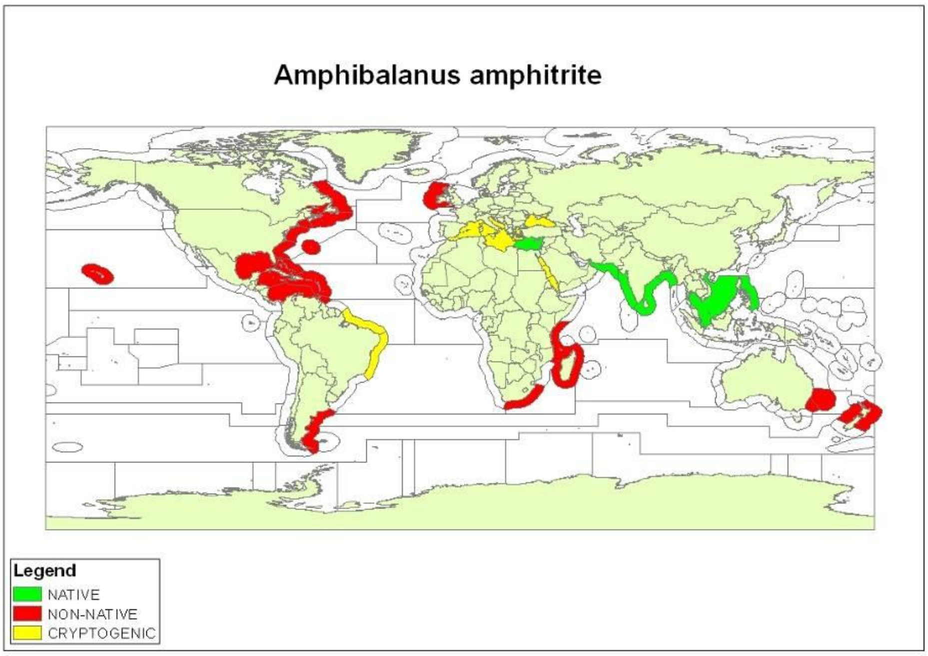

Figure 31: Global distribution of *Amphibalanus amphitrite*

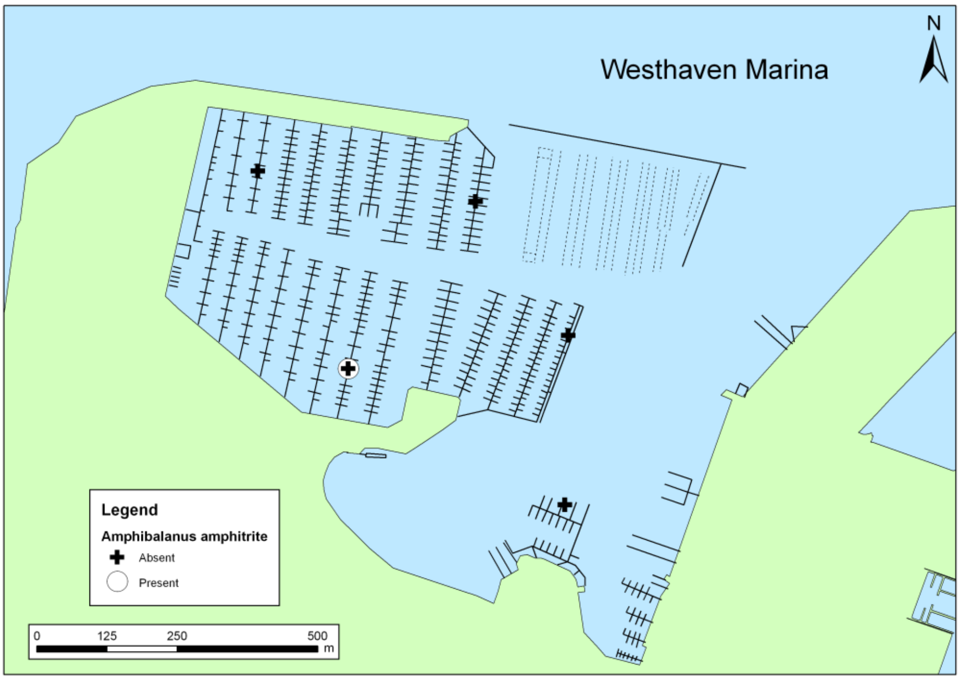

Figure 32: ***Amphibalanus amphitrite*** **distribution in the baseline survey of the Westhaven Marina**

Bugula flabellata (Thompson in Gray, 1848)

Image and information: NIMPIS (2002b)

Bugula flabellata is an erect bryozoan with broad, flat branches. It is a colonial organism and consists of numerous ‘zooids’ connected to one another. It is pale pink and can grow to about 4 cm high and attaches to hard surfaces such as rocks, pilings and pontoons or the shells of other marine organisms. It is often found growing with other erect bryozoan species such as *B. neritina* (see below) or growing on encrusting bryozoans. Vertical, shaded, sub-littoral rock surfaces also form substrata for this species. It has been recorded down to 35 m. *Bugula flabellata* is native to the British Isles and North Sea and has been introduced to Chile, Florida and the Caribbean and the northern east and west coasts of the USA, as well as Australia and New Zealand. It is cryptogenic on the Atlantic coasts of Spain, Portugal and France (Figure 33). *Bugula flabellata* is a major fouling bryozoan in ports and harbours, particularly on vessel hulls, pilings and pontoons and has also been reported from offshore oil platforms. *Bugula flabellata* has been present in New Zealand since at least 1949 and is present in most New Zealand ports. There have been no recorded impacts from *B. flabellata.*

During the initial port baseline surveys it was recorded from Opua marina, Whangarei, Tauranga, Napier, Taranaki, Wellington, Picton, Nelson, Lyttelton, Timaru, Dunedin Bluff and the ports of Auckland (Table 12). During the second baseline surveys of *B. flabellata* was recorded from the ports of Opua, Whangarei, Auckland, Tauranga, Gisborne, Taranaki, Wellington, Picton, Nelson, Lyttelton, Timaru, Dunedin, Bluff (Inglis *et al*. 2006c; Inglis *et al*. 2006g; Inglis *et al*. 2006h; Inglis *et al*. 2006i; Inglis *et al*. 2006j, k, l, m, n, o) and in this initial survey of Westhaven Marina (Figure 34; Table 10; Table 12)

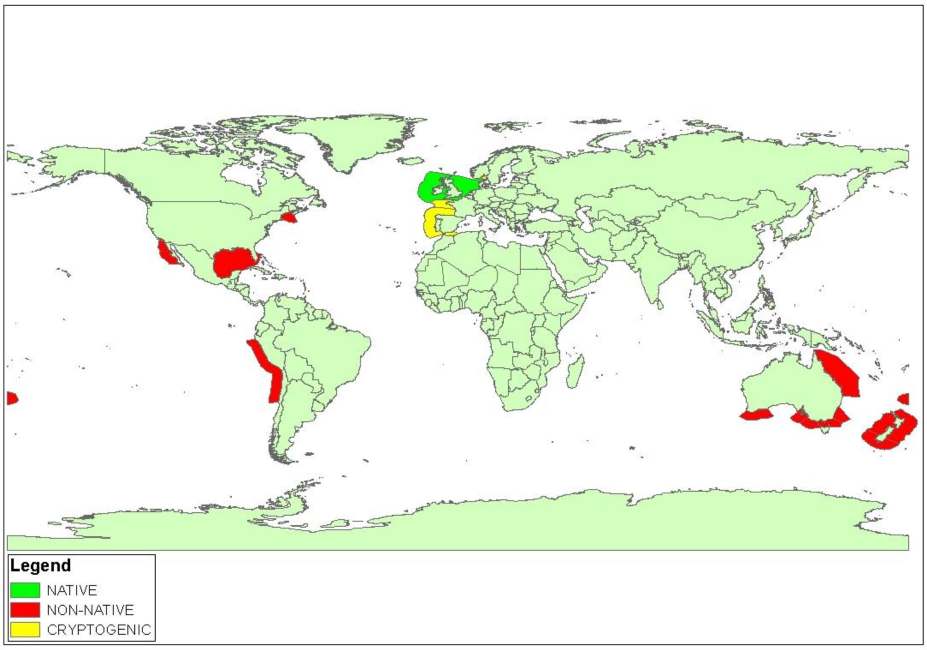

Figure 33: Global distribution of *Bugula flabellata*

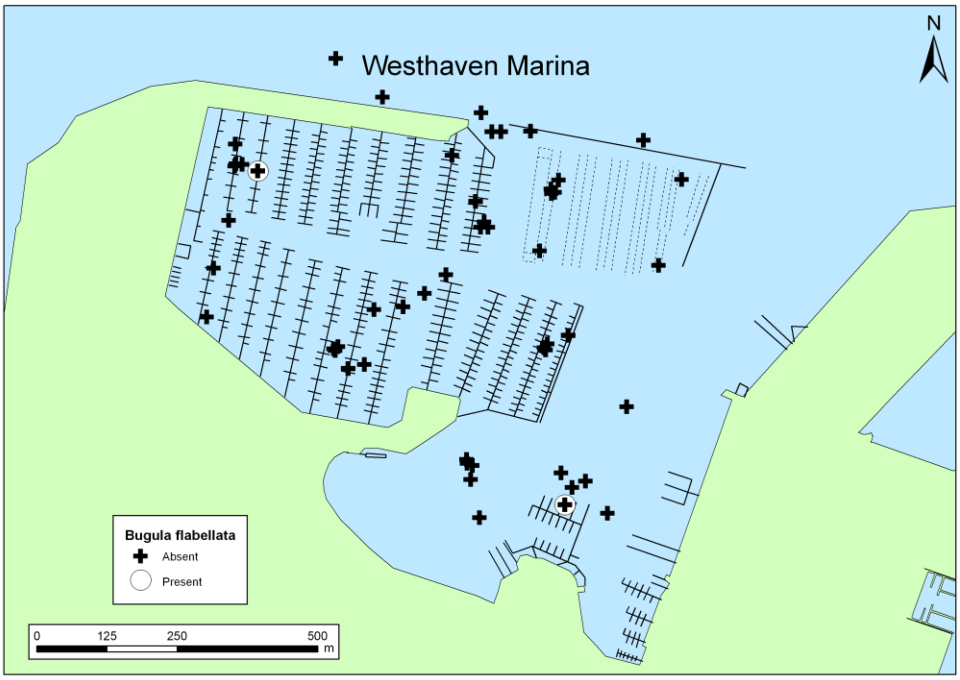

Figure 34: *Bugula flabellata* distribution in the baseline survey of the Westhaven Marina

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

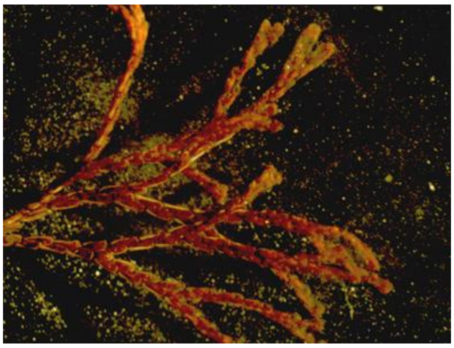

Image and information: NIMPIS (2002c)

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. It has been introduced to most of North America, Hawaii, India, the Japanese and China Seas, Australia and New Zealand (
Figure 35). 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, Whangarei Harbour (Marsden Point, Whangarei Port and Town Basin marina), and the ports of Tauranga, Taranaki, Napier, Gisborne, Lyttelton, Timaru and Dunedin (Inglis *et al*. 2006a, b, c, f; Inglis *et al*. 2006g; Inglis *et al*. 2006h, k, l, m, o). In the repeat baseline surveys it was recorded from Opua, Whangarei, Gulf Harbour Marina, Gisborne, Tauranga, Taranaki, Picton, Lyttelton, Timaru, Dunedin, Napier (Inglis *et al*. 2006q, r, s, t, u) and in this initial survey of Westhaven Marina (
Figure 36; Table 10; Table 12)

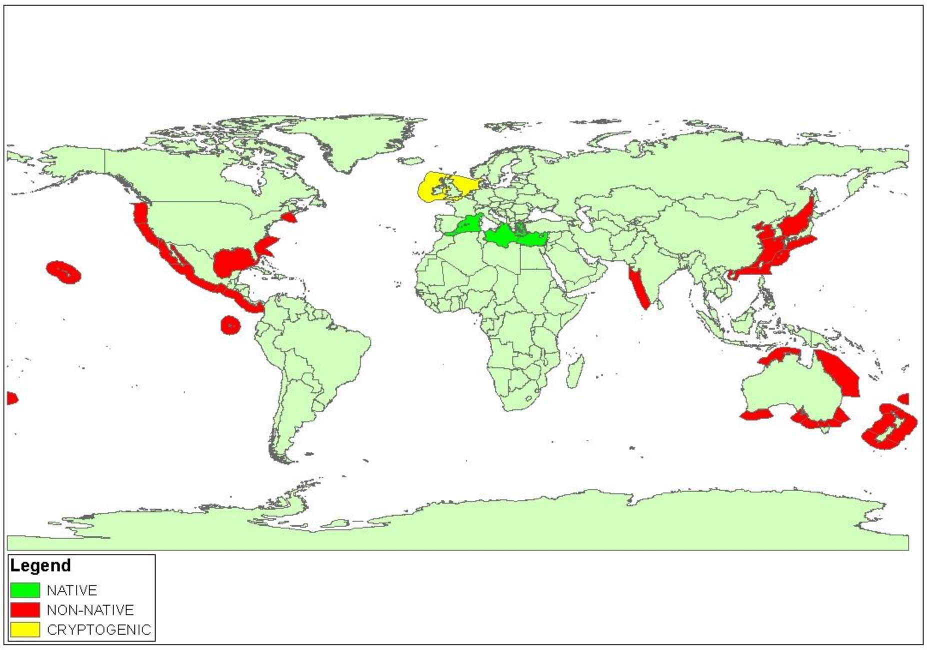

Figure 35: Global distribution of *Bugula neritina*

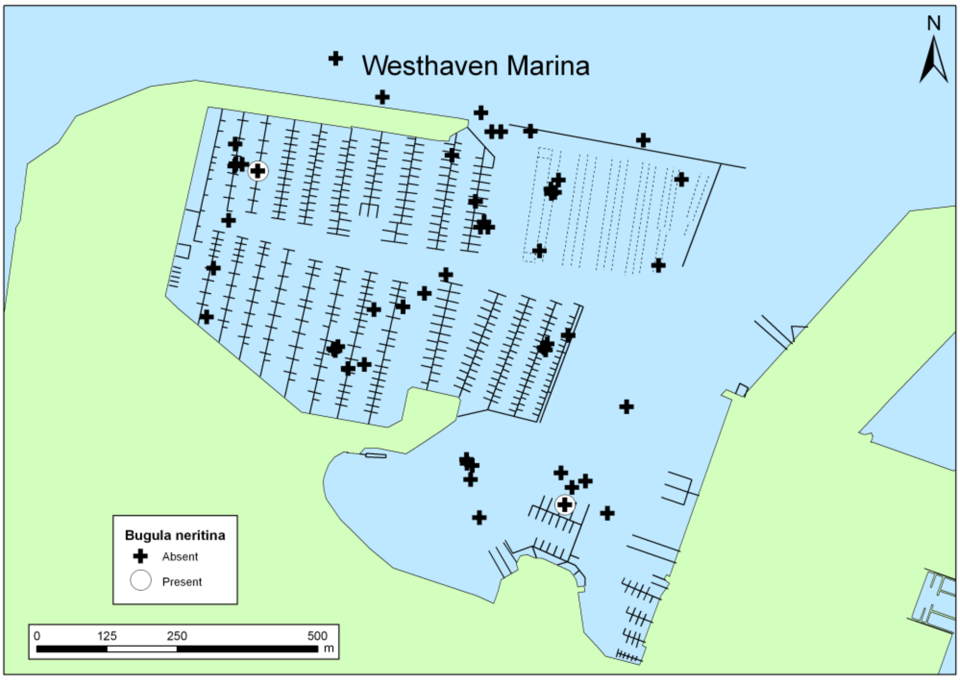

Figure 36: *Bugula neritina* distribution in the baseline survey of the Westhaven Marina

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).

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.

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 37). 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 Taranaki, Whangarei and Whangarei Marina (Inglis *et al*. 2006k, o) and in the second survey of Gisborne, Napier, Opua, Whangarei Harbour, Viaduct Harbour Marina, Gulf Harbour Marina (Inglis *et al*, in press) and in this survey of Westhaven Marina (
Figure 38; Table 10; Table 12).

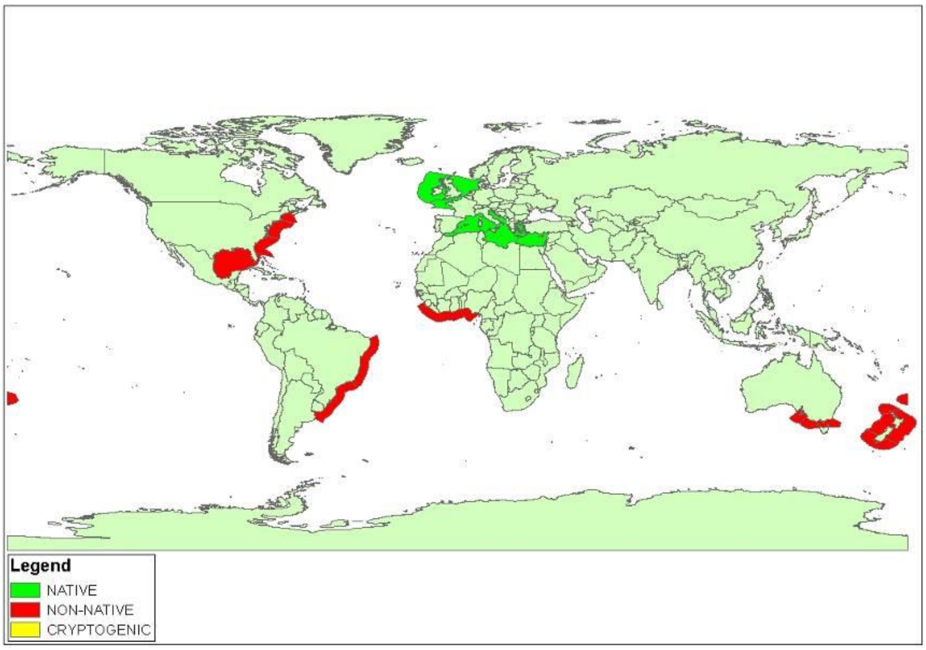

Figure 37: Global distribution of *Bugula stolonifera*

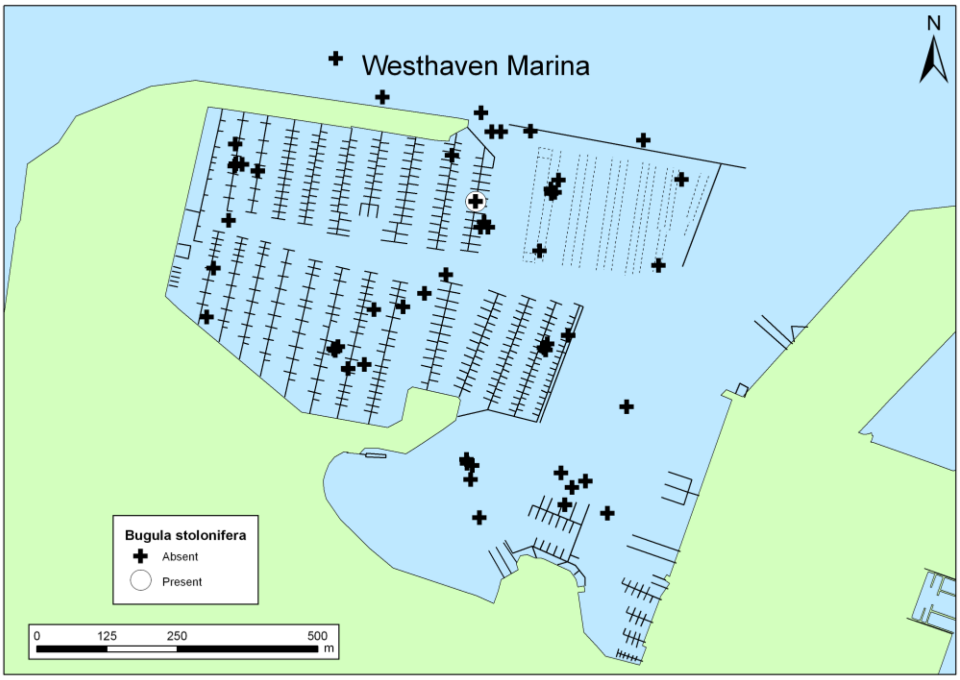

Figure 38: *Bugula stolonifera* distribution in the baseline survey of the Westhaven Marina

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 39). *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 recorded from Nelson, Whangarei Harbour and the Gulf Harbour Marinas (Inglis *et al*. 2006i; Inglis *et al*. 2006p); (Inglis *et al*. 2006o)). During the repeat surveys *S. errata* was recorded in the Gulf Harbour Marina, Viaduct Harbour Marnia and Opua Marina, Whangarei Port and in this survey of the Westhaven Marina (Inglis *et al.* in press;
Figure 40; Table 10; Table 12).

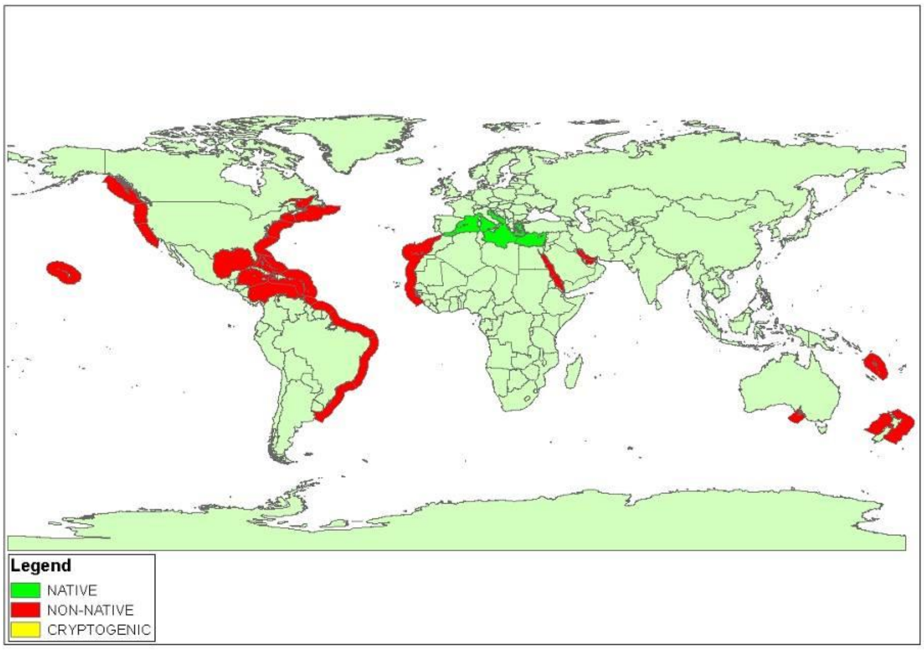

Figure 39: Global distribution of *Schizoporella errata*

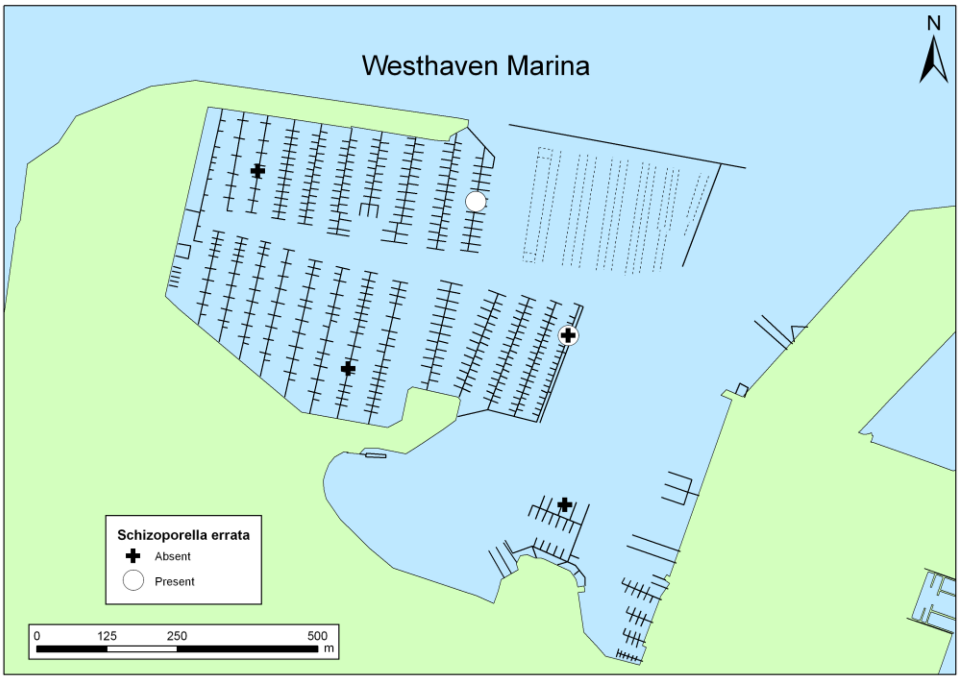

Figure 40: *Schizoporella errata* distribution in the baseline survey of the Westhaven Marina

Tricellaria catalinensis (Robertson, 1905)

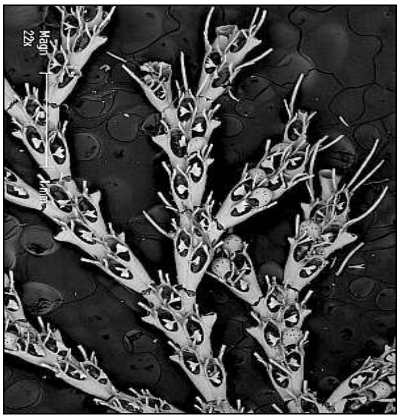

Image: Bock (2004)

Tricellaria catalinensis is an erect bryozoan composed of unilaminar branches branching dichotomously with anchoring rhizoids. Colonies are cream to buff coloured (Dyrynda *et al*. 2000).

The type locality of *T. catalinensis* is Venice, Italy. An assessment of samples and literature from various global regions by Dyrynda *et al*. (Dyrynda et al.) . (2000) suggests that Atlantic and Adriatic T. catalinensis correspond with a morphospecies known to be invasive in New Zealand, and cryptogenic in Pacific North America, Japan and Australia (
Figure 41). The morphospecies in question has usually been referred to as *T. occidentalis* (Trask, 1857) and, in at least one instance, as *T. porteri* (MacGillivray, 1889) (see Dyrynda *et al*. 2000). A more precise identification of its source region is not possible due to its widespread Pacific distribution and the possibility of anthropogenic dispersal there in historical times (Dyrynda *et al*. 2000).

Tricellaria catalinensis is found within ports and marinas, and on natural shores. It is able to tolerate a range of salinities (i.e., 20-35 ppt) and inhabit brackish waters *ADDIN EN.CITE <EndNote><Cite><Author>Dyrynda</Author><Year>2000</Year><RecNum>85</RecNum><record><rec-number>85</rec-number><ref-type name="Journal Article">17</ref-type><contributors><authors><author>Dyrynda, P.E.J</author><author>Fairall, V.R</author><author>d'Hondt, J.L</author><author>Occhipinti Ambrogi, A</author></authors></contributors><titles><title><style face="normal" font="default" size="100%">The distribution, origins and taxonomy of </style><style face="italic" font="default" size="100%">Tricellaria inopinata</style><style face="normal" font="default" size="100%"> d'Hondt & Occhipinti Ambrogi, 1985, an invasive bryozoan new to the Atlantic</style></title><secondary-title>Journal of Natural History</secondary-title></titles><periodical><full-title>Journal of Natural History</full-title></periodical><pages>1993-2006</pages><volume>34</volume><dates><year>2000</year></dates><urls></urls></record></Cite></EndNote>* *(Dyrynda et al. 2000) . It is usually found within the infralittoral fringe, favouring strong currents and brackish salinities, and is well represented within fouling assemblages colonizing a wide range of anthropogenic and natural substrata. Tricellaria catalinensis* is a filter feeder.

Tricellaria catalinensis was listed (as *T. occidentalis*) as a medium priority domestic pest in Australia by Hayes *et al*. (2004). They ranked it 17th of 53 species in its impact potential (Hayes *et al*. 2005a). *Tricellaria catalinensis* is a prolific fouling species with a high reproductive output. It has documented impacts on the abundance of native bryozoan species;

for example, the invasion of *T. catalinensis* in Laguna di Venezia (Italy) resulted in a sharp decline in the abundance of native bryozoans whose populations had been stable prior to its introduction(Occhipinti Ambrogi 2000). It is known to foul mussel byssal threads (Occhipinti Ambrogi 2000). In Japan, it is known to be a vigorous colonizer of set nets and boat hulls (Dyrynda *et al*. 2000). The most likely pathway for introduction to a new location is through attachment to ships, pathways for dispersal within New Zealand include attachment to navigation buoys and marina floats, through translocations of fish or shellfish, through fishery products, packing or substrate and naturally through planktonic dispersal and rafting of adults on biogenic substrata.

T. catalinensis was first documented in New Zealand in 1964 (as *T. occidentalis*, (Gordon and Mawatari 1992)). It has been recorded from Whangarei, Auckland, Tauranga, Gisborne, Napier, Porirua Harbour, Tarakohe, Pelorus Sound, Nelson and Lyttelton (Gordon and Mawatari 1992) . During the initial port baseline surveys, it was recorded from Whangarei (Marsden Point), Gisborne, Taranaki and Lyttelton, from the second survey of the ports of Picton and Gisbrone, the survey of Viaduct Harbour Marina, (Inglis *et al*. 2006f; Inglis *et al*. 2006g; Inglis *et al*. 2006k, o; Inglis *et al*. 2006r) and in this survey of Westhaven Marina (Figure 42; Table 10; **REF _Ref136672234 \h * MERGEFORMAT Table 12).**

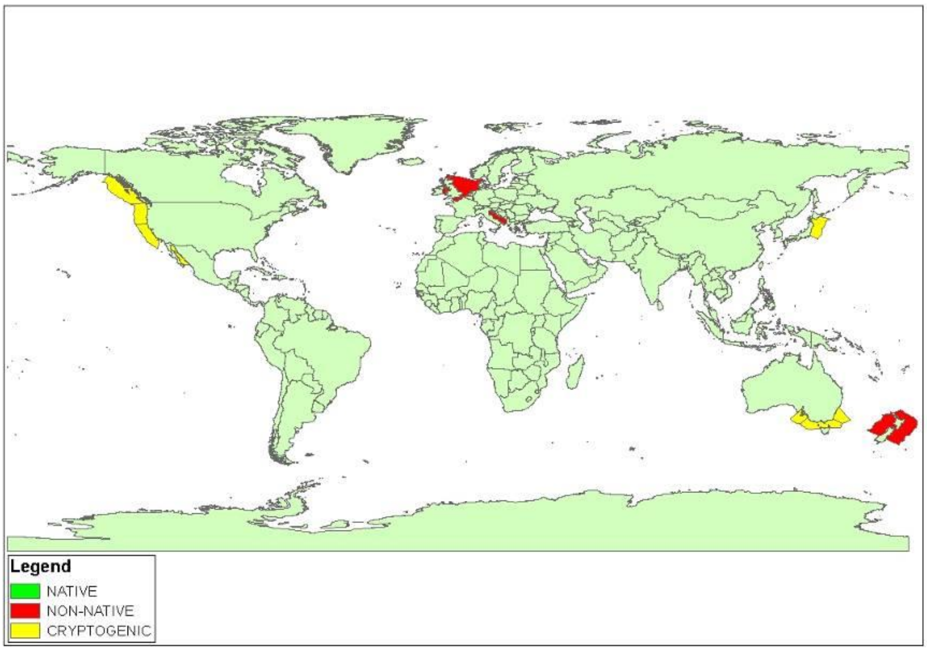

Figure 41: Global distribution of *Tricellaria catalinensis*

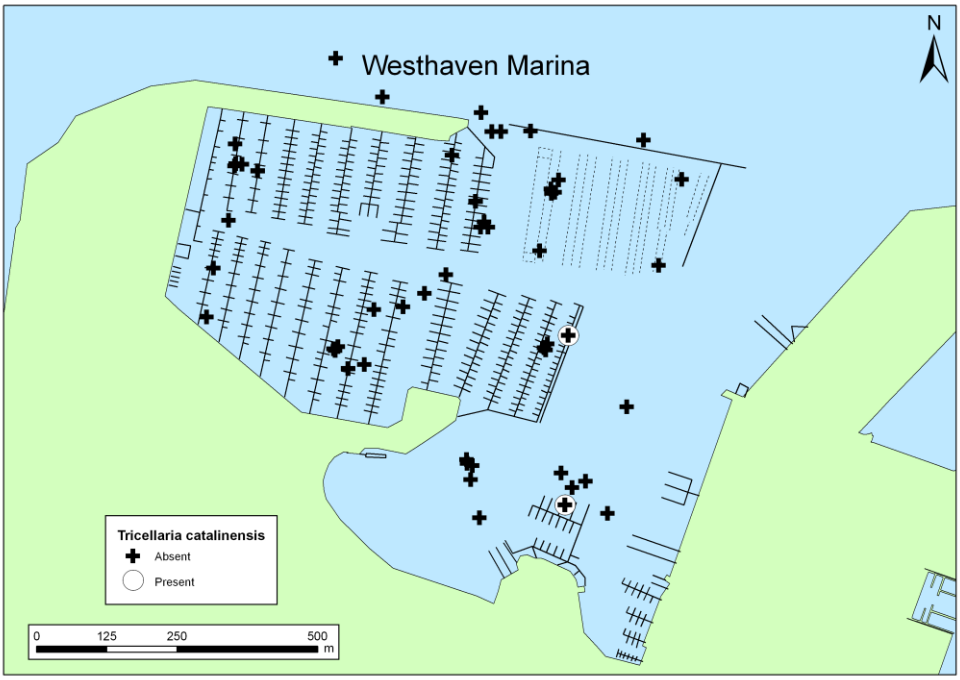

Figure 42: **Tricellaria catalinensis distribution in the baseline survey of the Westhaven Marina**

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

Image: (Hill 2001)

Bowerbankia gracilis is a pale yellow to tan-coloured encrusting bryozoan. Zooids are almost transparent, cylindrical and disjunct ADDIN EN.CITE <EndNote><Cite><Author>Gordon</Author><Year>1992</Year><RecNum>97</RecNum><record><rec-number>97</rec-number><ref-type name="Generic">13</ref-type><contributors><authors><author>Gordon, DP</author><author>Mawatari, SF</author></authors></contributors><titles><title>Atlas of marine fouling bryozoa of New Zealand Ports and Harbours. Miscellaneous Publications of the New Zealand Oceanographic Institute Vol 107</title></titles><pages>1-52</pages><dates><year>1992</year></dates><publisher>New Zealand Oceanographic Institute</publisher><urls></urls></record></Cite></EndNote> (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 ADDIN EN.CITE <EndNote><Cite><Author>Gordon</Author><Year>1992</Year><RecNum>97</RecNum><record><rec-number>97</rec-number><ref-type name="Generic">13</ref-type><contributors><authors><author>Gordon, DP</author><author>Mawatari, SF</author></authors></contributors><titles><title>Atlas of marine fouling bryozoa of New Zealand Ports and Harbours. Miscellaneous Publications of the New Zealand Oceanographic Institute Vol 107</title></titles><pages>1-52</pages><dates><year>1992</year></dates><publisher>New Zealand Oceanographic Institute</publisher><urls></urls></record></Cite></EndNote> (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.

As well as fouling on structures, B. gracilis can settle on cultivated species and consequently have a deleterious impact on the aquaculture industry ADDIN EN.CITE <EndNote><Cite><Author>Soule</Author><Year>1977</Year><RecNum>973</RecNum><record><rec-number>973</rec-number><ref-type name="Book Section">5</ref-type><contributors><authors><author>Soule, J.D., & Soule, D.F.</author></authors><secondary-authors><author>Woollacott, RM, & Zimmer, RL. </author></secondary-authors></contributors><titles><title>Fouling and bioadhesion: Life strategies of bryozoans.</title><secondary-title>Biology of Bryozoans</secondary-title></titles><pages>437-457</pages><keywords><keyword>Bryozoa</keyword></keywords><dates><year>197

7</year></dates><pub-location>New York</pub-location><publisher>Academic Press</publisher><urls></urls></record></Cite></EndNote> (Soule 1977) . Additionally, this species has the potential to out-compete native species and disrupt species assemblages.

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 43). *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, Gulf Harbour Marina, Viaduct Harbour Marina (Inglis *et al.* in press) and in this survey of Westhaven Marina (* MERGEFORMAT ; Table 12).

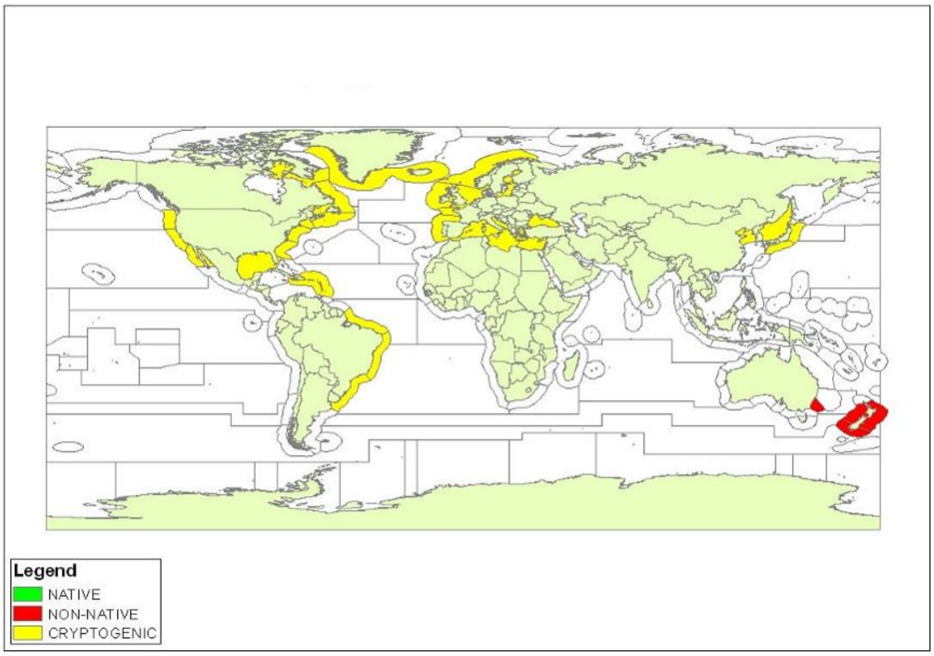

Figure SEQ Figure * ARABIC 43 : Global distribution of Bowerbankia gracilis

Figure SEQ Figure * ARABIC 44 : Bowerbankia gracilis distribution in the baseline
SEQ Figure * ARABIC 44 : Bowerbankia gracilis distribution in the baseline survey of the Westhaven Marina
Bowerbankia gracilis distribution in the baseline survey of the Westhaven Marina
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Zoobotryon verticillatum (Delle Chiaje, 1828)
(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 (ADDIN EN.CITE <EndNote><Cite><Author>Gordon</Author><Year>1992</Year><RecNum>97</RecNum><record><rec-number>97</rec-number><ref-type name="Generic">13</ref-type><contributors><authors><author>Gordon, DP</author><author>Mawatari, SF</author></authors></contributors><titles><title>Atlas of marine fouling bryozoa of New Zealand Ports and Harbours. Miscellaneous Publications of the New Zealand Oceanographic Institute Vol 107</title></titles><pages>1-52</pages><dates><year>1992</year></dates><publisher>New Zealand Oceanographic Institute</publisher><urls></urls></record></Cite></EndNote> (Gordon and Mawatari 1992) ; REF _Ref221356485 \h * MERGEFORMAT
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Figure 45). 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.

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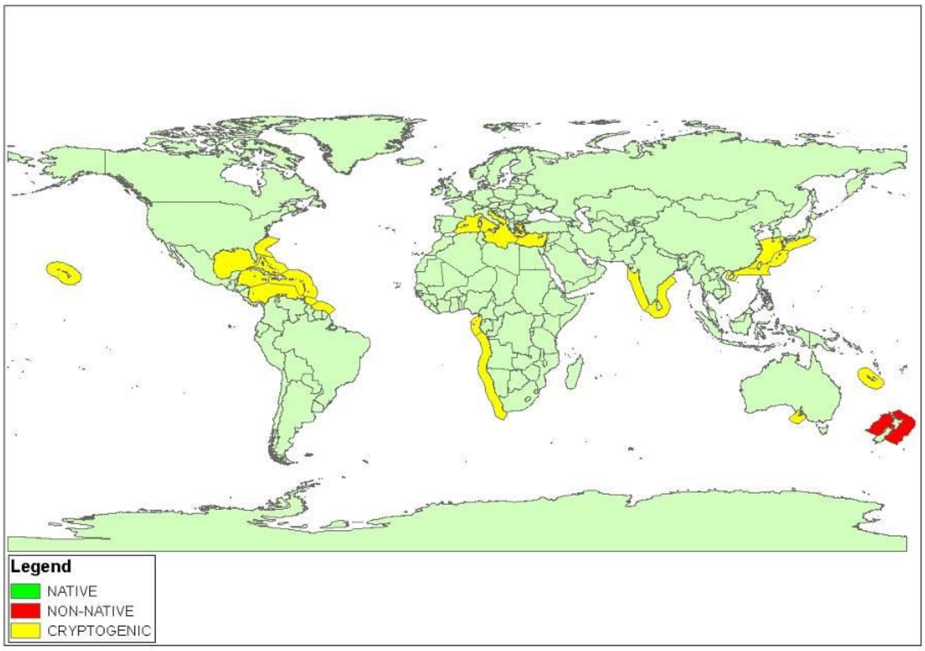
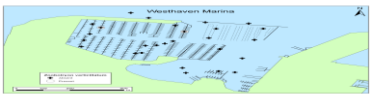
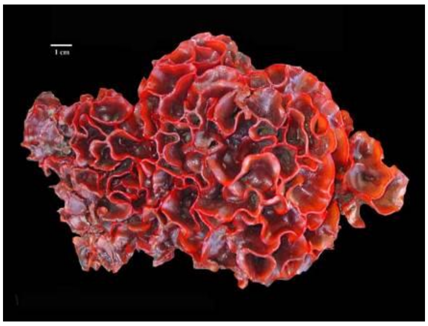


Figure 45: Global distribution of *Zoobotryon verticillatum*



Figure??Error! No sequence specified.**: *Zoobotryon verticillatum* distribution in the baseline survey of the Westhaven Marina**

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



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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. 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 (Figure 46).

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 Matawari 1992). During the initial port baseline surveys, it was recorded from the Opua and Gulf Harbour marinas, Whangarei Harbour (Marsden Point and Whangarei Port) and the ports of Tauranga, Gisborne, Napier, Taranaki, Wellington, Picton, Nelson, Lyttelton, Timaru, Dunedin and Bluff (Inglis *et al*. 2006b, c; Inglis *et al*. 2006g, i; Inglis *et al*. 2006j, k, l, m, n, o). During the repeat baseline surveys *W. subtorquata* was recorded from the ports of Opua, Whangarei, Tauranga, Auckland, Gulf Harbour Marina, Taranaki, Wellington, Picton, Nelson, Lyttelton, Timaru Gisborne, Otago, Bluff (Inglis *et al*. 2006q, r, s, t, u; Inglis *et al*. 2006v; Inglis *et al*. 2006w) and in this initial survey of Westhaven Marina (Figure 47; Table 10; Table 12)

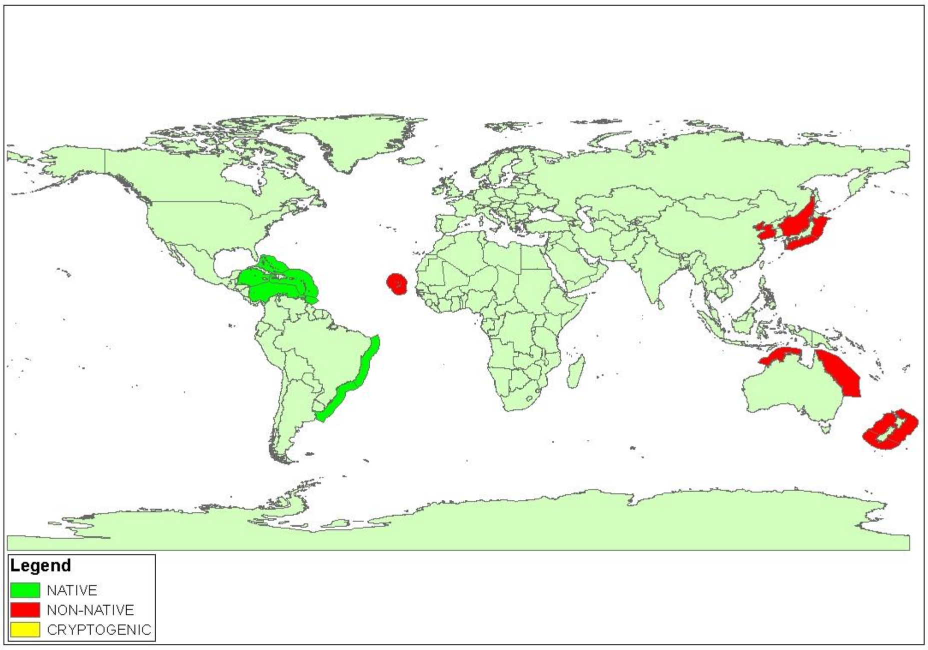

Figure 46: Global distribution of *Watersipora subtorquata*

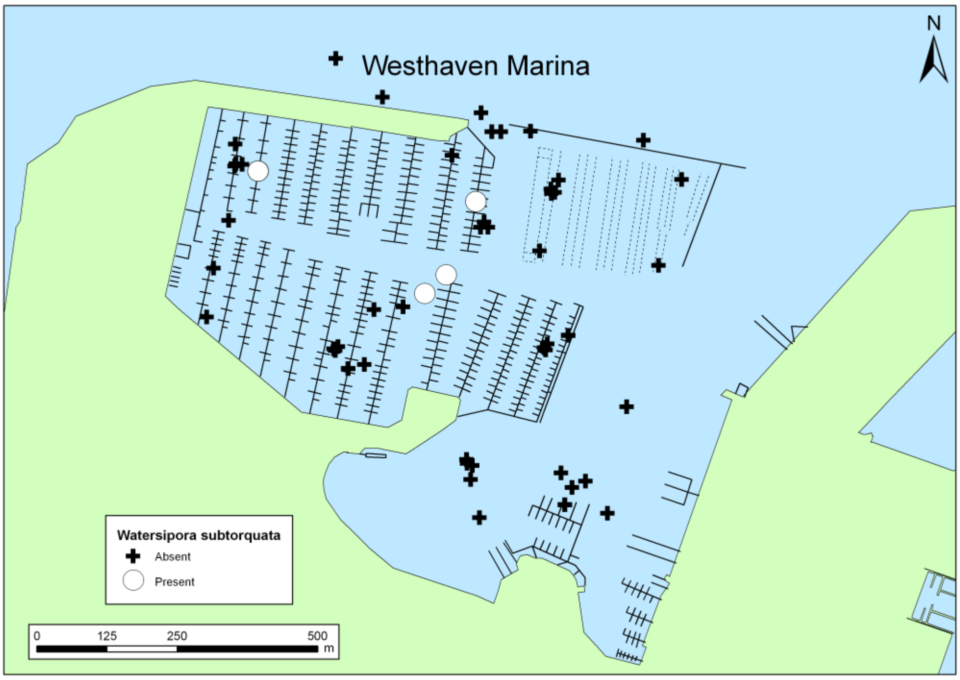

Figure 47: *Watersipora subtorquata* distribution in the baseline survey of the Westhaven Marina

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

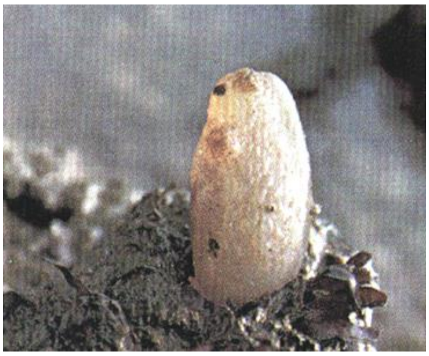

Image and information: NIMPIS (2002a)

Ascidiella aspersa is a solitary ascidian that is native to northwest Europe, the British Isles, the Mediterranean Sea and the northwest African coasts. It has been introduced to India, Australia and New Zealand, and is cryptogenic to the east coast of the USA (
Figure 48). *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 Bluff and Napier, and from Gulf Harbour Marina (Inglis *et al*. 2006b, e, 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 *Ascidiella aspersa* was recorded from the Viaduct Harbour Marina and the Ports of Lyttelton, Dunedin and Bluff, and in this survey of Westhaven Marina (Inglis, *et al* (2006); Inglis in press;
Figure 49; Table 10; Table 12).

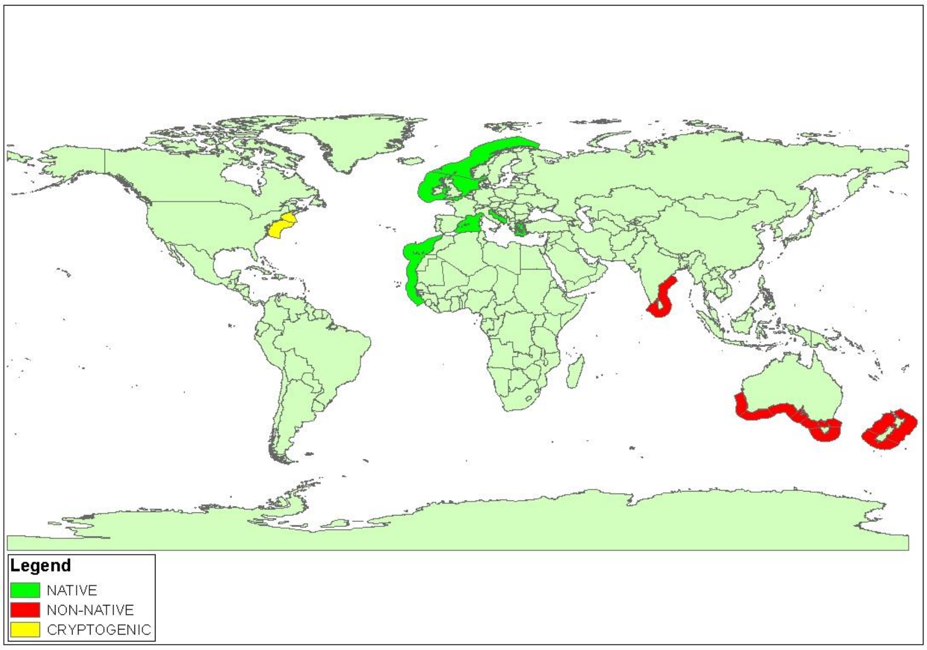

Figure 48: Global distribution of *Ascidiella aspersa*

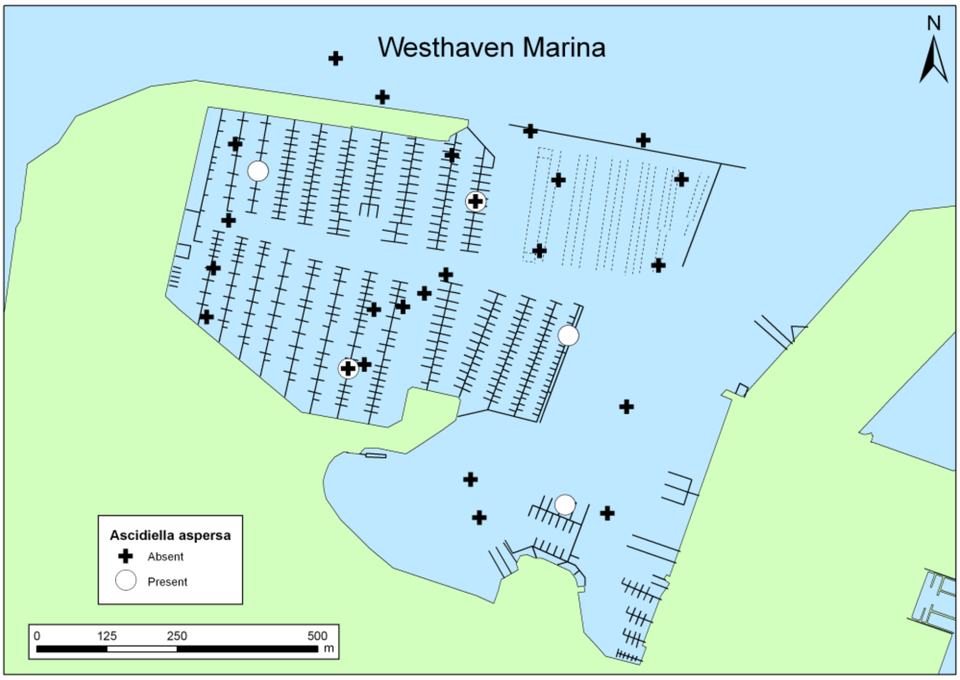

Figure 49: *Ascidiella aspersa* distribution in the baseline survey of the Westhaven Marina

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 50). 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, Taranaki, Whangarei and Taharoa (Inglis *et al*. 2006a, d, h, k, l, p). Since changing status to NIS, *D. listerianum* has been recorded in the resurvey of the ports of Lyttelton, Tauranga, Dunedin, Auckland, Bluff, Napier, Whangarei, Viaduct Harbour Marina, Gulf Harbour Marina (Inglis *et al*. 2006q, t), Inglis in press.) and in this survey of Westhaven Marina (Figure 51; Table 10; Table 12).

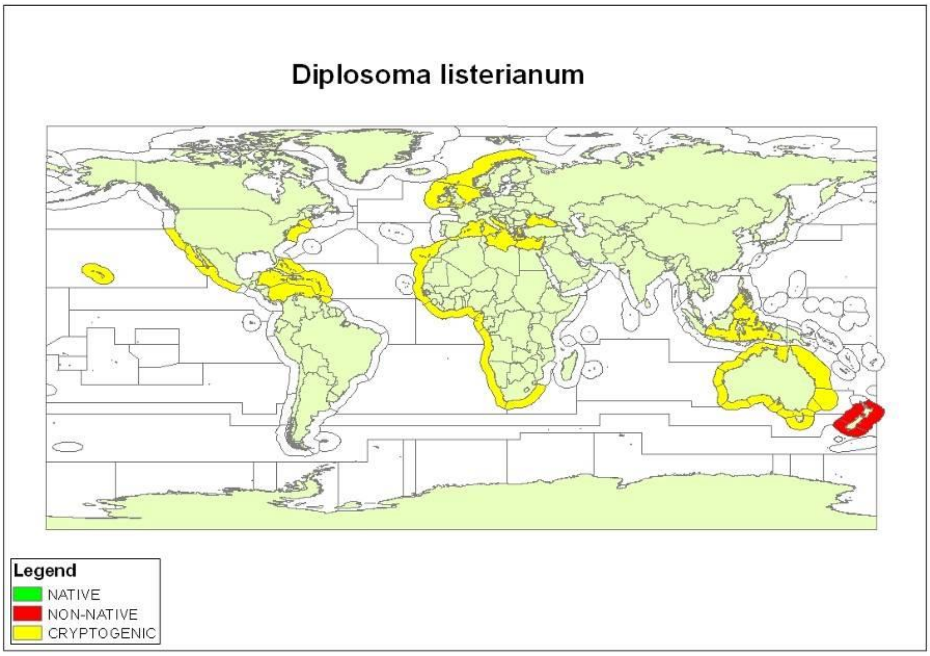

Figure 50: Global distribution of *Diplosoma listerianum*

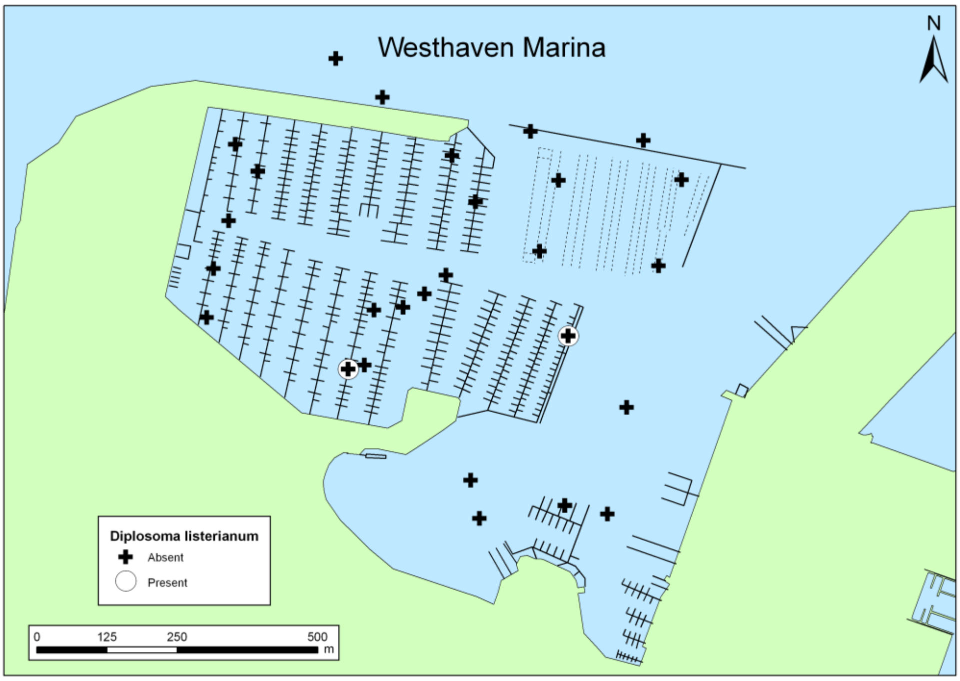

Figure 51: *Diplosoma listerianum* distribution in the baseline survey of the Westhaven Marina.

Botryllus tuberatus (Ritter & Forsyth, 1917)

Image: (DORIS 2008)

Botryllus tuberatus is an encrusting ascidian which forms a thin crust over rocks and other substrates. The individual zooids are of pinhead size and of a pale yellow colour; they are arranged in elliptical patterns. (Hinton 1988). *B. tuberatus* prefers quiet bay waters and has been collected on *Ulva reticulate* (Monniot and Monniot 2001).

The type locality for *B. tuberatus* is California but this is a very common ascidian and is distributed worldwide (Monniot and Monniot 2001) (
Figure 52). In New Zealand *B. tuberatus* has been recorded in Wellington. In the port baseline surveys *B. tuberatus* has only been recorded from Viaduct Harbour Marina (Inglis *et al*. in press) and from this survey of Westhaven Marina (
Figure 53 Table 10; Table 12).

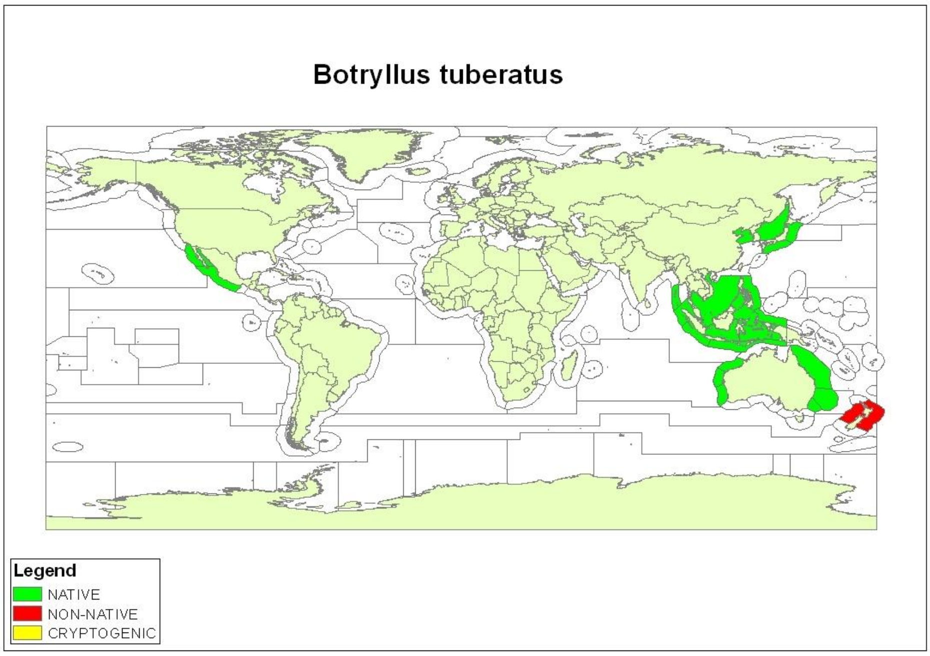

Figure 52: Global distribution of *Botryllus tuberatus*

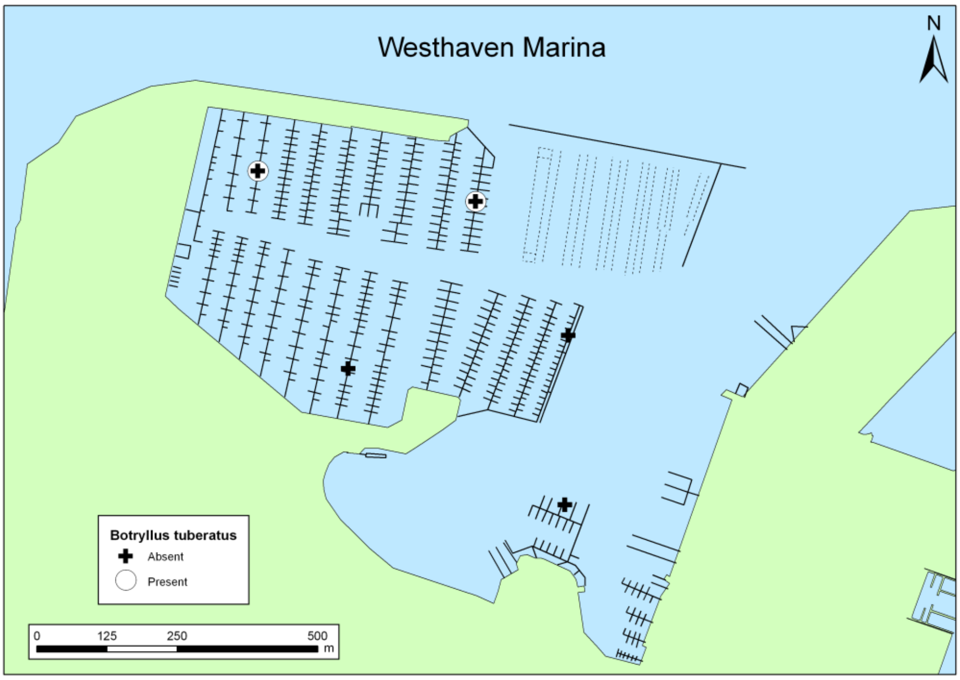

Figure 53: ***Botryllus tuberatus*** **distribution in the baseline survey of the Westhaven Marina.**

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 54). 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 15ºC 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 Auckland, Gulf Harbour Marina, Lyttelton (Inglis *et al*. 2006q); Inglis *et al.* in press) and in this initial survey of Viaduct Harbour and Westhaven Marina (
Figure 55; Table 10; Table 12).

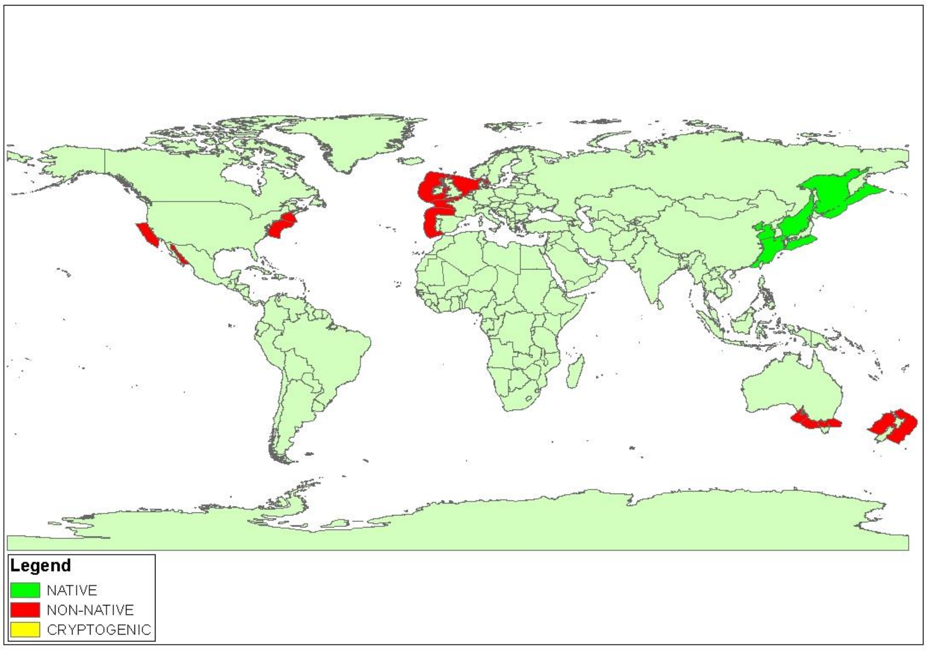

Figure 54: Global distribution of *Styela clava*

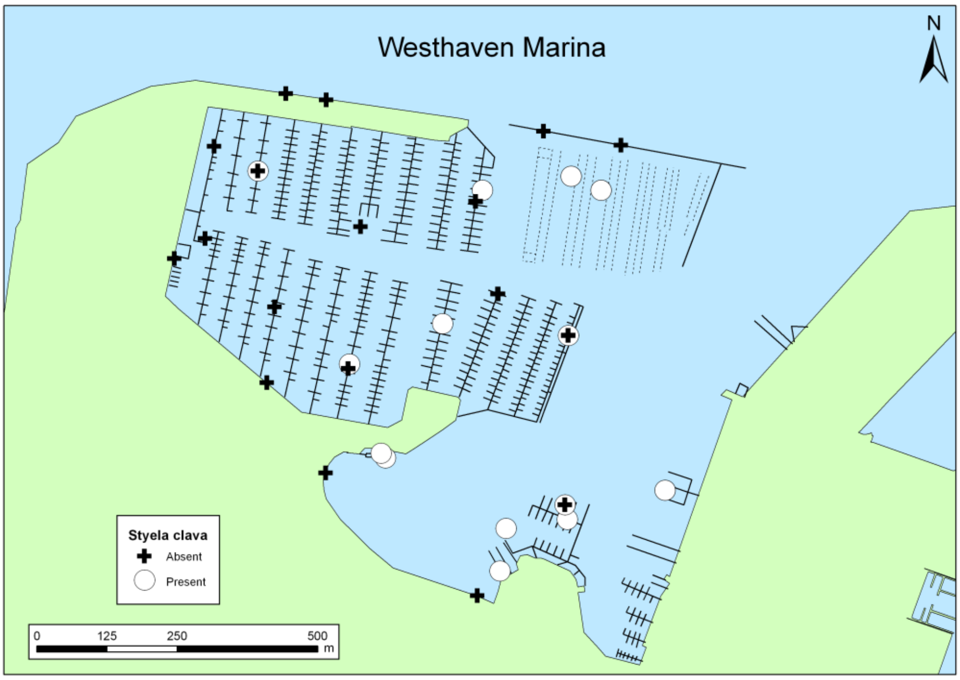

Figure 55: *Styela clava* distribution in the baseline survey of the Westhaven Marina

***Pennaria disticha* (Goldfuss, 1820)**

Image and information: Eldredge and Smith (2001)

Pennaria disticha is a hydroid that forms large colonies as tall as 30 cm, with dark brown to black stems and branches. The branches are usually overgrown with diatoms and algae, making them appear muddy brown. The branching is alternate. The polyps at the tip of the branches are white with a reddish tinge. *Pennaria disticha* lives attached to artificial and natural hard substrates where there is some water movement. It is a very common fouling organism in harbours and commonly found on reefs usually in more protected areas or in cracks and crevices. The native range of *P. disticha* is thought to be the north east Atlantic, but it now occurs in tropical and subtropical seas around the world (Cranfield *et al*. 1998) (Figure 56). Its impacts on native organisms are unknown.

It has been present in New Zealand since at least 1928 (Cranfield *et al*. 1998). During the initial port baseline surveys it was recorded in the Port of Auckland (Inglis *et al*. 2005). In the second baseline surveys it was reported in Auckland, Dunedin, Viaduct Harbour Marina, Bluff, the Kaikoura area and in this survey of Westhaven Marina (Inglis in press; Figure 57; Table 10; Table 12).

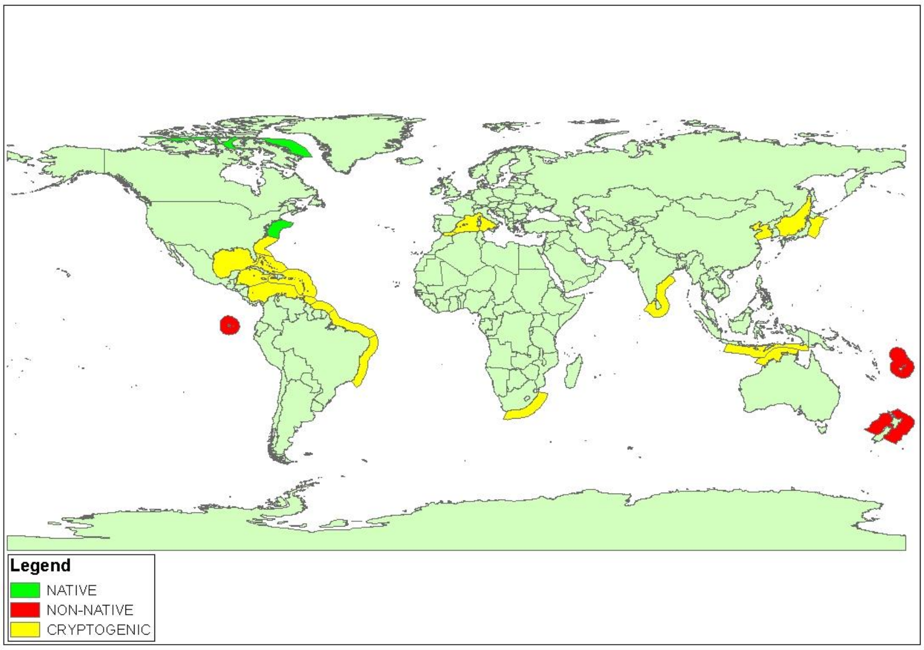

Figure 56: Global distribution of *Pennaria disticha*

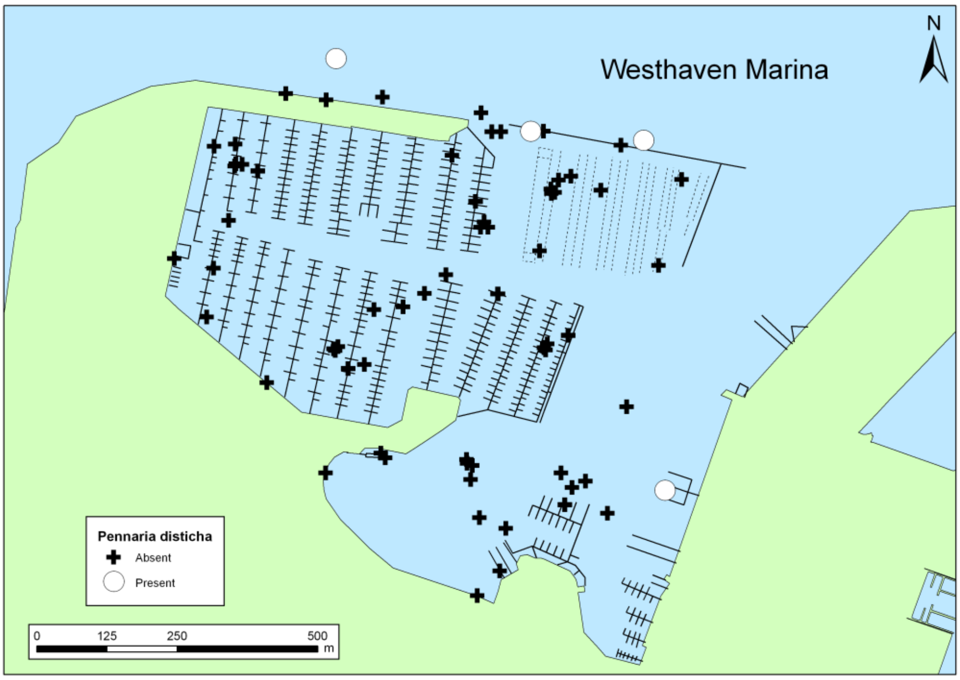

Figure 57: ***Pennaria disticha*** **distribution in the baseline survey of the Westhaven Marina**

***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 58). 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, Gulf Harbour Marina, Kaipara (Inglis *et al*. in press) and in this survey of Westhaven Marina (
Figure 59; Table 10; Table 12).

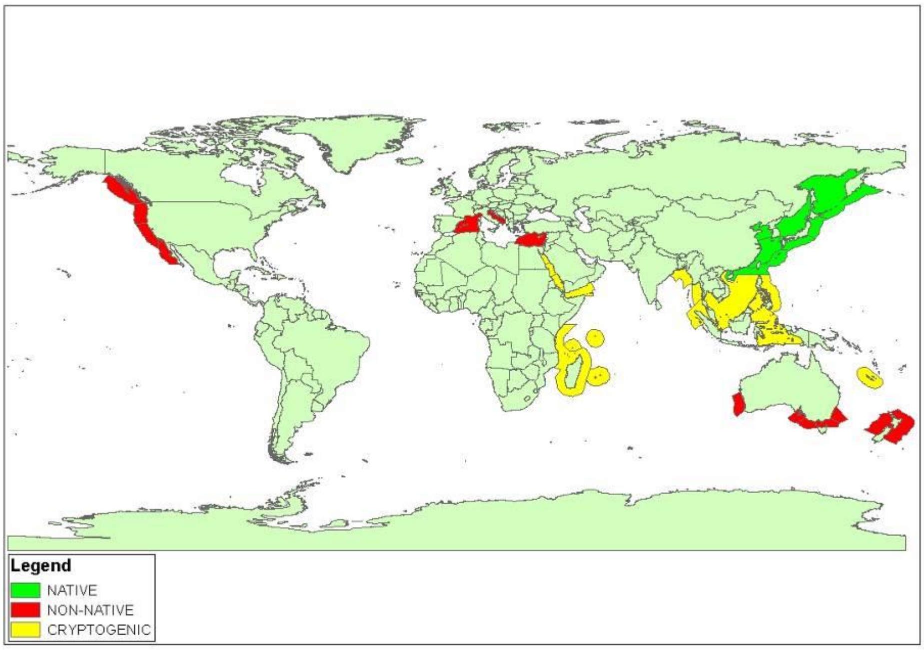

Figure 58: **Global distribution of *Musculista senhousia***

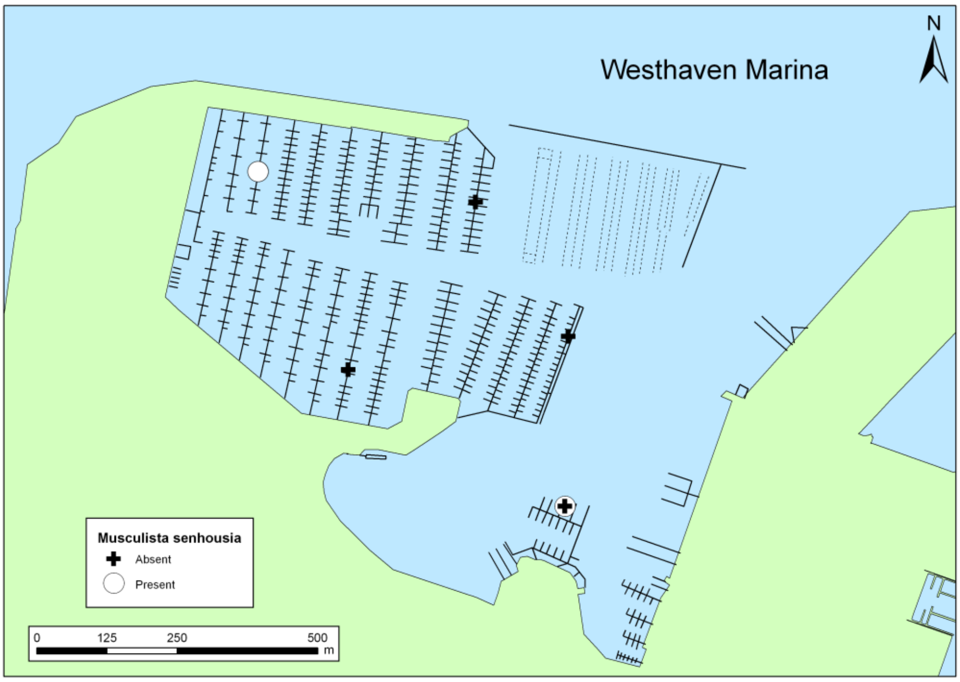

Figure 59: ***Musculista senhousia* distribution in the baseline survey of the Westhaven Marina**

Crassostrea gigas (Thunberg, 1793)

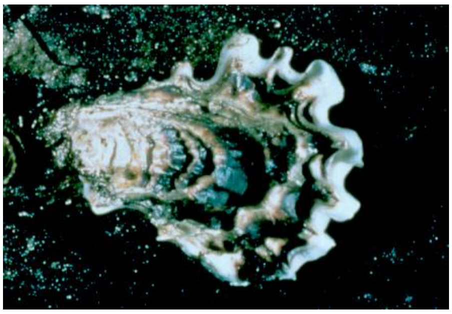

Image and information: NIMPIS (2002d)

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 60). 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 (

Figure 60). *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 documented 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, 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 Nelson, Auckland and Whangarei (Whangarei Port and Town Basin Marina), Opua, and Gulf Harbour Marinas (Inglis *et al*. 2006s; Inglis *et al*. 2006w) and in this survey of Westhaven Marina (
Figure 61; Table 10; Table 12).

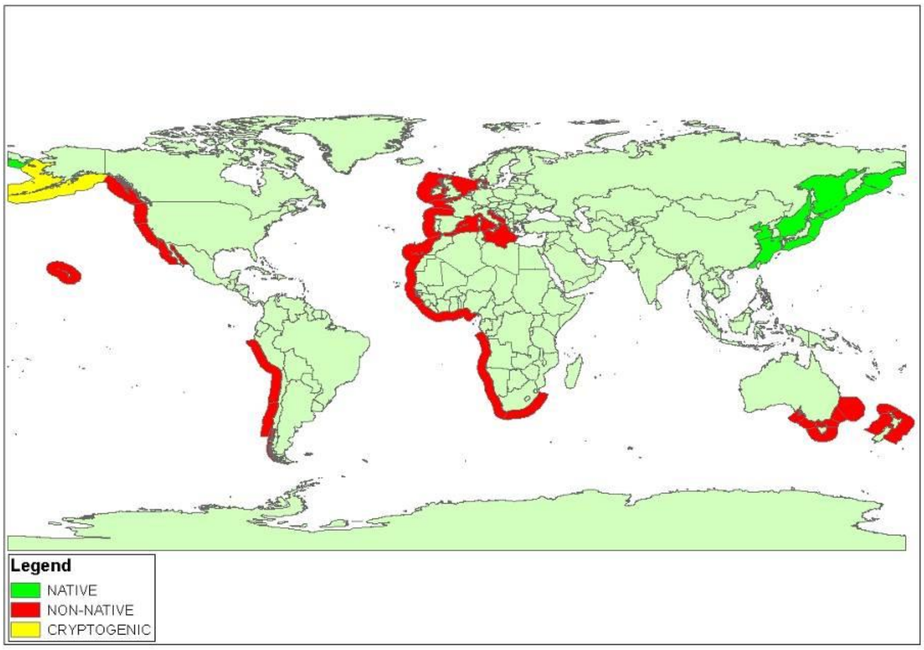

Figure 60: Global distribution of *Crassostrea gigas*

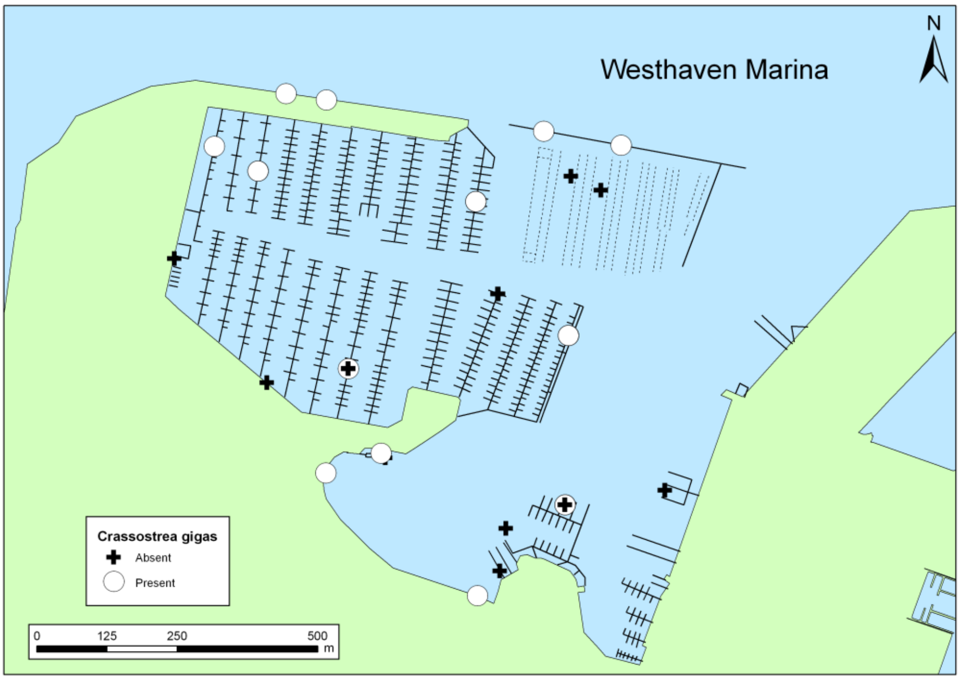

Figure 61: *Crassostrea gigas* distribution in the baseline survey of the Westhaven Marina

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

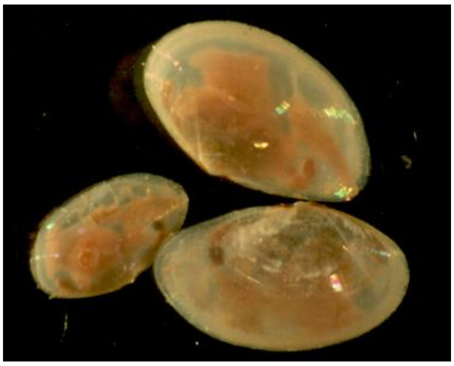

Image and information: NIMPIS (2002h)

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 (
Figure 62). *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) (Table 10). 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 (Table 12).

During the initial port baseline surveys, it was recorded from Opua marina, Whangarei port and marina, Gulf Harbour marina, and the ports of Auckland, Napier (

Figure 62), Taranaki, Wellington, Nelson, and Lyttelton (Table 12). During the second baseline surveys, *T. lubrica* was recorded from Opua, Whangarei, Taranaki, Napier, Wellington, Picton, Nelson, Lyttelton, and in this survey of Westhaven Marina (Inglis *et al*. 2006q, r, s; Inglis *et al*. 2006v; Inglis *et al*. 2006w)(Inglis in press) (

Figure 63; Table 10; Table 12).

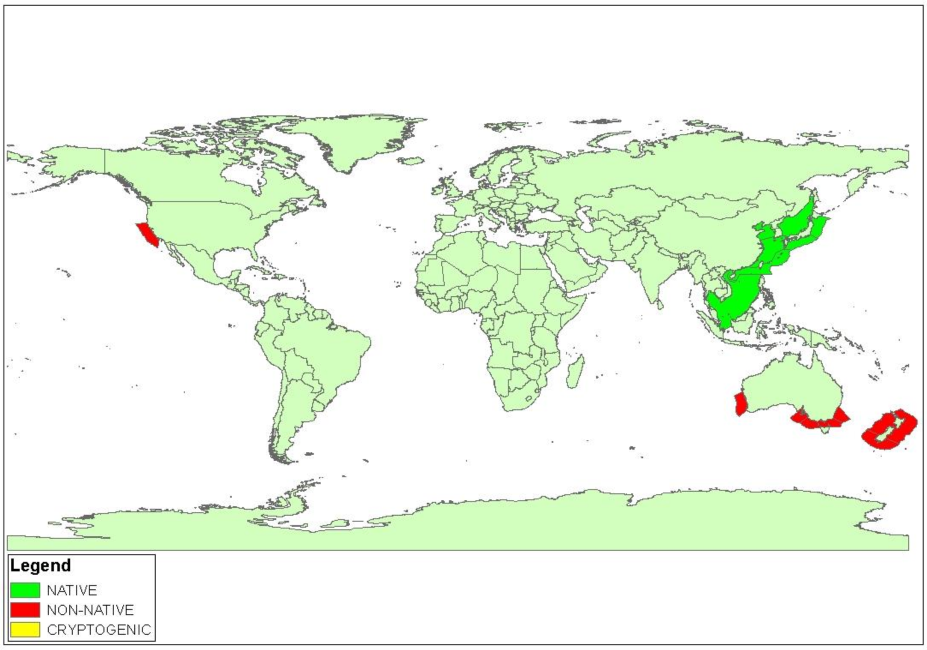

Figure 62: Global distribution of *Theora lubrica*

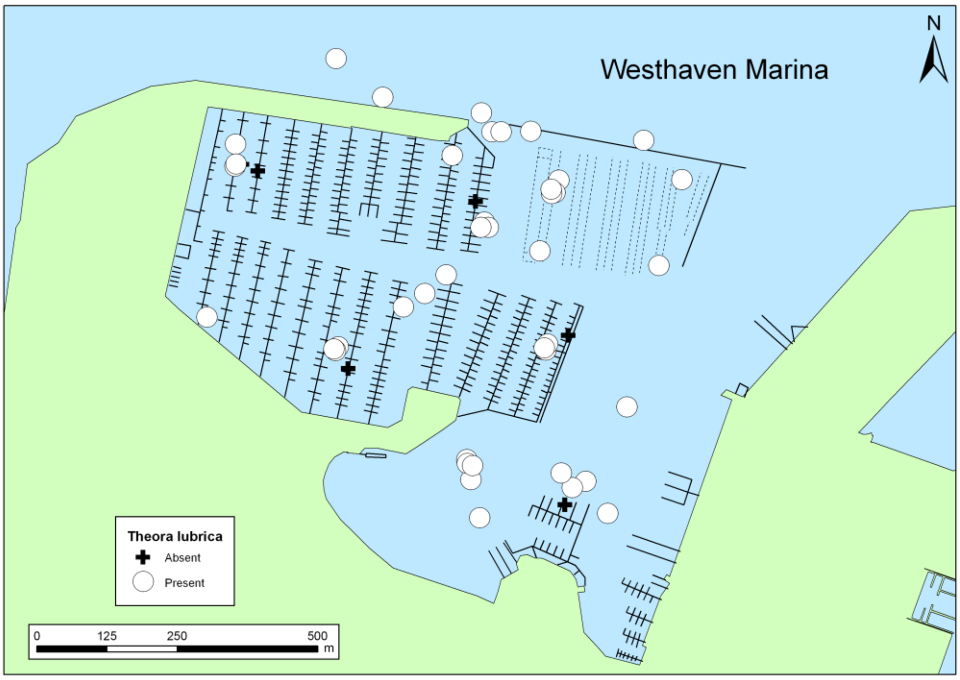

Figure 63: *Theora lubrica* distribution in the baseline survey of the Westhaven Marina

Undaria pinnatifida **(Harvey) Suringar, 1873**

Image: NIWA

Undaria pinnatifida is a brown seaweed that can reach an overall length of 1-3 metres. It is an annual species with two separate life stages; it has a large, "macroscopic" stage, usually present through the late winter to early summer months, and small, "microscopic" stage, present during the colder months. The macroscopic stage is golden-brown in colour, with a lighter coloured stipe with leaf-like extensions at the beginning of the blade and develops a distinctive convoluted structure called the "sporophyll" at the base during the reproductive season. It is this sporophyll that makes *U. pinnatifida* easily distinguishable from native New Zealand kelp species such as *Ecklonia radiata.* It is native to the Japan Sea and the northwest Pacific coasts of Japan and Korea and has been introduced to the Mediterranean and Atlantic coasts of France, Spain and Italy, the south coast of England, southern California, Argentina parts of the coastline of Tasmania and Victoria (Australia), and New Zealand (Figure 64). It is cryptogenic on the coast of China.

Undaria pinnatifida is an opportunistic alga that has the ability to rapidly colonise disturbed or new surfaces. It grows from the intertidal zone down to the subtidal zone to a depth of 15-20 metres, particularly in sheltered reef areas subject to oceanic influence. It does not tend to become established successfully in areas with high wave action, exposure and abundant local vegetation. *U. pinnatifida* is highly invasive, grows rapidly and has the potential to overgrow and exclude native algal species. The effects on the marine communities it invades are not yet well understood, although its presence may alter the food resources of herbivores that would normally consume native species. In areas of Tasmania (Australia) it has become very common, growing in large numbers in areas where sea urchins have depleted stocks of native algae. It can also become a problem for marine farms by increasing labour costs due to fouling problems.

U. pinnatifida is known to occur in a range of ports and marinas throughout eastern New Zealand, from Napier to Stewart Island and, recently, the Snares Islands (Table 12). With the exception of Bluff, it is considered to be absent from the southern and western coasts of the South Island and most of the western coast of the North Island (Russell *et al*. 2008). During the initial port baseline surveys, it was recorded from the ports of Napier (

Figure 64) Wellington, Picton, Lyttelton, Timaru and Dunedin (Inglis *et al*. 2006a, f; Inglis *et al*. 2006g; Inglis *et al*. 2006h, j, m, n). During the second baseline surveys *U. pinnatifida* was recorded from the ports of Auckland, Napier, Taranaki, Tauranga, Wellington, Picton, Nelson, Lyttelton, Timaru, and Bluff (Inglis *et al*. 2006q, r, s, t, u; Inglis *et al*. 2006v; Inglis *et al*. 2006w)(Inglis in press.) and in this initial survey of Westhaven Marina (

Figure 65; Table 10; Table 12).

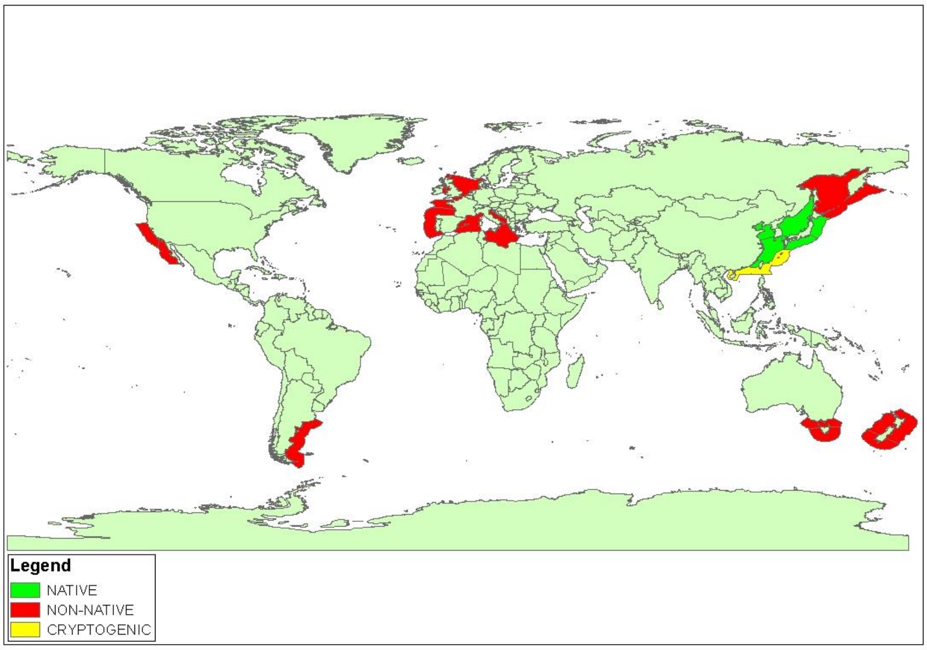

Figure 64: Global distribution of *Undaria pinnatifida*

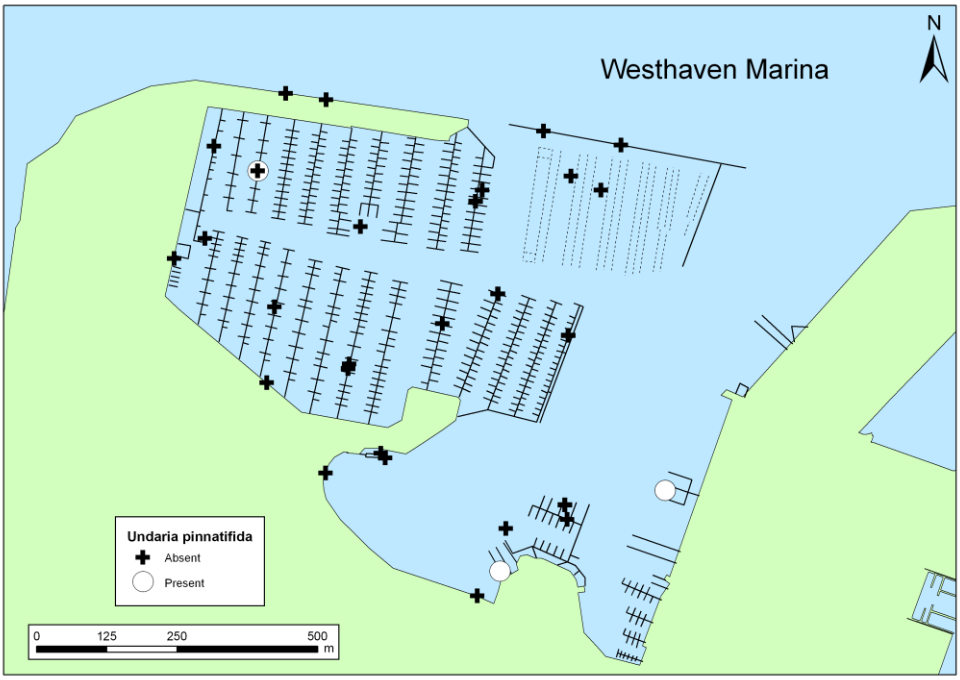

Figure 65: *Undaria pinnatifida* distribution in the baseline survey of the Westhaven Marina

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 66). 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). During the second surveys it was recorded in Gulf Harbour Marina and in this survey of Westhaven Marina (
Figure 67; Table 10; Table 12).

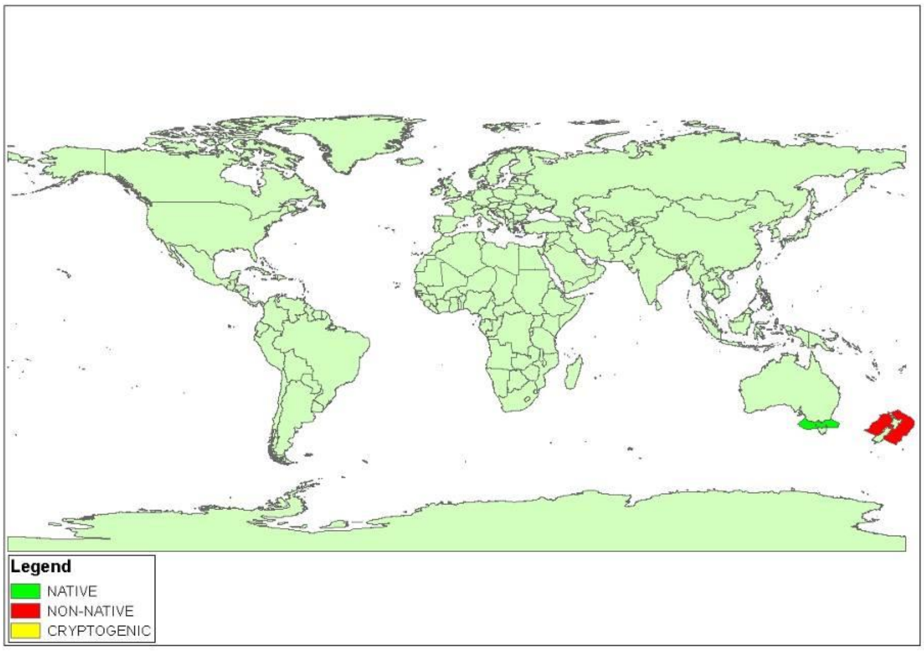

Figure 66: Global distribution of *Vosmaeropsis* cf. *macera*

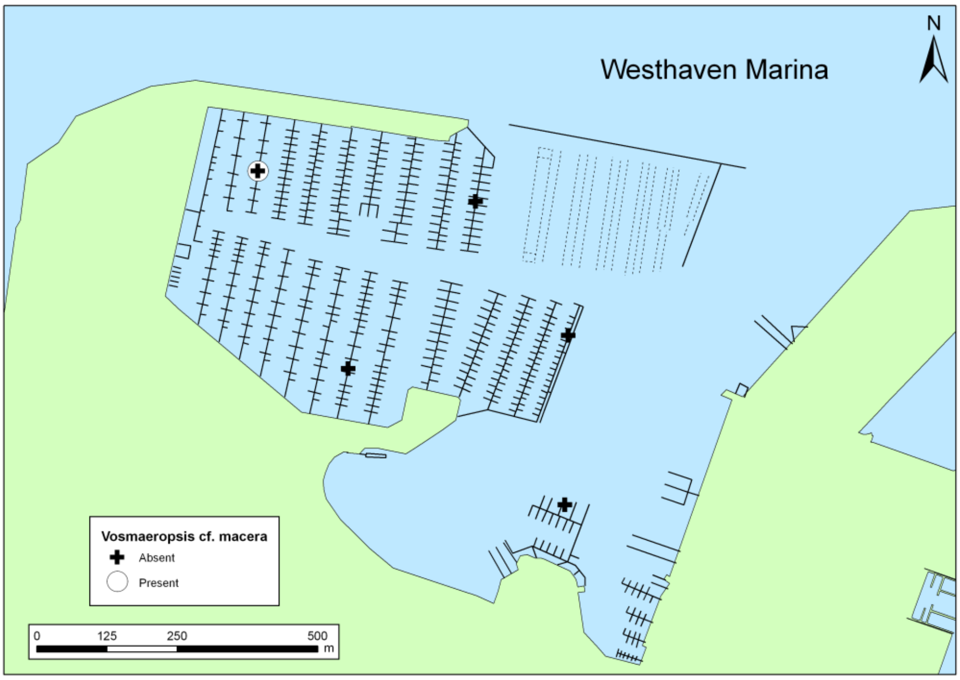

Figure 67: ***Vosmaeropsis* cf. *macera* distribution in the baseline survey of the Westhaven Marina**

Amphilectus fucorum **(Esper, 1794)**

Image: (Picton 2005)

Amphilectus fucorum is a soft textured sponge which is extremely polymorphic and fast growing and can change shape in just a few weeks. It may be encrusting as thin sheets or cushions, massive lobose, with or without tassels, or branched (Picton 2005). It is usually between 2 and 15 cm thick. The color is often vivid yellow or orange. On the not so common deeper locations, with limited light exposure the colour is usually pale yellow or even grey (Telnes 2009). *A. fucorum* is common on the low shore and shallow sublittoral, it is seldom found in the circalittoral zone. It occurs in a wide range of habitats from extremely sheltered to extremely exposed and also under a wide range of current regimes (Picton 2005).

A common and widespread species, *A. fucorum* has been recorded from the Northeast Atlantic, Cape Verde, the Faroe Islands, Sweden, the United Kingdom, West Africa and the West Mediterranean (Van Soest 2009) (Figure 68).

A. fucorum was recorded as the cryptogenic category 2 taxon *Esperiopsis* new sp. 1 in the initial baseline surveys of Auckland, Picton, Tauranga and Taranaki (Inglis *et al*. 2006d, j, k, l). In the resurveys it was recorded as *Esperiopsis* new sp. 1 in Picton, Taranaki, Tauranga, Opua and Whangarei. Subsequent re-examination of specimens suggest these should be considered the non-indigenous species *A. fucorum*. It has been accorded this name in surveys of the Port of Auckland (Inglis *et al*. 2006r, s, t) and in this survey of Westhaven Marina (Figure 69; Table 10; Table 12).

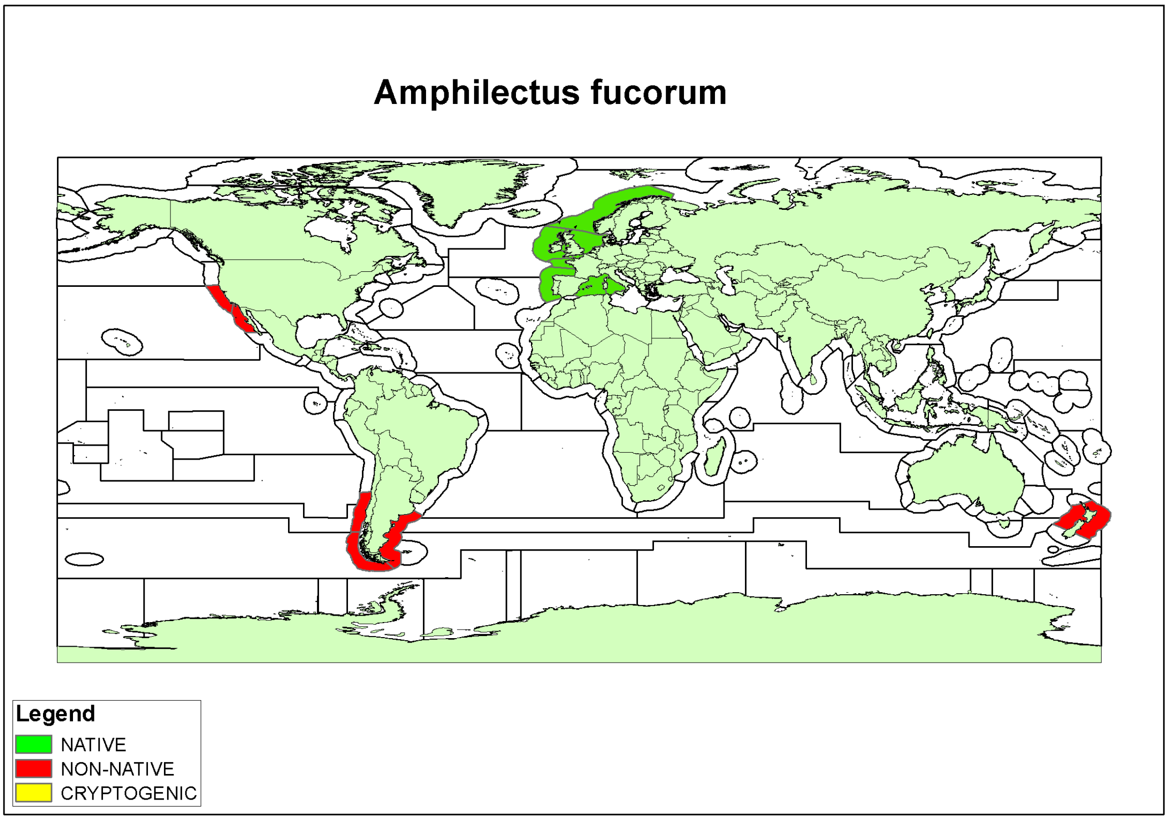

Figure 68: **Global distribution of *Amphilectus fucorum***

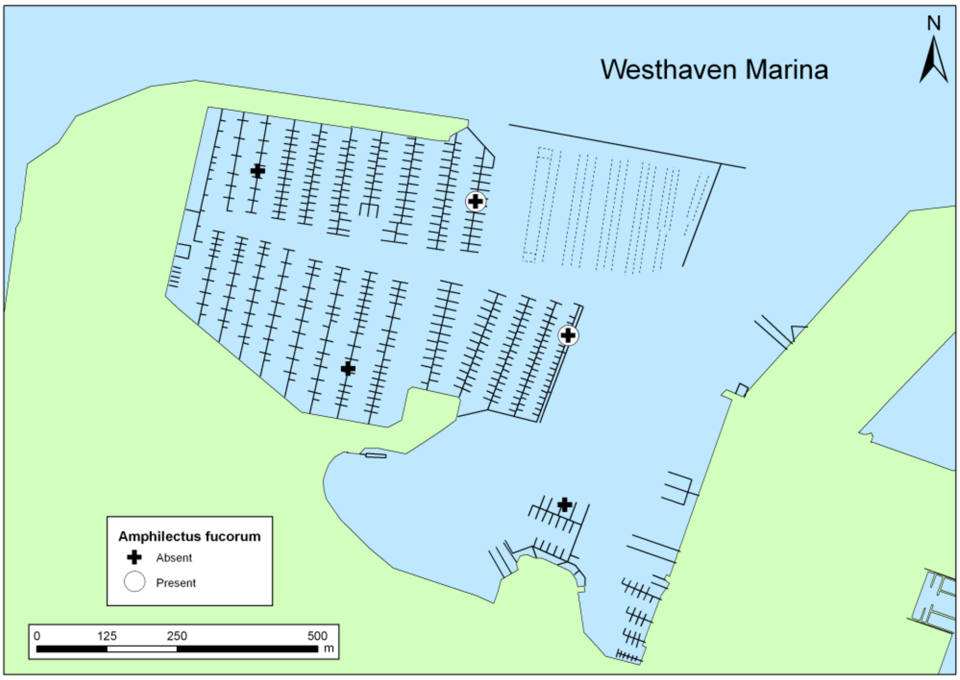

Figure 69: ***Amphilectus fucorum* distribution in the survey of the Westhaven Marina**

Indeterminate taxa

In the survey of Westhaven Marina, 47 organisms were classified as indeterminate taxa. If each of these organisms is considered a species of unresolved identity, then together they represent 23.2 % of all species collected from this survey (Figure 15). Indeterminate taxa from Westhaven Marina included nine annelids, nine crustaceans, four fish, four rhodophyta, three ascidians, three bryozoans, three molluscs, two echinoderms, two blown algae, and one each of the phylums Chrolophyta, Cnidaria, Cyanobacteria, Mollusca, Nemertea, Platyhelminthes as well as one unidentified plant and one unidentified algae (Table 11).

Notifiable and unwanted species

Two species recorded from Westhaven Marina, the Asian seaweed, *Undaria pinnatifida* and the club-shaped ascidian *Styela clava,* are currently listed on the New Zealand Register of Unwanted Organisms (Table 13).

The Australian Consultative Committee on Introduced Marine Pest Emergencies (CCIMPE) has a Trigger List (Table 14) of marine pest species (CCIMPE 2006). Four taxa on this list have been recorded from Westhaven Marina as NIS. Exotic invasive strains of the colonial ascidian *Didemnum* sp. the Asian paddle crab, *Charybdis japonica* are listed as trigger species still exotic to Australia. *Didemnum* sp. was recorded in the Westhaven Marina survey (see "Results: Cryptogenic taxa", above). The bivalve *Musculista senhousia* and the Asian kelp *Undaria pinnatifida* are both listed as established but not widespread in Australia.

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. Of the 53 Australian priority domestic pests (ie. those already present in Australia) listed, 13 are present in Westhaven Marina. These are listed in descending order of the impact potential ranking attributed to them by Hayes *et al*. (2005a): *Crassostrea gigas, Bugula neritina, Schizoporella errata, Bugula flabellata,Undaria pinnatifida, Musculista senhousia, Watersipora subtorquata, Styela clava, Hydroides ezoensis, Zoobotryon verticillatum, Theora lubrica, Apocorophium acutum* and *Pseudopolydora paucibranchiata.*

One of the 37 priority international pests (ie. those not yet in Australia), identified by Hayes *et al*. (2005a), the Asian paddle crab *Charybdis japonica* (ranked as 11th on the impact potential scale) was present in the survey of Westhaven Marina.

Species not previously recorded in New Zealand

Although no species were recorded as new to New Zealand in the survey of Westhaven Marina, the non-indigenous shrimp, *Lysmata vittata*, recorded in the present survey, was recorded as new to New Zealand in the survey of the Viaduct Harbour Marina which occurred simultaneously, and in close proximity to Westhaven Marina.

The survey of Westhaven marina is also the first record of the indeterminate Aplacophoran mollusc in the baseline surveys. This taxon is likely to be native and therefore probably not a recent arrival to New Zealand.

Range extensions

Three species from the Westhaven Marina survey represent range extensions in New Zealand. These species are the annelids *Simplaria pseudomilitaris* (C1: previously known from Goat Island) and *Hydroides ezoensis* (NIS; previously known from Opua and Gulf Harbour

Marina) and the ascidian *Polyzoa opuntia* (Native; previously known from Auckland, Kaipara, Picton and Nelson).

Cyst-forming species

No dinoflagellate cysts were collected during the survey of Westhaven Marina.

Depth stratification trends

While sampling effort was greatest in the >3-6 m depth class, the largest proportions of NIS and C1 taxa (85.2 %) and native taxa (61.5 %) were recorded from the 0-3 m depth class (Figure 70). This was most likely due to the large proportions of taxa, both NIS and C1 (82.1 %) and native (56 %), that were recorded in pile scrapings of which 80 % were conducted in the 0-3 m depth class - demonstrating that the pile scraping method is an effective method for sampling many organisms.

Samples taken from deeper depth classes (>3-6 m, and >6-9 m) were mostly taken using benthic sleds, benthic grabs, and crab, fish and seastar traps. Furthermore, sampling in the >3-6 m, and >6-9 m depth classes, yielded more native taxa than NIS and C1 taxa (Figure 70). This reflects the high proportion of NIS and C1 taxa recorded during the survey that were fouling organisms and which were sampled from pile scrapes of wharf and pontoon structures at <3 m depth.

Of the 27 NIS and C1 taxa, 23 (85.1 %) were collected at 0-3 m depth (Figure 70). Eleven of these 27 taxa were not recorded from deeper samples. The four taxa that were not collected in samples from 0-3 m depth were the annelid *Paralepidonotus ampulliferus*, the bryozoan *Bugula stolonifera*, the cnidarian *Pennaria disticha* and the brown alga *Undaria pinnatifida*. These were collected in benthic grab, pile scrape and wharf piling miscellaneous samples (Table 15).

Native taxa were recorded from each depth class, ranging from 37 taxa at >6-9 m depth, to 74 native taxa at 0-3 m depth (Table 16). Of the 109 native taxa recorded, 27 (24.8 %) were recorded from only the 0-3 m depth class, 19 (17.4 %) were recorded only from the >3-6 m depth class and five (4.6 %) were 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.

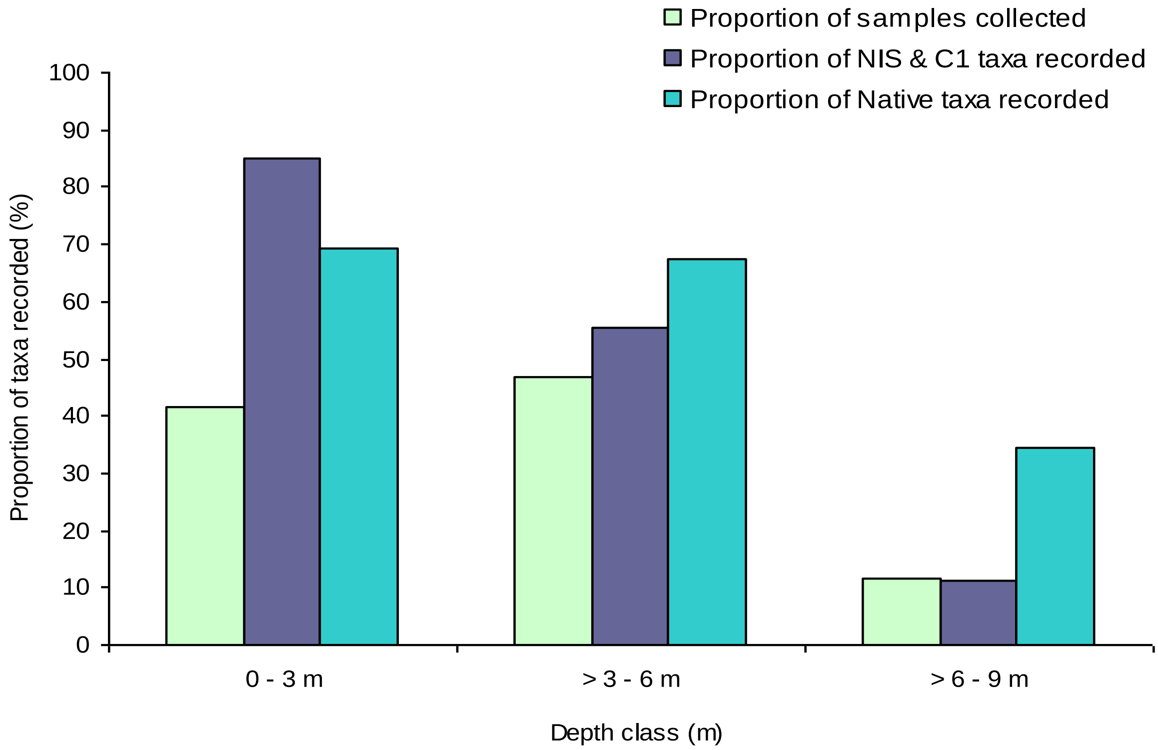

Figure 70: Proportion of taxa recorded from four depth classes during the second survey of Westhaven Marina. The proportion of taxa sums to a total of >100% across depth classes, as some taxa were recorded from more than one depth class.

RAREFRACTION CURVES FROM THE BASELINE SURVEY OF THE WESTHAVEN MARINA

Pile scrape samples

Native species

Rarefaction curves and estimates of total species richness in pile scrape samples taken from the survey of the Westhaven Marina are presented in

Figure 71. Sixty-one native species were recorded in the 80 samples collected (
Table 17). Curves for the observed native species richness increased steadily as more samples were taken. Although the curve did not approach an asymptote, after 70 quadrat samples the increase was low; only one new species was discovered every three samples. Estimates of total species richness plateaued after 35 quadrat samples, but failed to converge with observed richness (
Figure **71**), indicating an incomplete inventory of this group and a number of unsampled species in the assemblages. Indeed, as sample size increased, more unique species (i.e. those that occurred in only one sample) were added to the survey. These ‘rare’ species comprised 36 % (22 of 61 taxa;
Table 17) of the sampled assemblage. At the observed species rate indicated in

Figure 71 a further 36 quadrat samples (116 samples in total) would need to be taken to reach the estimated richness of 89 species (ICE estimate).

Cryptogenic category 2 taxa

Too few taxa were recorded in this category for quantitative estimation of taxa richness. Only five cryptogenic category 2 taxa were collected in the survey from the pile scrape samples (Table 17).

Non-indigenous and cryptogenic category 1 species

Thirty-one non-indigenous and cryptogenic category 1 species were recorded in the survey of the Westhaven Marina (Table 17). After 60 quadrat samples the observed richness curve began to plateau, with the low discovery rate of one new species every seven samples taken (Figure **71**). The estimated richness remained higher than the observed richness throughout all samples and, although it plateaued after 70 quadrat samples, the two curves failed to converge suggesting an incomplete inventory of this group and that a number of unsampled 'rare' species were present in this assemblages. These 'rare' species comprised 32 % (10 of 31 taxa; Table 17) of the sampled assemblage. At the rate indicated in Figure **71** a further 15 samples (95 samples in total) would need to be taken to reach the estimated richness of 38 species (Chao-2 Bias corrected estimate).

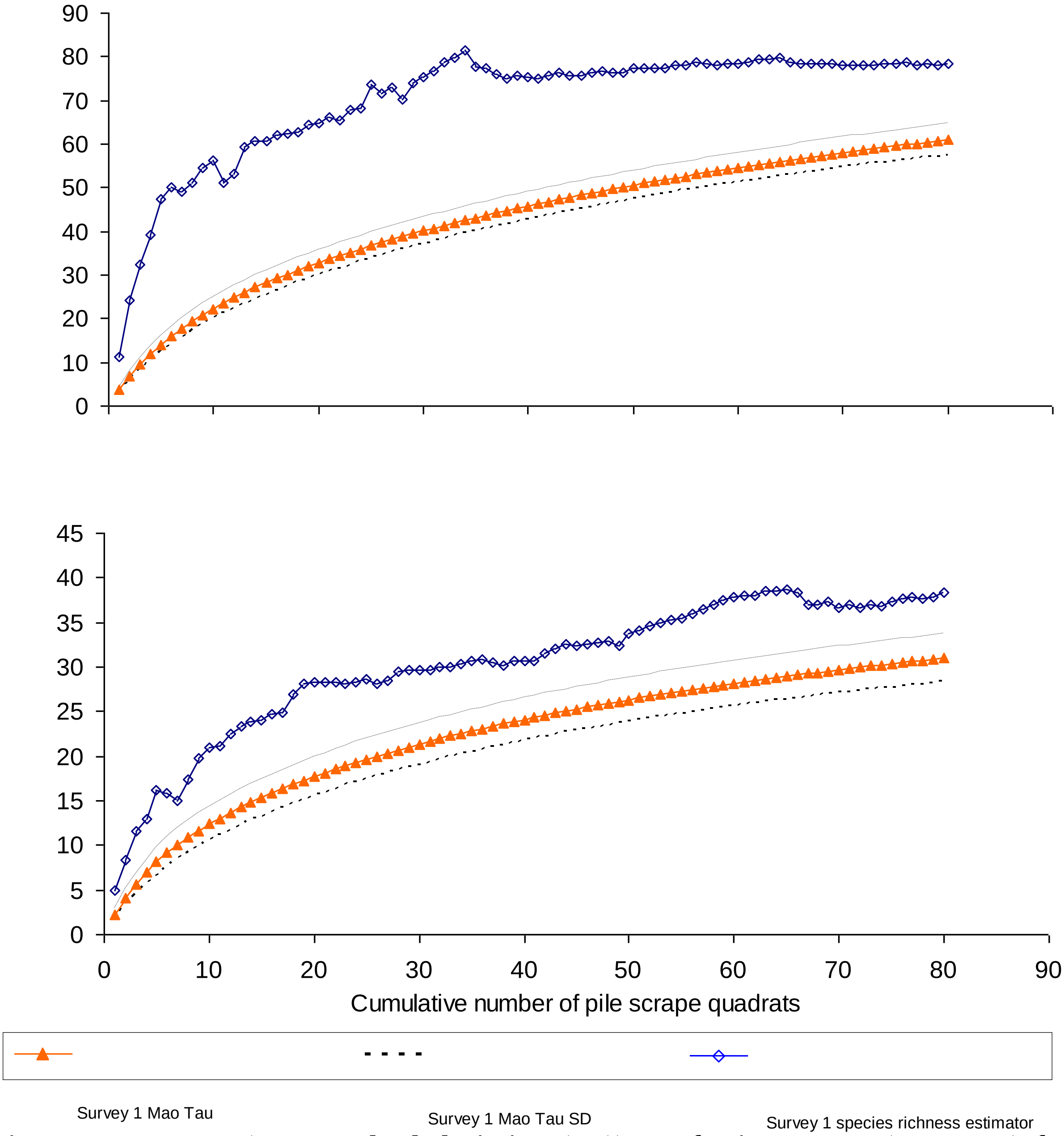

Figure 71: Mean (± 1 standard deviation (SD)) rarefaction curves (Mao Tau) for native (a) and non-indigenous and cryptogenic category one (b) taxa collected from pile scrape quadrats (full triangles, ± SD (dashed lines. Species richness estimators are also shown (empty diamonds); the ICE formula was used for native taxa and the Chao 2 bias-corrected formula was used for non-indigenous and cryptogenic category 1 taxa.

Benthic sled samples

Native species

Fifty-two native taxa were recorded in the 24 benthic sleds samples taken in the Westhaven Marina (

Table 17). The trajectory of the observed richness rarefaction curve was relatively flat, indicating slow accumulation of species with additional samples. At the rate indicated in

Figure 72 more than double the survey effort (i.e. ~57 samples) would be needed to capture the estimated species richness of the assemblage (ICE estimate = 117 species), although the estimate itself had not completely stabilised indicating that, as more samples were taken, the rate of discovery of unsampled, rare species remained relatively constant. Indeed samples taken using this method were dominated by uniques (56% of species;
Table 17), resulting in the comparatively large estimate of total species richness (
Figure 72) and suggesting a number of undetected species present in this assembly and an incomplete inventory.

Cryptogenic category 2 taxa

Too few taxa were recorded in this category for quantitative estimation of taxa richness. Only three cryptogenic category 2 taxa were collected in the survey from the benthic sled samples (
Table 17).

Non-indigenous and cryptogenic category 1 species

Eight non-indigenous and cryptogenic category 1 species were recorded in the 24 benthic sled samples taken in the Westhaven Marina (
Table 17). The observed species density plateaued after 15 samples, with only one new species discovered in the final 10 benthic sled samples (
Figure 72). By 24 samples, the observed species richness had reached the estimated richness of 8 species (Chao-2 Bias corrected;
Figure 72). The estimated richness curve had plateaued after approximately 10 benthic sleds. This suggests a complete inventory of this group with a small proportion of uniques (13 %) and, therefore, few undetected species (
Table 17).

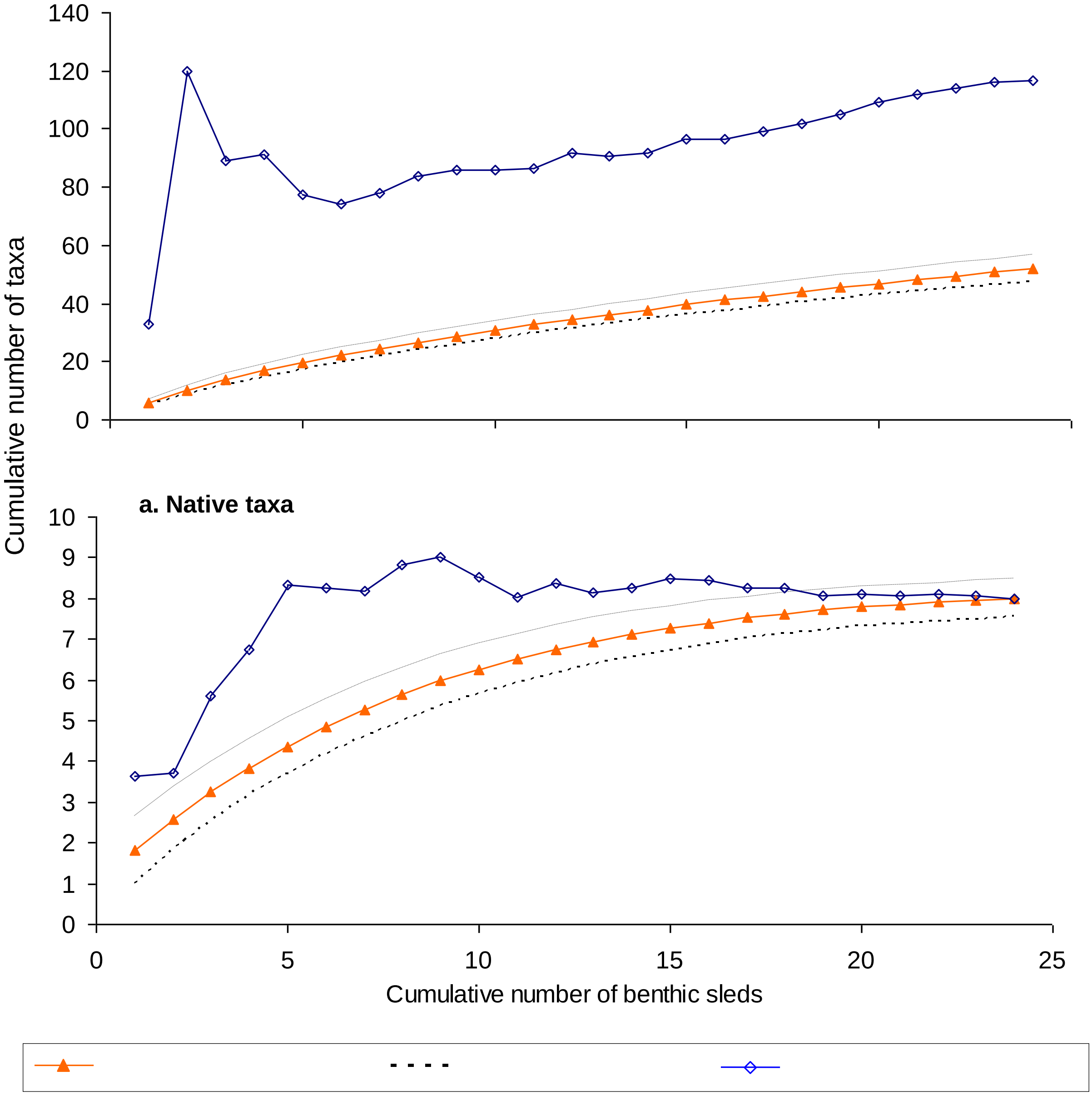

Figure 72: Mean (± 1 standard deviation (SD)) rarefaction curves (Mao Tau) for native (a) and non-indigenous and cryptogenic category one (b) taxa combined collected in benthic sled tows (full triangles, ± SD (dashed lines)). There were too few cryptogenic category two taxa encountered for a meaningful analysis of this group. Species richness estimators are also shown (empty diamonds); the Chao 2 Bias formula was used for NIS & C1 taxa and the ICE formula was used for native taxa.

Benthic grab samples

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

A total of 16 taxa were recorded in the 24 benthic grab samples collected (

Table 17). The observed richness curve steadily increased throughout all samples taken and did not reach an asymptote (
Figure 73). Although the estimated richness had plateaued after nine samples, at around 20 species, it was higher than the observed richness and the two curves failed to converge suggesting an incomplete inventory of this group. At the rate indicated in
Figure 73, 32 samples (i.e. an additional eight benthic grabs) would be needed to reach the estimated richness of 21 species (ICE estimate). The discrepancy shown between observed and estimated richness is most likely to be a result of the large number of uniques (5 of 16 taxa; 33 %;
Table 17). These ‘rare’, patchily distributed species are a typical of most marine benthic communities.

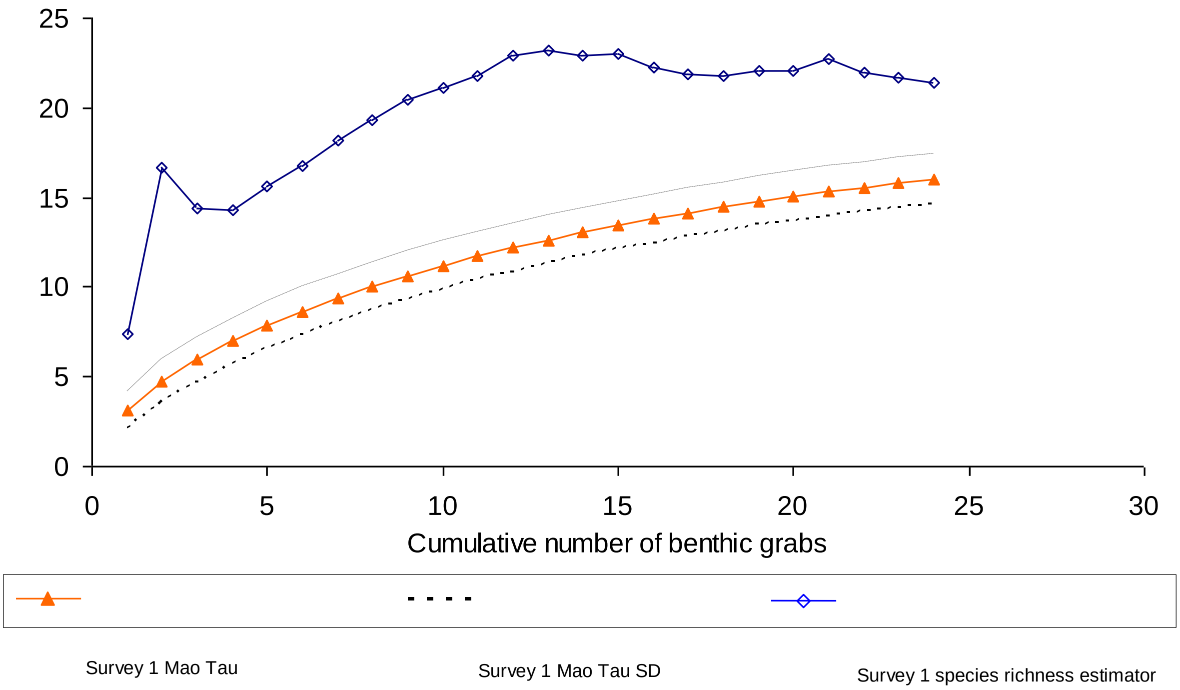

Figure 73: Mean (± 1 standard deviation (SD)) rarefaction curves (Mao Tau) for native, cryptogenic and non-indigenous taxa combined collected in benthic grab samples (full triangles, ± SD (dashed lines)). Species richness estimators (ICE formula) are also shown for the (empty diamonds).

Crab trap samples

Samples obtained using baited crab traps were characterised by relatively few taxa. This was a feature of all of the passive trapping techniques. In total, nine taxa were sampled using the crab traps; one non-indigenous species and no cryptogenic category 1 or category 2 taxa were recorded (
Table 17). For this reason, analysis was done on the pooled species assemblage (
Figure 74).

The estimated species richness curve increased steeply for the first 11 samples, before reaching a plateau and the final estimate of 10 species (Chao-2 Bias corrected estimate;
Figure 74). The observed richness curve increased throughout all samples and, by 35 crab traps, was approaching the estimated richness (

Figure 74). The modest difference between the estimated and observed curves suggests a relatively complete inventory of this assemblage and that sufficient crab trap samples were taken in the baseline survey of Westhaven Marina.

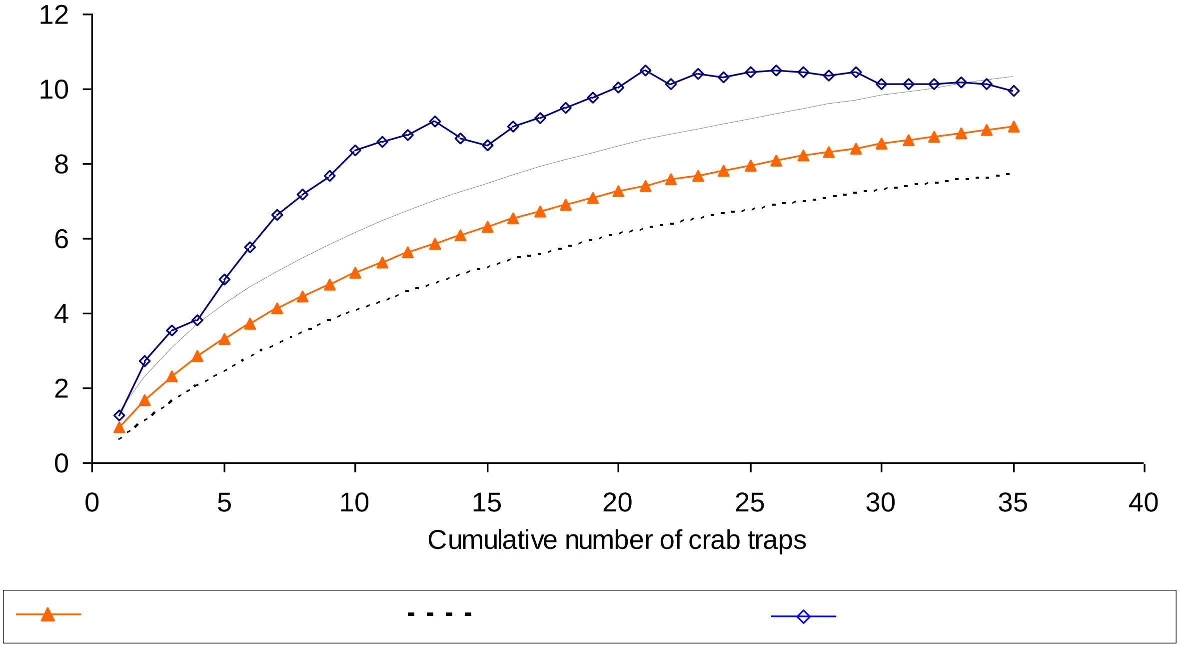

Figure 74: Mean (± 1 standard deviation (SD)) rarefaction curves (Mao Tau) for native and non-indigenous taxa combined collected in crab traps (full triangles, ± SD (dashed lines)). Species richness estimators are also shown (empty diamonds, Chao 2 bias-corrected formula).

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

The non-indigenous species located in Westhaven Marina are thought to have arrived in New Zealand mostly via international shipping. They may have reached Westhaven Marina directly from overseas or through domestic spread (natural and/or anthropogenic) from other New Zealand ports. Table 10 indicates the possible vectors for the introduction of each NIS recorded from Westhaven 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 1 of the 27 NIS (4 %) probably arrived via ballast water, 15 species (56 %) were most likely to be associated with hull fouling, nine species (33 %) could have arrived either by transport in ballast water or as biofouling and the vectors of introduction of two species (7 %) are currently unknown.

Assessment of the risk of new introductions to the port

Many non-indigenous species introduced to New Zealand ports by shipping do not survive to establish self-sustaining local populations. Those that do, often come from coastlines that have similar marine environments to New Zealand. For example, approximately 80 % of the marine NIS known to be present within New Zealand are native to temperate coastlines of Europe, the northwest Pacific, and southern Australia (Cranfield *et al*. 1998).

The majority of international recreational vessel arrivals to New Zealand come from the South Pacific (around 80%) or Australia (16%; O. Floerl, NIWA, pers. comm., Feb 2007; see Description of the Westhaven Marina: 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. 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, vessels arriving from Sydney and southern Australia present perhaps the greatest risk of introducing new non-indigenous species to the Westhaven Marina. Furthermore, five of the eight marine pests on the New Zealand Register of Unwanted Organisms 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 port

An estimated 2,186 recreational vessels depart Westhaven Marina annually and travel to one of 36 ports throughout New Zealand. Gulf Harbour Marina, Auckland Westpark Marina, Opua Marina, Great Barrier Island, Tauranga and Wellington were the next ports of call for most domestic vessel movements from Westhaven (O. Floerl, NIWA, pers. comm., Feb 2007; see Description of the Westhaven Marina: Vessel movements and ballast discharge patterns, above). Although many of the non-indigenous species found in the survey of Westhaven Marina have been recorded in other locations throughout New Zealand (Table 12), they were not detected in all of the other ports surveyed. There is, therefore, a risk that species established in Westhaven Marina could be spread to other New Zealand locations.

Of particular note are the two species present in Westhaven Marina that are on the New Zealand Register of Unwanted Species: the invasive alga *Undaria pinnatifida* and the club-shaped ascidian, *Styela clava*. *U. pinnatifida* has been present in New Zealand since at least 1987 and has spread through shipping and other vectors to 11 of the 16 ports and marinas surveyed during the baseline surveys (the exceptions being Opua, Whangarei Port and Marina, Gulf Harbour Marina and Tauranga Port).

Styela clava is found throughout the Hauraki Gulf and is known from Lyttelton Harbour and Tutukaka Marina (Gust *et al*. 2006). 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. Although there are few vessel movements between Westhaven Marina and Picton (in the Marlborough Sounds), the risk for translocation of this species by yacht movements is present. Because they are fouling organisms, the risk of translocating *S. clava* is highest for slow-moving vessels, such as yachts and barges, and vessels that have long residence times in ports and marinas.

Several other species recorded during the baseline survey have relatively restricted distributions nationwide and could, therefore, be spread from Westhaven Marina to other locations. These include the ascidians *Botryllus tuberatus* and *Styela clava*, the mollusc *Musculista senhousia*, the annelids, *Hydroides ezoensis* and *Paralepidonotus ampuliferus*, the barnacle *Amphibalanus amphitrite*, the crab *Charybdis japonica* and the bryozoan *Bugula flabellata*. Information on the ecology of these species is limited, but only *S. clava* and *C. japonica* are is known to have potential for significant impacts.

Management of existing non-indigenous species in the port

Many of the other NIS detected in this survey appear to be well established in the marina. Only seven of the 27 NIS recorded in this survey were recorded from one site within the marina (Table 12). Six of these seven species were recorded from only a single sample, while *C. japonica* was found in six samples. These species may not be well established in Westhaven Marina, and several of them (*H. ezoensis*, *P. ampuliferus*, *A. amphitrite* and *V.* cf. *macera*) have been recorded in few other New Zealand ports, and thus, based on the results of the baseline survey project, do not appear to be well established in New Zealand.

Management activities could 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* and *Undaria pinnatifida* and for potentially damaging species like *Charybdis japonica*. MAF Biosecurity NZ led an initial response to the incursion by Styela clava into New Zealand. However, in December 2005 a technical advisory group of marine experts from New Zealand, Australia and North America determined that, because it was so widespread in the Hauraki Gulf, eradication was not technically feasible. The group recommended measures to slow the spread spread of Styela. MAF Biosecurity NZ has since moved towards pathway management measures to target vessels or equipment that might spread pests like *S. clava*.

Prevention of new introductions

Interception of unwanted species transported by shipping is best achieved offshore, through control and treatment of ships destined for Westhaven 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 adopted by the International Maritime Organisation (IMO) in 2004. When the convention comes into force, all merchant vessels will be required to meet discharge standards for ballast water stipulated within the agreement by 2016.

Options are currently lacking, however, for effective in-situ treatment of biofouling and sea-chests. MAF Biosecurity New Zealand has recently completed a national survey of biofouling on vessels entering New Zealand from overseas and is currently developing specific border requirements regarding biofouling, based on the outcomes of the study. Shipping companies and vessel owners can reduce the risk of transporting NIS in hull fouling or sea chests through regular maintenance and antifouling of their vessels. Until effective risk mitigation options are developed, it is recommended that local authorities and port companies assess the risk of activities such as in-water cleaning of vessel hulls and sea-chests and discharge of waste material from shore-based cleaning facilities. These activities can increase the likelihood of non-indigenous fouling species being released and potentially becoming established within the port. They should be discouraged where the risk is considered unacceptable. Slow moving barges or vessels that are laid up in overseas ports for long periods before travelling to New Zealand can carry large densities of non-indigenous marine organisms with them. Cleaning and maintenance of these vessels should be encouraged by port authorities and shipping companies prior to their departure for New Zealand waters.

Studies of historical patterns of invasion have suggested that changes in trade routes can herald an influx of new NIS from regions that have not traditionally had major shipping links with the country or port (Carlton 1987; Hayden *et al*. 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 to 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. They represent a first step towards a comprehensive assessment of the risks posed to native coastal marine ecosystems from non-indigenous marine species. Although measures are being taken by the New Zealand government to reduce the rate of new incursions, foreign species are likely to continue to be introduced to New Zealand waters by shipping. There is a need for continued monitoring of non-indigenous marine species in port environments to allow for (1) early detection and control of harmful or potentially harmful non-indigenous species, (2) to provide on-going evaluation of the efficacy of management activities, and (3) to allow trading partners to be notified of species that may be potentially harmful.

The species assemblage in the survey of Westhaven Marina 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 each case, additional information can be used to address this problem. Three of the five NIS found in only a single sample have been present in New Zealand for at least 45 years, while the date of introduction of *Paralepidonotus ampulliferus* is estimated as 2003, and in introduction of *Polydora hoplura* is unknown (Cranfield *et al*. 1998; Kospartov 2008). A repeat survey of Westhaven Marina would give a basis for comparison of detected species assemblies and densities.

As several recent analyses have shown, the large area of habitat available for marine organisms within shipping ports 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; Inglis *et al*. 2007). 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, as up to 28 % of native species recorded in the surveys 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, 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 port. 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.	
Species composition	The types or identities of species present in a sample, site, or region.	

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

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

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

References

AMOG Consulting. (2002). Hull fouling as a vector for the translocation of marine organisms. Phase I: Hull fouling research. Ballast Water Research Series, Report No. 14. Department of Agriculture, Fisheries and Forestry Australia, Canberra, 142 p.

Andrews, D., Whayman, G., Edgar, G. (1996). Assessment of optimal trapping techniques to control densities of the northern Pacific seastars on marine farm leases. Final report to the Fisheries Research and Development Corporation. Report No. FRDC 95/066.

Australian Faunal Directory (2005). Australian Biological Resources Study Web publication <http://www.deh.gov.au/biodiversity/abrs/online-resources/fauna/afd/index.html>, Accessed 22/07/2005.

Biosecurity Council. (2003). Tiakina Aotearoa: Protect New Zealand. The Biosecurity Strategy for New Zealand. Available online at: <www.maf.govt.nz/biosecurity-strategy> Accessed 22/07/2005. Biosecurity Council, Wellington. 67 p.

Biosecurity New Zealand (2005). *Styela clava* The clubbed tunicate - marine pest guide. Web publication <http://www.biosecurity.govt.nz/files/pests-diseases/animals/seasquirt/sea-squirt-divers-card.pdf>. Accessed 28/04/2006.

Bock, P. (2004). *Tricellaria inopinata* D'Hondt & Occhipinti Ambrogi, 1985. RMIT University Civil & Geological Engineering web publication <http://www.civgeo.rmit.edu.au/bryozoa/cheilostomata/candidae/tricino.html>, Accessed 24/04/2004.

Bourque, D., Landry, T., Davidson, J., McNair, N. (2003). Impact of an invasive tunicate in Atlantic Canada: Recruitment and competition. *Journal of Shellfish Research 22*: 320.

California Academy of Sciences (2002). Animal Images. Web publication <http://www.calacademy.org/research/izg/SFBay2K/animalthumbnailimages.htm>. Accessed 12/07/2006.

Campbell, M. (2004). Analysis of vessel entries into New Zealand between 1998 and 2003. Unpublished report, Ministry of Fisheries, Wellington.

Carlton, J. (1985). Transoceanic and interoceanic dispersal of coastal marine organisms: the biology of ballast water. *Oceanography and Marine Biology Annual Reviews 23*: 313-371.

Carlton, J. (1987). Patterns of transoceanic marine biological invasions in the Pacific Ocean. *Bulletin of Marine Science 41*: 452-465.

Carlton, J. (1996). Biological invasions and cryptogenic species. *Ecology 77*: 1653-1655.

Carlton, J., Geller, J. (1993). Ecological roulette: The global transport of nonindigenous marine organisms. *Science 261(5117)*: 78-82.

Carlton, J.T. (1992). Blue immigrants: the marine biology of maritime history. *The log of Mystic Seaport Museum 44(2)*: 31-36.

Carlton, J.T. (1999). The scale and ecological consequences of biological invasions in the world's oceans. *In*: Sandlund, T., Schei, P.J., Viken, A. (eds). Invasive species and biodiversity management, pp. 195-212. Kluwer academic, Dordrecht.

Carlton, J.T. (2001). *Introduced Species in U.S. Coastal Waters: Pew Oceans Commissions Report*. Pew Oceans Commissions: Washington, DC.

CCIMPE (2006). Consultative Committee on Introduced Marine Pest Emergencies (CCIMPE) Trigger List. Final agreed list 2006. CCIMPE, Canberra. .

Chapman, J.W., Carlton, J.T. (1991). A test of criteria for introduced species: the global invasion by the isopod *Synidotea laevidorsalis* (Miers, 1881). *Journal of Crustacean Biology 11*: 386-400.

Chapman, J.W., Carlton, J.T. (1994). Predicted discoveries of the introduced isopod *Synidotea laevidorsalis* (Miers, 1881). *Journal of Crustacean Biology 14*: 700-714.

Chazdon, R.L., Colwell, R.K., Denslow, J.S., Guariguata, M.R. (1998). Statistical methods for estimating species richness of woody regeneration in primary and secondary rain forests of NE Costa Rica. *In*: Dallmeier, F., Comiskey, J.A. (eds). Forest biodiversity research, monitoring and modeling: Conceptual background and Old World case studies, pp. 285-309. Parthenon Publishing, Paris.

Cohen, A., Carlton, J. (1998). Accelerating invasion rate in a highly invaded estuary. *Science 279*: 555-558.

Cohen, A.N. (2005). Guide to the exotic species of San Francisco Bay. San Francisco Estuary Institute, Oakland, CA. Web publication <http://www.exoticsguide.org/>, Accessed 24/03/2006. Oakland, CA, San Francisco Estuary Institute.

Cohen, A.N., Carlton, J.T. (1995). Nonindigenous aquatic species in a United States estuary: a case study of the biological invasions of the San Francisco Bay and delta. Report for the U. S. Fish and Wildlife Service, Washington DC.

Colautti, R.I., MacIsaac, H.J. (2004). A neutral terminology to define 'invasive' species. . *Diversity and Distributions 10*: 134-141.

Colwell, R. (2005). EstimateS: Statistical estimation of species richness and shared species from samples. Version 7.5. User's Guide and application published at: <http://purl.oclc.org/estimates> Accessed 22/07/2007.

Colwell, R.K., Coddington, J.A. (1994). Estimating terrestrial biodiversity through extrapolation. *Philosophical Transactions of the Royal Society of London B 345*: 101-118.

Colwell, R.K., Mao, C.X., Chang, J. (2004). Interpolating, extrapolating, and comparing incidence-based species accumulation curves. *Ecology 85*: 2717-2727.

Coutts, A., Moore, K., Hewitt, C. (2003). Ships' sea chests: an overlooked transfer mechanism for non-indigenous marine species? *Marine Pollution Bulletin 46*: 1504-1515.

Cranfield, H., Gordon, D., Willan, R., Marshall, B., Battershill, C., Francis, M., Nelson, W., Glasby, C., Read, G. (1998). Adventive marine species in New Zealand. NIWA technical report No. 34. Hamilton, NIWA.

Creese, R., Hooker, S., Deluca, S., Wharton, Y. (1997). Ecology and environmental impact of *Musculista senhousia* (Mollusca: Bivalvia: Mytlidae) in Tamaki estuary, Auckland, New Zealand. *New Zealand Journal of Marine and Freshwater Research 31*: 225-236.

Crooks, J.A. (1996). The population ecology of an exotic mussel, *Musculista senhousia*, in a southern California Bay. *Estuaries 19*: 42-50.

Cummings, V., Hatton, S., Nicholls, P. (2002). Upper Waitemata Harbour benthic habitat survey. ARC Technical Publication 219, 58pp.

Daniel, A. (1958). The development and metamorphosis of three species of sessile barnacles. *Journal of Madras University 28 (B)*: 23-47.

DORIS (2008). Donnees d'Observations pour la Reconnaissance et l'Identification de la foune et de la flore Sunaquatiques: Faune et flore marines de l'Indo-Pacifique. <http://doris.ffessm.fr/fiches_liste.asp?groupe_numero=45&fichier=Faune%20et%20flore%20marines%20de%20l'Indo-Pacifique&numero_fichier=3>. Accessed 07/02/2009.

Dromgoole, F.I., Foster, B.A. (1983). Changes to the marine biota of the Auckland Harbour. *Tane (29)*: 79-96.

Dyrynda, P.E.J., Fairall, V.R., d'Hondt, J.L., Occhipinti Ambrogi, A. (2000). The distribution, origins and taxonomy of *Tricellaria inopinata* d'Hondt & Occhipinti Ambrogi, 1985, an invasive bryozoan new to the Atlantic. *Journal of Natural History 34*: 1993-2006.

Eldredge, L., Carlton, J.T. (2002). Hawaiian marine bioinvasions: a preliminary assessment. *Pacific Science 56*: 211-212.

Falk-Petersen, J., Bohn, T., Sandlund, O.T. (2006). On the numerous concepts in invasion biology. *Biological Invasions 8(6)*: 1409-1424.

Ferrell, D., Avery, R., Blount, C., Hayes, L., Pratt, R. (1994). The utility of small, baited traps for surveys of snapper (*Pagrus auratus*) and other demersal fishes. NSW Fisheries Research Institute Report. Cronulla, NSW Fisheries Research Institute.

Floerl, O., Smith, M., Inglis, G., Davey, N., Seaward, K., Johnston, O., Fitridge, I., Rush, N., Middleton, C., Coutts, A. (2008). Vessel biofouling as a vector for the introduction of non-indigenous marine species to New Zealand: Recreational yachts. *MAF Biosecurity NZ Research Project ZBS2004-03A No.* 175 p.

Fofonoff, P., Ruiz, G., Steves, B., Hines, A., Carlton, J. (2003). National Exotic Marine and Estuarine Species Information System. Web publication <http://invasions.si.edu/nemesis/> Accessed 22/07/2005.

Francis, M., Walsh, C., Morrison, M., Middleton, C. (2003). Invasion of the Asian goby, *Acentrogobius pflaumii*, into New Zealand, with new locality records of the introduced bridled goby, *Arenigobius bifrenatus*. *New Zealand Journal of Marine and Freshwater Research 37*: 105-112.

Francis, M.P., Walsh, C., Smith, P.J., Gomon, M.F. (2004). First records of the Australian blenny, Omobranchus anolius, from New Zealand. New Zealand. *New Zealand Journal of Marine and Freshwater Research 38*: 671-679.

Furlani, D.M. (1996). A guide to the introduced marine species in Australian waters. CSIRO Centre for Research on Introduced Marine Pests Technical Report No. 5. CSIRO Division of Fisheries, Hobart. .

Gordon, D., Mawatari, S. (1992). Atlas of marine fouling bryozoa of New Zealand Ports and Harbours. Miscellaneous Publications of the New Zealand Oceanographic Institute Vol 107. New Zealand Oceanographic Institute.

Gordon, D.P. (1986). The marine fauna of New Zealand: Bryozoa: Gymnolaemata (Ctenostomata and Cheilostomata Anasca) from the western South Island continental shelf and slope. *New Zealand Oceanographic Institute Memoir 95*: 1-121.

Gotelli, N.J., Colwell, R.K. (2001). Quantifying biodiversity: procedures and pitfalls in the measurement and comparison of species richness. *Ecology Letters 4*: 379-391.

Gray, J.S. (2000). The measurement of marine species diversity, with an application to the benthic fauna of the Norwegian continental shelf. *Journal of Experimental Marine Biology and Ecology 250*: 23-49.

Grosholz, E. (2002). Ecological and evolutionary consequences of coastal invasions. *Trends in Ecology & Evolution 17*: 22-27.

Gust, N., Inglis, G. (2006). Adaptive multi-scale sampling to determine an invasive crab's habitat usage and range in New Zealand. *Biological Invasions 8(3)*: 339-353.

Gust, N., Floerl, O., Inglis, G., Miller, S., Fitridge, I., Hurren, H. (2005). Rapid delimitation survey of *Styela clava* in the Viaduct Harbour and Freemans Bay, Auckland. NIWA Client Report: CHC2005-147. Prepared for Biosecurity New Zealand Research Project ZBS 200532. *No.* p.

Gust, N., Inglis, G., Hayden, B. (2001). Design of baseline surveys for exotic marine organisms. Final research report for MFISH project ZBS2000/04. Christchurch, National Institute for Water and Atmospheric Research.

Gust, N., Inglis, G.J., Peacock, L., Miller, S., Floerl, O., Hayden, B.J., Fitridge, I., Johnston, O., Hurren, H. (2006). Rapid nationwide delimitation surveys for *Styela clava*. NIWA Client Report: CHC2006-24. Prepared for Biosecurity New Zealand Project ZBS2005-32. Christchurch, NIWA. 81 pp.

Halliday, J., Hewitt, J., Lundquist, C. (2006). Central Waitemata Harbour Ecological Monitoring: 2000-2006. Prepared for Auckland Regional Council Environmental Research. Auckland Regional Council Technical Publication No. 314, 2006. 101pp. .

Handley, S. (1995). Spionid polychaetes in Pacific oysters, *Crassostrea gigas* (Thunberg) from Admiralty Bay, Marlborough Sounds, New Zealand. *New Zealand Journal of Marine and Freshwater Research 29*: 305-309.

Hayden, B.J., Inglis, G.J., Schiel, D.R. (2009). Marine invasions in New Zealand: a history of complex supply-side dynamics. *In*: Rilov, G., Crooks, J. (eds). Marine Bioinvasions: Ecology, Conservation and Management Perspectives, pp. Springer, Heidelberg.

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

Hayes, K.R., Cannon, R., Neil, K., Inglis, G.J. (2005b). Sensitivity and cost considerations for the detection and eradication of marine pests in ports. *Marine Pollution Bulletin 50*: 823-834.

Hayward, B. (1997a). Introduced marine organisms in New Zealand and their impact in the Waitemata Harbour, Auckland. *Tane 36*: 197-223.

Hayward, B., Stephenson, A., Morley, M., Riley, J., Grenfell, H. (1997). Faunal changes in Waitemata Harbour sediments, 1930s-1990s. *Journal of The Royal Society of New Zealand 27*: 1-20.

Hayward, B.W. (1997b). Introduced marine organisms in New Zealand and their impact in the Waitemata Harbour, Auckland. . *Tane (36)*.

Heiri, O., Lotter, A.F., Lemcke, G. (2001). Loss on ignition as a method for estimating organic and carbonate content in sediments: reproducibility and comparability of results. *Journal of Paleolimnology 25*: 101-110.

Hewitt, C., Campbell, M., Thresher, R., Martin, R. (1999). Marine biological invasions of Port Phillip Bay, Victoria. CRIMP Technical Report NO. 20. Hobart, Centre for Research on Introduced Marine Species.

Hewitt, C., Martin, R. (1996). Port surveys for introduced marine species - background considerations and sampling protocols. CRIMP technical report No 4. Hobart, CSIRO Division of Fisheries.

Hewitt, C., Martin, R. (2001). Revised protocols for baseline surveys for introduced marine species - survey design, sampling protocols and specimen handling. CRIMP Technical Report No. 22. Hobart, Centre for Research on Introduced Marine Pests.

Hewitt, C., Martin, R., Sliwa, C., McEnnulty, F., Murphy, N., Jones, T., Cooper, S. (eds). (2002). National Introduced Marine Pest Information System. Web publication <http://crimp.marine.csiro.au/nimpis> Accessed 22/07/2005.

Hill, K. (2001). Smithsonian Marine Station. *Bugula stolonifera*. Web publication <http://www.sms.si.edu/irlspec/Bugula_stolon.htm>, Accessed 21/07/2006.

Hinton, S. (1988). Seashore Life of Southern California: An Introduction to the Animal Life of California Beaches South of Santa Barbara. revised, illustrated. University of California Press, 1988, 217 p.

Inglis, G., Floerl, O. (2002). Risks to marine biosecurity associated with recreational boats. Prepared for Yachting New Zealand Ltd. NIWA Client Report: CHC02/23. *No.* p.

Inglis, G., Gust, N., Fitridge, I., Floerl, O., Hayden, B.J., Fenwick, G. (2005). Port of Auckland: baseline survey for non-indigenous marine species. Biosecurity New Zealand Technical Paper No: 2005/08. *No.* 58 p.

Inglis, G., Kospartov, M., Fitridge, I., Gust, N., Floerl, O., Fenwick, G., Hayden, B. (2007). Port baseline surveys for introduced marine species. Summary of results: Research Project ZBS2000/04. Biosecurity New Zealand Technical Paper. Prepared for Biosecurity New Zealand Post-clearance Directorate for Project ZBS2000-04. 97 pp. + Appendices + Supp.

Inglis, G.J. (2003). Invasive aquatic species surveys and monitoring in New Zealand. *In*: Raaymakers, S. (ed.). 1st International Workshop on Guidelines and Standards for Invasive Aquatic Species Surveys and Monitoring, Arraial do Cabo, Brazil, 13-17 April 2003. Workshop Report. GloBallast Monograph Series, I.M.O. London., pp.

Inglis, G.J., Gust, N. (2003). Potential indirect effects of shellfish culture on the reproductive success of benthic predators. *Journal of Applied Ecology 40(6)*: 1077-1089.

Inglis, G.J., Gust, N., Fitridge, I., Fenwick, G.D., Floerl, O., Hayden, B.J. (2003). Surveillance design for new exotic marine organisms in New Zealand's ports and other high risk entry points. Final Research Report for Ministry of Fisheries Research Projects ZBS2000/04 Objective 5. NIWA Client Report. Wellington. 47p, National Institute of Water and Atmospheric Research.

Inglis, G.J., Gust, N., Fitridge, I., Floerl, O., Hayden, B.J., Fenwick, G.D. (2006a). Dunedin Harbour (Port Otago and Port Chalmers): baseline survey for non-indenous marine species. Biosecurity New Zealand Technical Paper No: 2005/10. Prepared for Biosecurity New Zealand Post-clearance Directorate for Project ZBS2000-04. 67 pp. + Appendices.

Inglis, G.J., Gust, N., Fitridge, I., Floerl, O., Hayden, B.J., Fenwick, G.D. (2006b). Gulf Harbour marina: baseline survey for non-indenous marine species. Biosecurity New Zealand Technical Paper No: 2005/12. Prepared for Biosecurity New Zealand Post-clearance Directorate for Project ZBS2000-04. 53 pp. + Appendices.

Inglis, G.J., Gust, N., Fitridge, I., Floerl, O., Hayden, B.J., Fenwick, G.D. (2006c). Opua marina: baseline survey for non-indenous marine species. Biosecurity New Zealand Technical Paper No: 2005/14. Prepared for Biosecurity New Zealand Post-clearance Directorate for Project ZBS2000-04. 50 pp. + Appendices.

Inglis, G.J., Gust, N., Fitridge, I., Floerl, O., Hayden, B.J., Fenwick, G.D. (2006d). Port of Auckland: baseline survey for non-indenous marine species. Biosecurity New Zealand Technical Paper No: 2005/08. Prepared for Biosecurity New Zealand Post-clearance Directorate for Project ZBS2000-04. 58 pp. + Appendices.

Inglis, G.J., Gust, N., Fitridge, I., Floerl, O., Hayden, B.J., Fenwick, G.D. (2006e). Port of Bluff: baseline survey for non-indenous marine species. Biosecurity New Zealand Technical Paper No: 2005/09. Prepared for Biosecurity New Zealand Post-clearance Directorate for Project ZBS2000-04. 57 pp. + Appendices.

Inglis, G.J., Gust, N., Fitridge, I., Floerl, O., Hayden, B.J., Fenwick, G.D. (2006f). Port of Gisborne: baseline survey for non-indenous marine species. Biosecurity New Zealand Technical Paper No: 2005/11. Prepared for Biosecurity New Zealand Post-clearance Directorate for Project ZBS2000-04. 56 pp. + Appendices.

Inglis, G.J., Gust, N., Fitridge, I., Floerl, O., Hayden, B.J., Fenwick, G.D. (2006g). Port of Lyttelton: baseline survey for non-indenous marine species. Biosecurity New Zealand Technical Paper No: 2005/01. Prepared for Biosecurity New Zealand Post-clearance Directorate for Project ZBS2000-04. 64 pp. + Appendices.

Inglis, G.J., Gust, N., Fitridge, I., Floerl, O., Hayden, B.J., Fenwick, G.D. (2006h). Port of Napier: baseline survey for non-indenous marine species. Biosecurity New Zealand Technical Paper No: 2005/13. Prepared for Biosecurity New Zealand Post-clearance Directorate for Project ZBS2000-04. 52 pp. + Appendices.

Inglis, G.J., Gust, N., Fitridge, I., Floerl, O., Hayden, B.J., Fenwick, G.D. (2006i). Port of Nelson: baseline survey for non-indenous marine species. Biosecurity New Zealand Technical Paper No: 2005/02. Prepared for Biosecurity New Zealand Post-clearance Directorate for Project ZBS2000-04. 56 pp. + Appendices.

Inglis, G.J., Gust, N., Fitridge, I., Floerl, O., Hayden, B.J., Fenwick, G.D. (2006j). Port of Picton: baseline survey for non-indenous marine species. Biosecurity New Zealand Technical Paper No: 2005/03. Prepared for Biosecurity New Zealand Post-clearance Directorate for Project ZBS2000-04. 49 pp. + Appendices.

Inglis, G.J., Gust, N., Fitridge, I., Floerl, O., Hayden, B.J., Fenwick, G.D. (2006k). Port of Taranaki: baseline survey for non-indenous marine species. Biosecurity New Zealand Technical Paper No: 2005/04. Prepared for Biosecurity New Zealand Post-clearance Directorate for Project ZBS2000-04. 60 pp. + Appendices.

Inglis, G.J., Gust, N., Fitridge, I., Floerl, O., Hayden, B.J., Fenwick, G.D. (2006l). Port of Tauranga: baseline survey for non-indenous marine species. Biosecurity New Zealand Technical Paper No: 2005/05. Prepared for Biosecurity New Zealand Post-clearance Directorate for Project ZBS2000-04. 55 pp. + Appendices.

Inglis, G.J., Gust, N., Fitridge, I., Floerl, O., Hayden, B.J., Fenwick, G.D. (2006m). Port of Timaru: baseline survey for non-indenous marine species. Biosecurity New Zealand Technical Paper No: 2005/06. Prepared for Biosecurity New Zealand Post-clearance Directorate for Project ZBS2000-04. 61 pp. + Appendices.

Inglis, G.J., Gust, N., Fitridge, I., Floerl, O., Hayden, B.J., Fenwick, G.D. (2006n). Port of Wellington: baseline survey for non-indenous marine species. Biosecurity New Zealand Technical Paper No: 2005/07. Prepared for Biosecurity New Zealand Post-clearance Directorate for Project ZBS2000-04. 61 pp. + Appendices.

Inglis, G.J., Gust, N., Fitridge, I., Floerl, O., Hayden, B.J., Fenwick, G.D. (2006o). Whangarei Harbour (Whangarei Port and Marsden Point): baseline survey for non-indenous marine species. Biosecurity New Zealand Technical Paper No: 2005/16. Prepared for Biosecurity New Zealand Post-clearance Directorate for Project ZBS2000-04. 68 pp. + Appendices.

Inglis, G.J., Gust, N., Fitridge, I., Floerl, O., Hayden, B.J., Fenwick, G.D. (2006p). Whangarei marina: baseline survey for non-indigenous marine species. Biosecurity New Zealand Technical Paper No: 2005/15. Prepared for Biosecurity New Zealand Post-clearance Directorate for Project ZBS2000-04. 49 pp. + Appendices.

Inglis, G.J., Gust, N., Fitridge, I., Floerl, O., Woods, C., Kospartov, M., Hayden, B.J., Fenwick, G.D. (2006q). Port of Lyttelton: second baseline survey for non-indenous marine species. Biosecurity New Zealand Technical Paper No: 2006/01. Prepared for Biosecurity New Zealand Post-clearance Directorate for Project ZBS2000-04. 105 pp. + Appendices.

Inglis, G.J., Gust, N., Fitridge, I., Floerl, O., Woods, C., Kospartov, M., Hayden, B.J., Fenwick, G.D. (2006r). Port of Picton: second baseline survey for non-indenous marine species. Biosecurity New Zealand Technical Paper No: 2006/03. Prepared for Biosecurity New Zealand Post-clearance Directorate for Project ZBS2000-04. 91 pp. + Appendices.

Inglis, G.J., Gust, N., Fitridge, I., Floerl, O., Woods, C., Kospartov, M., Hayden, B.J., Fenwick, G.D. (2006s). Port of Taranaki: second baseline survey for non-indenous marine species. Biosecurity New Zealand Technical Paper No: 2006/06. Prepared for Biosecurity New Zealand Post-clearance Directorate for Project ZBS2000-04. 95 pp. + Appendices.

Inglis, G.J., Gust, N., Fitridge, I., Floerl, O., Woods, C., Kospartov, M., Hayden, B.J., Fenwick, G.D. (2006t). Port of Tauranga: second baseline survey for non-indenous marine species. Biosecurity New Zealand Technical Paper No: 2006/07. Prepared for Biosecurity New Zealand Post-clearance Directorate for Project ZBS2000-04. 89 pp. + Appendices.

Inglis, G.J., Gust, N., Fitridge, I., Floerl, O., Woods, C., Kospartov, M., Hayden, B.J., Fenwick, G.D. (2006u). Port of Timaru: second baseline survey for non-indenous marine species. Biosecurity New Zealand Technical Paper No: 2006/02. Prepared for Biosecurity New Zealand Post-clearance Directorate for Project ZBS2000-04. 105 pp. + Appendices.

Inglis, G.J., Gust, N., Fitridge, I., Morrisey, D., Floerl, O., Woods, C., Kospartov, M., Hayden, B.J., Fenwick, G.D. (2006v). Port of Wellington: second baseline survey for non-indenous marine species. Biosecurity New Zealand Technical Paper No: 2006/05. Prepared for Biosecurity New Zealand Post-clearance Directorate for Project ZBS2000-04. 97 pp. + Appendices.

Inglis, G.J., Gust, N., Fitridge, I., Morrisey, D.J., Floerl, O., Woods, C., Kospartov, M., Hayden, B.J., Fenwick, G.D. (2006w). Port of Nelson: second baseline survey for non-indenous marine species. Biosecurity New Zealand Technical Paper No: 2006/04. Prepared for Biosecurity New Zealand Post-clearance Directorate for Project ZBS2000-04. 95 pp. + Appendices.

Inglis, G.J., Hurren, H., Gust, N., Oldman, J., Fitridge, I., Floerl, O., Hayden, B.J. (2006x). Surveillance design for early detection of unwanted exotic marine organisms in New Zealand. Biosecurity New Zealand Technical Paper No: 2005-17. Prepared for Biosecurity New Zealand Post-clearance Directorate for Project ZBS2001-01. 110 pp + Appendices.

Kospartov, M., Inglis, G., Seaward, K., van den Brink, A., D'Archino, R., Ahyong, S. (2008). Non-indigenous and cryptogenic marine species in New Zealand - Current state of knowledge: Interim report. . *NIWA Research Report prepared for MAF-BNZ Project BNZ10740. 25 pp + tables + appendices.* .

Kott, P. (2002). A complex didemnid ascidian from Whangamata, New Zealand. *Journal of Marine Biology Association of the United Kingdom 82*: 625-628.

Kott, P. (2004a). New and little-known species of Didemnidae (Ascidiacea, Tunicata) from Australia (part 2). *Journal of Natural History 38*: 2455-2526.

Kott, P. (2004b). A new species of *Didemnum* (Ascidiacea, Tunicata) from the Atlantic coast of North America. *Zootaxa 732*: 1-10.

Leppakoski, E., Gollasch, S., Gruszka, P., Ojaveer, H., Olenin, S., Panov, V. (2002). The Baltic - a sea of invaders. *Canadian Journal of Fisheries and Aquatic Sciences 59*: 1175-1188.

Lleonart, M., Handlinger, J., Powell, M. (2003). Spionid mudworm infestation of farmed abalone (*Haliotis* spp.). *Aquaculture 221*: 85-96.

Longino, J.T., Coddington, J., Colwell, R.K. (2002). The ant fauna of a tropical rain forest: estimating species richness three different ways. *Ecology 83*: 689-702.

Mack, R., Simberloff, D., Lonsdale, W., Evans, H., Clout, M., Bazzaz, F. (2000). Biotic invasions: causes, epidemiology, global consequences and control. *Ecological Applications 10(3)*: 689-710.

MacKenzie, D.I., Royle, J.A., Brown, J.A., Nichols, J.D. (2004). Occupancy estimation and modelling for rare and elusive populations. *In*: Thompson, W.R. (ed.). Sampling rare or elusive species: concepts, designs, and techniques for estimating population parameters, pp. 149-171. Island Press, Washington.

Matsuoka, K., Fukuyo, Y. (2000). Technical guide for modern dinoflagellate cyst study. Report prepared for the WESTPAC-HAB Project. WESTPAC-HAB/WESTPAC/IOC <http://dinos.anesc.u-tokyo.ac.jp/technical_guide/main.pdf> Accessed 22/07/2005. 77p.

Miller, A., Inglis, G., Poulin, R. (2006). Comparison of the parasite fauna of an invasive swimming crab, *Charybdis japonica* (Portunidae), with sympatric and allopatric populations of a native New Zealand portunid, *Ovalipes catharus*. *New Zealand Journal of Marine and Freshwater Research 40*: 369-378.

Monniot, F., Monniot, C. (2001). Ascidians from the tropical western Pacific. *Zoosystema 23(2)*: 201-383.

Morrisey, D., Peacock, L., Inglis, L., Floerl, O. (2007). Surveillance for early detection of unwanted exotic marine organisms in New Zealand: Summer 2005-2006. *MAF Biosecurity New Zealand Technical Paper No: 2007/02 No.* p.

Morrisey, D.J., Howitt, L., Underwood, A.J., Stark, J.S. (1992a). Spatial variation in soft-sediment benthos. *Marine Ecology Progress Series 81*: 197-204.

Morrisey, D.J., Howitt, L., Underwood, A.J., Stark, J.S. (1992b). Temporal variation in soft-sediment benthos. *Journal of Experimental Marine Biology and Ecology 164*: 233-245.

Myers, A., McGrath, D., King, R. (2006). Keys to the north east Atlantic and Mediterranean amphipods. Web publication <http://www.amphipoda.com/index.html>, Accessed 26/04/2006.

Nicholls, P., Hewitt, J., Hatton, S. (2002). Waitemata Harbour ecological monitoring programme - results from the first year of sampling, October 2000-2001. ARC Technical Publication 225, 37pp. .

NIMPIS (2002a). *Ascidiella aspersa* species summary. National Introduced Marine Pest Information System (Eds: Hewitt C.L., Martin R.B., Sliwa C., McEnnulty, F.R., Murphy, N.E., Jones T. & Cooper, S.). Web publication <http://crimp.marine.csiro.au/nimpis>, Accessed 07/18/2006.

NIMPIS (2002b). *Bugula flabellata* species summary. National Introduced Marine Pest Information System (Eds: Hewitt CL, Martin RB, Sliwa C, McEnnulty FR, Murphy NE, Jones T & Cooper S). Web publication <http://crimp.marine.csiro.au/nimpis>, Accessed 3/25/2004.

NIMPIS (2002c). *Bugula neritina* species summary. National Introduced Marine Pest Information System (Eds: Hewitt CL, Martin RB, Sliwa C, McEnnulty FR, Murphy NE, Jones T & Cooper S). Web publication <http://crimp.marine.csiro.au/nimpis>, Accessed 03/25/2004.

NIMPIS (2002d). *Crassostrea gigas* species summary. National Introduced Marine Pest Information System (Eds: Hewitt CL, Martin RB, Sliwa C, McEnnulty FR, Murphy NE, Jones T & Cooper S). Web publication <http://crimp.marine.csiro.au/nimpis>, Accessed 03/24/2004.

NIMPIS (2002e). *Hydroides elegans* species summary. National Introduced Marine Pest Information System (Eds: Hewitt C.L., Martin R.B., Sliwa C., McEnnulty, F.R., Murphy, N.E., Jones T. & Cooper, S.). Web publication <http://crimp.marine.csiro.au/nimpis>, Accessed 17/07/2006.

NIMPIS (2002f). *Pseudopolydora paucibranchiata* species summary. National Introduced Marine Pest Information System (Eds: Hewitt CL, Martin RB, Sliwa C, McEnnulty FR, Murphy NE, Jones T & Cooper S). Web publication <http://crimp.marine.csiro.au/nimpis>, Accessed 13/07/2006.

NIMPIS (2002g). *Styela clava* species summary. National Introduced Marine Pest Information System (Eds: Hewitt C.L., Martin R.B., Sliwa C., McEnnulty, F.R., Murphy, N.E., Jones T. & Cooper, S.). Web publication <http://crimp.marine.csiro.au/nimpis>, Accessed 19/07/2006.

NIMPIS (2002h). *Theora lubrica* species summary. National Introduced Marine Pest Information System (Eds: Hewitt CL, Martin RB, Sliwa C, McEnnulty FR, Murphy NE, Jones T & Cooper S). Web publication <http://crimp.marine.csiro.au/nimpis>, Accessed 03/25/2004.

NIWA (2006). Invasive sea squirt (*Styela clava*) fact sheet. Web publication <http://www.niwascience.co.nz/ncabb/tools/sea_squirt>. Accessed 28/04/2006.

Occhipinti-Ambrogi, A., Galil, B.S. (2004). A uniform terminology on bioinvasions: a chimera or an operational tool? *Marine Pollution Bulletin 49*: 688-694.

Occhipinti Ambrogi, A. (2000). Biotic Invasions in a Mediterranean Lagoon. *Biological Invasions 2*: 165-176.

Okuda, S. (1937). Spioniform polychaetes from Japan. *Journal of the Faculty of Science of the Hokkaido Imperial University (6)5(3)*: 217-254.

Parker, I., Simberloff, D., Lonsdale, W., Goodell, K., Wonham, M., Kareiva, P., Williamson, M., Holle, B.V., Moyle, P., Byers, J., Goldwasser, L. (1999). Impact: Toward a Framework for Understanding the Ecological Effects of Invaders. *Biological Invasions 1*: 3-19.

Picton, B.E., & Morrow, C.C. (2005). Amphilectus fucorum (Esper, 1794). In] Encyclopedia of Marine Life of Britain and Ireland <http://www.habitas.org.uk/marinelife/species.asp?item=C5960> Accessed 22/07/2006.

Picton, B.E., & Morrow, C.C. (2007). [In] Encyclopedia of Marine Life of Britain and Ireland <http://www.habitas.org.uk/marinelife/species.asp?item=ZD2140 > Accessed 22/07/2008

Powell, A.W.B. (1937). Animal communities of the sea bottom in Auckland and Manukau harbours. *Transactions of the Royal Society of New Zealand 66*: 354-401.

Pregenzer, C. (1983). Survey of metazoan symbionts of *Mytilus edulis* (Mollusca: Pelecypoda) in Southern Australia. *Australian Journal of Marine and Freshwater Research 34*: 387-396.

Raaymakers, S. (2003). AIS survey network spreads. *Ballast Water News 15*: 5-7.

Read, G. (2001). Shell-damaging worms: what and where are they? *In* Aquaculture Update Online, Issue 29. Web publication <http://www.niwascience.co.nz/pubs/au/au/29/worms.htm>, Accessed 02/05/2006.

Read, G. (2006). Adventive occurrence in New Zealand of the scale-worm Paralepidonotus ampulliferus (Annelida: Polychaeta: Polynoidae). New Zealand Journal of Marine and Freshwater Research 40: 643-654.

Read, G., Gordon, D. (1991). Adventive occurrence of the fouling serpulid Ficopomatus enigmaticus (Polychaeta) in New Zealand. New Zealand Journal of Marine and Freshwater Research 25: 269-273.

Read, G.B. (1975). Systematics and biology of polydorid species (Polychaeta: Spionidae) from Wellington Harbour. Journal of the Royal Society of New Zealand 5: 395-419.

Read, G.B. (2004). Guide to New Zealand Shell Polychaetes. Web publication. <http://biocollections.org/pub/worms/nz/Polychaeta/ShellsPoly/NZShellsPolychaeta.htm> Last updated 23/07/2004, Accessed 05/05/2006.

Ricciardi, A. (2001). Facilitative interactions among aquatic invaders: is an "invasional meltdown" occurring in the Great Lakes? *Canadian Journal of Fisheries and Aquatic Sciences 58*: 2513-2525.

Ruiz, G., Fofonoff, P., Hines, A., Grosholz, E. (1999). Non-indigenous species as stressors in estuarine and marine communities: assessing invasion impacts and interactions. *Limnology Oceanography 44*: 950-972.

Russell, K., Hepburn, C.D., Hurd, C., Stuart, M. (2008). The expanding range of *Undaria pinnatifida* in southern New Zealand: distribution, dispersal mechanisms and the invasion of wave- exposed environments. *Biological Invasions 10*: 103-115.

Soule, J.D., & Soule, D.F. (1977). Fouling and bioadhesion: Life strategies of bryozoans. *In*: Woollacott, R., & Zimmer, RL. (ed.). Biology of Bryozoans, pp. 437-457. Academic Press, New York.

Stafford, H., Willan, R.C. (2007). Is it a pest? Introduced and naturalised marine animal species of Torres Strait Northern Australia. Queensland Department of Primary Industries and Fisheries, Cairns.

Stuart, M., McClary, D.J. (2004). Delimination survey of *Undaria pinnatifida* in selected areas in the Waitemata Harbour. Final Research Report for the Ministry of Fisheries Biosecurity Research Project ZBS2004/11.

Taylor, M., MacKenzie, L. (2001). Delimitation survey of the toxic dinoflagellate *Gymnodinium catenatum* in New Zealand. Cawthron Report 661, 12pp. Prepared for Ministry of Fisheries.

Telnes, K. (2009). Amphilectus fucorum. The Marine Fauna Gallery of Norway. <http://www.seawater.no/fauna/Svamp/fucorum.htm> Accessed 22/11/2009.

Thompson, R.M.C. (1981). A bibliography of the major ports and harbours of New Zealand (marine geology, physical oceanography and related topics). Wellington, New Zealand Oceanographic Institute Misc. publication 93.

Thrush, S.F., Schultz, D., Hewitt, J.E., Talley, D. (2002). Habitat structure in soft sediment environments and abundance of juvenile snapper Pagrus auratus. Marine Ecology Progress Series 245: 273-280.

Van Soest, R.W.M. (2009). Amphilectus fucorum (Esper, 1794). . In: Van Soest, R.W.M, Boury-Esnault, N., Hooper, J.N.A., Rützler, K, de Voogd, N.J., Alvarez, B., Hajdu, E., Pisera, A.B., Vacelet, J. Manconi, R., Schoenberg, C., Janussen, D., Tabachnick, K.R., Klautau, M. (Eds) (2009). World Porifera database. Accessed through the World Register of Marine Species at < HYPERLINK "http://www.marinespecies.org/aphia.php?p=taxdetails&id=150225" http://www.marinespecies.org/aphia.php?p=taxdetails&id=150225> Accessed 03/05/2009

Vervoort, W., Watson, J. (2003). The marine fauna of New Zealand: Leptothecata (Cnidaria: Hydrozoa) (Thecate Hydroids). NIWA Biodiversity Memoir 119. Wellington, NIWA.

Warwick, R.M. (1996). Marine biodiversity: a selection of papers presented at the conference "Marine Biodiversity: causes and consequences", York, U.K. 30 August - 2 September 1994. *Journal of Experimental Marine Biology and Ecology 202*: IX-X.

Webber, R. (2001). Space invaders: crabs that turn up in NZ unannounced. *Seafood New Zealand November*: 80-84.

Westhaven Marina (2007). Westhaven Marina website <www.westhaven.co.nz>. Accessed 30/07/2007.

Wilcove, D., Rothstein, D., Dubow, J., Phillips, A., Losos, E. (1998). Quantifying threats to imperiled species in the United States. *Bioscience 48(8)*: 607-615.

Willan, R. (1987). The mussel Musculista senhousia in Australasia: another aggressive alien highlights the need for quarantine at ports. *Bulletin of Marine Science 41(2)*: 475-489.

Wittenberg, R., Cock, M. (2001). Invasive alien species. How to address one of the greatest threats to biodiversity: a toolkit of best prevention and management practices. Wallingford, Oxon, U.K, CAB International.

Zullo, V.A. (1963). A preliminary report on systematics and distribution of barnacles (Cirripedia) of Cape Cod region. *Systematics - ecology program, Marine Biology Laboratory No.* p.

Tables

Table 1: Berthage facilities in the Westhaven Marina

Pier
A Recreational vessels/ loading pier/ dingy racks Floating concrete pier/wood pile 200 3 B Recreational vessels Floating concrete pier/wood pile 200 3 C Recreational vessels Recreational vessels/ loading pier/ dingy racks
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D
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V

w
x
z
Dinoflagellate cysts
Benthic infauna
Dinoflagellates
Zooplankton and/ phytoplankton
Crab/shrimp

Macrobiota

Sedentary / encrusting biota   Quadrat scraping   0.10 m2 quadrats sampled at -0.5 m, -3.0 m and -7.0 m on 3 outer piles per berth

Quadrat scraping

Fish
Fish/mobile epifauna

Table SEQ Table * ARABIC 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
8 mm Sieve ~ Small pebbles (Wentworth division describes pebbles as 4 mm to 64
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el < 2.8 mm to > 2 mm Sieve < 2 mm to > 1 mm Sieve Very coarse sand < 1
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2 mm to > 1 mm   Sieve   Very coarse sand   < 1 mm to > 0.5 mm   Sieve   Coarse
mm to > 1 mm   Sieve   Very coarse sand   < 1 mm to > 0.5 mm   Sieve   Coarse sand   <
mm to > 1 mm   Sieve   Very coarse sand   < 1 mm to > 0.5 mm   Sieve   Coarse sand   <
m to > 1 mm   Sieve   Very coarse sand   < 1 mm to > 0.5 mm   Sieve   Coarse sand   <
to > 1 mm   Sieve   Very coarse sand   < 1 mm to > 0.5 mm   Sieve   Coarse sand   < 500
to > 1 mm   Sieve   Very coarse sand   < 1 mm to > 0.5 mm   Sieve   Coarse sand   < 500
o > 1 mm   Sieve   Very coarse sand   < 1 mm to > 0.5 mm   Sieve   Coarse sand   < 500
> 1 mm   Sieve   Very coarse sand   < 1 mm to > 0.5 mm   Sieve   Coarse sand   < 500
> 1 mm   Sieve   Very coarse sand   < 1 mm to > 0.5 mm   Sieve   Coarse sand   < 500 µm
1 mm   Sieve   Very coarse sand   < 1 mm to > 0.5 mm   Sieve   Coarse sand   < 500 µm
1 mm   Sieve   Very coarse sand   < 1 mm to > 0.5 mm   Sieve   Coarse sand   < 500 µm
mm   Sieve   Very coarse sand   < 1 mm to > 0.5 mm   Sieve   Coarse sand   < 500 µm to
mm   Sieve   Very coarse sand   < 1 mm to > 0.5 mm   Sieve   Coarse sand   < 500 µm to
m   Sieve   Very coarse sand   < 1 mm to > 0.5 mm   Sieve   Coarse sand   < 500 µm to >
Sieve   Very coarse sand   < 1 mm to > 0.5 mm   Sieve   Coarse sand   < 500 µm to >
Sieve   Very coarse sand   < 1 mm to > 0.5 mm   Sieve   Coarse sand   < 500 µm to > 250
ieve   Very coarse sand   < 1 mm to > 0.5 mm   Sieve   Coarse sand   < 500 µm to > 250
eve   Very coarse sand   < 1 mm to > 0.5 mm   Sieve   Coarse sand   < 500 µm to > 250
ve   Very coarse sand   < 1 mm to > 0.5 mm   Sieve   Coarse sand   < 500 µm to > 250
e   Very coarse sand   < 1 mm to > 0.5 mm   Sieve   Coarse sand   < 500 µm to > 250
Very coarse sand   < 1 mm to > 0.5 mm   Sieve   Coarse sand   < 500 µm to > 250
Very coarse sand   < 1 mm to > 0.5 mm   Sieve   Coarse sand   < 500 µm to > 250
ery coarse sand   < 1 mm to > 0.5 mm   Sieve   Coarse sand   < 500 µm to > 250
ry coarse sand   < 1 mm to > 0.5 mm   Sieve   Coarse sand   < 500 µm to > 250
y coarse sand   < 1 mm to > 0.5 mm   Sieve   Coarse sand   < 500 µm to > 250 µm   Laser
coarse sand   < 1 mm to > 0.5 mm   Sieve   Coarse sand   < 500 µm to > 250 µm   Laser
coarse sand   < 1 mm to > 0.5 mm   Sieve   Coarse sand   < 500 µm to > 250 µm   Laser
oarse sand   < 1 mm to > 0.5 mm   Sieve   Coarse sand   < 500 µm to > 250 µm   Laser
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rse sand   < 1 mm to > 0.5 mm   Sieve   Coarse sand   < 500 µm to > 250 µm   Laser
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and   < 1 mm to > 0.5 mm   Sieve   Coarse sand   < 500 µm to > 250 µm   Laser
nd   < 1 mm to > 0.5 mm   Sieve   Coarse sand   < 500 µm to > 250 µm   Laser
d   < 1 mm to > 0.5 mm   Sieve   Coarse sand   < 500 µm to > 250 µm   Laser
< 1 mm to > 0.5 mm   Sieve   Coarse sand   < 500 µm to > 250 µm   Laser
< 1 mm to > 0.5 mm   Sieve   Coarse sand   < 500 µm to > 250 µm   Laser
< 1 mm to > 0.5 mm   Sieve   Coarse sand   < 500 µm to > 250 µm   Laser
1 mm to > 0.5 mm   Sieve   Coarse sand   < 500 µm to > 250 µm   Laser analysis   Medium
1 mm to > 0.5 mm   Sieve   Coarse sand   < 500 µm to > 250 µm   Laser analysis   Medium
mm to > 0.5 mm   Sieve   Coarse sand   < 500 µm to > 250 µm   Laser analysis   Medium
mm to > 0.5 mm   Sieve   Coarse sand   < 500 µm to > 250 µm   Laser analysis   Medium
m to > 0.5 mm   Sieve   Coarse sand   < 500 µm to > 250 µm   Laser analysis   Medium
to > 0.5 mm   Sieve   Coarse sand   < 500 µm to > 250 µm   Laser analysis   Medium
to > 0.5 mm   Sieve   Coarse sand   < 500 µm to > 250 µm   Laser analysis   Medium
o > 0.5 mm   Sieve   Coarse sand   < 500 µm to > 250 µm   Laser analysis   Medium
> 0.5 mm   Sieve   Coarse sand   < 500 µm to > 250 µm   Laser analysis   Medium
> 0.5 mm   Sieve   Coarse sand   < 500 µm to > 250 µm   Laser analysis   Medium
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Sampling method Site name FSHTP CRBTP SHRTP STFTP BGRB BSLD CYST PSC Photo stills & video Qualitative visual search

Caltex fuel wharf 3 2 2 2 Jetty A 4 7 2 4 3 2 2 16 58 5 1 Jetty G

Jetty A 4 7 2 4 3 2 2 16 58 5 1 Jetty G 4 6 2 4 3 2 2 16 67 6 1 Jetty K & L 2 Jetty R

Jetty A 4 7 2 4 3 2 2 16 58 5 1 Jetty G 4 6 2 4 3 2 2 16 67 6 1 Jetty K & L 2 Jetty R

Jetty G 4 6 2 4 3 2 2 16 67 6 1 Jetty K & L 2 Jetty R 4 4 2 4 3 2 2 16 16 5 1 Jetty S & T

Sampling method											
Site name	FSHTP	CRBTP	SHRTP	STFTP	BGRB	BSLD	CYST	PSC	Photo stills & video	Qualitative visual search	Sediment
Jetty G	4	6	2	4	3	2	2	16	67	6	1
Jetty K & L						2					
Jetty R	4	4	2	4	3	2	2	16	16	5	1
Jetty S & T						2					
Jetty U										2	
Jetty X	4	7	2	4	3	2		16	66	5	1
Jetty Z		2			3			16	64	5	1
Outer breakwall 1	4	4	2	4	3	2				2	1
Outer breakwall 2	4	4	2	4		2				2	
Pile Moorings	4	10	2	6	3	4	2			4	1
Public Boat ramp		6								3	
St Mary's Bay	4	4	2	6	3	2	2			3	1
Jetty J		5								3	
Jetty N				2						2	
Jetty T										1	
Jetty D		2								1	
Marina entrance		3		4							

Jetty C				2							
Jetty S		3									
Jetty P		3									
Jetty F1				2							
Jetty K		3									
Total	32	76	16	48	24	24	10	80	271	51	8

\# Qualitative visual search consisted of post-pile scrape, diver transect and above-water searches. For details see the "Diver observations and collections on wharf piles" and "Visual searches" sections above.

Table SEQ Table * ARABIC 5: **Preservatives used for the major taxonomic groups of organisms collected during the 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) Mollus ca (with shell) Ctenophora Ctenophora Ctenophora tenophora enophora nophora ophora phora hora ora 1 Mollusca ra 1 Mollusca a 1 Mollusca 1 Mollusca 1, 1 Mollusca 1, Mollusca 1, 2 Mollusca 1, 2 ollusca 1, 2 llusca 1, 2 lusca 1, 2 usca 1, 2 sca 1, 2 ca 1, 2 (without a 1, 2 (without 1, 2 (without 1, 2 (without , 2 (without 2 (without 2 (without (without (without		

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	Scyphozoa 1, 2	Platyhelminthes 1, 3			
	Hydrozoa	Codium 4			
	Actiniaria & Corallimorphari a1, 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: Physical characteristics of the sites sampled during the basline survey of Westhaven 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)
Caltex Fuel Wharf	4.3	-	-	-	-
Jetty A	8.8	1.5	29	20.9	0
Jetty G	5.6	2	28	21.3	0
Jetty K & L	3.6	-	-	-	-
Jetty R	6	1.75	30	20.5	0
Jetty S & T	4.2	-	-	-	-
Jetty U	-	-	-	-	-
Jetty X	5.1	1.75	30	20.5	0
Jetty Z	5.2	1.8	32	20.6	1
Outer Breakwall 1	8	-	-	-	-
Outer Breakwall 2	4	-	-	-	-
Pile Moorings	6	-	-	-	-
Public Boat ramp	-	-	-	-	-
St Mary's Bay	2.9	-	-	-	-
St Marys Bay Breakwall	1.2	-	-	-	-
Average across all sites	**4.99**	**1.76**	**29.80**	**20.76**	**0.20**
SE of average across all sites	**0.56**	**0.08**	**0.66**	**0.15**	**0.20**

Table 7: Sediment particle sizes at eight sites sampled during the baseline survey of Westhaven 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 A	0.15	17.97	81.89	0.00	0.00
St Mary's Bay	0.03	7.28	92.61	0.10	0.00
Jetty Z	0.19	22.48	77.35	0.00	0.00
Jetty G	0.34	14.47	85.19	0.00	0.00
Outer Breakwall 1	0.05	5.04	94.49	0.42	0.00
Jetty X	0.10	18.41	81.51	0.00	0.00
Jetty R	0.21	22.12	77.67	0.00	0.00
Pile Moorings	0.09	13.65	86.25	0.00	0.00

Table 8: Native species recorded from Westhaven Marina.

Phylum, Class	Order	Family	Taxon name
Annelida			
Polychaeta	Eunicida	Lumbrineridae	*Abyssoninoe galatheae*
Polychaeta	Phyllodocida	Glyceridae	*Glycera lamelliformis*
Polychaeta	Phyllodocida	Nephtyidae	*Aglaophamus verrilli*
Polychaeta	Phyllodocida	Nereididae	*Neanthes kerguelensis*
Polychaeta	Phyllodocida	Nereididae	*Nereis falcaria*
Polychaeta	Phyllodocida	Nereididae	*Platynereis Platynereis_australis*_group
Polychaeta	Phyllodocida	Nereididae	*Perinereis camiguinoides*
Polychaeta	Phyllodocida	Polynoidae	*Harmothoe macrolepidota*
Polychaeta	Phyllodocida	Polynoidae	*Lepidonotus polychromus*
Polychaeta	Phyllodocida	Sigalionidae	*Labiosthenolepis laevis*
Polychaeta	Phyllodocida	Syllidae	*Trypanosyllis zebra*
Polychaeta	Phyllodocida	Goniadidae	*Glycinde trifida*
Polychaeta	Sabellida	Sabellidae	*Megalomma suspiciens*
Polychaeta	Sabellida	Sabellidae	*Pseudopotamilla laciniosa*
Polychaeta	Sabellida	Sabellidae	*Demonax aberrans*
Polychaeta	Sabellida	Serpulidae	*Spirobranchus cariniferus*
Polychaeta	Sabellida	Oweniidae	*Owenia petersenae*
Polychaeta	Scolecida	Maldanidae	*Asychis amphiglyptus*
Polychaeta	Scolecida	Orbiniidae	*Phylo novazealandiae*
Polychaeta	Scolecida	Scalibregmatidae	*Hyboscolex longiseta*
Polychaeta	Scolecida	Cossuridae	*Cossura consimilis*
Polychaeta	Spionida	Spionidae	*Prionospio aucklandica*
Polychaeta	Spionida	Spionidae	*Boccardia syrtis*
Polychaeta	Terebellida	Cirratulidae	*Protocirrineris nuchalis*
Polychaeta	Terebellida	Cirratulidae	*Timarete anchylochaetus*
Polychaeta	Terebellida	Flabelligeridae	*Flabelligera affinis*
Polychaeta	Terebellida	Flabelligeridae	*Pherusa parmata*
Polychaeta	Terebellida	Pectinariidae	*Pectinaria australis*
Polychaeta	Terebellida	Terebellidae	*Pseudopista rostrata*
Polychaeta	Terebellida	Terebellidae	*Streblosoma toddae*
Polychaeta	Terebellida	Trichobranchidae	*Terebellides narribri*
Polychaeta	Terebellida	Acrocirridae	*Acrocirrus trisectus*
Arthropoda			
Malacostraca	Amphipoda	Melitidae	*Melita festiva*
Malacostraca	Amphipoda	Phoxocephalidae	*Torridoharpinia hurleyi*
Malacostraca	Amphipoda	Lysianassidae	*Parawaldeckia vesca*
Malacostraca	Amphipoda	Aoridae	*Aora maculata*
Malacostraca	Amphipoda	Aoridae	*Haplocheira barbimana*
Malacostraca	Amphipoda	Leucothoidae	*Leucothoe trailli*
Malacostraca	Amphipoda	Isaeidae	*Gammaropsis typica*
Malacostraca	Cumacea	Botriidae	*Cyclaspsis laevis*
Malacostraca	Decapoda	Alpheidae	*Alpheus richardsoni*
Malacostraca	Decapoda	Crangonidae	*Philocheras australis*
Malacostraca	Decapoda	Crangonidae	*Philocheras cf. australis*
Malacostraca	Decapoda	Diogenidae	*Paguristes setosus*
Malacostraca	Decapoda	Hymenosomatidae	*Halicarcinus varius*
Malacostraca	Decapoda	Hymenosomatidae	*Neohymenicus pubescens*
Malacostraca	Decapoda	Majidae	*Notomithrax minor*
Malacostraca	Decapoda	Majidae	*Notomithrax peronii*
Malacostraca	Decapoda	Ocypodidae	*Macrophthalmus hirtipes*
Malacostraca	Decapoda	Palemonidae	*Periclimenes yaldwyni*

Phylum, Class	Order	Family	Taxon name
Malacostraca	Decapoda	Pilumnidae	*Pilumnopeus serratifrons*
Malacostraca	Decapoda	Pinnotheridae	*Pinnotheres novaezelandiae*
Malacostraca	Decapoda	Porcellanidae	*Petrolisthes elongatus*
Malacostraca	Decapoda	Porcellanidae	*Petrolisthes novaezelandiae*
Malacostraca	Decapoda	Paguridae	*Pagurus novizealandiae*
Malacostraca	Decapoda	Cancridae	*Metacarcinus novaezelandiae*
Malacostraca	Decapoda	Grapsidae	*Hemigrapsus sexdentatus*
Malacostraca	Decapoda	Xanthidae	*Pilumnus novaezelandiae*
Malacostraca	Decapoda	Xanthidae	*Pilumnus lumpinus*
Malacostraca	Isopoda	Cirolanidae	*Natatolana rossi*
Malacostraca	Isopoda	Cirolanidae	*Cirolana quechso*
Maxillopoda	Sessilia	Archaeobalanidae	*Austrominius modestus*
Maxillopoda	Sessilia	Balanidae	*Balanus trigonus*
Bryozoa			
Gymnolaemata	Cheilostomata	Candidae	*Caberea rostrata*
Chlorophyta			
Ulvophyceae	Bryopsidales	Codiaceae	*Codium fragile*
Chordata			
Actinopterygii	Mugiliformes	Mugilidae	*Aldrichetta forsteri*
Actinopterygii	Perciformes	Arripidae	*Arripis trutta*
Actinopterygii	Perciformes	Labridae	*Notolabrus celidotus*
Actinopterygii	Perciformes	Sparidae	*Pagrus auratus*
Actinopterygii	Perciformes	Tripterygiidae	*Grahamina capito*
Actinopterygii	Perciformes	Tripterygiidae	*Forsterygion malcolmi*
Actinopterygii	Perciformes	Gobiesocidae	*Trachelochismus melobesia*
Actinopterygii	Perciformes	Carangidae	*Pseudocaranx dentex*
Actinopterygii	Perciformes	Carangidae	*Trachurus novaezelandiae*
Actinopterygii	Perciformes	Carangidae	*Caranx georgianus*
Actinopterygii	Gasterosteiformes	Syngnathidae	*Hippocampus abdominalis*
Ascidiacea	Enterogona	Polyclinidae	*Aplidium phortax*
Ascidiacea	Pleurogona	Molgulidae	*Molgula mortenseni*
Ascidiacea	Pleurogona	Pyuridae	*Pyura rugata*
Ascidiacea	Pleurogona	Pyuridae	*Pyura pulla*
Ascidiacea	Pleurogona	Styelidae	*Asterocarpa cerea*
Ascidiacea	Pleurogona	Styelidae	*Cnemidocarpa nisiotis*
Ascidiacea	Pleurogona	Polyzoinae	*Polyzoa opuntia*
Echinodermata			
Asteroidea	Valvatida	Asterinidae	*Patiriella regularis*
Ophiuroidea	Ophiurida	Ophiactidae	*Ophiactis resiliens*
Mollusca			
Bivalvia	Mytiloida	Mytilidae	*Modiolarca impacta*
Bivalvia	Mytiloida	Mytilidae	*Perna canaliculus*
Bivalvia	Mytiloida	Mytilidae	*Xenostrobus pulex*
Bivalvia	Ostreoida	Ostreidae	*Ostrea chilensis*
Bivalvia	Veneroida	Veneridae	*Austrovenus stutchburyi*
Bivalvia	Nuculoida	Nuculidae	*Nucula hartvigiana*
Gastropoda	Mesogastropoda	Struthiolariidae	*Pelicaria vermis*
Gastropoda	Neogastropoda	Buccinidae	*Cominella adspersa*
Gastropoda	Neotaenioglossa	Calyptraeidae	*Sigapatella novaezelandiae*
Gastropoda	Neotaenioglossa	Calyptraeidae	*Crepidula costata*
Gastropoda	Neotaenioglossa	Turritellidae	*Maoricolpus roseus*
Gastropoda	Nudibranchia	Dendrodorididae	*Dendrodoris citrina*
Polyplacophora	Ischnochitonina	Chitonidae	*Sypharochiton pelliserpentis*
Ochrophyta			
Phaeophyceae	Fucales	Sargassaceae	*Carpophyllum flexuosum*
Phaeophyceae	Fucales	Hormosiraceae	*Hormosira banksii*
Phaeophyceae	Laminariales	Alariaceae	*Ecklonia radiata*
Porifera			

Phylum, Class	Order	Family	Taxon name
Demospongiae	Haplosclerida	Chalinidae	*Adocia cf. parietalioides*
Demospongiae	Poecilosclerida	Microcionidae	*Plocamia novizelanicum*
Demospongiae	Poecilosclerida	Mycalidae	*Mycale (Carmia) tasmani*
Demospongiae	Poecilosclerida	Tedaniidae	*Tedania diversiraphidiophora*
Demospongiae	Poecilosclerida	Tedaniidae	*Tedania spinostylota*
Rhodophyta			
Florideophyceae	Plocamiales	Plocamiaceae	*Plocamium angustum*
Florideophyceae	Corallinales	Corallinaceae	*Corallina officinalis*

Table 9: Cryptogenic category 1 (C1) and category 2 (C2) marine taxa recorded from Westhaven Marina.

Phylum, Class	Order	Family	Taxon name	Status
Annelida				
Polychaeta	Phyllodocida	Nereididae	*Neanthes* aff. *succinea*	C2
Polychaeta	Sabellida	Serpulidae	*Simplaria pseudomilitaris*	C1
Arthropoda				
Malacostraca	Decapoda	Hippolytidae	*Lysmata vittata*	C1
Polychaeta	Scolecida	Capitellidae	*Heteromastus filiformis*	C1
Bryozoa				
Gymnolaemata	Cheilostomata	Scrupariidae	*Scruparia ambigua*	C1
Chordata				
Ascidiacea	Enterogona	Rhodosomatidae	*Corella eumyota*	C1
Ascidiacea	Enterogona	Didemnidae	*Didemnum* sp.[#]	C1
Ascidiacea	Enterogona	Polycitoridae	*Cystodytes dellechiajei*	C1
Ascidiacea	Pleurogona	Botryllinae	*Botrylloides leachi*	C1
Ascidiacea	Pleurogona	Pyuridae	*Microcosmus squamiger*	C1
Ascidiacea	Pleurogona	Styelidae	*Styela plicata*	C1
Porifera				
Demospongiae	Halichondrida	Halichondriidae	*Halichondria* new sp. 1	C2
Demospongiae	Haplosclerida	Chalinidae	*Haliclona* new sp. 3	C2
Demospongiae	Haplosclerida	Chalinidae	*Haliclona heterofibrosa*	C1
Demospongiae	Haplosclerida	Chalinidae	*Adocia* new sp. 6	C2
Demospongiae	Haplosclerida	Chalinidae	*Haliclona* new sp. 5	C2
Demospongiae	Poecilosclerida	Microcionidae	*Dictyociona* cf. *atoxa*	C2
Demospongiae	Poecilosclerida	Mycalidae	*Paraesperella* new sp. 1	C2
Demospongiae	Poecilosclerida	Coelosphaeridae	*Lissodendoryx isodictyalis*	C1
Demospongiae	Dendroceratida	Darwinellidae	*Dendrilla* new sp. 1	C2

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

Table 10: Non-indigenous marine species recorded from the Westhaven Marina. Likely vectors of introduction are largely derived from Cranfield *et al*. (1998), where H = Hull fouling and B = Ballast water transport. Novel NIS not listed in Cranfield *et al*. (1998) or previously encountered by taxonomic experts in New Zealand waters are marked as New Records (NR). For these species and others for which information is scarce, we provide dates of first detection rather than probable dates of introduction.

Phylum, Class	Order	Family	Taxon name	Date of first record or introduction	Method of intro
Annelida					
Polychaeta	Sabellida	Serpulidae	*Hydroides elegans*	Pre-1952	H or B
Polychaeta	Sabellida	Serpulidae	*Hydroides ezoensis*	April 2003	H
Polychaeta	Spionida	Spionidae	*Polydora hoplura*	Unknown	H
Polychaeta	Spionida	Spionidae	*Pseudopolydora paucibranchiata*	Pre-1975	H or B
Polychaeta	Phyllodocida	Polynoidae	*Paralepidonotus ampulliferus*	2003	H or B
Arthropoda					
Malacostraca	Amphipoda	Corophiidae	*Apocorophium acutum*	Pre-1921	H
Malacostraca	Decapoda	Portunidae	*Charybdis japonica*	pre-2000	H or B
Maxillopoda	Sessilia	Balanidae	*Amphibalanus amphitrite*	1960	H
Bryozoa					
Gymnolaemata	Ctenostomata	Bugulidae	*Bugula flabellata*	Pre-1949	H
Gymnolaemata	Ctenostomata	Bugulidae	*Bugula neritina*	Probably 1949	H
Gymnolaemata	Ctenostomata	Bugulidae	*Bugula stolonifera*	1962	H
Gymnolaemata	Ctenostomata	Schizoporellidae	*Schizoporella errata*	Pre-1960	H
Gymnolaemata	Ctenostomata	Candidae	*Tricellaria catalinensis*	Pre-1964	H
Gymnolaemata	Ctenostomata	Vesiculariidae	*Bowerbankia gracilis*	Pre-1965	H or B
Gymnolaemata	Ctenostomata	Vesiculariidae	*Zoobotryon verticillatum*	1960	H or B
Gymnolaemata	Ctenostomata	Watersiporidae	*Watersipora subtorquata*	Pre-1982	H or B
Chordata					
Ascidiacea	Enterogona	Ascidiidae	*Ascidiella aspersa*	1900s	H
Ascidiacea	Enterogona	Didemnidae	*Diplosoma listerianum*	Pre-1996	H
Ascidiacea	Pleurogona	Styelidae	*Botryllus tuberatus*	Unknown	H or B
Ascidiacea	Pleurogona	Styelidae	*Styela clava*	November 2004	H
Cnidaria					
Hydrozoa	Hydroida	Pennariidae	*Pennaria disticha*	Pre-1928	H
Mollusca					
Bivalvia	Mytiloida	Mytilidae	*Musculista senhousia*	1978	H or B
Bivalvia	Ostreoida	Ostreidae	*Crassostrea gigas*	1961	H
Bivalvia	Veneroida	Semelidae	*Theora lubrica*	1971	B
Ochrophyta					
Phaeophyceae	Laminariales	Alariaceae	*Undaria pinnatifida*	Pre-1987	H or B
Porifera					
Calcarea	Leucosolenida	Heteropiidae	*Vosmaeropsis* cf. *macera*	Unknown [1]	H
Demospongiae	Poecilosclerida	Esperiopsidae	*Amphilectus fucorum*	December 2001	0

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

Table 11: Indeterminate taxa recorded from Westhaven Marina. 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
Annelida			
Polychaeta	Phyllodocida	Syllidae	*Syllidae* Indet.
Polychaeta	Sabellida	Serpulidae	*Serpula* sp.
Polychaeta	Sabellida	Serpulidae	*Janua* sp.
Polychaeta	Scolecida	Maldanidae	*Asychis* sp.
Polychaeta	Spionida	Spionidae	Spionidae Indet.
Polychaeta	Spionida	Spionidae	*Polydora* sp.
Polychaeta	Terebellida	Cirratulidae	Cirratulidae Indet.
Polychaeta	Terebellida	Cirratulidae	*Aphelochaeta aphelochaeta*-1 undescribed
Polychaeta	Terebellida	Terebellidae	Lysilla sp.
Arthropoda			
Malacostraca			Malacostraca Indet.
Malacostraca	Amphipoda	Ampithoidae	Ampithoidae
Malacostraca	Decapoda		Decapoda Indet.
Malacostraca	Decapoda	Majidae	*Notomithrax* sp.
Malacostraca	Decapoda	Paguridae	*Pagurus* sp.
Malacostraca	Isopoda		Isopoda
Malacostraca	Isopoda	Cymothoidae	*Ceratothoa* sp.
Maxillopoda			Maxillopoda Indet.
Ostracoda	Myodocopida		Myodocopida
Bryozoa			
			Bryozoa Indet.
Gymnolaemata	Cheilostomata	Lepraliellidae	*Celleporaria* sp.
Gymnolaemata	Cheilostomata	Flustridae	*Gregarinidra* sp.
Chlorophyta			
Ulvophyceae	Cladophorales	Cladophoraceae	*Cladophora* sp.
Chordata			
Actinopterygii			Actinopterygii
Actinopterygii	Perciformes	Gobiidae	*Eviota* sp.
Actinopterygii	Perciformes	Gobiidae	Gobiidae
Actinopterygii	Perciformes	Mugilidae	Mugilidae
Ascidiacea			Ascidiacea
Ascidiacea	Enterogona	Didemnidae	*Diplosoma* sp.
Ascidiacea	Enterogona	Didemnidae	Didemnidae
Cnidaria			
Hydrozoa			Hydrozoa
Echinodermata			
Asteroidea	Forcipulatida	Asteriidae	*Allostichaster* sp.
Asteroidea	Valvatida	Asterinidae	*Patiriella* sp.
Mollusca			
Aplacophora			Aplacophora
Bivalvia			Bivalvia
Gastropoda			Gastropoda
Gastropoda	Neogastropoda	Buccinidae	*Cominella* sp.

Phylum, Class	Order	Family	Taxon name
Ochrophyta			
Phaeophyceae	Laminariales	Alariaceae	*Ecklonia* sp.
Dictyochophyceae	Dictyochales	Dictyochaceae	*Dictyota* sp.
Rhodophyta			
Florideophyceae	Ceramiales	Rhodomelaceae	*Polysiphonia* sp.
Florideophyceae	Ceramiales	Ceramiaceae	*Ceramium* sp.
Florideophyceae	Ceramiales	Delesseriaceae	*Delesseria* sp.
Florideophyceae	Rhodymeniales	Rhodymeniaceae	*Rhodymenia* sp.
Platyhelminthes			
Platyhelminthes			Platyhelminthes
Nemertea			
Nemertea			Nemertea
Cyanobacteria			
Cyanobacteria			Cyanobacteria
Unidentified			
Plantae			Plantae
			Unidentified algae

Table 12: Non-indigenous marine organisms recorded from the Westhaven Marina survey and the techniques used to capture each species. Species distributions throughout the marina and in other ports and marinas around New Zealand are indicated.

Taxon name	Capture techniques in Westhaven Marina	Locations detected in Westhaven Marina	Detected in other locations surveyed in ZBS2000_04, ZBS2005_18 & ZBS 2005_19
Annelida			
Hydroides elegans	PSC	Jetty Z	Gulf Harbour Marina, Viaduct Harbour Marina, Auckland, Nelson
Hydroides ezoensis	PSC	Jetty G	Opua, Gulf Harbour Marina
Paralepidonotus ampulliferus	BGRB	Jetty A	Whangarei, Auckland, Viaduct Harbour Marina
Polydora hoplura	PSC	Jetty G, Jetty X	Whangarei, Viaduct Harbour Marina, Tauranga, Napier, Wellington, Picton, Nelson, Lyttelton, Timaru, Dunedin, Bluff
Pseudopolydora paucibranchiata	BSLD	Jetty X, Pile Moorings, St Mary's Bay	Whangarei, Gulf Harbour Marina, Viaduct Harbour Marina, Gisborne
Arthropoda			
Amphibalanus amphitrite	PSC	Jetty R	Gulf Harbour Marina
Apocorophium acutum	PSC	Jetty A, Jetty G, Jetty Z	Opua, Whangarei, Auckland, Gulf Harbour Marina, Napier, Tauranga, Lyttelton, Dunedin, Bluff
Charybdis japonica	CRBTP	Westhaven	Auckland
Bryozoa			
Bowerbankia gracilis	PSC	Jetty A, Jetty G, Jetty R, Jetty Z	Opua, Whangarei, Gulf Harbour Marina, Viaduct Harbour Marina, Gisborne, Napier, Port Underwood
Bugula flabellata	PSC	Jetty G, Jetty Z	Whangarei, Napier
Bugula neritina	PSC	Jetty G, Jetty Z	Opua, Whangarei, Auckland, Gisborne, Napier, Tauranga, Taranaki, Wellington, Port Underwood, Picton, Nelson, Lyttelton, Timaru, Dunedin, Bluff
Bugula stolonifera	PSC	Jetty A	Opua, Whangarei, Gulf Harbour Marina, Viaduct Harbour Marina, Gisborne, Napier
Schizoporella errata	PSC	Jetty A, Jetty X	Opua, Whangarei, Gulf Harbour Marina, Viaduct Harbour Marina, Nelson
Tricellaria catalinensis	PSC	Jetty X, Jetty Z	Whangarei, Viadcut Harbour Marina, Gisborne, Taranaki, Picton, Lyttelton
Watersipora subtorquata	BSLD, PSC	Jetty A, Jetty G, Jetty S & T	Opua, Whangarei, Gulf Harbour Marina, Tauranga, Gisborne, Napier, Taranaki, Wellington,Port Underwood, Picton, Nelson, Lyttelton, Timaru, Dunedin, Bluff
Zoobotryon verticillatum	PSC	Jetty A, Jetty G	Gulf Harbour Marina, Tauranga
Chordata			
Ascidiella aspersa	PSC	Jetty A, Jetty G, Jetty R, Jetty X, Jetty Z	Gulf Harbour Marina, Viadcut Harbour Marina, Gisborne, Napier, Port Underwood, Lyttelton, Dunedin, Bluff.
Botryllus tuberatus	PSC	Jetty A, Jetty G	Viaduct Harbour Marina
Diplosoma listerianum	PSC	Jetty R, Jetty X	Whangarei, Gulf Harbour Marina, Viaduct Harbour Marina, Auckland, Tauranga, Gisborne, Napier, Taharoa, Taranaki, Lyttelton, Dunedin, Bluff

Taxon name	Capture techniques in Westhaven Marina	Locations detected in Westhaven Marina	Detected in other locations surveyed in ZBS2000_04, ZBS2005_18 & ZBS 2005_19
Styela clava	PSCM, VISS, PSC	Caltex Fuel Wharf, Jetty G, Jetty Z, Pile Moorings, Public Boat ramp, St Mary's Bay, Westhaven, Westhaven Boat ramp, Westhaven by rowing club, westhaven pile moorings 1, westhaven pile moorings 2	Gulf Harbour Marina, Auckland, Lyttelton
Cnidaria			
Pennaria disticha	BGRB, VISS	Caltex Fuel Wharf, Outer Breakwall 1, Outer Breakwall 2	Auckland, Westhaven Marina, Kaikoura area, Dunedin, Bluff
Mollusca			
Crassostrea gigas	PSC, VISS	Jetty A, Jetty G, Jetty R, Jetty X, Jetty Z, Outer Breakwall 1, Outer Breakwall 2, St Mary's Bay, Westhaven, westhaven outer breakwall 1, westhaven outer breakwall 2, Westhaven sales berth	Opua, Whangarei, Kaipara, Gulf Harbour Marina, Auckland, Taranaki, Nelson, Dunedin
Musculista senhousia	PSC	Jetty G, Jetty Z	Opua, Whangarei, Kaipara, Gulf Harbour Marina
Theora lubrica	BSLD, BGRB	Caltex Fuel Wharf, Jetty A, Jetty G, Jetty K & L, Jetty R, Jetty S & T, Jetty X, Jetty Z, Outer Breakwall 1, Outer Breakwall 2, Pile Moorings, St Mary's Bay	Opua, Whangarei, Gulf Harbour Marina, Viaduct Harbour Marina, Auckland, Gisborne, Napier, Taranaki, Wellington, Nelson, Picton, Port Underwood, Kaikoura area, Lyttelton
Ochrophyta			
Undaria pinnatifida	VISS, PSCM	Caltex Fuel Wharf, Jetty G, Westhaven Boat Ramp	Gisborne, Waitemata Harbour, Napier, Taranaki, Wellington, Picton, Port Underwood, Nelson, Kaikoura area, Lyttelton, Timaru, Dunedin, Bluff
Porifera			
Amphilectus fucorum	PSC	Jetty A, Jetty X	Opua, Whangarei, Auckland, Tauranga, Taranaki, Picton
Vosmaeropsis cf. *macera*	PSC	Jetty G	Whangarei, Gulf Harbour Marina

Table 13: 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 14: 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 15: Depth class and method of collection for each NIS collected during the baseline survey of Westhaven Marina. Data are numbers of samples each species occurred in.

Species	Method *	0 - 3 m	> 3 - 6 m	> 6 - 9 m	Total
Apocorophium acutum	PSC	6	2		**8**
Bowerbankia gracilis	PSC	2	3		**5**
Bugula flabellata	PSC	1	1		**2**
Bugula neritina	PSC	2			**2**
Bugula stolonifera	PSC		1		**1**
Crassostrea gigas	PSC	27	7		**34**
Hydroides ezoensis	PSC	3			**3**
Schizoporella errata	PSC	3			**3**
Theora lubrica	BSLD	3	24	1	**28**
	BGRB	3	14	6	**23**
Watersipora subtorquata	BSLD		2		**2**
	PSC	8	1		**9**
Ascidiella aspersa	PSC	20	5		**25**
Diplosoma listerianum	PSC	5			**5**
Pennaria disticha	BSLD		2	1	**3**
Polydora hoplura	PSC	3			**3**
Undaria pinnatifida	PSCM		1		**1**
Botryllus tuberatus	PSC	2			**2**
Hydroides elegans	PSC	1			**1**
Paralepidonotus ampulliferus	BGRB			1	**1**
Pseudopolydora paucibranchiata	BSLD	1	3		**4**
Styela clava	PSC	1			**1**
	PSCM		1		**1**
Tricellaria catalinensis	PSC	2			**2**
Zoobotryon verticillatum	PSC	1	2		**3**
Amphibalanus amphitrite	PSC	1			**1**
Amphilectus fucorum	PSC	4	2		**6**
Charybdis japonica	STFTP		1		**1**
	CRBTP	2	1		**3**
Musculista senhousia	PSC	6			**6**
Vosmaeropsis cf. *macera*	PSC	1			**1**
Total number of NIS & C1 specimens		**154**	**99**	**11**	**190**
Proportion of all NIS & C1 specimens (%)		**81.1**	**52.1**	**5.8**	**139**
Total number of NIS & C1 taxa		**23**	**15**	**3**	**27**
Proportion of all NIS & C1 taxa (%)		**85.2**	**55.6**	**11.1**	**#**

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 baseline survey of Westhaven Marina. Data are numbers of samples each species occurred in.

Species	Method *	0 - 3 m	> 3 - 6 m	> 6 - 9 m	Total
Adocia cf. parietalioides	BSLD			1	**1**
	PSC	1			**1**
Aglaophamus verrilli	BSLD	1	1		**2**
	BGRB			2	**2**
Aldrichetta forsteri	CRBTP	1	2		**3**
	BGRB			1	**1**
	FSHTP	8	10		**18**
Alpheus richardsoni	BSLD	2	9		**11**
	PSC	1			**1**
	BGRB	1	2	1	**4**
Aplidium phortax	PSC	4			**4**
Austrominius modestus	PSC	1			**1**
Austrovenus stutchburyi	BSLD	2			**2**
Balanus trigonus	BSLD			1	**1**
	PSC	11	9		**20**
Cnemidocarpa nisiotis	BSLD			1	**1**
Cominella adspersa	BSLD	1			**1**
	CRBTP	2			**2**
	FSHTP	2			**2**
Flabelligera affinis	BSLD		1		**1**
Glycera lamelliformis	BSLD		4		**4**
	BGRB	1	1	2	**4**
Grahamina capito	PSC		1		**1**
Halicarcinus varius	BSLD	1	1		**2**
	PSC	6	4		**10**
Harmothoe macrolepidota	BSLD			1	**1**
	PSC	18	4		**22**
Hyboscolex longiseta	BSLD			1	**1**
Labiosthenolepis laevis	BSLD	2	6		**8**
Lepidonotus polychromus	BSLD		1	1	**2**
	PSC	3	1		**4**
Macrophthalmus hirtipes	BSLD		1		**1**
Maoricolpus roseus	BSLD		1	1	**2**
Megalomma suspiciens	BSLD		1	1	**2**
	PSC	4	3		**7**
Modiolarca impacta	BSLD			1	**1**
Molgula mortenseni	PSC	15			**15**
Natatolana rossi	SHRTP		2	1	**3**
Neanthes kerguelensis	PSC	4	1		**5**
Neohymenicus pubescens	PSC	1	1		**2**
Nereis falcaria	PSC		2		**2**
Notolabrus celidotus	CRBTP	7	11	2	**20**
	FSHTP	5	7	1	**13**
Notomithrax minor	BSLD			1	**1**
	PSC	6	4		**10**
Pagrus auratus	CRBTP	1	3	1	**5**
	FSHTP		3	2	**5**

Species	Method *	0 - 3 m	> 3 - 6 m	> 6 - 9 m	Total
	STFTP	2			**2**
Patiriella regularis	BSLD		3		**3**
	CRBTP	3	1		**4**
	STFTP	2	2	3	**7**
Pectinaria australis	BSLD	1	1	1	**3**
Pelicaria vermis	BSLD	1			**1**
Periclimenes yaldwyni	BSLD			1	**1**
	PSC	1	1		**2**
Perna canaliculus	PSC	1			**1**
Petrolisthes elongatus	PSC	4	1		**5**
Petrolisthes novaezelandiae	BSLD		1	1	**2**
	PSC	5	3		**8**
Philocheras australis	BSLD	1	6	1	**8**
	PSC	1	1		**2**
Phylo novazealandiae	BSLD	2	17		**19**
	PSC		1		**1**
	BGRB	3	9	3	**15**
Pilumnopeus serratifrons	PSC	7	5		**12**
Platynereis Platynereis_australis_group	PSC	2			**2**
Protocirrineris nuchalis	PSC	3	1		**4**
Pseudopista rostrata	PSC	1	2		**3**
Pyura rugata	BSLD		1		**1**
	PSC	21	3		**24**
Sigapatella novaezelandiae	PSC	1			**1**
Spirobranchus cariniferus	PSC	2			**2**
Streblosoma toddae	PSC	10	6		**16**
Terebellides narribri	BSLD		2		**2**
Timarete anchylochaetus	PSC	1			**1**
Torridoharpinia hurleyi	BSLD	1	1		**2**
	BGRB	1			**1**
Xenostrobus pulex	PSC	2			**2**
Acrocirrus trisectus	PSC	1	1		**2**
Aora maculata	PSC	1			**1**
Asterocarpa cerea	PSC	2			**2**
Caberea rostrata	PSC	2	1		**3**
Glycinde trifida	BSLD	3	5		**8**
	PSC		1		**1**
	BGRB	1	1		**2**
Hemigrapsus sexdentatus	PSC	1			**1**
Leucothoe trailli	BSLD			1	**1**
	PSC	5	2		**7**
Metacarcinus novaezelandiae	CRBTP	1			**1**
Mycale (Carmia) tasmani	PSC	6	3		**9**
Notomithrax peronii	CRBTP			1	**1**
	FSHTP	1			**1**
Ostrea chilensis	PSC	9	3		**12**
Owenia petersenae	BSLD	1			**1**
Pagurus novizealandiae	BSLD	1			**1**
Parawaldeckia vesca	PSC		1		**1**
Pherusa parmata	BSLD		1	1	**2**
Prionospio aucklandica	BSLD		1		**1**
	PSC	1			**1**
	BGRB		1		**1**

Species	Method *	0 - 3 m	> 3 - 6 m	> 6 - 9 m	Total
Pyura pulla	PSC	1			**1**
Sypharochiton pelliserpentis	PSC	1			**1**
Trachelochismus melobesia	FSHTP		1	1	**2**
Trypanosyllis zebra	BSLD			1	**1**
	PSC	2			**2**
Abyssoninoe galatheae	BGRB		3	2	**5**
Boccardia syrtis	BSLD	1	9		**10**
	BGRB	3	6		**9**
Cirolana quechso	SHRTP		1	2	**3**
Cossura consimilis	BSLD		4		**4**
	BGRB		2		**2**
Crepidula costata	PSC	2			**2**
Forsterygion malcolmi	PSC		1		**1**
Melita festiva	BSLD		1		**1**
	PSC	3			**3**
Pilumnus novaezelandiae	PSC	14	3		**17**
Pinnotheres novaezelandiae	PSC	1			**1**
Pseudocaranx dentex	CRBTP		1		**1**
	FSHTP		1		**1**
Pseudopotamilla laciniosa	BSLD			1	**1**
	PSC		1		**1**
Trachurus novaezelandiae	FSHTP		2		**2**
Amphisbetia bispinosa	PSC	1			**1**
Arripis trutta	FSHTP			1	**1**
Asychis amphiglyptus	BGRB		1	1	**2**
Caranx georgianus	FSHTP		3		**3**
Carpophyllum flexuosum	PSC	2			**2**
Corallina officinalis	BSLD		1		**1**
	PSC	8			**8**
Cyclaspsis laevis	BSLD		1		**1**
Demonax aberrans	PSC	6			**6**
Dendrodoris citrina	BSLD		1	1	**2**
Ecklonia radiata	BSLD		1		**1**
	PSC	1			**1**
Gammaropsis typica	PSC	1			**1**
Haplocheira barbimana	BSLD			1	**1**
	PSC	1	1		**2**
Hippocampus abdominalis	STFTP		1		**1**
Nucula hartvigiana	BSLD	2	5		**7**
	BGRB	1	1		**2**
Ophiactis resiliens	BSLD	1	1	1	**3**
Paguristes setosus	BSLD		1		**1**
Perinereis camiguinoides	PSC	2			**2**
Philocheras cf. *australis*	BSLD		1		**1**
Pilumnus lumpinus	PSC	2	1		**3**
Plocamia novizelanicum	BSLD		1		**1**
Plocamium angustum	BGRB		1		**1**
Polyzoa opuntia	PSC		1		**1**
Tedania diversiraphidiophora	BSLD		1		**1**
Tedania spinostylota	BSLD			1	**1**
Total number of native specimens		**283**	**246**	**49**	**578**
Proportion of all native specimens (%)		**49.0**	**42.6**	**8.5**	**100**
Total number of native taxa		**74**	**72**	**37**	**107[1]**
Proportion of all native taxa (%)		**69.2**	**67.3**	**34.6**	**#**

* 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
[1]The total number of native taxa recorded in the survey was 109, however two species (*Codium fragile* and *Hormosira banksii* were found in a visual surface search where depth was not recorded, so are excluded from this table.

Table 17: Summary statistics for taxon assemblages collected in the Westhaven Marina using four different methods. See "Definitions of species categories" for definitions of Native, C1 and C2 (cryptogenic category 1 and 2) and NIS (non-indigenous species) taxa.

	No. of samples	No. of taxa	No. (%) of taxa in only one sample
Pile scrape quadrats			
Native	80	61	22 (36 %)
C2	80	5	1 (20 %)
NIS & C1	80	31	10 (32 %)
Benthic sleds			
Native	24	52	29 (56 %)
C2	24	3	3 (100 %)
NIS & C1	24	8	1 (13 %)
Benthic grabs			
Native	24	14	4 (29 %)
C2	24	0	-
NIS & C1	24	2	1 (50 %)
Native, C2, NIS & C1 taxa combined	24	16	5 (31 %)
Crab traps			
Native	35	8	3 (38 %)
C2	35	0	-
NIS & C1	35	1	0 (0 %)
Native, C2, NIS & C1 taxa combined	35	9	3 (33 %)

Appendices

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

Site	Easting	Northing	Survey Method*	Number of sample units
Caltex Fuel Wharf	2666613	6482963	BSLD	1
Caltex Fuel Wharf	2666647	6483153	BSLD	1
caltex fuel wharf	2666715	6483004	VISS	2
Jetty A	2666387	6483473	BGRB	1
Jetty A	2666393	6483482	BGRB	1
Jetty A	2666400	6483473	BGRB	1
Jetty A	2666325	6483388	BSLD	1
Jetty A	2666336	6483601	BSLD	1
Jetty A	2666370	6483429	CRBTP	2
Jetty A	2666383	6483580	CRBTP	2
Jetty A	2666377	6483449	CYST	1
Jetty A	2666390	6483566	CYST	1
Jetty A	2666384	6483462	FSHTP	2
Jetty A	2666389	6483579	FSHTP	2
Jetty A	2666378	6483519	PSC	16
Jetty A	2666393	6483482	SEDIMENT	1
Jetty A	2666370	6483429	SHRTP	1
Jetty A	2666383	6483580	SHRTP	1
Jetty A	2666370	6483429	STFTP	2
Jetty A	2666383	6483580	STFTP	2
Jetty G	2665949	6483582	BGRB	1
Jetty G	2665951	6483586	BGRB	1
Jetty G	2665962	6483585	BGRB	1
Jetty G	2665938	6483485	BSLD	1
Jetty G	2665950	6483621	BSLD	1
Jetty G	2665943	6483643	CRBTP	2
Jetty G	2665949	6483563	CRBTP	2
Jetty G	2665942	6483551	CYST	1
Jetty G	2665947	6483617	CYST	1
Jetty G	2665956	6483556	FSHTP	2
Jetty G	2665972	6483639	FSHTP	2
Jetty G	2665990	6483573	PSC	16
Jetty G	2665990	6483573	PSCM	1
Jetty G	2665962	6483585	SEDIMENT	1
Jetty G	2665943	6483643	SHRTP	1
Jetty G	2665949	6483563	SHRTP	1
Jetty G	2665943	6483643	STFTP	2
Jetty G	2665949	6483563	STFTP	2
Jetty K & L	2665899	6483313	BSLD	1
Jetty K & L	2665911	6483400	BSLD	1
Jetty R	2666125	6483256	BGRB	1
Jetty R	2666128	6483253	BGRB	1
Jetty R	2666133	6483260	BGRB	1
Jetty R	2666180	6483228	BSLD	1
Jetty R	2666197	6483326	BSLD	1

Site	Easting	Northing	Survey Method*	Number of sample units
Jetty R	2666126	6483151	CRBTP	2
Jetty R	2666130	6483249	CRBTP	2
Jetty R	2666103	6483187	CYST	1
Jetty R	2666132	6483232	CYST	1
Jetty R	2666117	6483147	FSHTP	2
Jetty R	2666153	6483317	FSHTP	2
Jetty R	2666151	6483221	PSC	16
Jetty R	2666133	6483260	SEDIMENT	1
Jetty R	2666126	6483151	SHRTP	1
Jetty R	2666130	6483249	SHRTP	1
Jetty R	2666126	6483151	STFTP	2
Jetty R	2666130	6483249	STFTP	2
Jetty S & T	2666249	6483331	BSLD	1
Jetty S & T	2666287	6483355	BSLD	1
Jetty U	2666418	6483354	VISS	1
Jetty X	2666500	6483258	BGRB	1
Jetty X	2666503	6483254	BGRB	1
Jetty X	2666506	6483265	BGRB	1
Jetty X	2667372	6483225	BSLD	1
Jetty X	2670197	6483188	BSLD	1
Jetty X	2666461	6483142	CRBTP	2
Jetty X	2666507	6483236	CRBTP	2
Jetty X	2666468	6483140	FSHTP	2
Jetty X	2666507	6483236	FSHTP	2
Jetty X	2666543	6483280	PSC	16
Jetty X	2666503	6483254	SEDIMENT	1
Jetty X	2666461	6483142	SHRTP	1
Jetty X	2666507	6483236	SHRTP	1
Jetty X	2666461	6483142	STFTP	2
Jetty X	2666507	6483236	STFTP	2
Jetty Z	2666530	6483035	BGRB	1
Jetty Z	2666550	6483009	BGRB	1
Jetty Z	2666574	6483020	BGRB	1
Jetty Z	2666537	6482978	PSC	16
Jetty Z	2666574	6483020	SEDIMENT	1
Outer Breakwall 1	2666388	6483677	BGRB	1
Outer Breakwall 1	2666407	6483643	BGRB	1
Outer Breakwall 1	2666423	6483643	BGRB	1
Outer Breakwall 1	2666476	6483644	BSLD	1
Outer Breakwall 1	2666677	6483628	BSLD	1
Outer Breakwall 1	2666650	6483623	CRBTP	2
Outer Breakwall 1	2666768	6483623	CRBTP	2
Outer Breakwall 1	2666588	6483630	FSHTP	2
Outer Breakwall 1	2666706	6483613	FSHTP	2
Outer Breakwall 1	2666407	6483643	SEDIMENT	1
Outer Breakwall 1	2666650	6483623	SHRTP	1
Outer Breakwall 1	2666768	6483623	SHRTP	1
Outer Breakwall 1	2666650	6483623	STFTP	2
Outer Breakwall 1	2666768	6483623	STFTP	2
Outer Breakwall 1	2666637	6483619	VISS	1
Outer Breakwall 2	2666129	6483774	BSLD	1

Site	Easting	Northing	Survey Method*	Number of sample units
Outer Breakwall 2	2666212	6483705	BSLD	1
Outer Breakwall 2	2666102	6483708	CRBTP	2
Outer Breakwall 2	2666173	6483683	CRBTP	2
Outer Breakwall 2	2666109	6483692	FSHTP	2
Outer Breakwall 2	2666250	6483674	FSHTP	2
Outer Breakwall 2	2666102	6483708	SHRTP	1
Outer Breakwall 2	2666173	6483683	SHRTP	1
Outer Breakwall 2	2666102	6483708	STFTP	2
Outer Breakwall 2	2666173	6483683	STFTP	2
Outer Breakwall 2	2666112	6483700	VISS	1
Pile Moorings	2666512	6483541	BGRB	1
Pile Moorings	2666513	6483533	BGRB	1
Pile Moorings	2666519	6483535	BGRB	1
Pile Moorings	2666492	6483431	BSLD	1
Pile Moorings	2666526	6483557	BSLD	1
Pile Moorings	2666704	6483405	BSLD	1
Pile Moorings	2666745	6483558	BSLD	1
Pile Moorings	2666470	6483453	CRBTP	2
Pile Moorings	2666470	6483462	CRBTP	2
Pile Moorings	2666473	6483453	CYST	1
Pile Moorings	2666499	6483521	CYST	1
Pile Moorings	2666481	6483436	FSHTP	2
Pile Moorings	2666482	6483449	FSHTP	2
Pile Moorings	2666519	6483535	SEDIMENT	1
Pile Moorings	2666470	6483453	SHRTP	1
Pile Moorings	2666470	6483462	SHRTP	1
Pile Moorings	2666470	6483453	STFTP	2
Pile Moorings	2666470	6483462	STFTP	2
Pile Moorings	2666548	6483564	VISS	1
Pile Moorings	2666601	6483539	VISS	1
Public Boat ramp	2666432	6482936	VISS	1
St Mary's Bay	2666362	6483059	BGRB	1
St Mary's Bay	2666363	6483052	BGRB	1
St Mary's Bay	2666372	6483048	BGRB	1
St Mary's Bay	2666369	6483023	BSLD	1
St Mary's Bay	2666385	6482955	BSLD	1
St Mary's Bay	2666306	6483092	CRBTP	2
St Mary's Bay	2666331	6483104	CRBTP	2
St Mary's Bay	2666292	6483050	CYST	1
St Mary's Bay	2666318	6483090	CYST	1
St Mary's Bay	2666362	6483059	SEDIMENT	1
St Mary's Bay	2666306	6483092	SHRTP	1
St Mary's Bay	2666331	6483104	SHRTP	1
St Mary's Bay	2666306	6483092	STFTP	2
St Mary's Bay	2666331	6483104	STFTP	2
St Mary's Bay	2666209	6483070	VISS	1
St Marys Bay Breakwall	2666278	6483085	FSHTP	2
St Marys Bay Breakwall	2666341	6483100	FSHTP	2
Westhaven	2665851	6483349	CRBTP	3
Westhaven	2665863	6483430	CRBTP	2
Westhaven	2665887	6483296	CRBTP	3

Site	Easting	Northing	Survey Method*	Number of sample units
Westhaven	2665965	6483633	CRBTP	2
Westhaven	2666052	6483171	CRBTP	3
Westhaven	2666182	6483474	CRBTP	2
Westhaven	2666234	6483169	CRBTP	3
Westhaven	2666366	6482882	CRBTP	3
Westhaven	2666368	6483414	CRBTP	3
Westhaven	2666556	6483312	CRBTP	3
Westhaven	2666575	6482986	CRBTP	2
Westhaven	2666588	6482820	CRBTP	3
Westhaven	2666703	6483583	CRBTP	3
Westhaven	2666723	6483054	CRBTP	3
Westhaven	2666730	6483385	CRBTP	3
Westhaven	2667066	6483448	CRBTP	3
Westhaven	2665896	6483453	PSCM	1
Westhaven	2665990	6483573	PSCM	1
Westhaven	2666020	6483331	PSCM	1
Westhaven	2666153	6483229	PSCM	1
Westhaven	2666173	6483474	PSCM	1
Westhaven	2666319	6483301	PSCM	1
Westhaven	2666390	6483539	PSCM	1
Westhaven	2666541	6482952	PSCM	1
Westhaven	2666543	6483280	PSCM	1
westhaven	2666031	6483427	STFTP	2
westhaven	2666054	6483628	STFTP	2
westhaven	2666288	6483606	STFTP	2
westhaven	2666325	6483110	STFTP	2
westhaven	2666574	6483603	STFTP	2
westhaven	2666721	6483006	STFTP	2
westhaven	2666826	6483270	STFTP	2
westhaven	2666894	6483306	STFTP	2
Westhaven	2665841	6483417	VISS	1
Westhaven	2666006	6483196	VISS	1
Westhaven	2666111	6483035	VISS	1
Westhaven	2666381	6482816	VISS	1
Westhaven Boat ramp	2666421	6482860	VISS	1
Westhaven by rowing club	2666217	6483062	VISS	1
westhaven end of pier U	2666417	6483354	VISS	1
westhaven outer breakwall 1	2666499	6483644	VISS	1
westhaven outer breakwall 2	2666040	6483711	VISS	1
westhaven pile moorings 1	2666548	6483564	VISS	1
westhaven pile moorings 2	2666601	6483539	VISS	1
Westhaven sales berth	2665912	6483617	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

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 fish trap samples.**
Appendix 3e: **Results from the crab trap samples.**
Appendix 3f: **Results from the seastar trap samples.**
Appendix 3g: **Results from the shrimp trap samples.**
Appendix 3h: **Results from the wharf piling miscellaneous search samples**
Appendix 3i: **Results from the opportunistic visual search samples**

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

Chapman and Carlton's (1994) nine criteria (C1 – C9) were assessed for each non-indigenous and cryptogenic category 1 taxon recorded from the Westhaven 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										
Paralepidonotus ampulliferus	NIS	yes	yes	no	no	no	yes	yes	yes	yes
Hydroides elegans	NIS	yes	yes	yes	yes	yes	yes	yes	yes	yes
Hydroides ezoensis	NIS	yes	no	yes	no	yes	yes	yes	yes	yes
Simplaria pseudomilitaris	C1	No data	No data	No data	No data	No data	No data	No data	No data	No data
Heteromastus filiformis	C1	no	no	no	no	no	no	no	yes	no
Polydora hoplura	NIS	no	no	yes	no	yes	yes	yes	yes	yes
Pseudopolydora paucibranchiata	NIS	yes	no	yes	no	yes	yes	yes	yes	yes
Arthropoda										
Apocorophium	NIS	no	no	yes	no	no	yes	no	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?
acutum										
Lysmata vittata	C1	no	no	no	no	no	no	no	no	no
Charybdis japonica	NIS	yes	yes	yes	no	no	yes	yes	yes	yes
Amphibalanus amphitrite	NIS	yes	no	yes	no	yes*	yes*	yes	yes	no
Bryozoa										
Bugula flabellata	NIS	yes	yes	yes	no	yes	yes	yes	yes	yes
Bugula neritina	NIS	yes	no	yes	no	yes	yes*	yes	yes	yes
Bugula stolonifera	NIS	yes	yes	yes	no	yes	yes	yes	yes	yes
Tricellaria catalinensis	NIS	yes	yes	yes	no	yes	yes	no	yes	yes
Schizoporella errata	NIS	yes	yes	yes	no	no	yes	yes	yes	no

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?
Scruparia ambigua	C1	No. Been in NZ for a long time, known based on Discovery material for decades.	Uncertain, no adequate records of absences or presences. Often co-occurs with *Bugula flabellata* (often attached to it). So if *B. flabellata* spread, would take *S. ambigua*	Unlikely. Can attach to seaweeds. Nothing to preclude drifting throughout southern oceans.	Sometimes, but not entirely, so no. It's an opportunistic epizooite epiphyte.	no	no	Semi-cosmopolitan but not really disjunct.	no	Unlikely
Watersipora subtorquata	NIS	yes	yes	yes	no	yes	yes	yes	yes	yes
Bowerbankia gracilis	NIS	yes	yes	yes	no	yes	yes	yes	yes	no
Zoobotryon verticillatum	NIS	yes	yes	no	no	yes	yes*	yes	yes	yes
Chordata										
Ascidiella aspersa	NIS	yes	yes	yes	yes	yes	yes	yes	yes	yes

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Didemnum sp.	C1	Unable to assess criteria for the genus	no	no	no	no	no	no	no	no
Diplosoma listerianum	NIS	yes	yes	yes	no	yes	yes	yes	yes	no
Cystodytes dellechiajei	C1	no	Unknown, there is no published data to support subsequent spread or indeed time of introduction.	Possibly: is associated with artificial structures and boat hulls, but no published studies to support a 'yes ' answer	no	no	The information on biogeography of NZ ascidians is fragmented at best, it is impossible to answer this question	yes	yes	no
Corella eumyota	C1	yes	yes	yes	no	yes	no	yes	yes	no
Botrylloides leachi	C1	yes	yes	yes	no	yes	yes	yes	yes	no

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Microcosmus squamiger	C1	Uncertain. Available records just indicate research progress, not necessarily new introductions	Unknown, there is no published data to support subsequent spread or indeed time of introduction.	Possibly: is associated with artificial structures and boat hulls, but no published studies to support a 'yes ' answer	No	Not really. In port surveys, found mostly on quadrat scrapings, but also found on rocky coastlines	The information on biogeography of NZ ascidians is fragmented at best, it is impossible to answer this question	yes	Don't know, but is most likely to have arrived in NZ on ships hulls	Don't know
Styela clava	NIS	yes	yes	yes	no	yes	yes	yes	yes	yes
Styela plicata	C1	yes	yes	yes	no	yes	yes	yes	yes	no
Botryllus tuberatus	NIS	no	no	no	no	no	no	no	no	no
Cnidaria										
Pennaria disticha	NIS	yes	no	yes	no	yes	yes	no	no	no
Mollusca										
Musculista senhousia	NIS	yes	yes	yes	no	no	yes	yes	yes	yes
Crassostrea gigas	NIS	yes	yes	yes	no	no	yes	yes	yes	yes
Theora lubrica	NIS	yes	yes	no	no	yes	yes	yes	yes	yes

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Ochrophyta										
Undaria pinnatifida	NIS	yes	yes	yes	no	yes	yes	yes	yes	yes
Porifera										
Vosmaeropsis cf. macera	NIS	yes	no	no	no	yes	no	yes	yes	yes
Haliclona heterofibrosa	C1	no	Uncertain. Early collections in these locations were not at all comprehensive and the species could have been overlooked	These are particularly common sponges where they occur around New Zealand so degree of subsequent spread is uncertain	no	no	no	yes	unlikely (short-lived viviparous larvae)	Uncertain. We don't know enough about interocean genetics; most work on so called cosmpolitan species that are similar to these species have been found to be genetically isolated.

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Lissodendoryx isodictyalis	C1	Only a single specimen described and identified with *L. isodictyalis* by Bergquist & Fromont (1988). Never picked up again in subtidal surveys in past 9 years, only found again in Gisborne and Whangarei	Since the species was only described from one location initially, it could be said that it has 'spread subsequently' but not in an active way. In fact the numbers of this species have gone down from c. 7 speciments to 1 specimens in the Whangarei second p	Possible the species spread between ports by hull movement, but Gisborne and Whangarei are far apart with Auckland and Tauranga inbetween. The species has not been recorded at either of these ports.	No	Previous literature indicates that *L. isodictyalis* (Carter, 1882) sensu strictu from the type localities of the Gulf of Mexico and Caribbean region has a preferences for sheltered and rather shallow habitats (Wiedenmayer, 1977).	Yes, it is restricted to only two North Island ports	The type location for *L. isodictyalis* (Carter, 1882) was Acapulco, Mexico, Gulf of Mexico, and it was subsequently identified from Connecticut (Hartman, 1958), and the central Caribbean (Simpson, 1968; Wiedenmayer, 1977; Van Soest, 1984).	Yes	Uncertain. Bergquist & Fromont (1988) seriously considered the possibility that their thin encrusting intertidal sponge from New Zealand was conspecific with the species *L. isodictyalis* (Carter, 1882).
Amphilectus fucorum	NIS	no	no	no	no	no	no	no	no	no