BIOSECURITY NEW ZEALAND

Port Underwood

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

MAF Biosecurity New Zealand Technical Paper No: 2019/08

Prepared for MAFBNZ Post-border Directorate
by Graeme Inglis, Anneke van den Brink, Kate Schimanski, Crispin Middleton, Olivia Johnston, Lisa Peacock, Anna Bradley, Hoe Chang, Geoff Read, Jill Burnett, Shane Ahyong, Serena Cox

NIWA
Taihoro Nukurangi

ISBN No: 978-1-98-857167-6
ISSN No: 2624-0203

June 2010

Ministry of Agriculture and Forestry
Te Manatū Ahuwhenua, Ngāherehere

Disclaimer

While every effort has been made to ensure the information in this publication is accurate, the Ministry of Agriculture and Forestry does not accept any responsibility or liability for error or fact omission, interpretation or opinion which may be present, nor for the consequences of any decisions based on this information.

Any view or opinions expressed do not necessarily represent the official view of the Ministry of Agriculture and Forestry.

The information in this report and any accompanying documentation is accurate to the best of the knowledge and belief of the National Institute of Water & Atmospheric Research Ltd (NIWA) acting on behalf of the Ministry of Agriculture and Forestry. While NIWA has exercised all reasonable skill and care in preparation of information in this report, neither NIWA nor the Ministry of Agriculture and Forestry accept any liability in contract, tort or otherwise for any loss, damage, injury, or expense, whether direct, indirect or consequential, arising out of the provision of information in this report.

Requests for further copies should be directed to:

Publication Adviser
MAF Information Bureau
P O Box 2526
WELLINGTON

Telephone: (04) 894 4100
Facsimile: (04) 894 4227

This publication is also available on the MAF website at
http://www.biosecurity.govt.nz/about-us/our-publications/technical-papers

Project Team:

Project Leader	Dr Graeme Inglis
Project Manager	Dr Barbara Hayden
Field Team	Crispin Middleton (Field Team Leader), Olivia Johnston (Field Laboratory Manager), Anna Bradley, Dan Cairney, Niki Davey, Dr Graeme Inglis, Marie Kospartov, Lisa Peacock
Sample & specimen management	Olivia Johnston, Serena Cox, Andrew Hosie
Data management & analysis	Kimberley Seaward, Anneke van den Brink, Lisa Peacock, Marie Kospartov, Dr Graeme Inglis, Martin Unwin
Reporting	Anneke van den Brink, Kate Schimanski, Dr Graeme Inglis, Lisa Peacock
Identification	NIWA experts: Dr Shane Ahyong (Amphipoda, Anthozoa, Cirripedia, Cumacea, Decapoda, Hydrozoa, Isopoda, Mysida, Ophiuroidea, Pycnogonida, Tanaidacea) Owen Anderson (Echinoidea) Anna Bradley (Ascidiacea) Jill Burnett (Mollusca) Dr F. Hoe Chang (Myzozoa, Bacillariophyta; all cysts & photoplankton) Dr Roberta D’Archino (Chlorophyta, Ochrophyta, Rhodophyta, Magnoliophyta) Niki Davey (Holothuroidea) Malcolm Francis (Actinopterygii) Dr Dennis Gordon (Bryozoa, Entoprocta) Andrew Hosie (Sessilia) Laith Jawad (Actinopterygii excluding galaxiids, Elasmobranchii) Dr Bob McDowall (Galaxiids) Sadie Mills (Ophiuroidea) Dr Michelle Kelly (Porifera) Kate Neill (Asteroidea) Dr Wendy Nelson (Chlorophyta, Ochrophyta, Rhodophyta, Magnoliophyta) Mike Page (Ascidiacea) Dr Geoff Read (Polychaeta)

Contents

Appendix 5: Generic descriptions of representative groups of the main marine phyla collected during sampling.

Appendix 6: Species information sheets for the NIS recorded from the Port Underwood survey and desktop review of existing marine species records.

Appendix 7: Species x site x sample results matrices for all taxa recorded from each method in the Port Underwood survey.

- Appendix 7a. Results from the anchor box dredge samples.
- Appendix 7b. Results from the benthic core (large hand corer) samples.
- Appendix 7c. Results from the benthic sled samples.
- Appendix 7d. Results from the crab trap samples.
- Appendix 7e. Results from the dinoflagellate cyst core samples.
- Appendix 7f. Results from the phytoplankton tow samples.
- Appendix 7g. Results from the poison station samples.
- Appendix 7h. Results from the pile scraping quadrats.
- Appendix 7i. Results from the beach seine net samples.
- Appendix 7j. Results from the shrimp trap samples.
- Appendix 7k. Results from the qualitative diver visual searches.
- Appendix 7l. Results from the beach wrack samples.
- Appendix 7m. Results from the zooplankton tow samples.

Executive summary

- This report describes the results of the first port baseline survey of Port Underwood, undertaken in April 2007. The survey provides an inventory of native, non indigenous and cryptogenic marine species within the fiord and surrounding coastal area and compares the biota with existing marine species records from the area.

- The survey is part of a nationwide investigation of native and non-native marine biodiversity in New Zealand's shipping ports and marinas of first entry for vessels entering New Zealand from overseas.

- Sampling methods used in these surveys were based on protocols developed by the Australian Centre for Research on Introduced Marine Pests (CRIMP) for baseline surveys of non-indigenous species in ports. Some variations to these protocols were necessary for use in the marine environments of Port Underwood.

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

- Sampling effort was distributed in Port Underwood and surrounding coastal environments according to priorities identified by MAF Biosecurity New Zealand. In total, 20 sites were sampled during the survey.

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

- Prior to the port baseline survey, a desktop review was conducted to compile an inventory of non-indigenous marine species that have been recorded previously from Port Underwood and surrounding areas. Eleven non-indigenous species had been reported from within Port Underwood. These were: (Arthropoda) *Caprella mutica* and *Apocorophium acutum*, (Chordata, Actinopterygii) *Oncorhynchus tshawytscha*, (Cnidaria) *Eudendrium generale*, (Ochrophyta) *Cutleria multifida*, *Asperococcus bullosus*, *Chnoospora minima* and *Undaria pinnatifida* and (Rhodophyta) *Griffithsia crassiuscula*, *Neosiphonia subtilissima* and *Polysiphonia senticulosa*

- Seven cryptogenic category one taxa (C1: those whose identity as native or non-indigenous is ambiguous) were also reported from within Port Underwood during the desktop review. These were: (Chordata, Ascidiacea) *Didemnum vexillum*, (Cnidaria) *Phialella quadrata* and *Halecium delicatulum*, (Myzozoa) *Gymnodinium catenatum*, *Alexandrium minutum* and *Alexandrium ostenfeldii* and (Ochrophyta) *Heterosigma akashiwo*

- The port baseline survey of Port Underwood recorded a total of 411 species or higher taxa. The collection consisted of 301 native taxa, seven non-indigenous species (NIS), six cryptogenic category one taxa, 14 cryptogenic category two taxa (species that have recently been discovered but for which there is insufficient biogeographic or taxonomic information to determine the native provenance), and one species of zooplankton (which was screened for target non-indigenous species but otherwise not identified), with the remaining 82 taxa being indeterminate (unable to be identified to species level).

- The seven NIS recorded in the baseline survey included four bryozoans (*Bugula flabellata*, *Cryptosula pallasiana*, *Watersipora subtorquata* and *Bowerbankia gracilis*), one ascidian (*Ascidiella aspersa*), one mollusc (*Theora lubrica*) and one brown alga (*Undaria pinnatifida*).

- The six cryptogenic category one taxa recorded from the baseline survey included three ascidians (*Didemnum* sp., *Corella eumyota* and *Botrylloides leachi*), two cnidarians (*Bougainvillia muscus* and *Plumularia setacea*) and one brown alga (*Heterosigma akashiwo*).

- The 13 NIS and C1 taxa were recorded from a total of only 96 of the 257 samples identified during the Port Underwood survey, in water depths ranging from the intertidal to below 20 m depth.

- None of the taxa recorded from the port baseline survey of Port Underwood are new records from New Zealand waters.

- One species (The brown alga *Undaria pinnatifida*) recorded during the Port Underwood survey and during the desktop review of existing species records is on the New Zealand register of unwanted organisms. Six species recorded in the port survey are on the Australian CCIMPE Trigger List (one diatom and one brown alga were also recorded in the deskptop review).

- Three toxin-producing dinoflagellates were recorded during the Port Underwood baseline survey – the native species *Dinophysis acuminata, Dinophysis acuta* and *Dinophysis tripos.* The toxin producing diatom, *Pseudo-nitzschia australis* was also recorded in the survey. Two native diatoms recorded during the port survey, *Chaetoceros convolutes* and *Chaetoceros concavicornis* are considered harmful to fish due to their barbed setae, but are not directly toxic.

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

- Most non-indigenous and C1 taxa recorded during the Port Underwood survey or desktop review are likely to have been introduced to New Zealand accidentally by international shipping, associated with fisheries or spread from other locations in New Zealand (including translocation by shipping).

- There is little shipping traffic operating in Port Underwood, and those that do operate there are generally fishing or recreation vessels. This lack of shipping activity significantly reduces the risk of introduction of new marine species to the area.

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 (NIS) in its coastal waters. A review of existing records suggested that by 1998, at least 148 NIS marine species had been recorded from New Zealand, with around 90 % of these establishing permanent populations (Cranfield et al. 1998). Since that review, at least another 41 non-indigenous species or suspected non-indigenous species (i.e. Cryptogenic category 1 – see “

Baseline survey **methods**: Definitions of biosecurity status", below) have been recorded from New Zealand waters. To manage the risk from these and other non-indigenous species, better information is needed on the current diversity and distribution of species present within New Zealand.

BIOLOGICAL BASELINE SURVEYS FOR NON-INDIGENOUS MARINE SPECIES

In 1997, the International Maritime Organisation (IMO) released guidelines for ballast water management (Resolution A868-20) encouraging countries to undertake biological surveys of port environments for potentially harmful non-indigenous aquatic species. The purpose of these surveys is to:

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

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

As part of its comprehensive five-year *Biodiversity Strategy* package on conservation, environment, fisheries, and biosecurity released in 2000, the New Zealand Government funded a national series of port baseline surveys for non-indigenous marine species. These surveys aimed to determine the identity, prevalence and distribution of native, cryptogenic and non-indigenous species in New Zealand's major shipping ports and other high risk points of entry for vessels entering New Zealand from overseas.

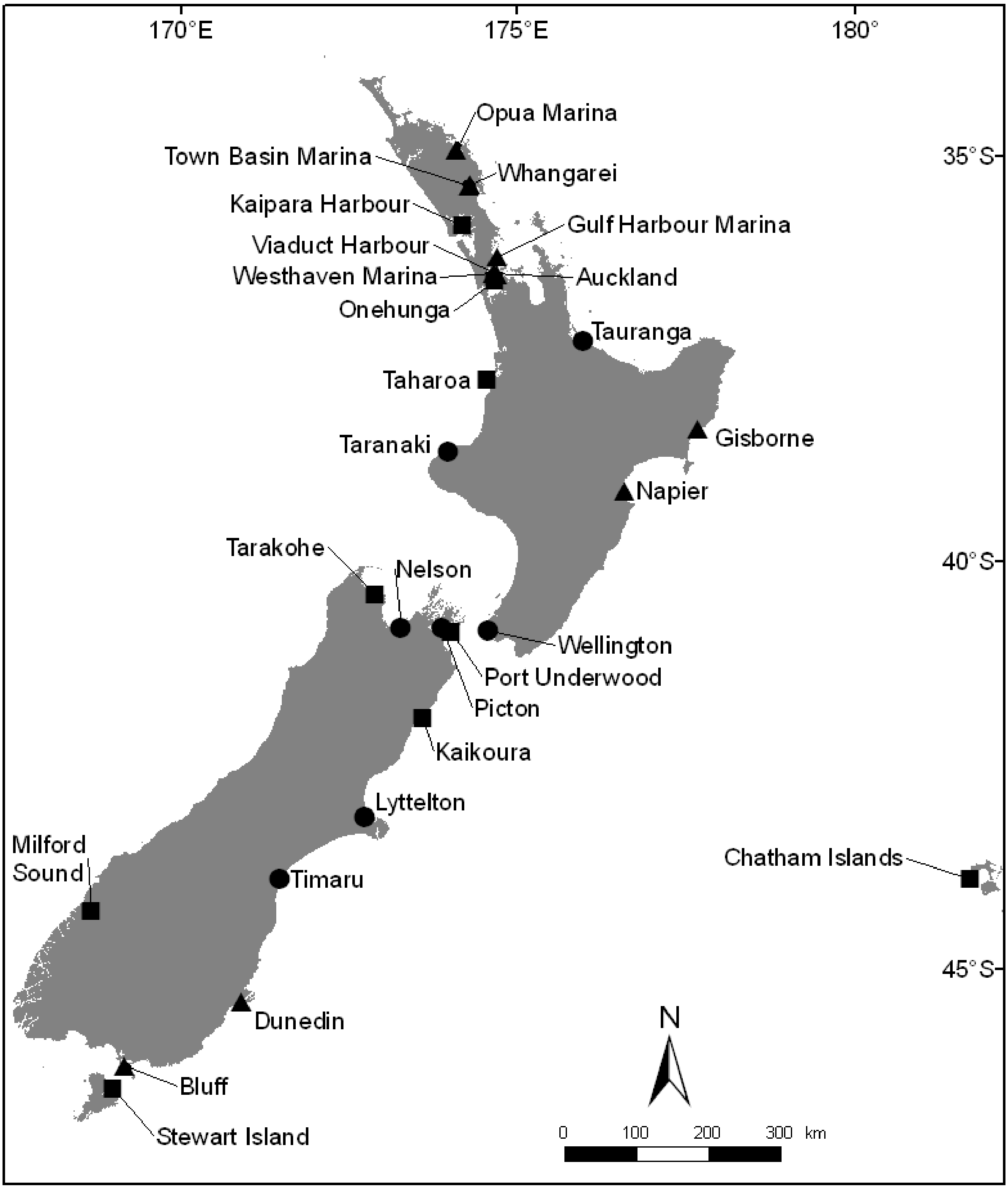


Figure 1: **Commercial shipping ports in New Zealand where baseline non-indigenous species surveys have been conducted. Group 1 ports (circles) were surveyed in the summer of 2001/2002 and re-surveyed in the summer of 2004/2005, Group 2 ports (triangles) were surveyed in the summer of 2002/2003 and re-surveyed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

Initial surveys were completed during the summers of 2001/2002 and 2002/2003 in 13 major shipping ports and three marinas of first entry for vessels entering New Zealand (Figure 1). The surveys recorded almost 1300 taxa; 126 of which were known or suspected to have been introduced to New Zealand. At least 18 of the non-indigenous species were recorded for the first time in New Zealand in the port baseline surveys. In addition, 106 species that are potentially new to science were discovered. These 16 locations were subsequently re-surveyed in the summers of 2004/05 and 2005/06 to establish changes in the number and identity of non-indigenous species present. The repeat surveys again recorded almost 1300 taxa, 124 of which were known or suspected to be introduced. Together, both surveys recorded over 155 taxa known or suspected to be introduced. Almost 40 taxa recorded in the first survey were not recorded in the second survey and almost 45 taxa recorded in the second survey were not recorded in the first survey.

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

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

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

Baseline survey **methods**: Definitions of biosecurity status", below).

DESCRIPTION OF PORT UNDERWOOD

General features

Port Underwood is a sheltered harbour on the northeast of New Zealand's South Island, on the east coast of the Marlborough Sounds (
Figure 2). The harbour lies to the north east of the Wairau plain and is a north-east extension of Cloudy Bay. The Marlborough area is where the Pacific and Indo Australian plates meet, and the Marlborough Sounds are formed as sunken river valleys that rise steeply from the water. The hills in the area are formed of schist and are subject to rapid erosion. Port Underwood comprises a sunken valley with two distinct arms and has a relatively narrow entrance to the south-south-east so it is sheltered from almost all winds. During colonisation the land around Port Underwood was deforested, but with the moderate rainfall and year round temperatures substantial regeneration has occurred. Extensive planting of *Pinus radiata* began in the 1970s in the Port Underwood area. After the Northbank plantations it forms the next most extensive plantation area in Marlborough.

Port Underwood has cooler water temperatures than the neighbouring Marlborough Sounds as it is located to the south of the front across Cook Strait where cold water in the Southland Current and warm water from Northern Cook Strait and the East Cape Current meet (Nelson and Duffy 1991). The temperature gradient across the front is typically 2^{o}C (Barnes 1985). A cold upwelling zone has also been reported in the Cloudy Bay area (Bowman et al. 1983; Barnes 1985). Water temperatures in Whangakoko Bay in Port Underwood vary between 7-9^{o}C in winter and 18-20^{o}C in summer (mean daily maxima reported in Nelson and Duffy (1991). The area has a tidal range of about 1.2 m and receives a fairly high sediment load, which is derived primarily from the Wairau River and driven north by southerly swells. Generally, the marine environment of Port Underwood comprises rocky shorelines sloping steeply to a mud substrate within 50 m of the shore, with maximum depths of 17-18 m. The major sediment zones are bedrock to depths of 5 m, a narrow band of gravel and shell material to about 6 m, sandy mud that becomes progressively siltier with depth, and soft mud below 14 m depth.

History of settlement and use

There is evidence of a large Maori population at Port Underwood at various times prior to European arrival in New Zealand, and there was already a Maori settlement there when Europeans arrived. In the 1820s the local Rangitane were defeated by the Ngāti Toa chief Te Rauparaha. Port Underwood was the first place in Marlborough to be settled by Europeans as it offered a sheltered port to anchor ships, ample timber and access to Cloudy Bay.

Originally considered to be part of Cloudy Bay, the port was known as Manganui, but it was later renamed Port Underwood after Joseph Underwood, owner of the Sydney shipping firm Kabel and Underwood, which used the port in the early 1800s.

Sealers first visited Port Underwood in about 1826 and were followed immediately by whalers. From the late 1820's to 1847 whaling took over Port Underwood. The southern right whale passed through the Cook Strait area between April and September each year, and during the 1830s large fleets of northern hemisphere whalers arrived for the season, basing themselves in Port Underwood where they had deep anchorage, shelter, and Maori assistance. At the peak of whaling around 1839, many American whaling ships anchored in the Port.

Shore based whaling stations were established in a number of bays, with the first shore-based whaling station established at Kakapo Bay in 1828 by John Guard. In 1836, there were 18 vessels bay-whaling in Port Underwood, most of them American, in addition to five shore stations (Prickett 2002). Many ships also anchored in the Port for shelter before crossing Cook Strait to Wellington, or making their passage to Sydney with cargo's of seal pelts, flax and whale product.

On 16 June 1840, the Treaty of Waitangi was brought to the South Island by Major Thomas Banbury on board the HMS *Herald* for the South Island chiefs to sign. The signing took place on Horahora-Kakahu Island just offshore from the eastern shoreline in Port Underwood.

The first communications cable between the North and South Islands was laid across the Cook Strait seabed in 1866 between Lyall Bay in Wellington and White's Bay south of Port Underwood. In 1964, the first power cable was laid across Cook Strait, entering the water at Fighting Bay on the easternmost peninsula of the Marlborough Sounds (
Figure 2), and Oteranga Bay on Wellington's southwest coast in the North Island. In 1966 an Act of Parliament was passed to protect the cables (Transpower 2006). Five new high voltage power and fibre optic communication cables were laid in 1991, and a further two communications cables were laid in 2002. The submarine cables lie unburied on the seabed within a 7 km wide Cable Protection Zone. The width of the zone narrows where the cables enter the water at Fighting Bay. With one minor exception, all fishing and anchoring is illegal within the Cook Strait Cable Protection Zone. The exception is that crayfishing, the taking of paua and kina and the use of set nets are permitted only within 200 m of the shore (low water mark) and outside the yellow warning signs located at either side of Oteranga Bay and Fighting Bay (Transpower 2006).

Today, the main economic activities in the area are mussel farming and forestry, and it is also popular with holiday makers and fishermen. The mussel farming industry in the Marlborough Sounds started in the 1960s. The early days of the industry were dominated by research and development, local sales, and an extract used to help alleviate arthritis. Today there are numerous marine farms in the area which produce mainly Greenlip mussel *Perna canaliculus*. Oyster Bay serves as a small port for vessels servicing the mussel farms and as an anchorage for commercial fishermen and pleasure craft. Crayfish (*Jasus edwardsii* and *J. verreauxi*) are fished commercially in Port Underwood and recreational fishing is very good, with butterfish, tarakihi, blue cod, moki and kahawai being the most abundant species caught.

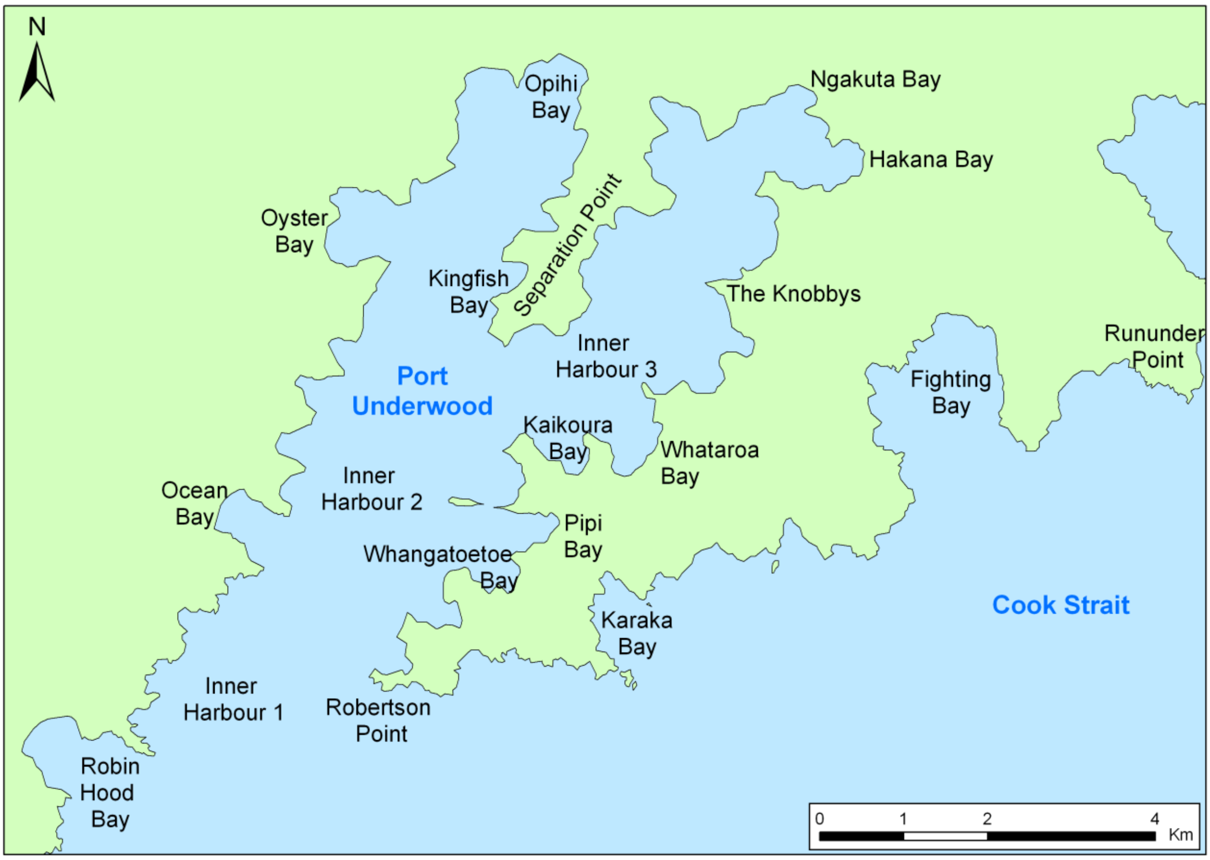


Figure 2: **Major geographic features of Port Underwood.**

Port operation, development and maintenance activities

Port Underwood was an important area for international shipping in the 1800s, serving as a centre for whaling operations in Cloudy bay between 1829 and 1839 (Morton 1982). With the establishment of shore-based whaling stations, the Port was also used as an anchorage by the predominantly American whaling fleet (McNab 1913). However, there are no major port facilities in Port Underwood.

Shipping movements and ballast discharge patterns

Vessel traffic in Port Underwood comprises pleasure craft, private and commercial fishing boats, and vessels servicing the mussel farms, with Oyster Bay serving as a small port for the area. There are no national or international shipping movements or discharge of ballast water from foreign ports in Port Underwood.

Voluntary guidelines for "zero discharge" ballast water regimes are promoted for all vessels entering New Zealand coastal waters (Guardians of Fiordlands's Fisheries & Marine Environment Inc. 2003; Ministry for the Environment 2004). Since June 2005, vessels in New Zealand have been required to comply with the Import Health Standard for Ships' Ballast Water from All Countries (Biosecurity New Zealand 2005). No ballast water is allowed to be discharged without the express permission of a Ministry of Agriculture and Forestry (MAF) inspector. To allow discharge, vessel Masters are responsible for providing the inspector with evidence of either: discharging ballast water at sea (200 nautical miles from the nearest land, and at least 200m depth); demonstrating ballast water is fresh (2.5 ppt sodium chloride); or having the ballast water treated by a MAF approved treatment system. Ballast water loaded in Tasmania and Port Philip Bay in Victoria (Australia) may not be discharged into New

Zealand water under any circumstances, due to the presence of several high-risk non-indigenous species in those areas (Biosecurity New Zealand 2005).

EXISTING BIOLOGICAL INFORMATION

There is limited information on the marine environment in Port Underwood and very little of this is available in the public domain. The following description of the marine environment in Port Underwood is derived primarily from the numerous benthic surveys undertaken for the marine farming industry in the area.

Most of the marine species in Port Underwood are regularly found throughout the Marlborough Sounds, with the exception of some of the larger brown seaweeds. Unlike the inner Marlborough Sounds, Port Underwood supports a diverse array of algae. In the shallows, brown algae (*Carpophyllum flexuosum, Colpomenia sinuosa, Cystophora* spp., *Ecklonia radiata*) and kelp (*Macrocystis pyrifera*) can form a dense canopy in the cobble and rocky zone, while dense beds of red algae (including *Rhodymenia* sp., *Grateloupia* sp.) occur on sandy mud at depths of 6-10 m. In Port Underwood, the red alga *Chnoospora minima* grows subtidally at a depth of about 8 m as unattached plants (Nelson and Duffy 1991). The alga is found only in Port Underwood and was not part of the algal flora recorded from New Zealand prior to 1991. It is known from the tropical and subtropical Indian, Pacific and western Atlantic oceans, and is assumed to be an adventive species in New Zealand (Nelson and Duffy 1991). In Port Underwood it is assumed to grow vegetatively as no reproductive structures were found by Nelson and Duffy (1991). It is likely that the alga arrived on the fouled hulls of whaling vessels in the 1800s. The introduced brown alga *Undaria pinnatifida* also grows in Port Underwood, fouling mussel lines and other hard structures.

Benthic habitat surveys in Port Underwood describe the following general species zonation pattern: The shallow rocky reef, covered with brown seaweeds, provides habitat for paua (*Haliotis iris*), *Scutus*, cats-eye snails (*Turbo smaragdus*), starfish, blue mussels (*Mytilus edulis*), kina (*Evechinus chloroticus*), saddle squirts (*Cnemidocarpa bicornuata*), sea cucumber (*Stichopus mollis*), and fishes such as the common triplefin (*Forsterygion lapillum*) and spotties (*Notolabrus celidotus*). Sabellid fan worms (*Branchiomma* sp.), large whelks (*Buccinulum* sp.) and top shells (*Trochus viridis*) inhabit the gravel and coarse shell between the brown and red algal zones. Between 6 and 10 m, in the red algal zone, horse mussels (*Atrina zelandica*), fan worms, clam shells, kina, cushion stars (*Patiriella regularis*), sea cucumber and scallops (*Pecten novaezelandiae*) can be found. Below 10 m, small parchment tube worms (*Spiochaetopterus* sp.), and other benthic infauna such as bivalves, polychaete worms and shrimps inhabit the sediment. Below 14 m, parchment tube worms are the most abundant species.

The parasitic disease of bivalves, *Bonamia* sp. is present in Port Underwood (Hine and Jones, 1994). Bonamiasis is almost certainly an endemic disease in the Southwest Pacific, and is associated with mortalities in wild oyster beds and collapse of the Bluff Oyster fishery in the late 1980s and early 1990s (Hine and Jones, 1994). *Bonamia* sp. is a haplosporidian parasite that is phaogocytosed by haemocytes, where it grows and divides, resulting in lysis of the haemocytes and release of parasites, which are phagocytosed again or shed by the host (Hine, 1991). In Foveaux Strait, oyster mortalities are usually greatest between February and April.

Cranfield et al. (1998) reviewed the published literature and classified 159 species as being adventive in New Zealand. One of these, the red alga *Chnoospora minima*, is reported only from Port Underwood. A number of other adventive algal species have disjunctive distributions in southern harbours and anchorages heavily used in the sealing and whaling days (Cranfield et al. 1998), so may also be present in Port Underwood. Three of them *Champia affinis*, *Griffithsia crassiuscula* and *Sargassum verruculosum*, were introduced from southern Australia and one, *Polysiphonia brodiei* was introduced from Europe (Adams 1991). *Champia affinis*, a native of Tasmania and South Australia, has been recorded in New Zealand from Port Pegasus (Stewart Island), Preservation Inlet and Otago Harbour. *Sargassum verruculosum*, native to western and southern Australia, New South Wales and Tasmania, has been recorded in Fiordland from Bligh, Thompson, Doubtful, Breaksea and Dusky Sounds and Chalky/Preservation Inlet, and from elsewhere in New Zealand at Stewart Island, Akaroa Harbour and Kaikoura. *Polysiphonia brodiei*, native to Ireland and northern Europe and introduced to eastern and western North America, Japan and Australia, has been recorded in New Zealand from Lyttelton, Wellington, Timaru, Tarakohe, Stewart Island and Dusky Sound in Fiordland.

Other species classed as adventive in New Zealad by Cranfield et al. (1998) were reported with less specific distributions that encompassed most parts of New Zealand and therefore it may be inferred that they could potentially be found in Port Underwood. These are the sponges *Clathrina coriacea*, *Cliona celata*, *Dendya poterium*, *Leucosolenia botryoides* and *Sycon ciliata*; the hydroids *Amphisbetia operculata*, *Obelia longissima* and *Plumularia setacea*; the bryozoans *Bugula flabellata*, *B. neritina*, and *Cryptosula pallasiana*; and the ascidians *Asterocarpa cerea* and *Corella eumyota*. Species that were reported from various locations in the Marlborough Sounds by Cranfield et al. (1998) include the bryozoans *Bugula stolonifera* and *Tricellaria porteri* the polychaetes *Polydora hoplura, Polydora websteri* and *Polydora armata*, the bivalves *Theora lubrica* and *Crassostrea gigas*, the algae *Asperococcus bullosus, Polysiphonia senticulosa, Neosiphonia subtilissima, Cutleria multifida*, the ascidian *Asterocarpa cerea*, and the amphipod *Apocorophium acutum*. The ascidians *Didemnum vexillum* and *Styela clava* have also been reported from the Marlborough Sounds. The colonial ascidian *D. vexillum* was initially introduced to the Marlborough Sounds (Shakespeare bay) on an unpowered deck barge (The 'Steel Mariner', (Coutts 2002), and has since spread throughout the Sounds despite attempts to eradicate it. Several individuals of the solitary ascidian *S. clava* have also been removed from the ports of Nelson and Picton (Vaughan 2008). The amphipod *Caprella mutica* has been reported in the Marlborough Sounds at two aquaculture sites in Pelorus Sound (Woods et al. 2008).

Marlborough District Council, the government agency responsible for environmental management in the region that encompasses Port Underwood, does not include any marine species as pests in their *Regional Pest Management Strategy for Marlborough* (Marlborough et al. 2007).

Baseline survey methods

REVIEW OF MARINE SPECIES RECORDS FROM PORT UNDERWOOD

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

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

During our desktop review, we compiled a list of all species records that we encountered from Port Underwood or from elsewhere in Marlborough, but focused particularly on obtaining a complete inventory of non-indigenous (NIS) and cryptogenic category 1 (C1) species. After compiling our initial species lists we sent the lists for each taxonomic group to relevant experts for them to review species names, reliability of the records and biosecurity status. We also asked the experts to add any NIS or C1 species records that we had missed, and to provide information on the New Zealand and global distribution for the NIS and C1 species. The distribution information was then mapped and species information sheets prepared for each NIS and C1 species.

PORT BASELINE SURVEY OF PORT UNDERWOOD

Baseline survey protocols are intended to sample a variety of habitats within ports, including epibenthic fouling communities on hard substrata, soft-sediment communities, mobile invertebrates and fishes, and dinoflagellates. We surveyed a variety of these habitat types at sites specified by MAF Biosecurity New Zealand within, and around Port Underwood, from April 18^{th} to 21^{st}, 2007.

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

SAMPLING EFFORT

Sampling sites and the methods to be employed at each site were specified by MAF Biosecurity New Zealand. A summary of the sampling completed during the first baseline survey of Port Underwood is provided in Table 1, and the spatial distribution for each of the sample methods is shown in

Figure 11 to

Figure 19. The exact geographic locations of sample sites are given in Appendix 2. Planned sampling that was not conducted, and the reasons for this, are given in Appendix 3.

FOULING COMMUNITIES

Fouling assemblages at piling and hard substrate sites were surveyed using photographic stills and video as well as qualitative visual surveys and/or scraping samples.

Divers recorded video transects continuously from the surface to 10 m depth (where possible). Following the video transects, quadrats (25 cm x 40 cm) were secured to the hard surfaces at depths of 0.5 m, 3.0 m and 7.0 m depth (where water depths allowed this), and still images were taken with a high-resolution digital camera. Four overlapping photographic stills were taken in each quadrat to cover the area. At sites where scraping was possible and permitted, once the first diver had obtained the photographic images, a second diver then removed fouling organisms by scraping the organisms inside each quadrat into a 1 mm mesh collection bag, attached to the base of the quadrat. Once scraping was completed, the sample bag was sealed and returned to the boat for processing. The divers also made a visual search of the area for known harmful invasive species and collected samples of large conspicuous organisms not represented in quadrats.

Figure 3: Diver sampling organisms by quadrat scraping.

BENTHIC INFAUNA

Benthic infauna were collected by sieving sediment collected using a large hand corer or an anchor box dredge (Figure 4). The large hand corer is 150 mm in diameter and 400 mm long. It is inserted 200 mm into the sediment, resulting in a sediment sample 150 mm in diameter by 200 mm length. At each site, triplicate samples were taken 50 m out from the pile and hard structure site (where applicable).

Figure 4: Large hand corer (left) and anchor box dredge (right) for sampling

DINOFLAGELLATE CYST-FORMING SPECIES

Triplicate samples were collected for dinoflagellate cysts at planned pile and hard substrate sites, with triplicate samples 50 m out from the pile and hard structure site (depth permitting). At sites with suitable benthos samples for dinoflagellate cysts were taken with a TFO gravity corer, but sites with stoney/cobble benthos required divers to manually take the samples using a small hand core (Figure 5). Sediment samples were kept on ice and refrigerated prior to dispatch to the specialist taxonomist.

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

The small hand core used by divers is a 20 cm long tube with 2 cm internal diameter. Tubes are forced into the substrate then capped at each end with a rubber bung to provide an airtight seal.

Figure 5: Diver manually taking a small core sediment sample for dinoflagellate cyst-forming species.

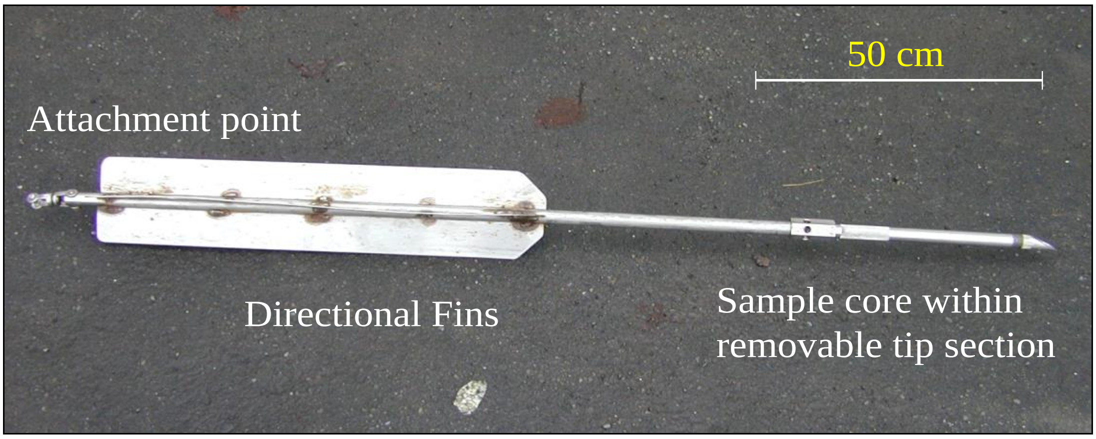


Figure 6: Javelin corer

DINOFLAGELLATES, PHYTOPLANKTON AND ZOOPLANKTON IN THE WATER COLUMN

A 100 µm net with a diameter of 70 cm was used to sample zooplankton in the water column. The net dropped vertically to approximately 1 metre from the substrate. Following the vertical drop the net was retrieved and carefully sprayed down to collect all the sample which was then placed in containers and preserved. A 20 µm net with a diameter of 25 cm was used to sample dinoflagellates and phytoplankton species. This net was towed just below the water surface behind the charter vessel at slow speed for 1 minute then retrieved, washed down, placed in sample containers and labelled for laboratory analysis.

Figure 7: Zooplankton net commencing its vertical drop.

EPIBENTHOS

Larger benthic organisms were sampled using 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 8). The mouth of the sled partially digs into the sediment and collects organisms in the surface layers to a depth of a few centimetres. Runners on each side of the sled prevent it from sinking completely into the sediment so that shallow burrowing organisms and small, epibenthic fauna pass into the exposed mouth. Sediment and other material that enters the sled is passed through a mesh basket that retains organisms larger than about 2 mm. Sleds were towed for a standard time of two minutes at approximately 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.

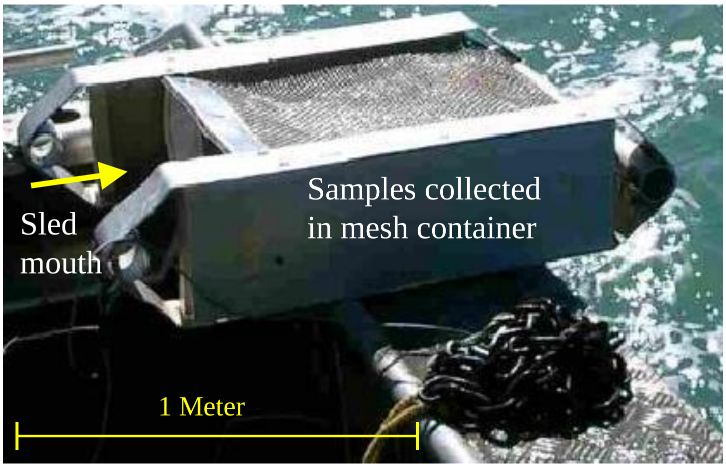


Figure 8: Benthic sled

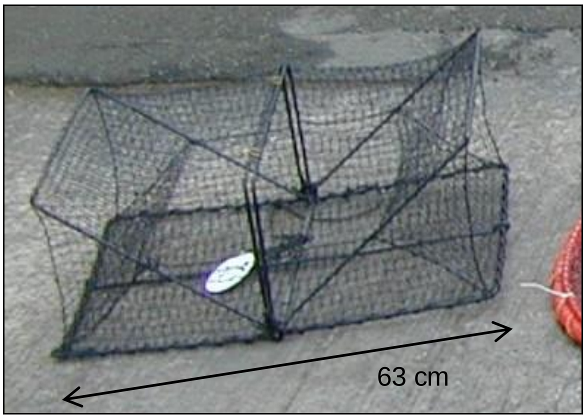
Qualitative visual surveys

At planned sites a qualitative visual survey dive was conducted over suitable substrata. Three replicate 10 m transects were recorded on video at each qualitative visual survey site. Representative fauna and flora were collected for subsequent identification. Large, conspicuous marcofauna and flora were identified from the video records.

Traps

Crab box traps (63 cm x 42 cm x 20 cm; Figure 9) with 1.3 cm mesh netting were used to sample mobile crabs and other small epibenthic scavengers. A central mesh bait holder containing two dead pilchards was secured inside the trap. Organisms attracted to the bait enter the traps through slits in inward sloping panels at each end. Two trap lines, each containing three box traps, were set on the sea floor at each site and left to soak overnight before retrieval.

Shrimp traps (Figure 9) were used to sample small, mobile crustaceans. They consisted of a 15 cm plastic cylinder with a 5 cm diameter screw top lid in which a funnel is fitted. The funnel has a 5 cm entrance that tapers in diameter to 1 cm. The entrance is covered with 1 cm plastic mesh to prevent larger animals from entering and becoming trapped in the funnel entrance. Each trap was baited with a single dead pilchard. Two trap lines, each containing three shrimp traps, were set on the sea floor at each site and left to soak overnight before retrieval.



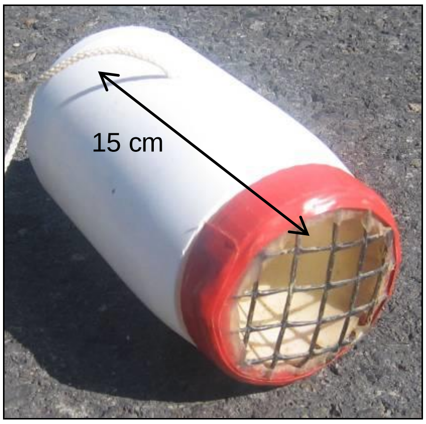


Figure 9: Crab box trap (left) and shrimp trap (right)

Fishes

Fishes were sampled using poison stations and beach seine netting.

Poison stations were sampled over hard substrata using clove oil. An area with suitable contours was selected and draped with a collection net. Clove oil was then applied to the area paying particular attention to potential hiding places for fish species. As the fish in the selected area became anesthetised they were collected using small aquarium dip nets and placed in a sealed bag. This was then returned to the charter boat for processing and labelling before being frozen.

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

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

Beach wrack

Qualitative visual surveys of beach wrack were conducted at specified sites to collect crab exuviae, target macroalgae or other target organisms. Beach wrack surveys are designed for surveyors to walk parallel to the water's edge 2 m from the shore, 5 m from the shore and 10 m from the shore.

ENVIRONMENTAL DATA

Water temperature, salinity and sea state

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

Sediment analysis

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. Typically, 250,000 to 500,000 particles were counted per sample.
7. The proportion of particles in each of five size categories (ranging from clay to small pebbles) was then calculated as a percent of the total net dry weight (Table 2).

SORTING AND IDENTIFICATION OF SPECIMENS

Each sample collected in the survey was allocated a unique code on waterproof labels and transported to a field laboratory onboard the research vessel, where it was sorted by a team into broad taxonomic groups (e.g. ascidians, barnacles, sponges etc.). These groups were then preserved and individually labelled. Details of the preservation techniques varied for many of the major taxonomic groups collected, and the protocols adopted and preservative solutions used are indicated in Table 3. Specimens were subsequently sent to approximately 20 taxonomic experts for identification to species or lowest taxonomic unit (LTU). We also sought information from each taxonomist on the known biogeography of each species within New Zealand and overseas. Species lists compiled for each port were compared with the marine species listed on the New Zealand Register of Unwanted Organisms under the Biosecurity Act 1993 (Table 4) and the Australian Trigger List produced by the Consultative Committee on Introduced Marine Pest Emergencies (Table 5).

Because of the difficulty of identifying all species from the zooplankton samples, an alternative approach was taken, in consultation with MAF Biosecurity New Zealand, whereby the samples were only screened for target non-indigenous species. The species looked for were larvae that were or were suspected to be the Chinese mitten crab *Eriocheir sinensis* (or other members of this genus), the European green crab *Carcinus maenas*, the northern Pacific seastar *Asterias amurensis* and the ascidian *Styela clava*. Identifications were not made for organisms other than these species in the samples. Experts were not available to examine platyhelminths or sipunculids, so these taxa could only be recorded as "indeterminate taxa (see "

Baseline survey **methods**: Definitions of biosecurity status”, below).

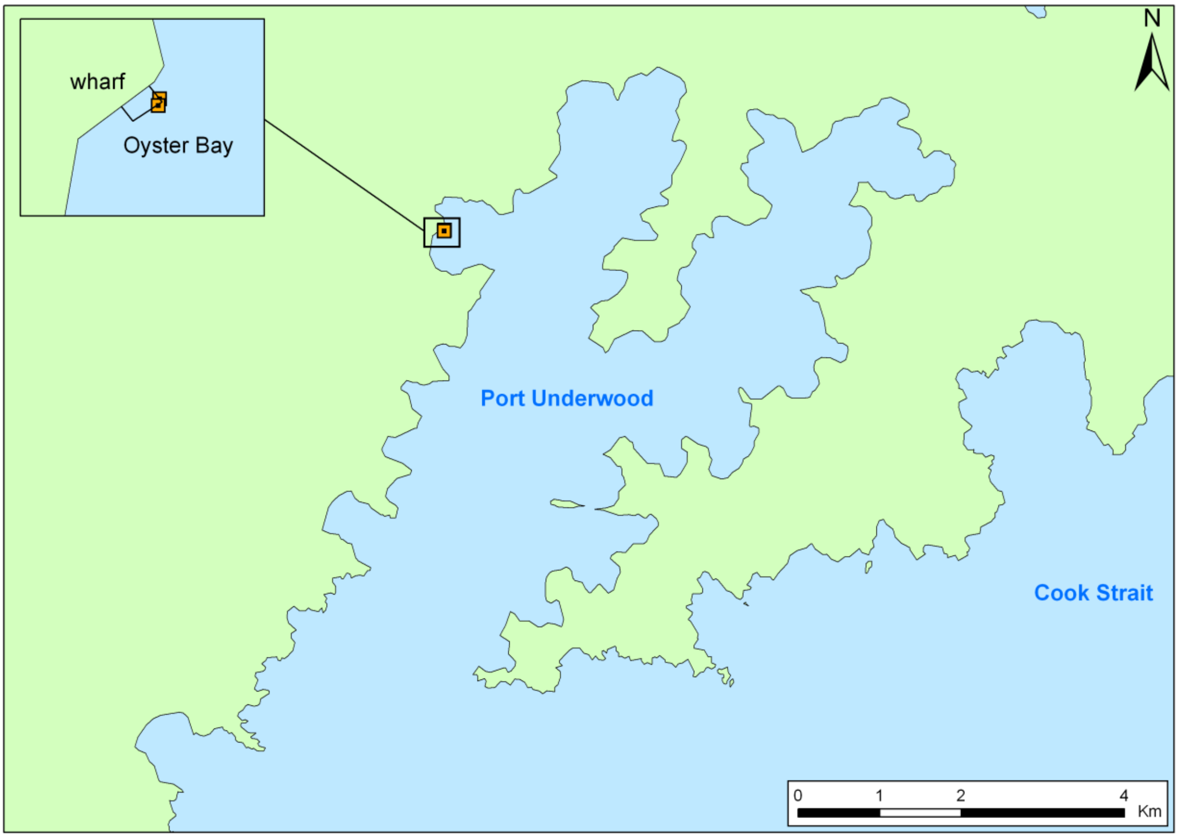


Figure 11: Quadrat scraping sites

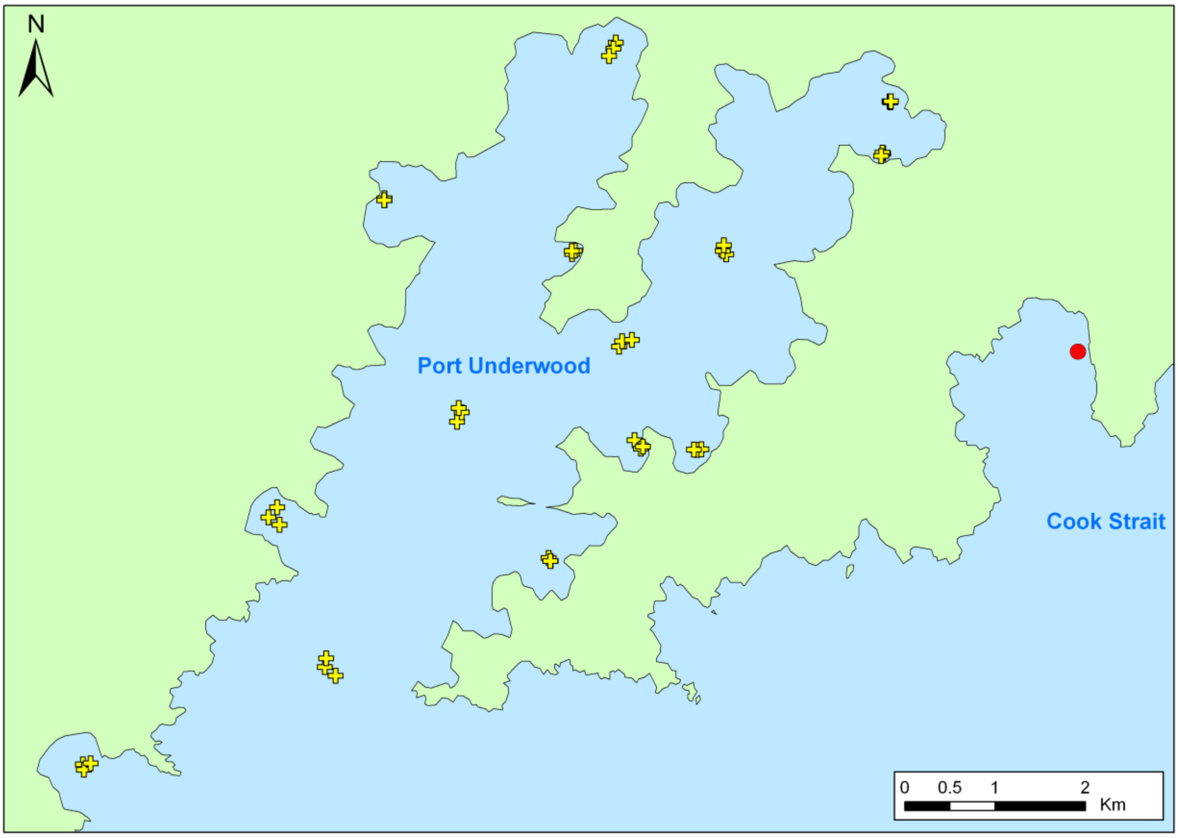


Figure 12: Anchor box dredge (yellow cross) and large benthic core (red circle) sampling sites

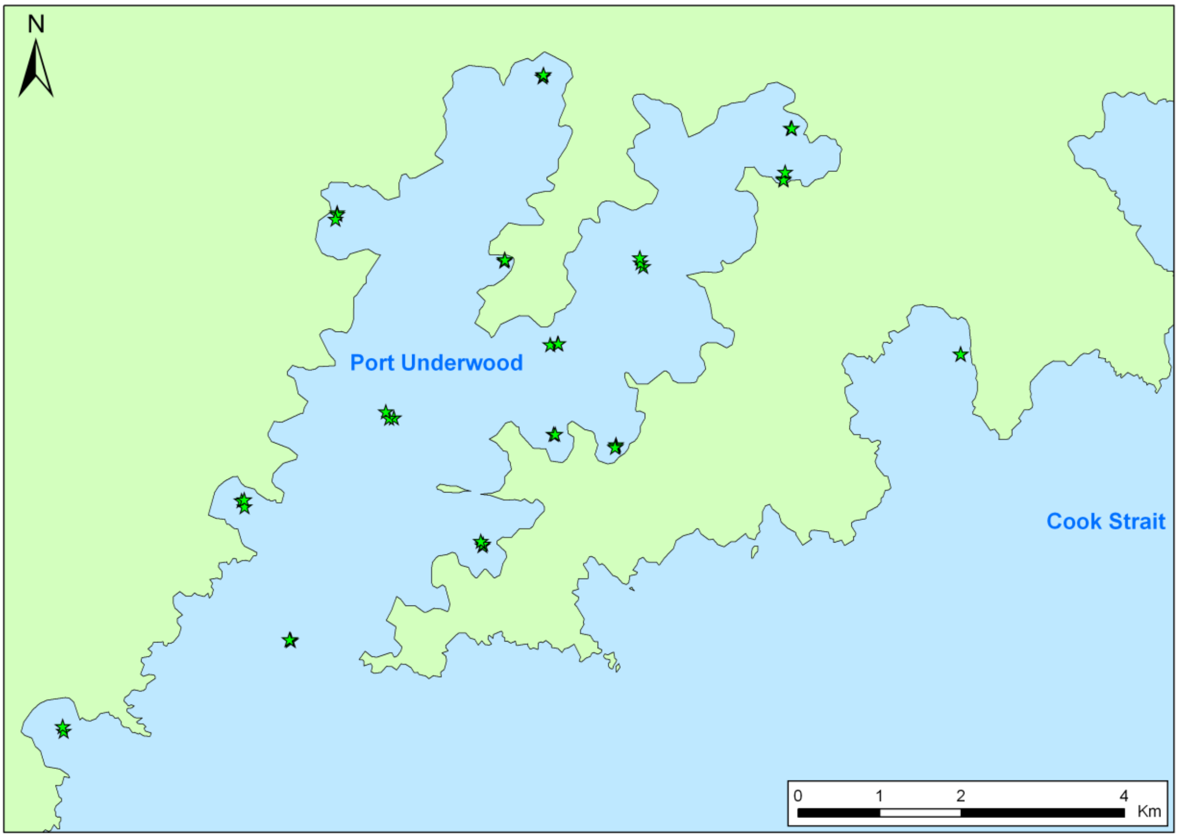


Figure 13: Cyst sampling sites

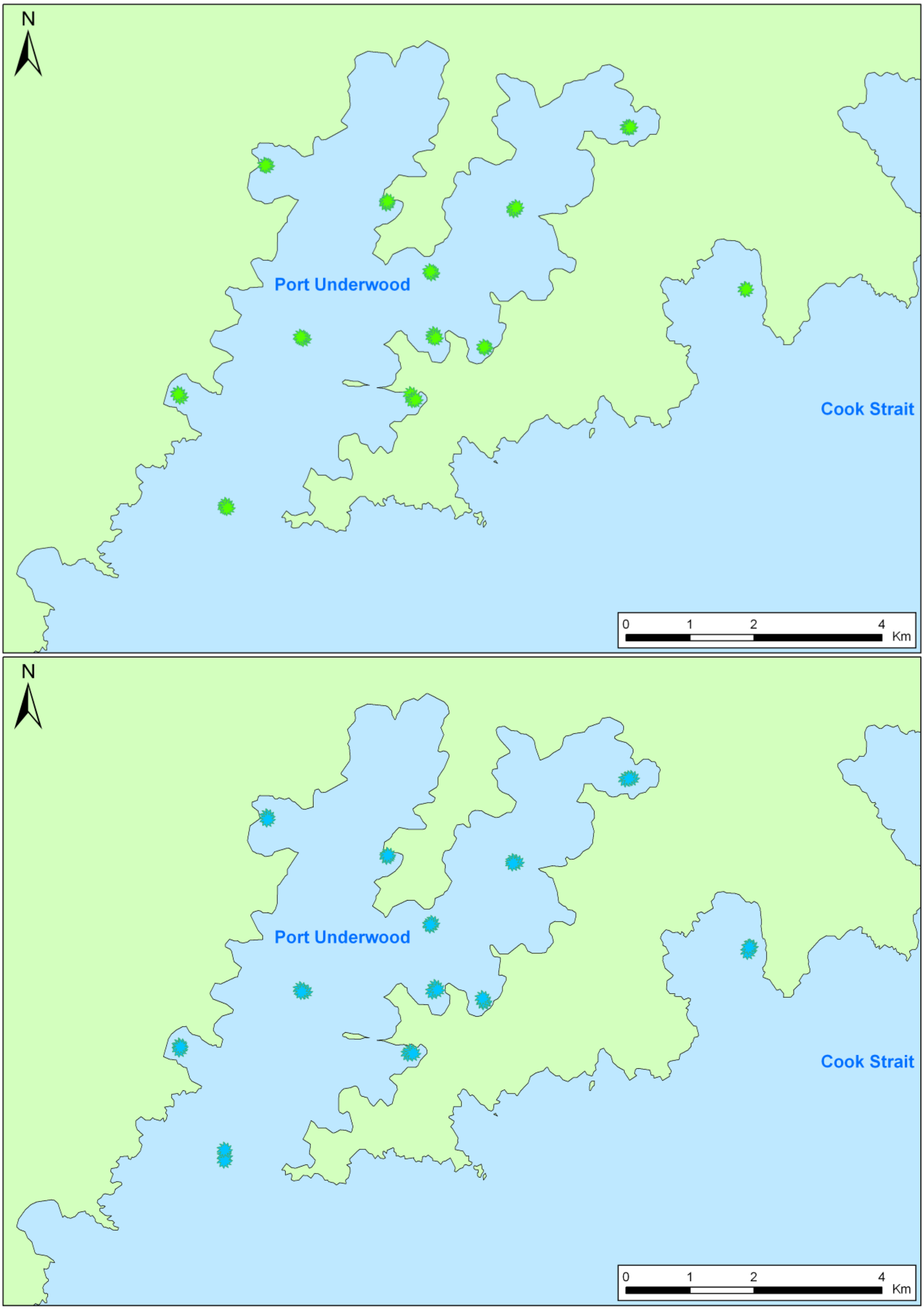


Figure 14: Water column sampling sites for zooplankton (green stars, top figure), phytoplankton (blue stars, bottom figure) and dinoflagellates

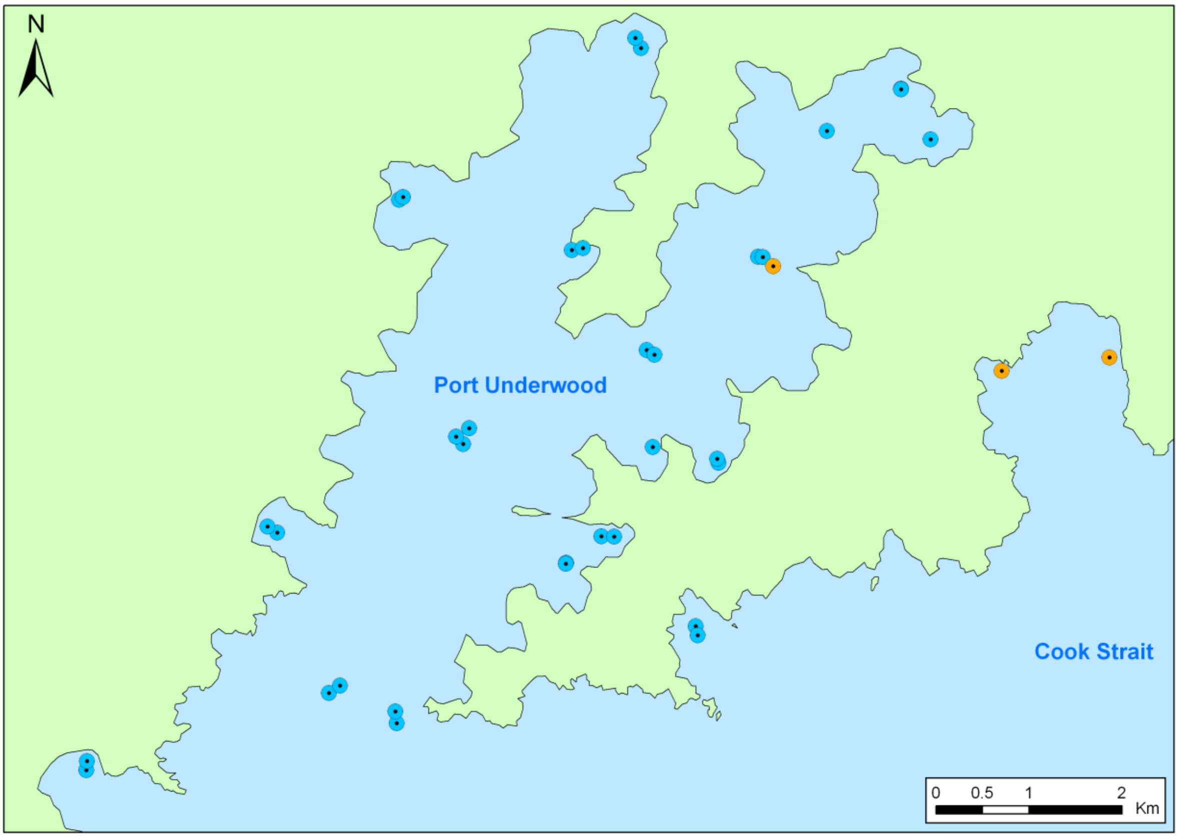


Figure 15: Diver visual transect and benthic sleds sites

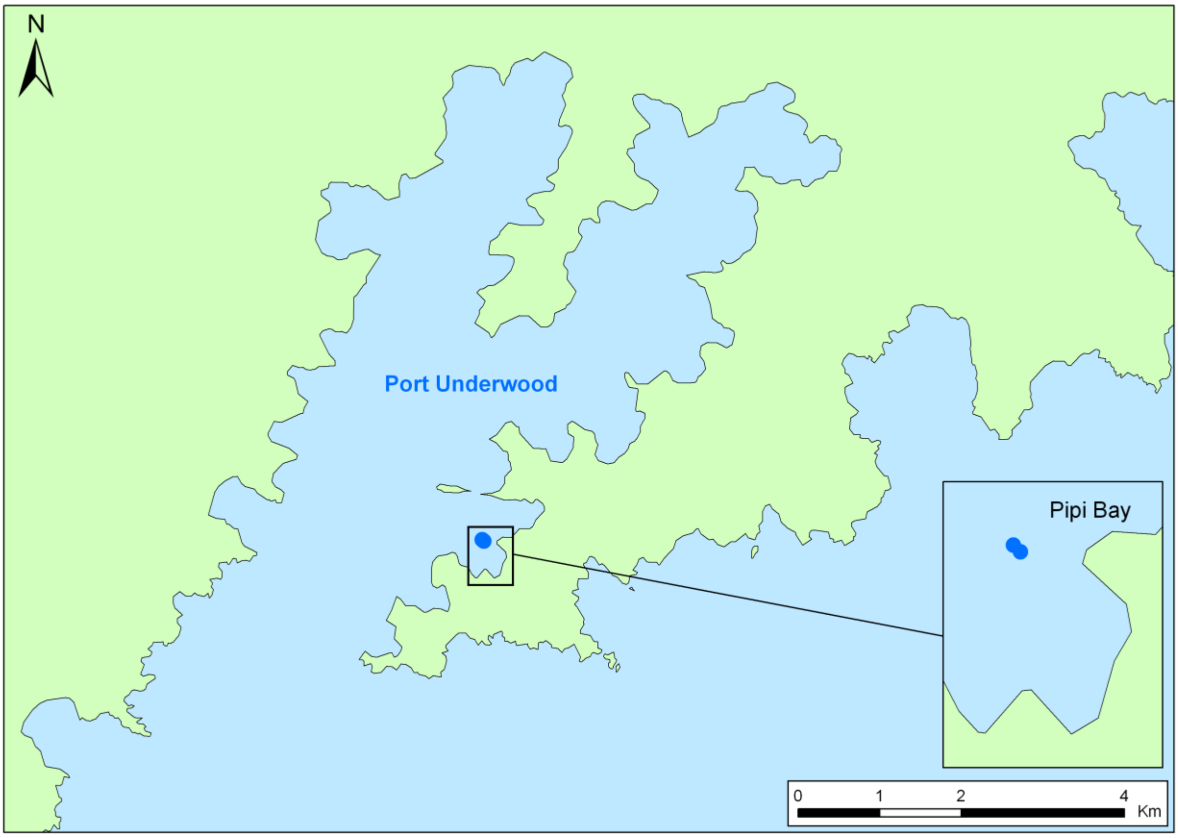


Figure 16: Crab and shrimp trapping sites

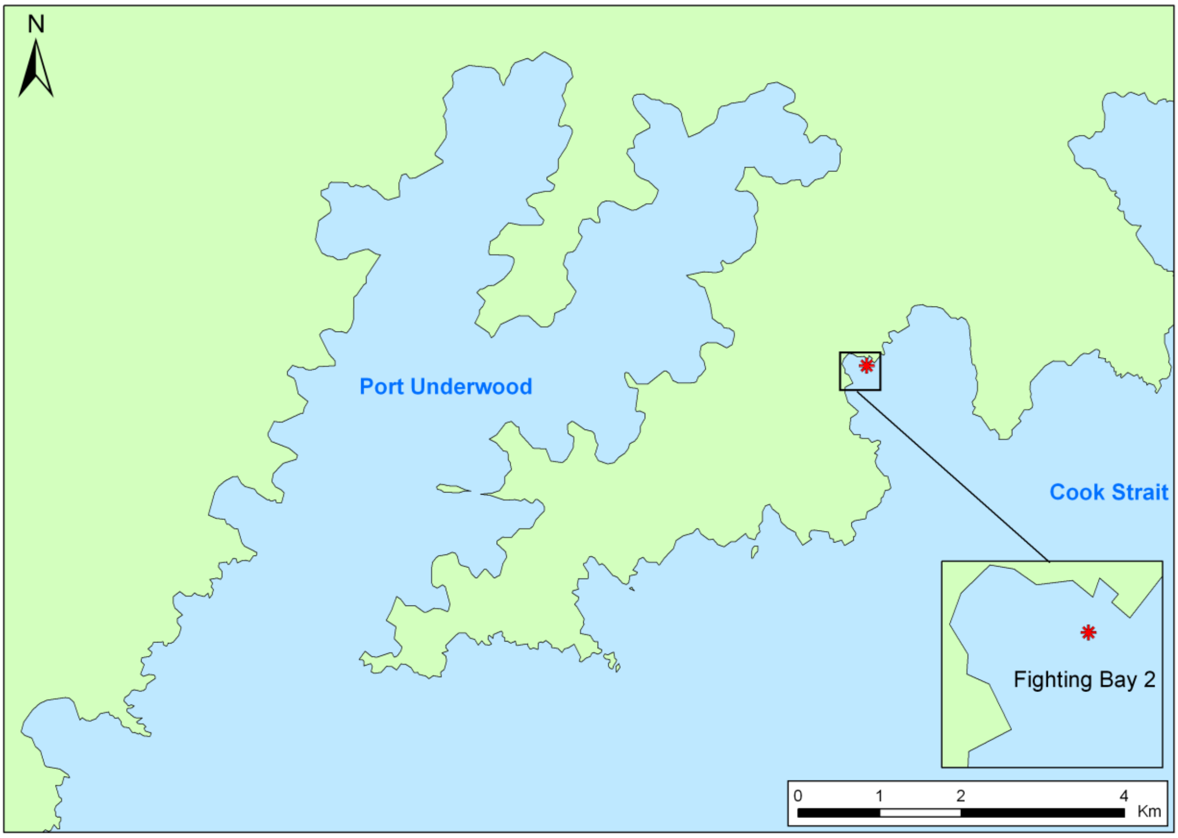


Figure 17: Poison stations sampling sites

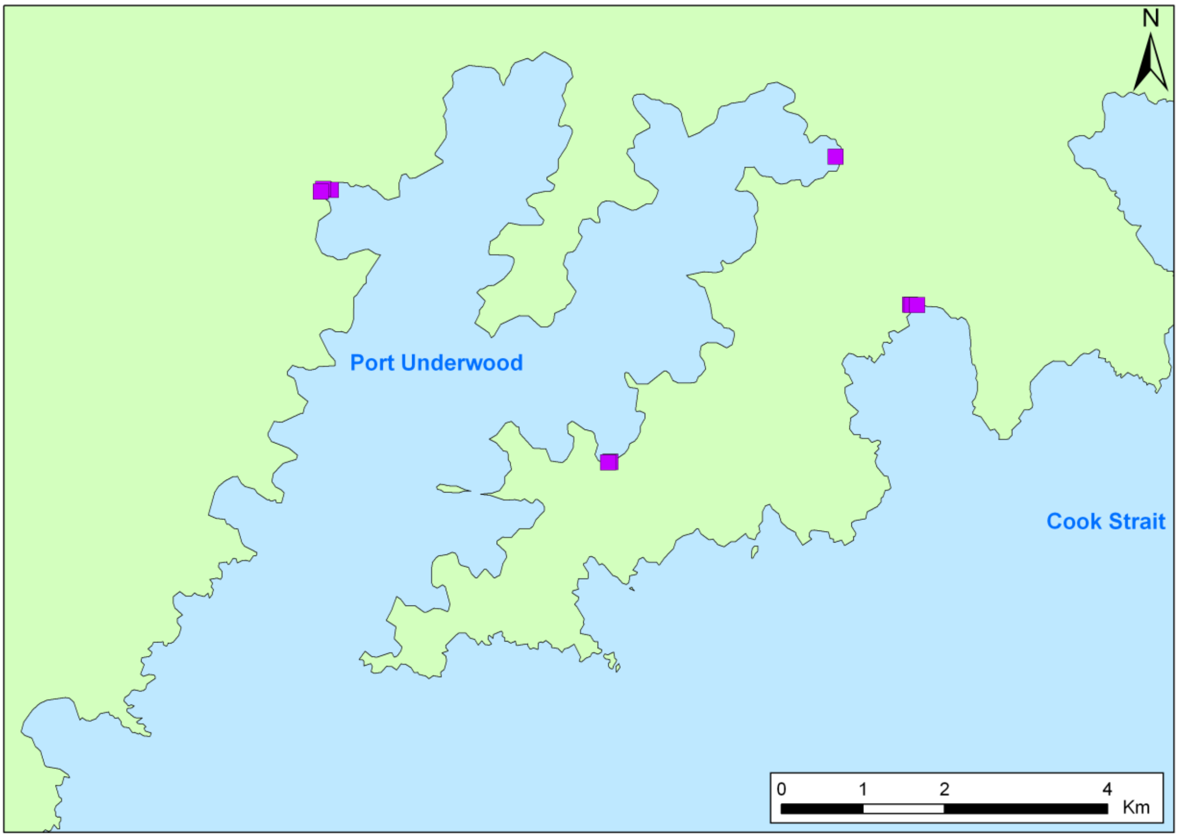


Figure 18: Beach seine sampling sites

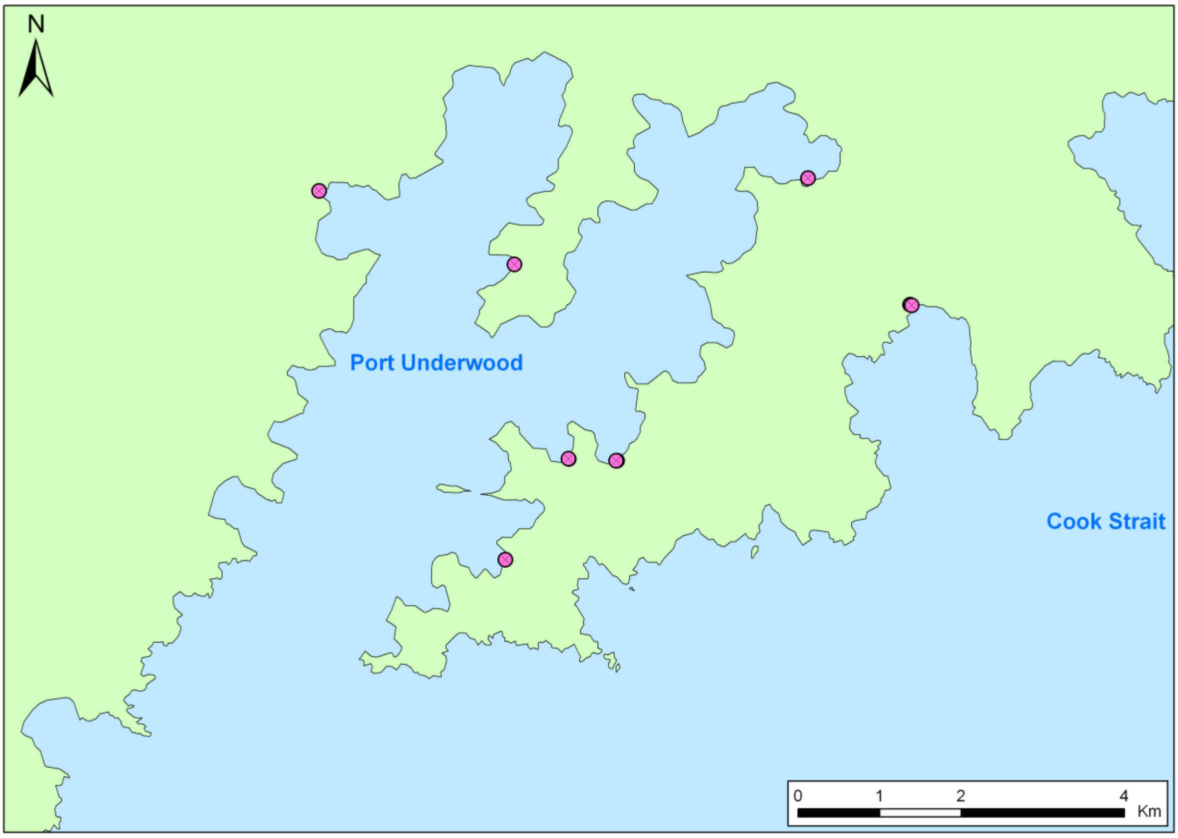


Figure 19: Beach wrack sampling sites

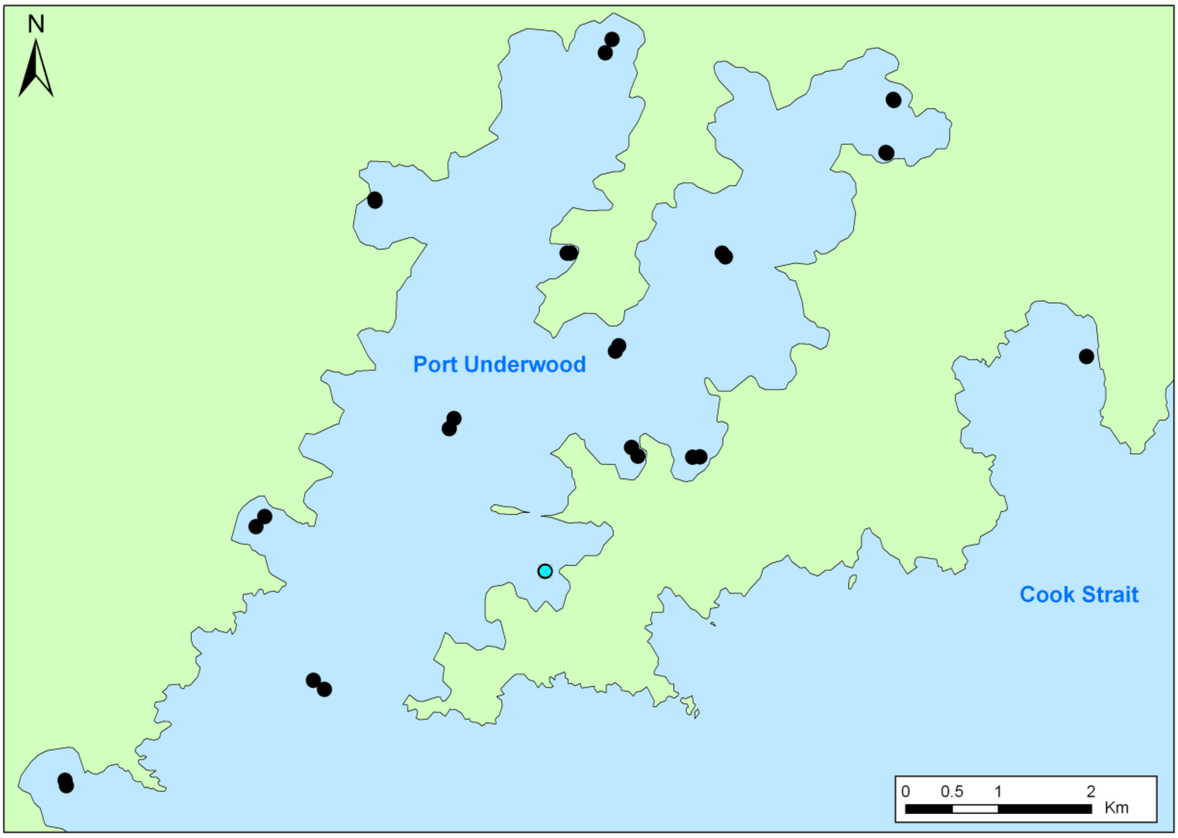


Figure 20: Sediment sampling sites

DEFINITIONS OF BIOSECURITY STATUS

Each species recovered during the survey was classified into one of five categories ("biosecurity status") that reflected its known or suspected geographic origin. To do this we used the experience of taxonomic experts and reviewed published literature and unpublished reports to collate information on the species' biogeography. Patterns of species distribution and diversity in the oceans are complex and still poorly understood (Warwick 1996). Worldwide, many species still remain undescribed or undiscovered and their biogeography is incomplete. These gaps in global marine taxonomy and biogeography make it difficult to determine the true range and origin of many species reliably. The biosecurity status we used reflect this uncertainty.

Species that were not demonstrably native or non-indigenous were classified as "cryptogenic" (sensu Carlton 1996). Cryptogenesis can arise because the species was spread globally by humans before scientific descriptions of marine flora and fauna began in earnest (i.e. historical introductions). Alternatively the species may have been discovered relatively recently and there is insufficient biogeographic information to determine its native range. We have used two categories of cryptogenesis to distinguish these different sources of uncertainty. A fifth biosecurity status ("indeterminate taxa") was used for specimens that could not be identified to species-level. Formal definitions for each biosecurity status are given below, and a full glossary is provided at the end of the report.

Native species

Native species occurred within the New Zealand biogeographical region historically and have not been introduced to coastal waters by human mediated transport.

Non-indigenous species (NIS)

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

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

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

7. Does the species have a disjunctive worldwide distribution?
8. Are dispersal mechanisms of the species inadequate to reach New Zealand, and is passive dispersal in ocean currents unlikely to bridge ocean gaps to reach New Zealand?
9. Is the species isolated from the genetically and morphologically most similar species elsewhere in the world?

Cryptogenic category 1 taxa (C1)

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

Cryptogenic category 2 taxa (C2)

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

Indeterminate taxa

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

PUBLIC AWARENESS PROGRAMME

A well-targeted public awareness programme was an important component of this project. Because Port Underwood is in a relatively remote part of New Zealand with small local communities, a large field research team is highly visible and requires the support and infrastructure of the communities. It is important, therefore, that the communities clearly understand the motives for the survey and how they may contribute to a successful national outcome (i.e. greater biosecurity awareness and protection).

NIWA worked closely with Biosecurity NZ and relevant local and regional authorities to develop a public awareness programme for the surveys. We made joint media releases to local media immediately before the surveys began. These outlined the activities to be undertaken during the surveys and encouraged any public reports or observations on potentially introduced species, including providing points of contact for reporting (Appendix 4). Where possible, any reports were followed up by the survey teams while they were on location or immediately after the surveys were completed. A log was kept of any such reports and the response to them. The public awareness programme included a communication plan that outlined the personnel (in NIWA and Biosecurity NZ) who are authorised to respond to media enquiries and scope of issues that they were authorised to address. For the Port Underwood port survey, consent was required to allow NIWA access to Fighting Bay and adjacent sites located within the Cook Straight Cable Protection Zone. An application was submitted to Transpower, Seaworks & Maritime New Zealand and an exception granted under the Submarine Cable and Pipeline Protection Act.

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

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

Media

- The Radio Network Marlborough
- Radio New Zealand Christhurch news desk
- Nelson Mail
- Radio New Zealand Our Changing World: Ms Veronika Meduna
- Radio New Zealand Wellington news desk
- The Dominion Post
- The Press

Stakeholders

- Te Atiawa, Ngati Toa Ki Wairau
- Te Runanga O Rangitane ki Wairau
- Ngati Rarua
- Te Tau Ihu Fishery Forum
- Marlborough District Council
- Ministry of Fisheries Officer, Blenheim
- Department of Conservation

Following media release, the following press coverage resulted:

- Marlborough Express: 'Hunt for foreign marine invaders in Marlborough', 16 April 2007, p.3.

Survey Results

REVIEW OF MARINE SPECIES RECORDS FROM PORT UNDERWOOD

A total of 61 taxa representing 12 phyla were recorded during the desktop review of existing marine species records from Port Underwood and surrounding areas. These include 42 native taxa (Table 6), 11 non-indigenous species (NIS; Table 7), seven cryptogenic category one (C1) taxa (Table 8), and one indeterminate taxa (

Table 9). For general descriptions of the main groups of organisms recorded during this review, refer to Appendix 5. A list of Chapman and Carlton's (1994) criteria (see "

Baseline survey **methods**: Definitions of biosecurity status", above) that were met by the NIS and C1 taxa is given in Table 10.

The 42 native taxa compiled in our review of existing marine species records from Port Underwood are comprised of nine phyla but are dominated by fish, dinoflagellates and and molluscs (Table 6). It should be noted that whilst our review was thorough, achieving an exhaustive list of native species was not possible within the resources available to the study.

The 11 non-indigenous species previously recorded from Port Underwood (Table 7) were predominantly all algae, with four "brown" algae *Cutleria multifida, Asperococcus bullosus, Chnoospora minima and Undaria pinnatifida;* and three "red" algae *Griffithsia crassiuscula, Neosiphonia subtilissima* and *Polysiphonia senticulosa*. The remaining taxa included the amphipods *Caprella mutica* and *Apocorophium acutum*; the Chinook salmon *Oncorhynchus* tshawytscha and the hydroid *Eudendrium generale*.

The seven C1 taxa previously recorded from Port Underwood (Table 8) include three dinoflagellates (*Gymnodinium catenatum*, *Alexandrium minutum* and *Alexandrium ostenfeldii*), two cnidarians (*Phialella quadrata* and *Halecium delicatulum*), one brown alga (*Heterosigma akashiwo*) and one ascidian (*Didemnum vexillum*). Available information on the ecology of each of these NIS and C1 species, their global and New Zealand distributions, vectors and potential impacts are provided in Appendix 6.

There were no C2 taxa in our literature review of existing marine species records from Port Underwood include.

Eight of the taxa recorded during the review are harmful algal species. These are the native diatoms *Pseudo-nitzschia australis* and *Pseudo-nitzschia pungens* the native dinoflagellates *Dinophysis acuta* and *D. acuminate,* the cryptogenic category 1 dinoflagellates *Gymnodinium catenatum, Alexandrium minutum* and *Alexandrium ostenfeldii* and the cryptogenic category 1 red alga *Heterosigma akashiwo* (Table 6). Evidence from toxin analyses suggest that *Alexandrium ostenfeldii* may be native in New Zealand (MacKenzie et al. 1996), but as this has not been confirmed, it is classed here as C1 (Table 8).

Alexandrium ostenfeldii is capable of producing Paralytic Shellfish Poisoning (PSP) toxins, although it is one of the least toxic of all the *Alexandrium* species tested for PSP toxins. Nonetheless, it may be hazardous for shellfish consumers in New Zealand (MacKenzie et al. 1996). *Dinophysis acuta* and *Dinophysis acuminata* form blooms that are associated with Diarrhetic Shellfish Poisoning (DSP), although it appears that not all *Dinophysis acuminata* blooms are toxic (Faust and Gulledge 2002). *Pseudo-nitzschia australis* can produce a domoic acid, which causes Amnesic Shellfish Poisoning (ASP, New Zealand Food Safety Authority 2003). However, not all isolates of *P. australis* in New Zealand have been confirmed to produce domoic acid (Hay et al. 2000).

PORT ENVIRONMENT

Sampling was carried out at 20 different sites throughout Port Underwood (

Figure 11 to

Figure 19, Table 11). Maximum recorded depths ranged from 60 m at Rununder Point to 6.5 m at Ocean Bay. Turbidity was greatest at the relatively exposed Robin Hood Bay (1 m secchi depth), while it was lowest in the sheltered Kaikoura Bay (8.9 m secchi depth). Salinity ranged between 28 ppt in Robin Hood Bay to 33.5 ppt at Opihi Bay. The average water temperature across all sites was 14.6 ± 0.8 °C and was highest at Karake Pt (15.4 °C) and lowest at Fighting Bay 1 and Rununder Point (13.8 °C). During sampling, sea states ranged from 0-2 on the Beaufort scale (i.e. approximately 0-6 knots wind speed and 0-0.2 m wave height). The sites that scored highest on the Beaufort scale (Rununder Point, Port Underwood Inner HbrApp1 and Fighting Bay 1) were predictably in the more exposed areas of the Port.

The majority of sediment samples (11 of 15) taken from sites in and around Port Underwood were dominated by silt-sized particles (Table 12), suggesting that Port Underwood is a relatively sheltered Harbour. All sites contained clay (ranging from 0.01 to 1.46 % of the sample), sand (19.71 - 94.44 %) and silt (4.55 - 79.59 %) sized particles (Table 12). Small pebbles were not recorded from any samples collected, and six of the 15 samples contained gravel-sized particles (ranging from 0.05 - 2.68 % of the sample). The outer sites of Fighting Bay and Robin Hood Bay (
Figure 2) contained the lowest proportion of clay (both sites = 0.01 %) and were dominated by sand-sized particles (94.26 - 95.44 %) this, and their locality on Cook Strait, suggests they are the most exposed sites sampled. Most inner sites (eight of ten) were dominated by silt-sized particles (Table 12). The exception to this was Ocean Bay and Oyster Bay, situated on the western side of the Harbour (
Figure 2). Samples collected from these sites were dominated by sand-sized particles (Table 12) suggesting that the western side of the harbour was more exposed than the eastern side.

The organic content of sediments in the Port Underwood area was low, with a mean LOI (Loss of Ignition) value across the 30 analysed samples collected from 15 sites of 3.93 % ±0.26 % (
Figure 21). The organic content of sediments showed a similar pattern as sediment particle size described above. The most exposed outer sites had the lowest LOI; Robin Hood Bay = 1.24 %; Ocean Bay = 1.6 % and Fighting Bay = 2.26 % (
Figure 21). Furthermore, the highest organic content was recorded in the sheltered inner sites, such as the Knobbys (5.53% LOI). Terrestrial runoff is also likely to contribute to the organic content recorded at these inner sites.

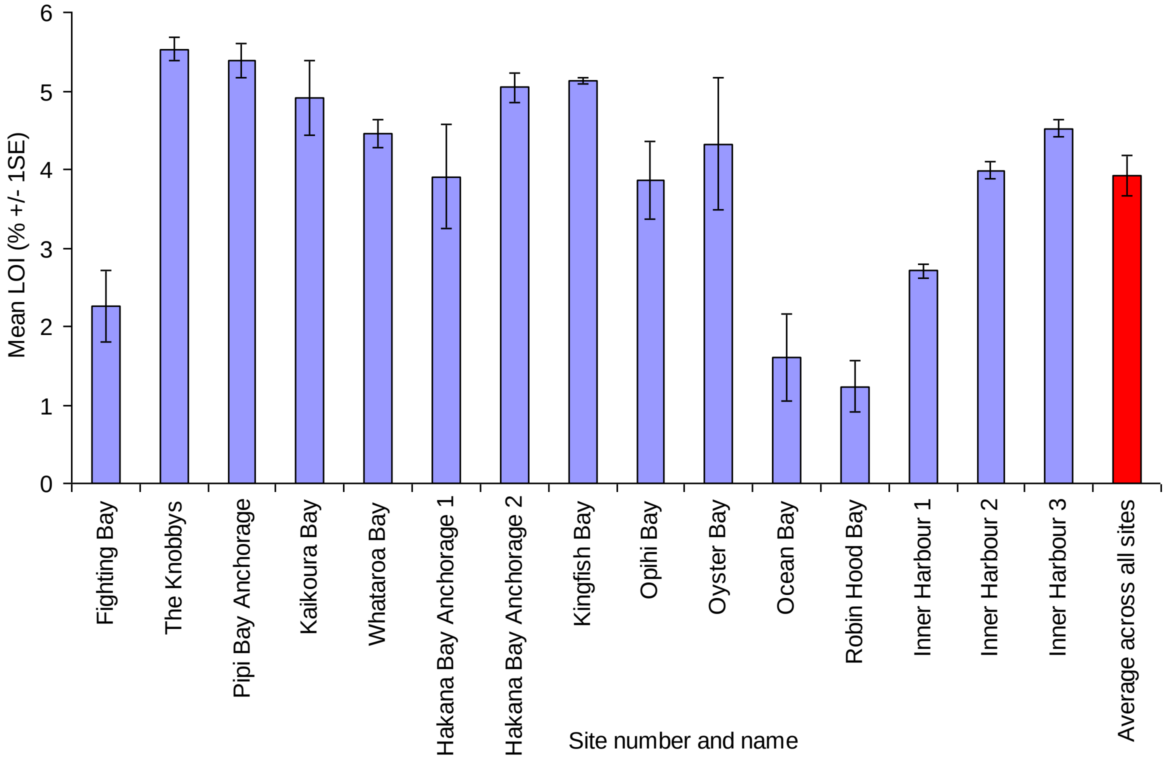


Figure 21: Organic content as determined by loss on ignition analyses of sediments from 15 sites at and around Port Underwood.

SPECIES RECORDED

A total of 411 species or higher taxa were identified from the baseline survey of Port Underwood. This collection consisted of 301 native taxa (Table 13), six cryptogenic category 1 taxa (Table 14), 14 cryptogenic category 2 taxa (Table 15), seven Non-indigenous species (Table 16), 82 indeterminate taxa (Table 17) and one zooplankton (which were screened for target non-indigenous species but not otherwise identified).

The biota recorded included a diverse array of organisms from 16 phyla, as well as one sample of unidentified non-target zooplankton and three specimens that could not be identified to phylum (Figure 23). For general descriptions of the main groups of organisms (Phyla) encountered during this study refer to Appendix 5, and for detailed species lists collected using each method refer to Appendix 7.

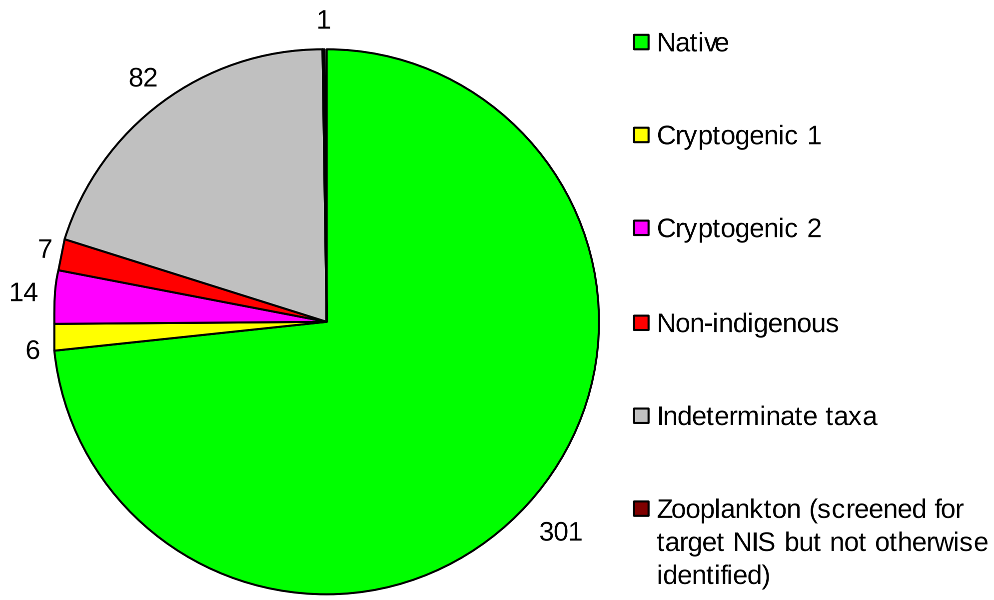


Figure 22: **Biosecurity status of marine species sampled in Port Underwood. Values indicate the number of taxa in each category. Zooplankton are included separately because they were screened for target NIS but non-target species were not identified.**

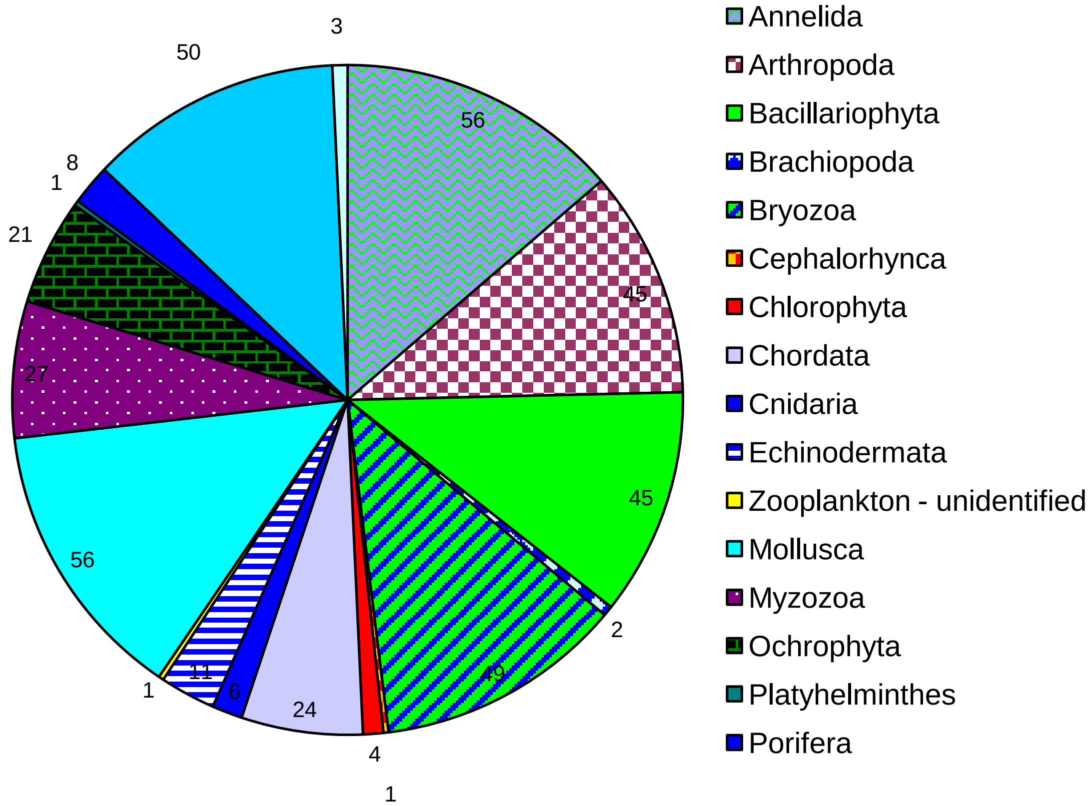


Figure 23: **Phyla recorded in Port Underwood. Values indicate the number of taxa in each of these groups.**

Native taxa

The 301 native species recorded during the Port Underwood survey (Table 13) represented 73 % of all species identified from this location and included diverse assemblages of molluscs (52 taxa), bryozoans (38 taxa), red algae (38 taxa), crustaceans (36 taxa), annelids (35 taxa), fish (seven taxa), diatoms (Bacillariophyta; 31 taxa), dinoflagellates (22 taxa), brown algae (16 taxa), echinoderms (10 taxa), ascidians (nine taxa), cnidarians (two taxa), brachiopods (two taxa) and one spronge, Cephalorhynca and green algal taxon (Table 13).

Non-indigenous taxa

The seven non-indigenous species (NIS) recorded in the survey of Port Underwood represented 1.7 % of all taxa identifies from the survey. These included four bryozoans, three and one brown alga, ascidian, and mollusc (Table 16).

None of the NIS recorded in this survey of the Port Underwood are new to New Zealand.

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

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

Bowerbankia gracilis occurred in one pile scrape sample taken at Oyster Bay and one anchor box dredge taken at the Inner Harbour 3 site (

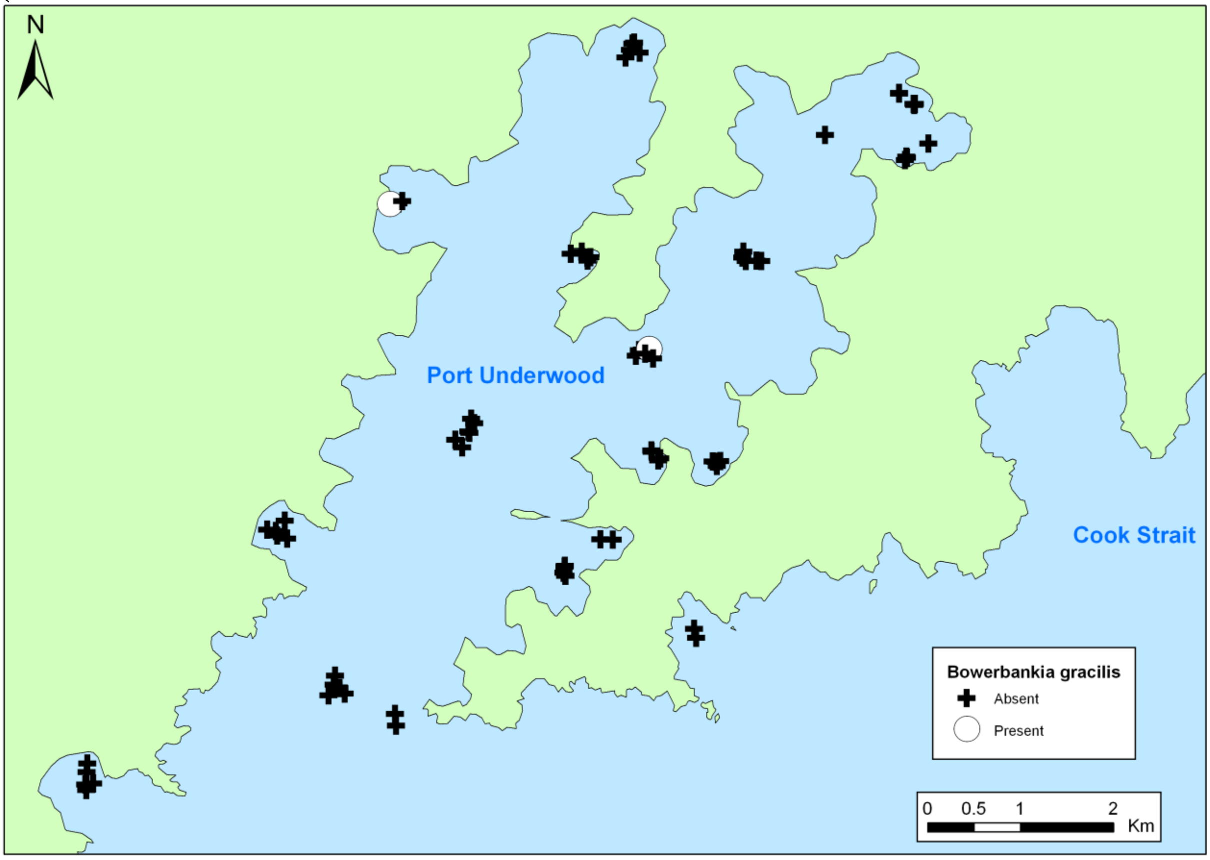


Figure 24).

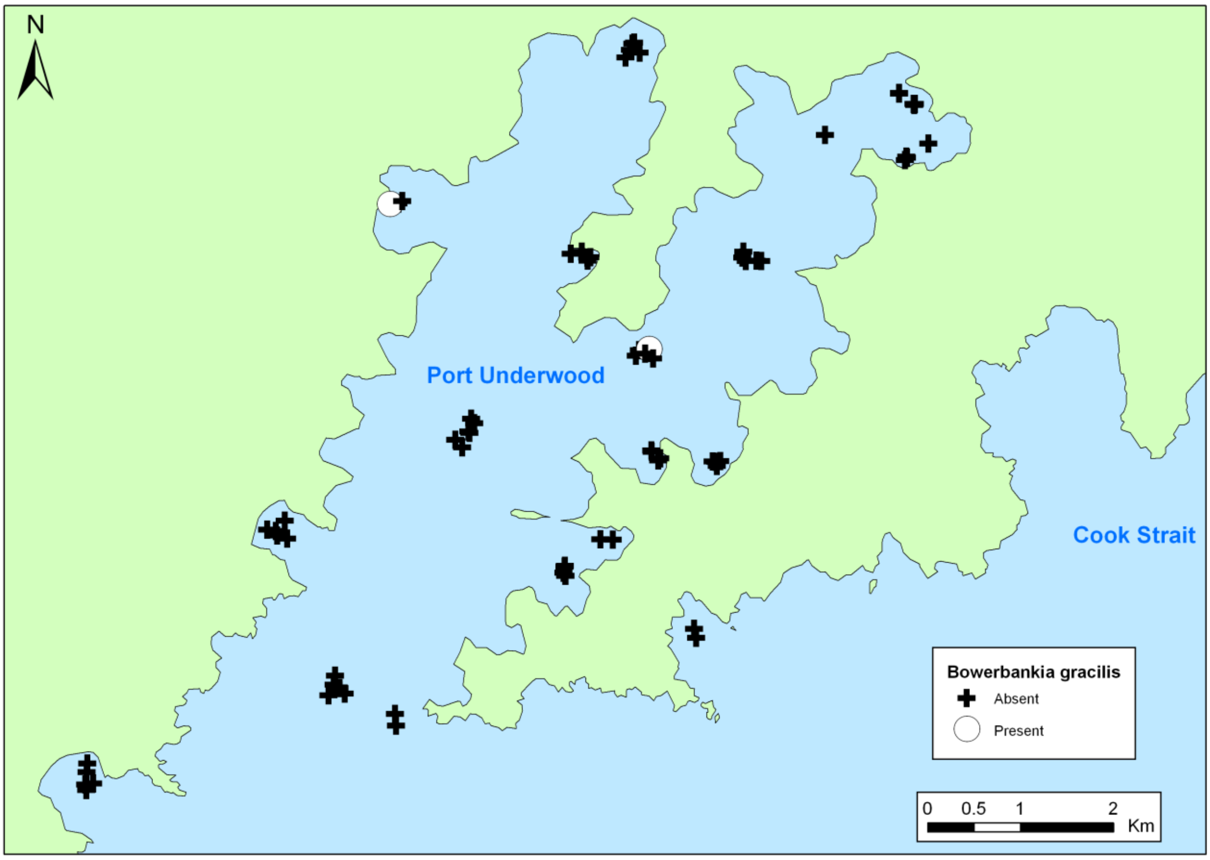


Figure 24: ***Bowerbankia gracilis*** **distribution in the Port Underwood survey**

Bugula flabellata (Thompson in Gray, 1848)

Bugula flabellata occurred in one benthic sled sample taken at the Pipi Bay Anchorage 1 site (Figure 25).

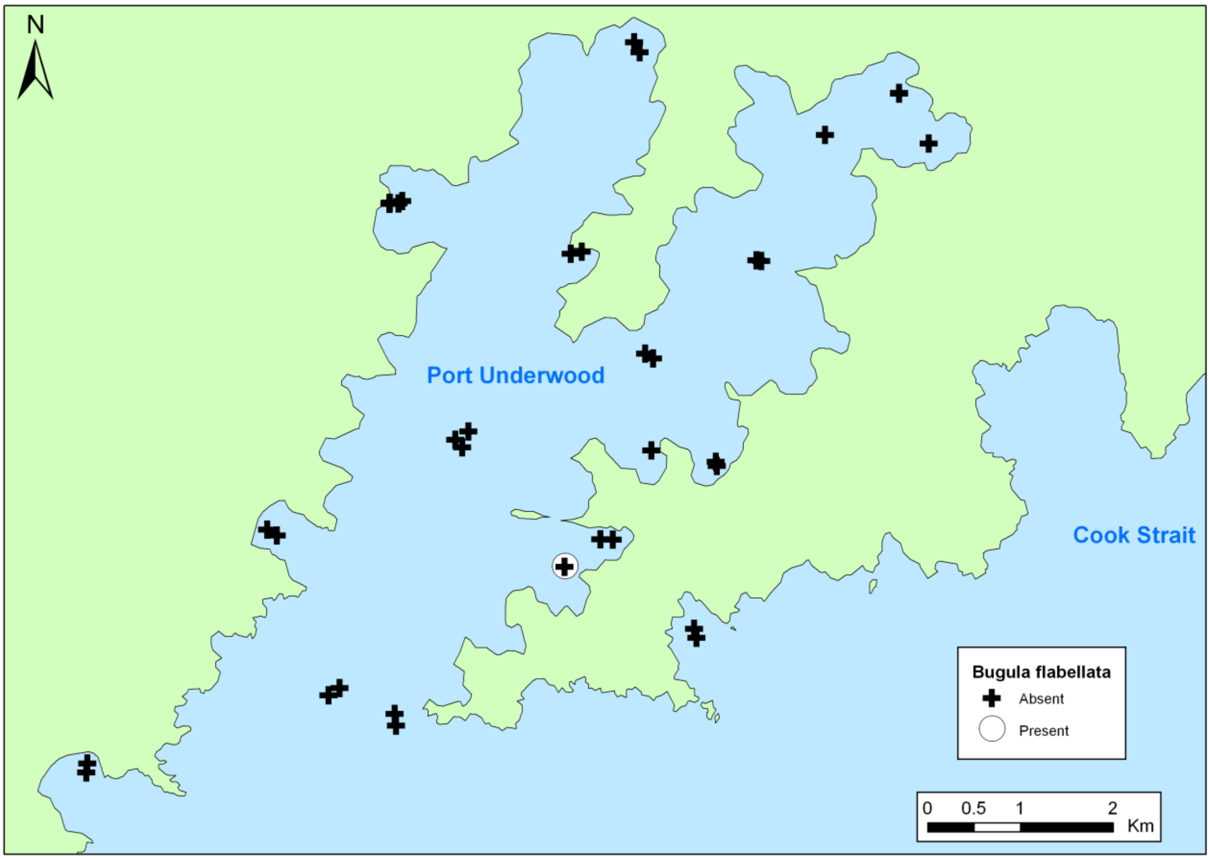


Figure 25: ***Bugula flabellata*** **distribution in the Port Underwood survey**

Cryptosula pallasiana (Moll, 1803)

Cryptosula pallasiana occurred in one pile scrape sample taken at Oyster Bay (

Figure 25).

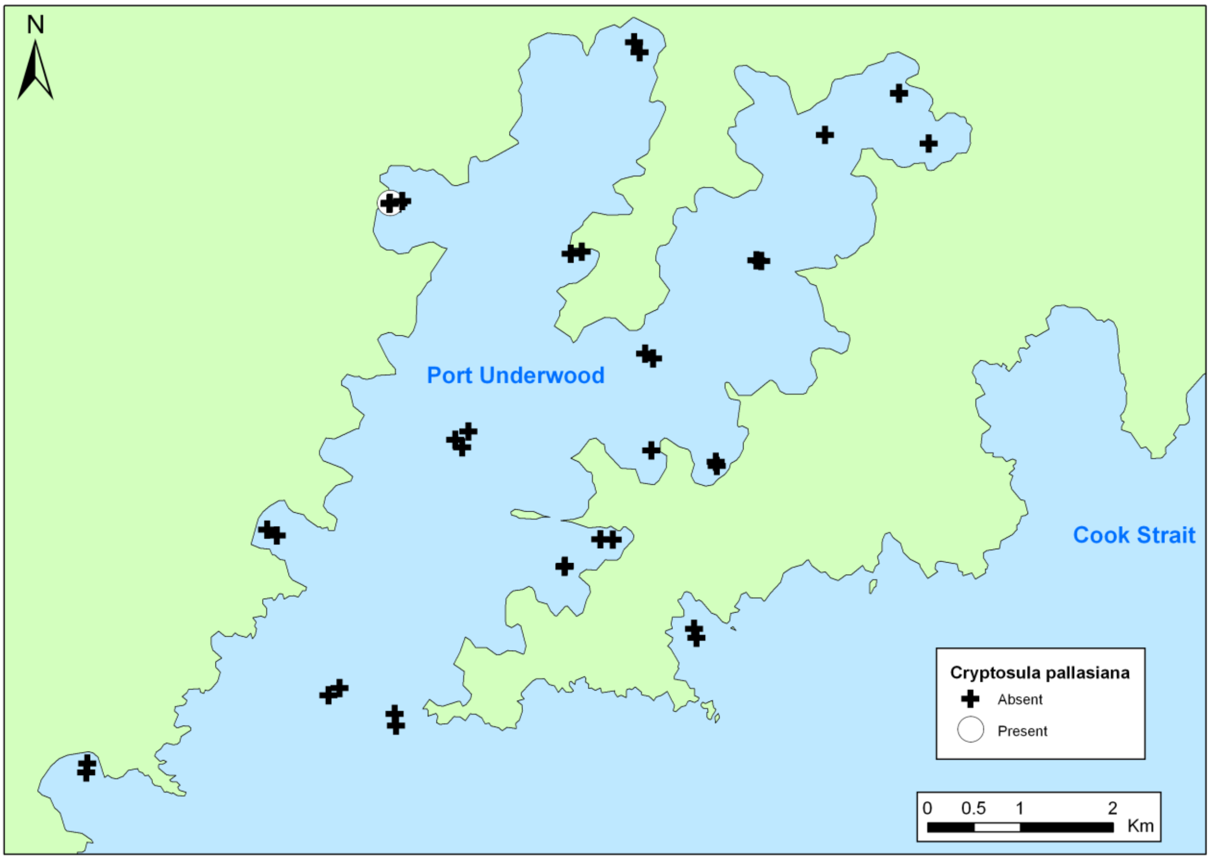


Figure 26: *Cryptosula pallasiana* distribution in the Port Underwood survey

Watersipora subtorquata (d'Orbigny, 1852)

Watersipora subtorquata occurred in ten samples; three pile scrape and seven pile scrape miscellaneous samples all from Oyster Bay (
Figure 27).

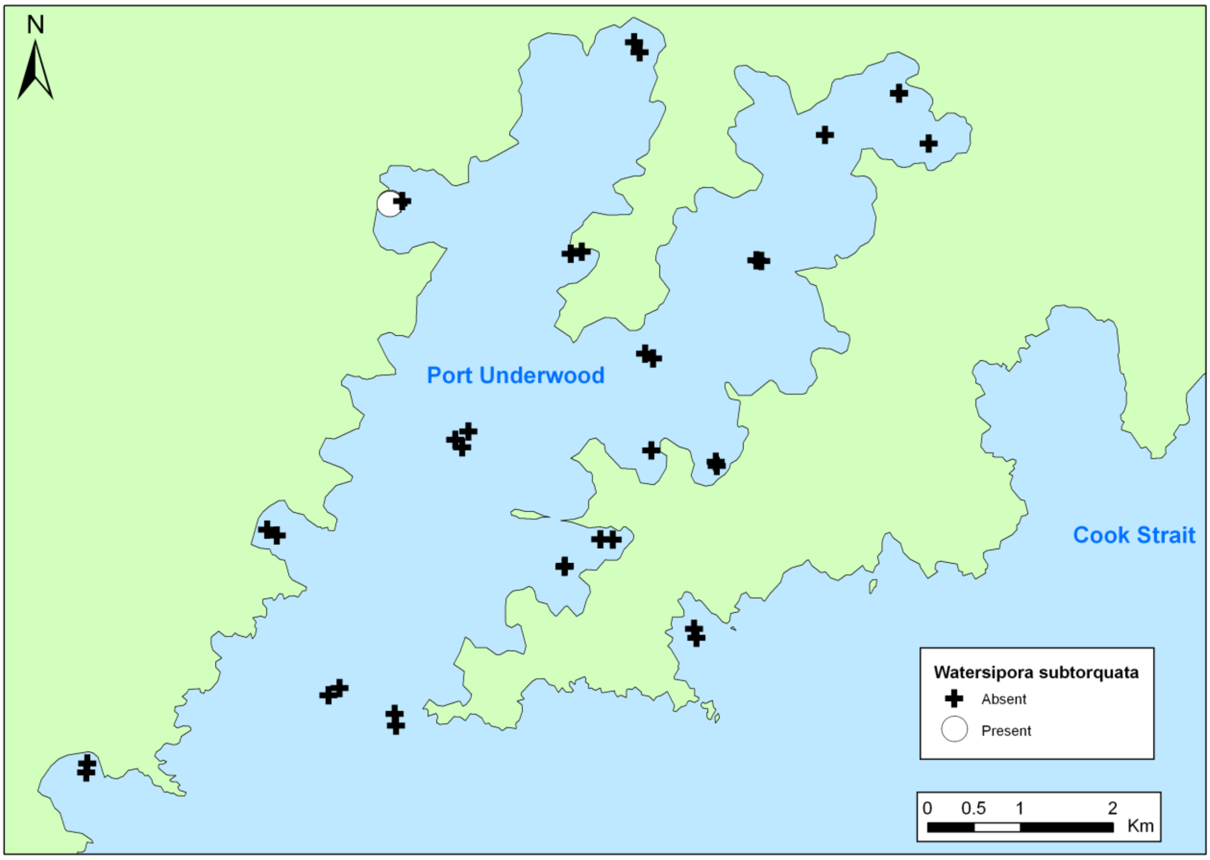


Figure 27: *Watersipora subtorquata* distribution in the Port Underwood survey

Ascidiella aspersa (Mueller, 1776)

Ascidiella aspersa occurred in two anchor box dredge samples taken from Pipi Bay Anchorage 1 and Oyster Bay (
Figure 28).

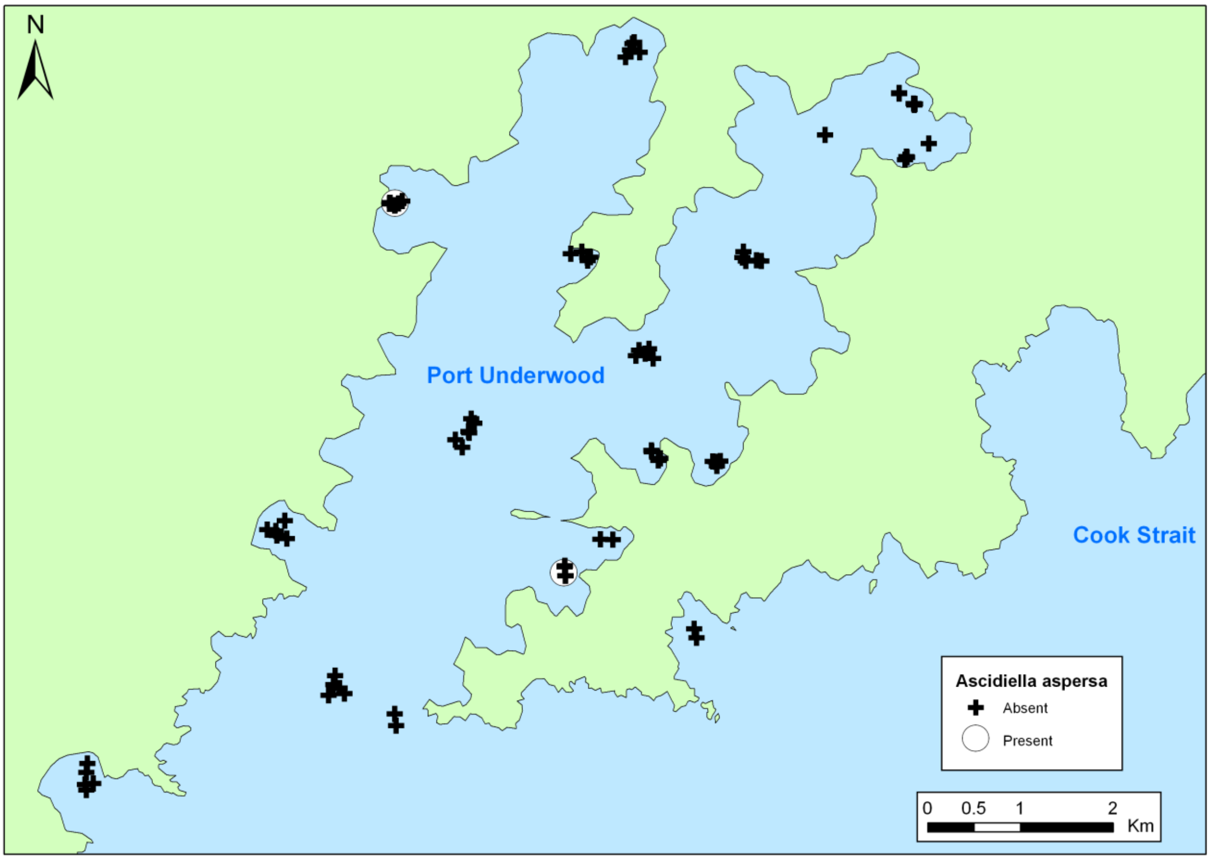


Figure 28: ***Ascidiella aspersa*** **distribution in the Port Underwood survey**

Theora lubrica (Gould, 1861)

Theora lubrica occurred in 52 samples; 23 benthic sleds taken from Kaikoura Bay, Whataroa Bay, The Knobbys, Robertson Point, Pipi Bay Anchorage 1 and 2, Hakana Bay Anchorage 1 and 2, Kingfish Bay, Opihi Bay, Oyster Bay, Robin Hood Bay, Inner Harbour 1, 2 and 3 and in 29 anchor box dredge samples taken from Whataroa Bay, The Knobbys, Kaikoura Bay, Hakana Bay 1 and 2, Kingfish Bay, Opihi Bay, Oyster Bay, Ocean Bay, Robin Hood Bay, Inner Harbour 1, 2 and 3 (Figure 29).

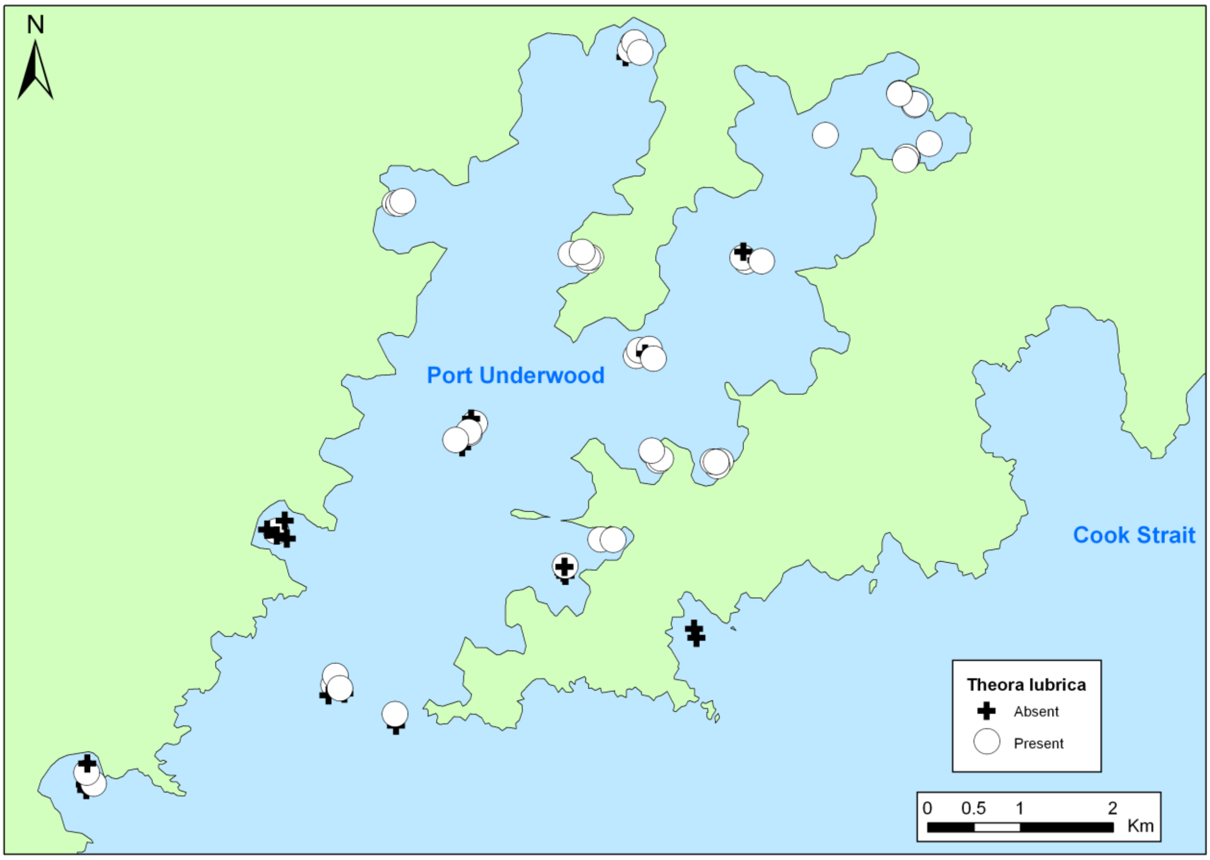


Figure 29: *Theora lubrica* distribution in the Port Underwood survey

Undaria pinnatifida ((Harv.) Suringar)

Undaria pinnatifida occurred in four samples; three pile scrape miscellaneous and one pile scrape sample all from Oyster Bay (
Figure 30).

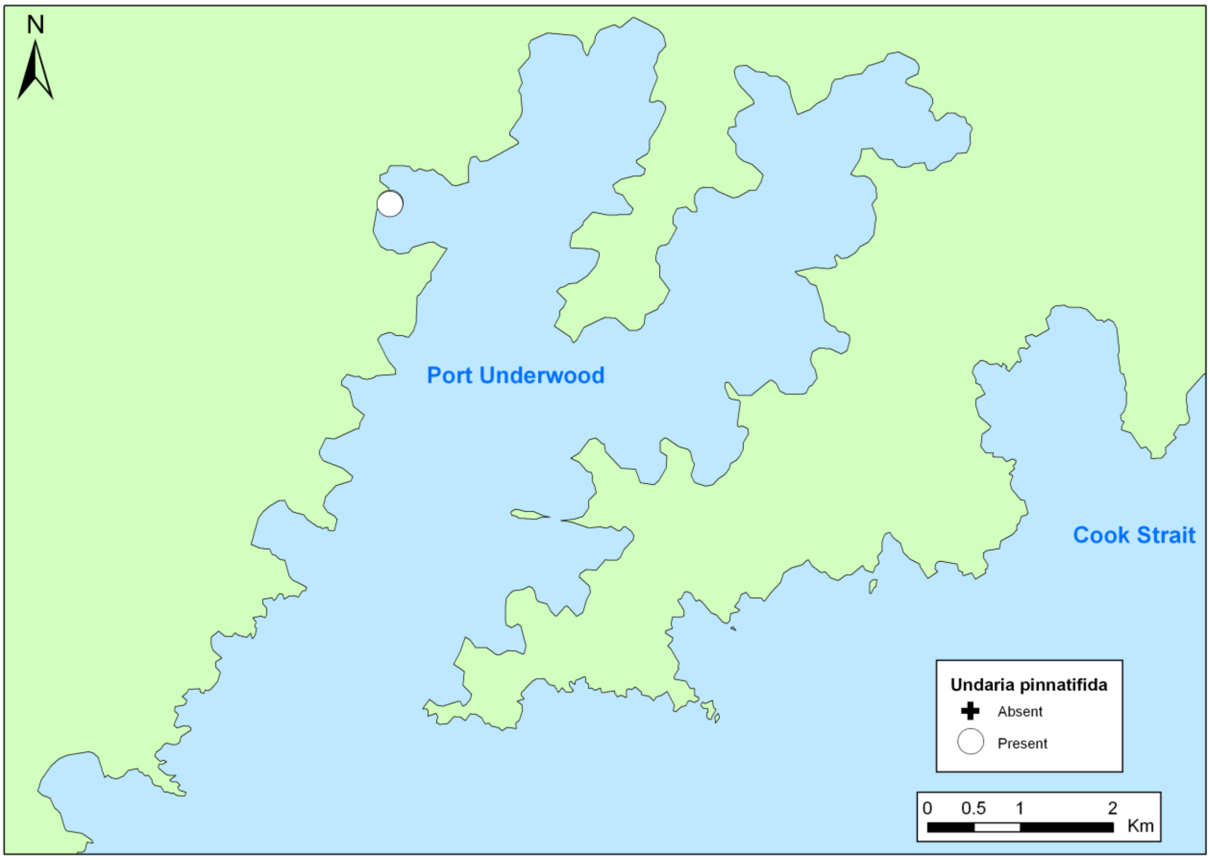


Figure 30: ***Undaria pinnatifida* distribution in the Port Underwood survey**

Cryptogenic category one taxa (C1)

There were six cryptogenic category one (C1) taxa recorded from the Port Underwood port survey, representing 1.5 % of all species or higher taxa recorded. These organisms included three ascidians, two cnidarians and one brown alga (Table 14). A list of Chapman and Carlton's (1994) criteria (see "

Baseline survey **methods**: Definitions of biosecurity status", above) that were met by the cryptogenic category one species recorded in this survey is given in Table 10.

One of the taxa included in the C1 category, *Didemnum* sp., encompasses a genus rather than an individual species, due to difficulties in identification of species within this genus. The genus *Didemnum* includes at least two species that have recently been reported from within New Zealand (*D. vexillum* and *D. incanum*) and two related, but distinct species from Europe (*D. lahillei*) and the north Atlantic (*D. vestum* sp. nov.) that have displayed invasive charactertistics (i.e. sudden appearance and rapid spread, Kott 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. All *Didemnum* specimens were therefore identified only to genus level, including *D. vexillum* which was recorded as a separate species in the literature review. We have reported these species collectively, as a species group (*Didemnum* sp.; Table 14).

None of the C1 taxa are new species records for New Zealand, and all are known from elsewhere in New Zealand. It is unlikely that the occurrence of any of these taxa in Port Underwood represents an extension of their known range within New Zealand.

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

Didemnum sp.

Didemnum sp. occurred in 15 samples; eight anchor box dredges from Kaikoura Bay, Kingfish Bay, Inner Harbour 2 and Inner Harbour 3; four benthic sleds taken from The Knobbye, Robertson Point, Hakana Bay and Kingfish Bay; one formal diver search from Fighting Bay and two beach wrack searches from Fighting Bay and Pipi Bay (
Figure 31).

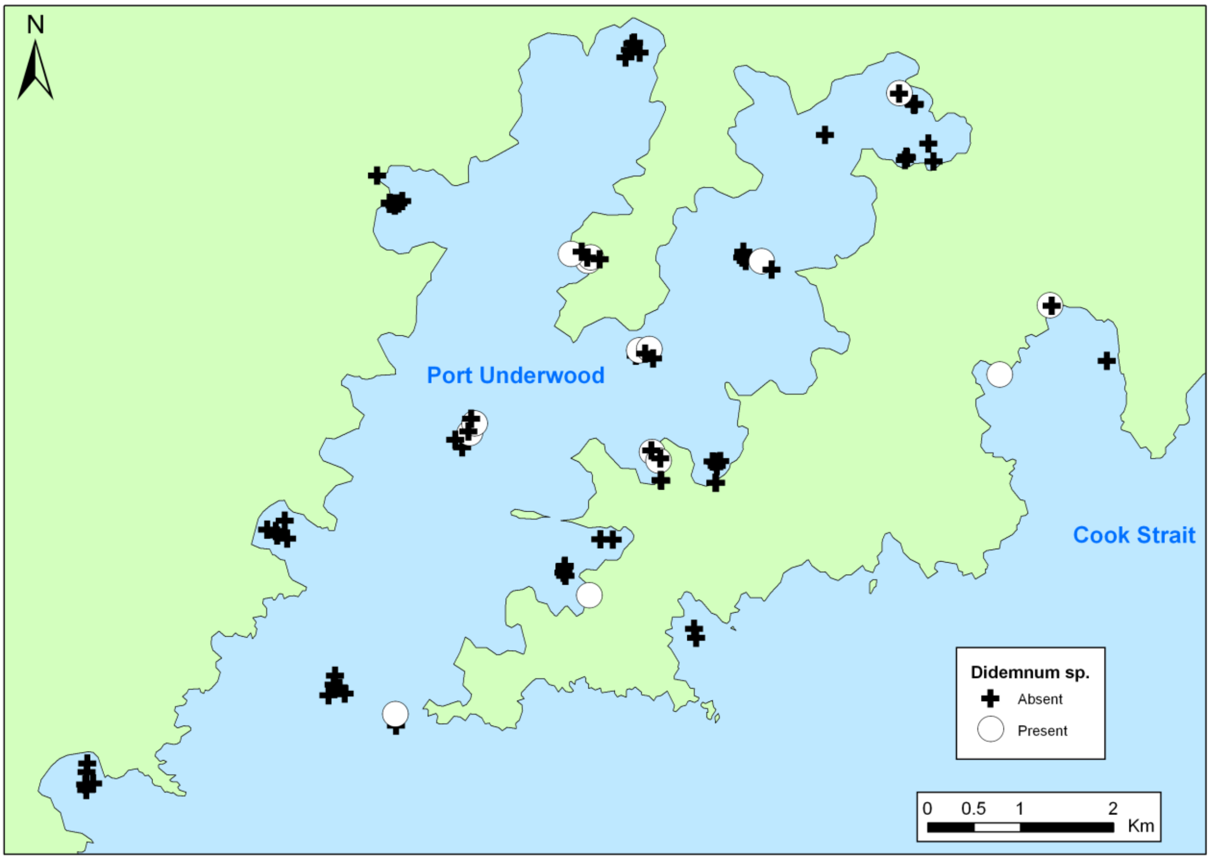


Figure 31: ***Didemnum* sp. distribution in the Port Underwood port survey**

Corella eumyota (Traustedt, 1882)

Corella eumyota was collected in one benthic sled sample taken from Pipi Bay (

Figure 32).

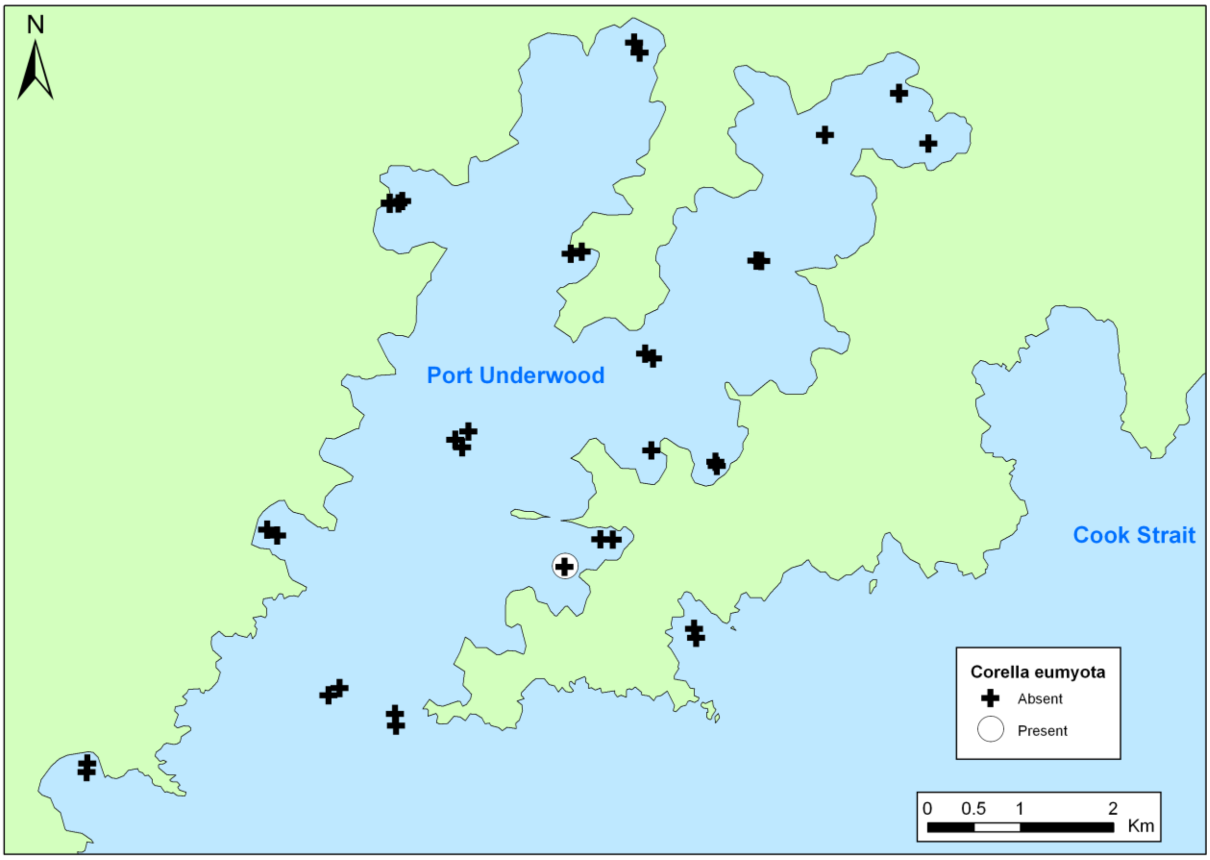


Figure 32: *Corella eumyota* distribution in the Port Underwood port survey

***Botrylloides leachi* (Savigny, 1816)**

Botrylloides leachi was recorded in five samples from Port Underwood; two benthic sled samles taken from Pipi Bay and Robertson Point; two anchor box dredge samples taken from Pipi Bay and Kaikoura Bay and one beach seine net sample taken from Whataroa Bay (Figure 33).

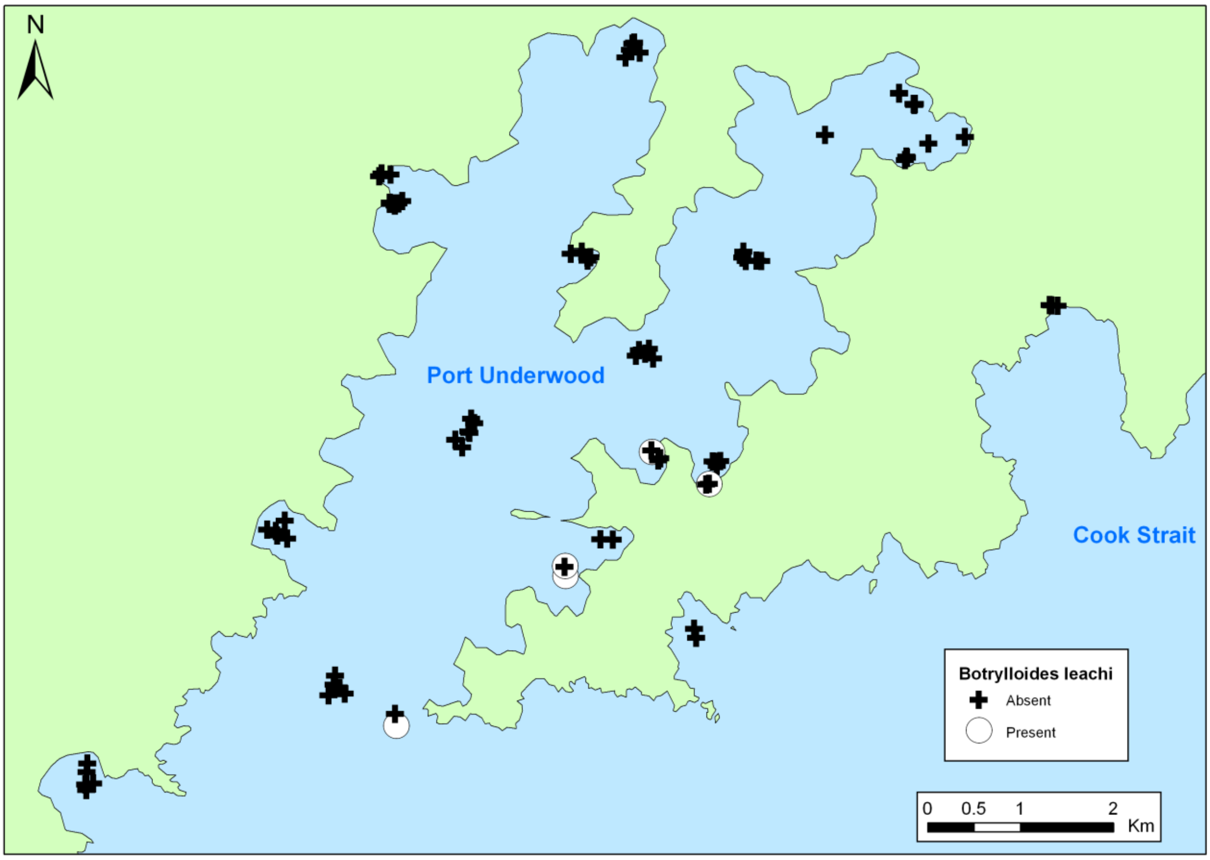


Figure 33: *Botrylloides leachi* distribution in the Port Underwood port survey

Bougainvillia muscus (Allman, 1863)

Bougainvillia muscus was recorded in one benthic sled sample taken from Robin Hood Bay (

Figure 34).

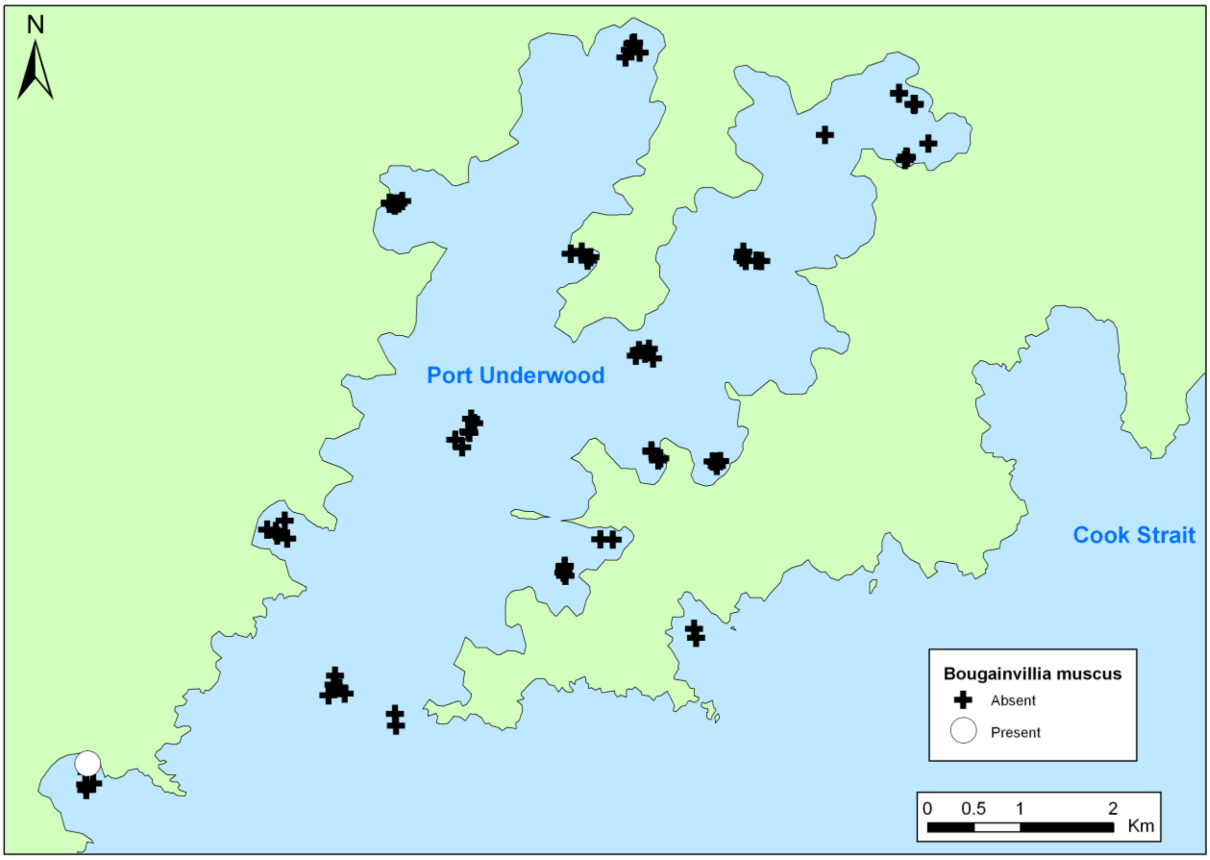


Figure 34: *Bougainvillia muscus* distribution in the Port Underwood port survey

Plumularia setacea

Plumularia setacea occurred in one benthic sled sample taken from Karake Point (
Figure 35).

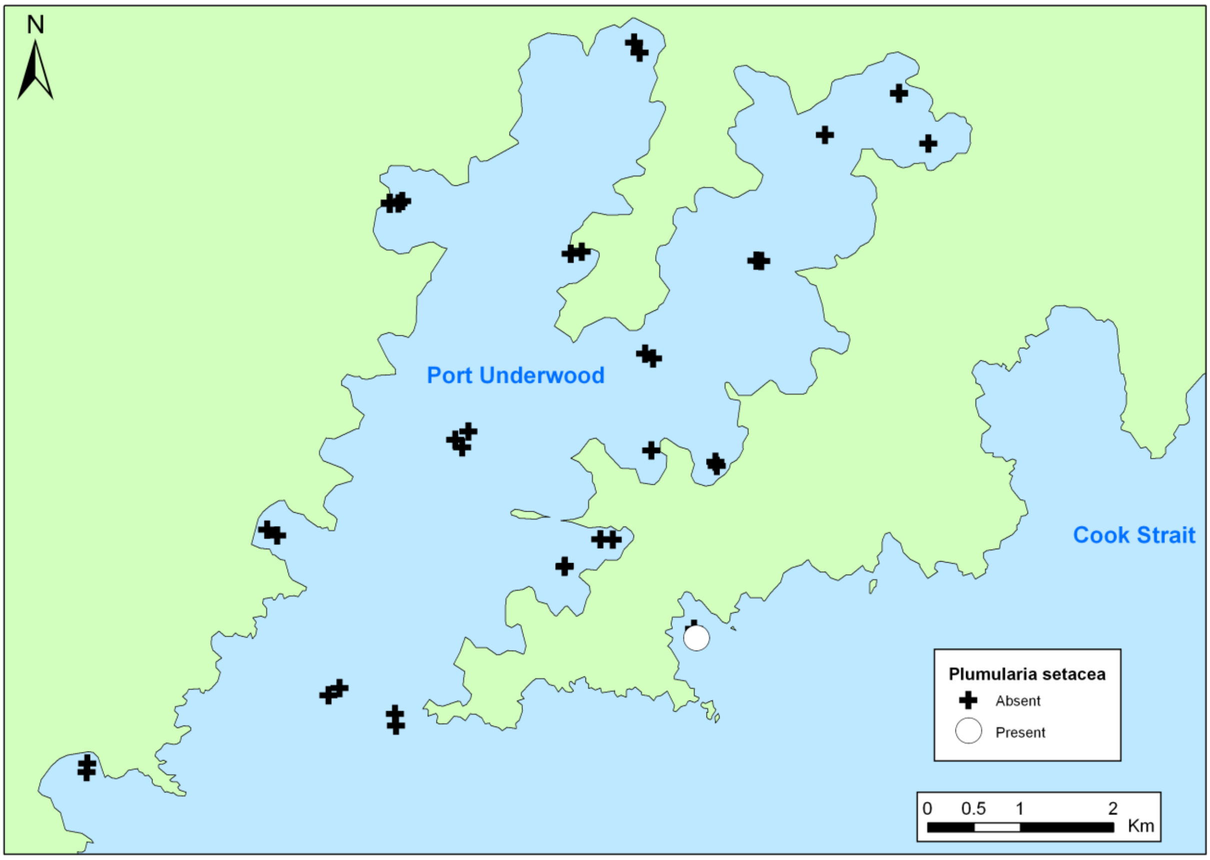


Figure 35: *Plumularia setacea* distribution in the Port Underwood port survey

***Heterosigma akashiwo* ((Hada) Hada ex Hara et Chihara 1987)**

Heterosigma akashiwo was recorded in one phytoplankton tow taken at The Knobbye (
Figure 36).

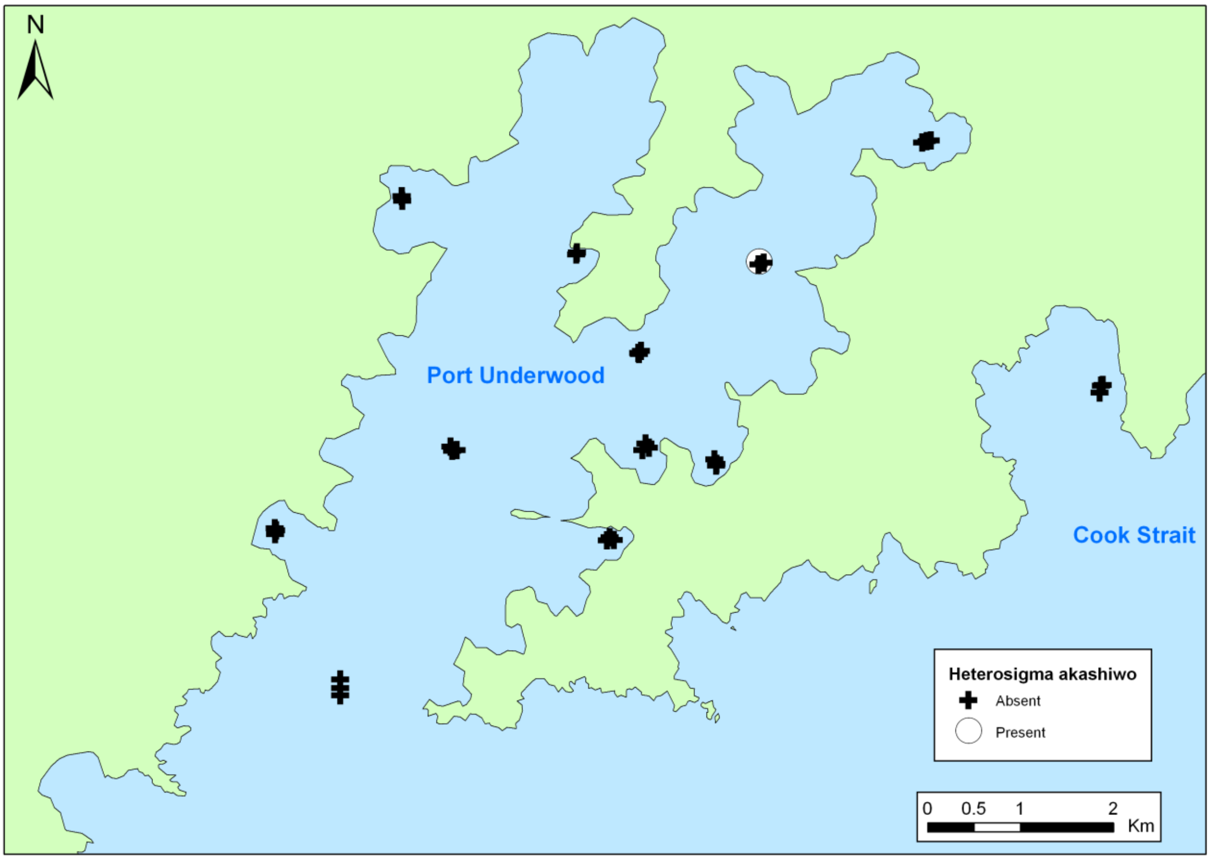


Figure 36: ***Heterosigma akashiwo* distribution in the Port Underwood port survey**

Cryptogenic category two taxa (C2)

During the survey of Port Underwood, 14 cryptogenic category two (C2) taxa were recorded (Table 15), representing 3.4 % of the total number of taxa identified. These included seven annelid worms and seven sponges. These taxa are recently discovered new species, or might be new species, for which there is insufficient information to determine whether New Zealand lies within their native range. None of the C2 taxa recorded in the Port Underwood port survey records represent new records in New Zealand.

Indeterminate taxa

During the Port Underwood survey, 82 organisms were classified as indeterminate taxa. This represents 20 % of all determinations made from this survey (Figure 22). Indeterminate taxa from the Port Underwood port survey included 14 annelids, 14 diatoms, 12 Rhodophyta, nine arthropods, seven bryozoans, six dinoflagellates, three Chlorophyta, three ascidians, three molluscs, three Ochrophyta, two cnidarians, one fish, one echinoderm, one flatworm and three organisms that were unable to be identified to phylum (Table 17).

Zooplankton

No target organisms (the Chinese mitten crab Eriocheir sinensis or other members of this genus, the European green crab Carcinus maenas, the northern Pacific seastar Asterias amurensis and the ascidian Styela clava) were identified from any of the zooplankton samples from Port Underwood. The zooplankton was dominated by copepods.

Notifiable and unwanted species

One of the species recorded from the Port Underwood port survey, the Asian seaweed, *Undaria pinnatifida*, is currently listed on the New Zealand Register of Unwanted Organisms (Table 4).

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

Cryptogenic category one taxa (C1*)*”, above). The brown alga *Undaria pinnatifida* is listed as established in Australia, but not widespread. The remaining three species, all diatoms, are listed as “Holoplankton alert species”, which means that their presence should be notified, but an eradication response within Australia is highly unlikely. The mollusc *Maoricolpus roseus* is also on this list, however it is considered native to New Zealand.

Three diatoms; *Pseudo-nitzschia australis, Chaetoceros concavicornis* and *Chaetoceros convolutes* are listed as ‘Holoplankton alert species’ in Australia, which means that their presence should be notified, but an eradication response within Australia is highly unlikely. These diatoms are all considered native in New Zealand, due to their cosmopolitan oceanic distributions but are listed here as unwanted due to the toxins they produce (see “Cyst- and toxin-producing species”, below).

Australia has also an expanded list of priority marine pests that includes 53 non-indigenous species that have already established in Australia and 37 potential pests that have not yet reached its shores (Hayes et al. 2005). A similar watch list for New Zealand is currently being prepared by MAF Biosecurity NZ. Six of the 53 Australian priority domestic pests were recorded during the Port Underwood port survey. These are listed in descending order of the impact potential ranking attributed to them by Hayes et al. (2005): *Bugula flabellata, Undaria pinnatifida, Watersipora subtorquata, Theora lubrica, Cryptosula pallasiana* and *Bougainvillia muscus.*

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

Species not previously recorded in New Zealand

No species recorded from the first port baseline survey of Port Underwood are new records from New Zealand waters.

Range extensions

Two species from the Port Underwood survey represent range extensions in New Zealand. These species are the ascidians *Eugyra novaezelandiae* (Native; Port underwood is a nothern extension of its range) and *Pyura spinosissima* (Native: previously known from Napier-Takuma Bay & Cape Kidnappers, Gisbornen, Wellington and Dunedin).

Cyst- and toxin-producing species

Cysts of 27 dinoflagellate taxa (Phylum Myzozoa) were collected during this survey, of which 21 are considered native species (Table 13) and six, indeterminate (Table 17). Three of the native species *Dinophysis acuminate, Dinophysis acuta* and *Dinophysis tripos* - are known to produce toxins, as described below.

Of the organisms identified from the phytoplankton samples (72 different dinoflagellate and diatom taxa; Table 13 and (Table 17), four were identified as toxin-producing species. These species, all considered native, include the diatom *Pseudo-nitzschia australis* (see “Notifiable and unwanted species”, above) and the dinoflagellates *Dinophysis acuminata, Dinophysis acuta* and *Dinophysis tripos* (Table 13). Other native diatom species recorded from the phytoplankton samples and mentioned in “Notifiable and unwanted species” above, *Chaetoceros convolutus* and *Chaetoceros concavicornis* are also worth noting. Although no direct toxic effects are known for these diatoms, they both have barbed setae that can become lodged in fish gills, causing death (Kraberg and Montagnes 2007).

Dinophysis acuta and *Dinophysis tripos* are associated with Diarrhetic Shellfish Poisoning (DSP) events, but no blooms have been reported for *Dinophysis tripos*, and it appears that not all *Dinophysis acuta* blooms are toxic (Faust and Gulledge 2002). *Pseudo-nitzschia australis* can produce a domoic acid, which causes Amnesic Shellfish Poisoning (ASP, New Zealand Food Safety Authority 2003). However, not all isolates of *P. australis* in New Zealand have been confirmed to produce domoic acid (Hay et al. 2000).

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

Depth stratification trends of NIS and C1 taxa

The greatest proportion of samples (45 %) was collected between -10 m and -15 m (Figure 37). This was also the depth class where the greatest proportion of NIS and C1 taxa (53.8 %) were collected, while the greatest proportion of native taxa was recorded in the <-5 to -10 m depth class. Lesser sampling effort in the intertidal (beach wrack surveys) and deeper depths (below -20 m depth) was reflected by fewer taxa being recorded from those depths.

Of the 13 NIS and C1 taxa for which depth was recorded, seven (53.8 %) were collected from the 0 to -5 m depth class. where only 13.6 % of samples were collected (Table 18). This disproportionate number reflects the shallow habitat preferences of most NIS and C1 taxa and the importance of sampling in the top 5 m of the water column for detection of NIS and C1 taxa. Of the seven NIS and C1 taxa collected between 0 and -5 m, four were not recorded from deeper samples. These were the cnidarian *Bougainvillia muscus*, the bryozoans *Cryptosula pallasiana* and *Watersipora subtorquata* and the brown alga *Undaria pinnatifida*. Of the six NIS and C1 taxa not recorded between 0 and -5 m, all were found in single samples at other depths except *Didemnum* sp. which was found in two samples in the intertidal, three samples in the <-5 to -10 m depth class, seven samples in the <-10 to -15m depth class and three samples in the <-15 to -20 m depth class.

Of the 301 native taxa for which depth was recorded, 150 (49.8 %) were recorded between -5 and -10 m depth (Table 19). Of these 150 taxa, 47 were only recorded from this depth range; while 10 were also recorded from the 0 to -5 m depth class and 41 were also recorded from deeper collections. Fewer taxa were recorded below -20 m with all other depths, excluding the intertidal zone. Six native taxa were only recorded from the intertidal zone, while 44 native taxa were only recorded in samples from the <0 to -5 m depth range, 26 native taxa were only recorded from <-10 to -15 m depth, 38 native taxa were only recorded from <-15 to -20 m depth, and two taxa were only recorded from below -20 m depth.

The 13 NIS and C1 taxa collected during the Port Underwood port survey were represented by 96 records. They occurred in samples collected by eight of the 14 different sampling methods (Table 18). Most of these records were collected in box anchor dredges (44 %), benthic sleds (34 %) and pile scrapings (10 %). The 11 records resulting from the other five methods were collected in samples from depths ranging from the intertidal (a beach wrack survey) to below -15 m depth (Table 18). In contract, of the 1528 native records collected from Port Underwood, 27 % were collected from anchor box dredges, 20 % from benthic sleds and only 6 % from pile scrapings, while most native taxa (37 %) were recorded from phytoplankton tows (Table 19). This emphasises the range of NIS and C1 taxa in Port Underwood able to take advantage of a variety of habitats, including benthic dwellers and fouling organisms, and therefore the importance of sampling a range of habitats and depths.

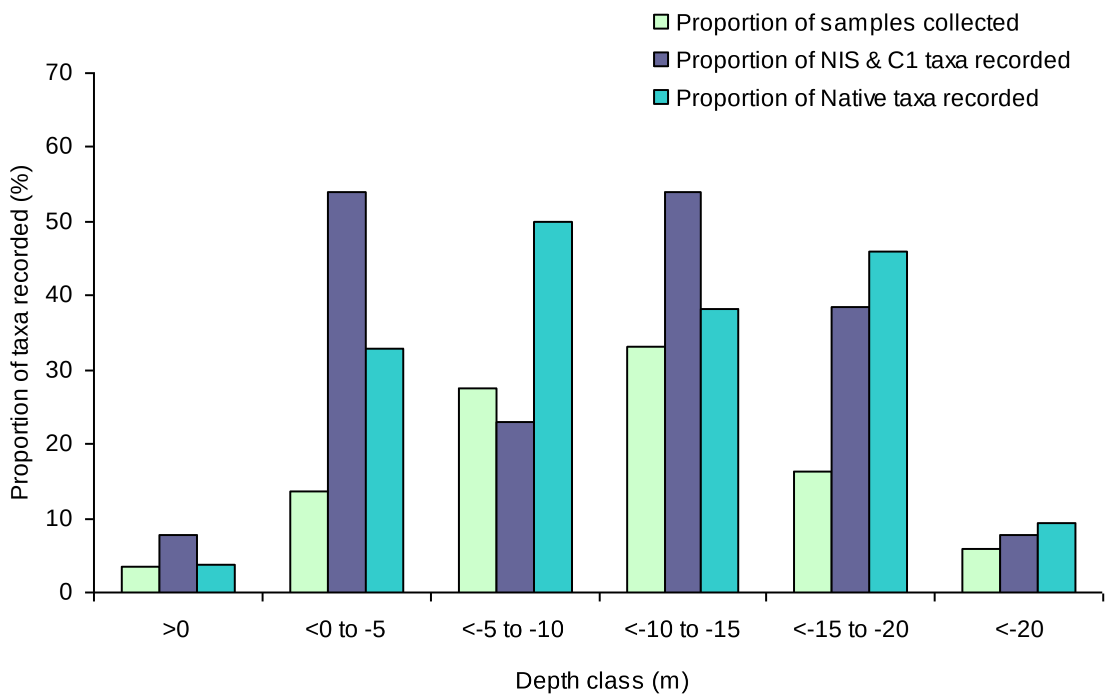


Figure 37: Proportion of taxa recorded from depth classes during the Port Underwood port survey. The proportion of taxa sums to a total of <100% across depth classes, as some taxa were recorded from more than one depth class.

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

The likely vectors of introduction of NIS and C1 taxa to New Zealand are largely derived from Hayes et al. (2005) and expert opinion. These are listed in Appendix 6. The possible vectors for the introduction of NIS and C1 taxa to New Zealand are indicated in Table 7 and Table 8 for taxa recorded during the desktop review of existing species records, and in Table 14 and Table 16 for taxa recorded during the Port Underwood port survey. Most of the NIS and C1 taxa recorded from Port Underwood during the port survey and review of existing species records are thought to have arrived in New Zealand via biofouling and international shipping.

Of the NIS recorded in either the literature or the survey, seven species (41 %) could have arrived via either biofouling on human generated debris, unintentional inclusion with fisheries products, packing or substrate or individual release (accidental or deliberate). Only one species (6 %), the mollusc *Theora lubrica* is thought to have arrived via only ballast water. The Chinook salmon *Oncorhynchus tshawytscha* arrived via deliberate translocation, while the caprellid *Caprella mutica* may have arrived via biofouling, ballast water or natural rafting on biogenic substrata. The ascidian *Ascidiella aspersa* is thought to have arrived via biolfouling or unintentional inclusion with fisheries products, packing or substrate. All of these NIS may have reached Port Underwood directly from overseas or through domestic spread (natural and/or anthropogenic) from other New Zealand ports.

Half of the 12 C1 taxa recorded in either the literature or the survey, are likely to have arrived via biofouling on ship hulls (Table 8), while four (the dinoflagellates *Gymnodinium catenatum, Alexandrium minutum* and *Alexandrium ostenfeldii,* and the brown alga *Heterosigma akashiwo*) may have arrived via either accidental translocation with deliberate transport of fish or shellfish, natural planktonic dispersal or in ballast water. Information on the means of introduction for the remaining two taxa (the ascidian Corella eumyota and the hydroid *Bougainvillia muscus*) is currently unavailable.

Spread within New Zealand of the NIS and C1 taxa recorded from Port Underwood is also often likely to be via fouling of ships' hulls (S1) or associated with translocations of fish or shellfish (F2, F3). Natural translocation, via planktonic dispersal (N1) or long-distance movement of adults as detached plants (N3) may also be responsible for the spread of several of these taxa. The spread of some of these taxa throughout New Zealand is probably also assisted by several other vectors (see Table 7, Table 8, Table 14 and Table 16).

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

Excluding indeterminate taxa, 328 taxa were recorded during the port baseline survey of Port Underwood, compared with only 60 in the desktop review of existing species records from the area. This highlights the paucity of biological information from this part of the New Zealand coast. Of the 60 taxa recorded in the desktop review (excluding indeterminate taxa), only eight were subsequently recorded during the port baseline survey of Port Underwood (six native (Table 6), one NIS (Table 7) and one C1 (Table 8)). Similarly, 320 of the 328 taxa (98 %) that were identified in the port survey (excluding indeterminate taxa) were not recorded in the desktop review. The port baseline survey has therefore made a valuable contribution to the knowledge of the flora and fauna of the Port Underwood area, apparently adding more than 320 taxa to those already known from the area.

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

Ten of the 11 NIS recorded during our desktop review were not recorded during the Port Underwood survey. One of these species, the Chinook salmon *Oncorhynchus tshawytscha*, would not be expected to be recorded by port survey methods due to their anadromous, semelparous nature (see species information sheet in Appendix 6). The absence of the remaining six NIS from the Port Underwood survey records could indicate that these taxa have gone locally extinct in the area since their discovery, or they may be present in densities low enough that they were not encountered during the port survey. More detailed delimitation surveys for these species would be needed to assess these possibilities. Conversely, six of the seven NIS recorded during the port survey were not recorded during the desktop review. Most of these taxa are small organisms that may have been overlooked in previous surveys or may have been missed in our desktop review.

Assessment of the risk of new introductions to Port Underwood

Many non-indigenous species and C1 taxa 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).

There is no international shipping traffic to Port Underwood (see "Introduction: Port operation, development and maintenance activities", above). The risk of new introductions from overseas to Port Underwood is therefore very low; many of the NIS and C1 taxa previously recorded from Port Underwood were probably introduced through historical whaling and sealing operations (see "

Survey Results: Review of marine species records from Port Underwood", above). Nonetheless, the consequences of a marine invasion in such a relatively valued marine environment could be severe. Therefore, rules for cruise ships and voluntary guidelines for other vessels have been introduced to try to reduce the likelihood of new introductions to Port Underwood (see "Introduction: Port operation, development and maintenance activities", above). These rules include the prohibition of ballasting and deballasting inside the area, and restrictions on hull cleaning procedures.

Most vessel movements in Port Underwood consist of pleasure craft, private and commercial fishing boats, and vessels servicing the mussel farms, however, there are no major port facilities in Port Underwood. The introduction of fouling organisms is more likely to occur via slow-moving vessels, such as barges and fishing boats. Therefore, these vessels, if travelling from areas outside the Marlbourogh Sounds area present the greatest risk of introducing new non-indigenous species to Port Underwood.

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

Although many of the NIS and C1 taxa recorded in Port Underwood have been recorded in other locations throughout New Zealand (see species information sheets, Appendix 6), they were not detected in all of the other New Zealand ports that have so far been surveyed (Inglis et al. 2007). There is, therefore, a risk that species established in Port Underwood could be spread to other New Zealand locations. However, due to its remote and exposed location, there is very little shipping traffic between Port Underwood and other parts of New Zealand.

Because many of the NIS and C1 taxa in Port Underwood are fouling organisms, the risk of translocating them is highest for slow-moving vessels, such as yachts and barges, and vessels that have long residence times in port. Commercial fishing vessels and some private vessels do spend longer periods in Port Underwood. During this time they could potentially become fouled with NIS and C1 taxa and may subsequently translocate them to other parts of New Zealand.

However, the densities of the NIS and C1 taxa in Port Underwood appear to be very low. Only seven of the 17 NIS previously recorded from Port Underwood were recorded during the port survey, despite sampling suitable habitats. The seven NIS were recorded from a total of only 72 of the 2097 samples identified during the Port Underwood survey. Of the seven NIS recorded, only two were found in more than four samples (*Theora lubrica*, found in 52 samples, and *Watersipora subtorquata*, found in 10 samples). Two NIS occurred in just a single sample during the survey. These were the bryozoans *Bugula flabellata* (found in a benthic sled in Pipi Bay Anchorage 1) and *Cryptosula pallasiana* (found in a pile scrape in Oyster Bay). Despite the low number of samples, both of these sites are relatively sheltered areas which are unlikely to have high wave action suggesting that larvae and cysts would be likely to accumulate. Furthermore, neither of these species were recorded in the literature of the area but have been recorded in New Zealand for at least 60 years, indicating that either this is a new incursion into Port Underwood from elsewhere in New Zealand, or that the environment in Port Underwood is not suitable for the prolification of these species and population density in the area is low.

Of the seven C1 taxa recorded in the literature, only one was found in the survey (the brown alga *Heterosigma akashiwo*). The six C1 taxa that were recorded during the survey, were found in a total of only 24 of the 2097 samples identified during the Port Underwood survey. Four C1 taxa occurred in just a single sample during the survey. These were the hydroids *Bougainvillia muscus* (found in a benthic sled in Robin Hood Bay) and *Plumularia setacea* (found in a benthic sled at Karake Point), the ascidian *Corella eumyota* (found in a benthic sled in Pipi Bay) and the Ochrophyta *Heterosigma akashiwo* (found in a cyst sample in The Knobbys). These areas are relatively exposed areas which are likely to have high wave action where larvae and cysts are unlikely to accumulate, and thus keep population densities low.

The five taxa listed on the CCIMPE Trigger List (CCIMPE 2006) that have previously been recorded in Port Underwood – *Didemnum* sp., *Undaria pinnatifida*, *Pseudo-nitzschia seriata*, *Chaetoceros concavicornis* and *Chaetoceros convolutus*, might also be considered particularly undesirable to translocate to other parts of New Zealand. The latter three species, all diatoms, are most likely to be transported by ballast water. The tight guidelines for no ballast water to be exchanged within New Zealand coastal waters (see “Introduction: Shipping movements and ballast discharge patterns”, above) is likely to reduce the chance of translocation of these species. The ascidian, *Didemnum* sp., and the alga *Undaria pinnatifida* are likely to be transported on vessel hulls. Due to the presence of such fouling organisms in Port Underwood, it may be prudent for vessels not only to be cleaned and inspected prior to arrival, but also before departing, to reduce the risk of translocation out of Port Underwood.

Although the NIS and C1 taxa recorded from both the survey and literature of Port Underwood appear to have relatievely widespread distributions throughout New Zealand (see species information sheets, Appendix 6), there is still a risk that these species could be spread from Port Underwood to other locations where they are not yet present. *Undaria pinnatifida* is present in Port Underwood and causes problems to the mussel farming industry by fouling mussel lines. If vessels facilitating the Port Underwood mussel farms are moved to other areas of aquaculture importance such as Northland, where *U. pinnatifida* has not been recorded, there is a risk of translocating the alga via biofouling to these new areas where it may cause severe problems to local aquaculture.

Management of existing NIS and C1 taxa in the port

Port Underwood is of high ecological value and is an important mussel aquaculture area (Vaughan 2008). The prevention or reduction of impacts from non-indigenous species is therefore a high priority. Biosecurity management in Marlborough is addressed in the strategic *Top of the South Island Marine Biosecurity Strategic Plan*, which was released in 2008 (Vaughan 2008). The *Top of the South Island Marine Biosecurity Strategic Plan* ("the Plan") has been initiated and developed by the members of the Top of the South Marine Biosecurity Partnership coordinated by MAFBNZ. It includes representation from Tasman District Council, Nelson City Council, Marlborough District Council, Ministry of Fisheries, Department of Conservation, the aquaculture industry, port companies, tangata whenua and other stakeholders (Vaughan 2008). The purpose of the plan is to prevent the introduction and minimise the spread of damaging marine species throughout the top of the South Island from Kahurangi Point on the west coast to Willawa Point on the east coast (Vaughan 2008).The plan provides a framework to develop interagency operational activites in relation to marine biosecurity and outlines 'priority actions' to reduce the risk of invasive organisms affecting the Tasman and Marlborough marine environment. Priority actions identified in the plan include vector management plans for recreational vessels (on moorings and in marinas), barges, marine farms, fishing vessels and merchant vessels (including oil rigs), surveillance of vectors, and control of damaging organisms. These actions are listed in the plan and include those where the regional partnership is committed to:

- Develop a risk management framework to target high risk marine biosecurity pathways, vectors and species. This would include:
    1. Identifying priority sites for protection within the region, and site-specific vectors and pathways.
    2. Developing a tool to quickly assess risks and manage events, including further developing and piloting systems to "manage" NZ internal traffic.
    3. Developing a process to enable rapid decisions on marine biosecurity actions where these are required.
- Assess and prioritise risks and actions for the region.
- Develop joint operational plans for:
    1. Vector management plans for recreational vessels (on moorings and in marinas), barges, marine farms, fishing vessels and merchant vessels (including oil rigs).
    2. Surveillance of vectors (organisms and vessels).
    3. Control of damaging organisms.
- Develop joint communications and information management plan.
- Assess regulatory options.
- Plan and undertake research (Vaughan 2008).

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

Prevention of new introductions

Although Port Underwood is relatively well protected from new marine introductions, through its remote location and low levels of shipping traffic, procedures to prevent new introductions should be encouraged.

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

Options are currently lacking for effective in-situ treatment of biofouling and sea-chests. MAF Biosecurity New Zealand has recently embarked on a national survey of hull fouling on vessels entering New Zealand from overseas. The study will characterise risks from this pathway (including high risk source regions and vessel types) and identify predictors of risk that may be used to manage problem vessels. Shipping companies and vessel owners can reduce the risk of transporting NIS and C1 taxa in biofouling or sea chests through regular maintenance and antifouling of their vessels. Slow moving barges or vessels that are laid up in ports for long periods before travelling to Port Underwood can carry large densities of non-indigenous marine organisms with them. Cleaning and maintenance of these vessels is suggested to 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 and C1 taxa from regions that have not traditionally had major shipping links with the country or port (Carlton 1987; Hayden et al. in review). The growing number of port baseline surveys internationally and an associated increase in published literature on marine NIS and C1 taxa means that information is becoming available that will allow more robust risk assessments to be carried out for new shipping or cruising routes. We recommend that port companies consider undertaking such assessments for their ports when new import or export markets are forecast to develop, or when new cruise itineraries are suggested. The assessment would allow potential problem species to be identified and appropriate management and monitoring requirements to be put in place.

Conclusions and recommendations for monitoring and resurveying

The national biological baseline surveys have significantly increased our understanding of the identity, prevalence and distribution of introduced and native species in New Zealand's shipping ports. 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 or cruising partners to be notified of species that may be potentially harmful.

The baseline survey of Port Underwood recorded 411 species or higher taxa. Excluding the 82 indeterminate records and the one collective zooplankton taxon, 320 (78 %) of these did not occur in our desktop review of existing marine species records from Port Underwood, and may be new records for the area. The initial port baseline survey has highlighted the diversity of the Port Underwood marine assemblage, with results indicating that it has few NIS and C1 taxa, and even fewer that are likely to be of significant impact to the native environment.

Despite the large number of species detected, the large area of habitat available for marine organisms and the logistic difficulties of sampling in environments like Port Underwood means that detection probabilities are likely to be comparatively low for species with low prevalence, even when species-specific survey methods are used (Inglis 2003; Inglis et al. 2003; Hayes et al. 2005; Gust et al. 2006; Inglis et al. 2006b). In generalised pest surveys, such as the port baseline surveys, this problem is compounded by the high cost of identifying all specimens (native and non-indigenous), which constrains the total number of samples that can be taken (Inglis 2003). A consequence is that a high proportion of comparatively rare species will remain undetected by any single survey. This problem is not limited to non-indigenous species; 40 % of native species recorded in the Port Underwood port survey occurred in just a single sample. Nor is it unique to marine assemblages. These results reflect the spatial and temporal variability that are features of marine biological assemblages (Morrisey et al. 1992a, 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. 2004a). Hewitt and Martin (2001) recommend repeating the baseline surveys on a regular basis to ensure they remain current. It may also be prudent to repeat at least components of a survey over a shorter time frame to achieve better estimates of occupancy without the confounding effects of temporal variation and new incursions.

The baseline survey provides a starting point for further investigations of the distribution, abundance and ecology of the species described within Port Underwood and for monitoring the rate of new incursions by NIS and C1 taxa over time. Non-indigenous marine species can have a range of adverse impacts through interactions with native organisms. These include competition with native species, predator-prey interactions, hybridisation, parasitism or toxicity and modification of the physical environment (Ruiz et al. 1999; Ricciardi 2001). Assessing the impact of NIS and C1 taxa discovered in a given location ideally requires information on a range of factors, including the mechanism of their impact and their local abundance and distribution (Parker et al. 1999). To predict or quantify their impacts over larger areas or longer time scales requires additional information on the species' seasonality, population size and mechanisms of dispersal (Mack et al. 2000).

Acknowledgements

We thank the Port Underwood authorities for access to their facilities and assistance during the survey and Alex van Wijngaarden (Port Underwood Harbour Master) for local information. We also thank the field team and taxonomists listed in the project team above.

Glossary

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

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

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

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

References

Adams, N.M. (1991). The New Zealand species of *Polysiphonia* Greville (Rhodophyta). *New Zealand Journal of Botany 29*: 411-427.
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.
Ayers, K., Rhodes, L., Tyrrell, J., Gladstone, M. (2005). International accreditation of sandwich hybridisation assay format DNA probes for micro-algae. *New Zealand Journal of Marine and Freshwater Research 39*: 1225-1231.
Barnard, J. (1972). Gammaridean Amphipoda of Australia, Part I. *Smithson. Contrib. Zool. 103*: i-vi 1-333.
Barnes, E.J. (1985). Eastern Cook Strait region circulation inferred from satellite-derived, sea surface temperature data. *New Zealand Journal of Marine and Freshwater Research 19*: 405-411.
Biosecurity Council. (2003). Tiakina Aotearoa: Protect New Zealand. The Biosecurity Strategy for New Zealand. Available online at: <www.maf.govt.nz/biosecurity-strategy>. Accessed 04/06/2009. Biosecurity Council, Wellington. 67 p.
Biosecurity New Zealand (2005). Import health standards for ships' ballast water from all countries. Issued pursuant to Section 22 of the Biosecurity Act 1993. Dated 13 June 2005. Available online <http://www.biosecurity.govt.nz/imports/non-organic/standards/ballastwater.htm> Accessed 04/06/2009.
Bouillon, J. (1995). Hydromedusae of the New Zealand Oceanographic Institute (Hydrozoa, Cnidaria). *New Zealand Journal of Zoology 22*: 223-238.
Bowman, M.J., Kibblewhite, A.C., Muctagh, R., Chiswell, S.M., Sanderson, B.G. (1983). Circulation and mixing in greater Cook Strait, New Zealand. *Oceanologica Acta 6(4)*: 383-391.
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.
Cawthron Institute (2007). Cawthron Institute culture collection of micro-algae (CICCM) Catalogue of strains: June 2007 Website edition. Accessible online at <http://www.cawthron.org.nz/seafood-safety-biotechnology/downloads/cat-web-july-2007.pdf>. Accessed 10/07/2007. Nelson, Cawthron Institute.
CCIMPE (2006). Consultative Committee on Introduced Marine Pest Emergencies (CCIMPE) Trigger List. Final agreed list 2006. CCIMPE, Canberra. .
Chang, F.H., Garthwaite, I., Anderson, D.M., Towers, N.; Stewart, R.; MacKenzie, L. (1999). Immunofluorescent detection of a PSP-producing dinoflagellate, *Alexandrium*

minutum, from Bay of Plenty, New Zealand. *New Zealand Journal of Marine and Freshwater Research 33*: 533-543.

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.

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

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.

Coutts, A. (2002). A biosecurity investigation of a barge in the Marlborough Sounds. Prepared for Heli Harvest Limited. Nelson, Cawthron Institute, Report No. 744.

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.

Davison, W., van Berkel, J.G. (1987). An annotated checklist of echinoderms collected from the Kaikoura region and kept in the reference collections of the Edward Percival Field Station Kaikoura. *Mauri ora 14*: 87-93.

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.

Faust, M.A., Gulledge, R.A. (2002). Identifying harmful marine dinoflagellates. *Smithsonian Contributions from the United States National Herbarium 42*: 1-144. Available online at <http://www.nmnh.si.edu/botany/projects/dinoflag/index.htm> Accessed 04/06/2009.

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.

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.

Guardians of Fiordlands's Fisheries & Marine Environment Inc. (2003). Fiordland marine conservation strategy. Available online at <http://www.mfe.govt.nz/publications/biodiversity/fiordland-marine-strategy/index.html>. Accessed 04/06/2009. Guardians of Fiordlands's Fisheries & Marine Environment Inc.

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.

Hay, B., Grant, C., McCoubrey, D. (2000). A review of the marine biotoxin monitoring programme for non-commercially harvested shellfish. Part 1: Technical Report. A report prepared for the NZ Ministry of Health by AquaBio Consultants Ltd. NZ Ministry of Health.

Hayden, B.J., Inglis, G.J., Schiel, D.R. (in review). 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. (2005). National priority pests. Part II, Ranking of Australian marine pests. Report undertaken for the Department of Environment and Heritage by CSIRO Marine Research. Commonwealth of Australia.

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, J., Funnell, G. (2005). Benthic marine habitats and communities of the Southern Kaipara, Auckland Regional Council Technical Publication 275. 23 pp.

Hine, P., Jones, J. (1994). Bonamia and other aquatic parasites of importance to New Zealand. *New Zealand Journal of Zoology 2(1)*: 49-56.

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., 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., Woods, C., Kospartov, M., Hayden, B.J., Fenwick, G.D. (2006a). 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., Hurren, H., Oldman, J., Haskew, R. (2006b). Using habitat suitability index and particle dispersion models for early detection of marine invaders. *Ecological Applications 16*: 1377-1390.

Kitching, J., Lockwood, J. (1974). Observations on shell form and its ecological significance in thaisid gastropods of the genus *Lepsiella* in New Zealand. *Marine Biology 28*: 131-144.

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.

Kraberg, A., Montagnes, D. (2007). The Harmful Phytoplankton Project: The user-friendly guide to harmful phytoplankton in EU waters. Website <http://www.liv.ac.uk/hab/>. Last updated 12/07/2007; Accessed 18/11/2007.

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.

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, A.L., White, D., Oshima, Y., Kapa, J. (1996). The resting cyst and toxicity of *Alexandrium ostenfeldii* (Dinophyceae) in New Zealand. *Phycologia 35(2)*: 148-155.

MacKenzie, D.I., Royle, J.A., Brown, J.A., Nichols, J.D. (2004a). 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.

MacKenzie, L., de Salas, M., Adamson, J., Beuzenberg, V. (2004b). The dinoflagellate genus *Alexandrium* (Halim) in New Zealand coastal waters: comparative morphology, toxicity and molecular genetics. *Harmful Algae 3*: 71-92.

Marlborough Regional Council (2007). Regional Pest Management Strategy for Marlborough. *No.* p.

McNab, R. (1913). Old Whaling Days. Christchurch.

Ministry for the Environment (2004). Implementing the Fiordland Marine Conservaton Strategy: Report of the Fiordland Marine Conservation Strategy Investigative Group. Available online <http://www.mfe.govt.nz/> Accessed 18/11/07. Wellington, Ministry for the Environment.

Moestrup, Ø. (ed.) (2004). IOC Taxonomic Reference List of Toxic Algae. Intergovernmental Oceanographic Commission of UNESCO. Available online at <ioc.unesco.org/hab/data.htm> Accessed 18/11/2007.

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.

Morton, H.A. (1982). The Whale's Wake. University of Otago Press, Dunedin. p.

Nelson, W., Maggs, C. (1996). Records of adventive marine algae in New Zealand: *Antithamnionella ternifolia, Polysiphonia senticulosa* (Ceramiales, Rhodophyta) and *Striaria attenuata* (Dictyosiphonales, Phaeophyta). *New Zealand Journal of Marine and Freshwater Research 30*: 449-453.

Nelson, W.A. (1999). A revised checklist of marine algae naturalised in New Zealand. *New Zealand Journal of Botany 37*: 355-359.

Nelson, W.A., Duffy, C.A.J. (1991). *Chnoospora minima* (Phaeophyta) in Port Underwood, Marlborough - a curious new algal record for New Zealand. *New Zealand Journal of Botany 29*: 341-344.

Nelson, W.A., Knight, G.A. (1995). *Asperococcus bullosus* - a new record for northern New Zealand of an adventive marine brown alga. *Tane 35*: 121-125.

New Zealand Food Safety Authority (2003). Non-Commercial Marine Biotoxin Monitoring in New Zealand Risk-Based Programme Enhancement - Final Report May 2003.

NIWA (2008). South Western Pacific Regional OBIS node. Website <http://obis.niwa.co.nz/index.do> Accessed 18/07/2006.

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

Ottaway, J.R. (1975). Review of *Actinia, Isactinia,* and *Cnidopus* (Cnidaria: Anthozoa) in New Zealand. *New Zealand Journal of Marine and Freshwater Research 9(1)*: 53-61.

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.

Paulin, C., Habib, G., Carey, C., Swanson, P., Voss, G. (1982). New records of Mobula japanica and Masturus lanceolatus, and further records of Luvaris imperialis (Pisces: Mobulidae, Molidae, Louvaridae) from New Zealand. *New Zealand Journal of Marine and Freshwater Research 16*: 11-17.

Prickett, N. (2002). The Archaeology of New Zealand Shore Whaling. Wellington. p.

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

Rhodes, L., Peake, B.M., Mackenzie, A.L., Marwick, S. (1995). Coccolithophores Gephyrocapsa oceanica and Emiliania huxleyi (Prymnesiophyceae = Haptophyceae) in New Zealand's coastal waters: characteristics of blooms and growth in laboratory culture. . *New Zealand Journal of Marine and Freshwater Research 29*: 345-357.

Rhodes, L., Thomas, A. (1997). *Coolia monotis* (Dinophyceae): a toxic epiphytic microalgal species found in New Zealand (Note). *New Zealand Journal of Marine and Freshwater Research 31*: 139-141.

Rhodes, L., White, D., Syhre, M., Atkinson, M. (1996). *Pseudo-nitzschia* species isolated from New Zealand coastal waters: domoic acid production *in vitro* and links with shellfish toxicity. *In*: Yasumoto, T.; Oshima, Y.; Fukuyo, Y. (eds). Harmful and toxic algal blooms. Proceedings of the seventh international conference on toxic phytoplankton. Sendai, Japan, 12-16 July 1995, pp. 155-158. Intergovernmental Oceanographic Commission of UNESCO, Paris.

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.

Ruiz, G.M., Hewitt, C.L. (2002). Toward understanding patterns of coastal marine invasions: a prospectus. *In*: Leppäkoski, E.; Gollasch, S.; Olenin, S. (eds). Invasive aquatic species of Europe: distribution, impacts and management, pp. 529-547. Kluwer, Dordrecht.

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.

Transpower (2006). Cook Strait Submarine Cable Protection Zone. *No.* 16 p.

Trusewich, B., Sim, B.; Busby, P.; Hughes, C. (1996). *Management of marine biotoxins in New Zealand*. *In*: Yasumoto, T.; Oshima, Y.; Fukuyo, Y. (eds). Harmful and toxic algal blooms. Proceedings of the seventh international conference on toxic phytoplankton. Sendai, Japan, 12-16 July 1995, pp. 27-30. Intergovernmental Oceanographic Commission of UNESCO, Paris.

Turner, R., McKoy, J.L. (1979). *Bankia neztalia* n.sp. (Mollusca: Bivalvia: Teredinidae) from Australia and New Zealand, and its relationships. *Journal of the Royal Society of New Zealand 9(4)*: 465-473.

Vaughan, L. (2008). Top of the South Marine Biosecurity Strategic Plan - EP08/12/07 - Report Prepared for Meeting of 16 December 2008. *No.* p.

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

Wards, B.J., Patel, H., Anderson, C.D., de Lisle, G.W. (1991). Characterisation by restriction endonuclease analysis and plasmid profiling of Vibrio ordalii strains from salmon (*Oncorhynchus tshawytscha* and *Oncorhynchus nerka*) with vibriosis in New Zealand. *New Zealand Journal of Marine and Freshwater Research 25*: 345-350.

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.

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.

Woods, C., Fenwick, G.D., Willis, K. (2008). Alien amphipod: hitchhiker of the sea. . *Water and Atmosphere 16(3)*: 24-25.

Tables

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

Site #	Site name	Quadrat scraping	Photo stills and video	Large hand corer	Anchor box dredge	Sediment samples	Cyst samples	Zoo-plankton net	Phyto-plankton net	Qualitative diver visual surveys	Benthic sled	Crab trap	Shrimp trap	Poison stations	Beach seine net	Beach wrack walk	Total (excl. photo & video)
22	Rununder Point							3	3								**6**
23	Fighting Bay 1			6		2	6	3	3	1							**21**
24	Fighting Bay 2									1				1	3	2	**7**
25	The Knobbye				3	2	3	3	3	1	2						**17**
26	Robertson Pt										2						**2**
27	Karake Pt										2						**2**
28	Pipi Bay Anchorage 1				3	2	3				2	6	6			3	**25**
29	Pipi Bay Anchorage 2							3	3		2						**8**
30	Kaikoura Bay				3	2	3	3	3		2					2	**18**
31	Whataroa Bay				3	2	3	3	3		2				3	2	**21**
32	Hakana Bay Anchorage 1				3	2	3	3	3		2				3	3	**22**
33	Hakana Bay Anchorage 2				3	2	3				2						**10**
34	Kingfish Bay				3	2	3	3	3		2					1	**17**
35	Opihi Bay				3	2	3				2						**10**
36	Oyster Bay	12	50		3	2	3	3	3		2				3	2	**36**
37	Ocean Bay				3	2	3	3	3		2						**16**
38	Robin Hood Bay				3	2	3				2						**10**
39	Port Underwood Inner HbrApp1				3	2	3	3	3		2						**16**
40	Port Underwood Inner HbrApp2				3	2	3	3	3		2						**16**
41	Port Underwood Inner HbrApp3				3	2	3	3	3		2						**16**
Total		**12**	**50**	**6**	**42**	**30**	**48**	**39**	**39**	**3**	**34**	**6**	**6**	**1**	**12**	**15**	**296**

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

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

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

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

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

Table 4: Marine pest species listed on the New Zealand register of Unwanted Organisms under the Biosecurity Act 1993.

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

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

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

***** Species on Interim CCIMPE Trigger List

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

Phylum, Class	Order	Family	Taxon name	Name as given in literature record[1]	Reference	Nearby Records	Recorded in port survey?
Bacillariophyta							
Bacillariophyceae	Bacillariales	Bacillariaceae	*Pseudo-nitzschia australis*		(Cawthron Institute 2007)	Whangakoko Hbr, Marlborough Sounds	Yes
Bacillariophyceae	Bacillariales	Bacillariaceae	*Pseudo-nitzschia pungens*	*Pseudo-nitzschia pungens f. pungens*	(Rhodes et al. 1996)	Marlborough Sounds: Anakoha Bay, Hallam Cove, Richmond Bay and South East Bay	
Bryozoa							
Gymnolaemata	Cheilostomata	Aeteidae	*Aetea australis*		(NIWA 2008)	Tory Channel, Station C869	
Gymnolaemata	Cheilostomata	Electridae	*Electra lesueuri*	*Electra pilosa*	(Gordon and Mawatari 1992)		
Chordata							
Actinopterygii	Gadiformes	Moridae	*Pseudophycis bachus*		(NIWA 2008)		
Actinopterygii	Ophidiiformes	Ophidiidae	*Genypterus blacodes*		(NIWA 2008)		
Actinopterygii	Perciformes	Arripidae	*Arripis trutta*		(NIWA 2008)		
Actinopterygii	Perciformes	Carangidae	*Trachurus declivis*		(NIWA 2008)		
Actinopterygii	Perciformes	Carangidae	*Trachurus novaezelandiae*		(NIWA 2008)		
Actinopterygii	Perciformes	Centrolophidae	*Seriolella brama*		(NIWA 2008)		
Actinopterygii	Perciformes	Centrolophidae	*Seriolella punctata*		(NIWA 2008)		
Actinopterygii	Perciformes	Cheilodactylidae	*Nemadactylus macropterus*		(NIWA 2008)		
Actinopterygii	Perciformes	Gempylidae	*Thyrsites atun*		(NIWA 2008)		
Actinopterygii	Perciformes	Latridae	*Latridopsis ciliaris*		(NIWA 2008)		
Actinopterygii	Perciformes	Luvaridae	*Luvaris imperialis*		(Paulin et al. 1982)		
Actinopterygii	Perciformes	Scombridae	*Scomber australasicus*		(NIWA 2008)		
Actinopterygii	Perciformes	Sparidae	*Pagrus auratus*		(NIWA 2008)		
Actinopterygii	Perciformes	Uranoscopidae	*Kathetostoma giganteum*		(NIWA 2008)		
Actinopterygii	Pleuronectiformes	Pleuronectidae	*Pelotretis flavilatus*		(NIWA 2008)		
Actinopterygii	Pleuronectiformes	Pleuronectidae	*Peltorhamphus latus*		(NIWA 2008)		
Actinopterygii	Pleuronectiformes	Pleuronectidae	*Peltorhamphus novaezeelandiae*		(NIWA 2008)		

Phylum, Class	Order	Family	Taxon name	Name as given in literature record[1]	Reference	Nearby Records	Recorded in port survey?
Actinopterygii	Pleuronectiformes	Pleuronectidae	*Rhombosolea leporina*		(NIWA 2008)		Yes
Actinopterygii	Pleuronectiformes	Pleuronectidae	*Rhombosolea plebeia*		(NIWA 2008)		
Actinopterygii	Scorpaeniformes	Triglidae	*Chelidonichthys kumu*		(NIWA 2008)		
Actinopterygii	Tetraodontiformes	Diodontidae	*Allomycterus jaculiferus*		(NIWA 2008)		
Actinopterygii	Tetraodontiformes	Molidae	*Masturus lanceolatus*		(Paulin et al. 1982)		
Elasmobranchii	Carcharhiniformes	Triakidae	*Galeorhinus galeus*		(NIWA 2008)		
Elasmobranchii	Carcharhiniformes	Triakidae	*Mustelus lenticulatus*		(Hewitt and Funnell 2005)		
Elasmobranchii	Rajiformes	Myliobatidae	*Mobula japanica*		(Paulin et al. 1982)		
Elasmobranchii	Squaliformes	Squalidae	*Squalus acanthias*		(NIWA 2008)		
Holocephali	Chimaeriformes	Callorhinchidae	*Callorhinchus milii*		(NIWA 2008)		
Cnidaria							
Anthozoa	Actiniaria	Actiniidae	*Actinia tenebrosa*		(Ottaway 1975)		
Echinodermata							
Asteroidea	Valvatida	Goniasteridae	*Pentagonaster pulchellus*		(Davison and van Berkel 1987)	off Wairau Bar (Blenheim)	
Haptophyta							
Prymnesiophyceae	Prymnesiales	Noelaerhabdaceae	*Emiliania huxleyi*		(Rhodes et al. 1995)		
Mollusca							
Bivalvia	Myoida	Teredinidae	*Bankia neztalia*		(Turner and McKoy 1979)	Pelorus Sound, Picton	
Bivalvia	Ostreoida	Ostreidae	*Ostrea chilensis*	Tiostrea	(Hine and Jones 1994)		
Gastropoda	Caenogastropoda	Muricidae	*Lepsiella scobina*	*Lepsiella albomarginata*	(Kitching and Lockwood 1974)		
Myzozoa							
Dinophyceae	Dinophysiales	Dinophysiaceae	*Dinophysis acuminata*		(Trusewich et al. 1996) and Hoe Chang pers. comm.		Yes
Dinophyceae	Dinophysiales	Dinophysiaceae	*Dinophysis acuta*		Hoe Chang, pers. comm. and (MacKenzie et al. 2004b)	Queen Charlotte Sound in Marlborough Sounds	Yes
Dinophyceae	Noctilucales	Noctilucaceae	*Noctiluca scintillans*		Chang (unpublished data)		Yes
Dinophyceae	Peridiniales	Ceratiaceae	*Ceratium fusus*		(Rhodes et al. 1996)		Yes
Platyhelminthes							
Trematoda	Strigeata	Bucephalidae	*Bucephalus longicornutus*		(Hine and Jones 1994)		

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

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

Phylum, Class	Order	Family	Taxon name	Name as given in literature record[1]	Reference	Nearby Records	Date of introduction, or detection (d)	Probable means of introduction to NZ	Probable means of spread within NZ	Recorded in port survey?
Arthropoda										
Malacostraca	Amphipoda	Caprellidae	*Caprella mutica*		G. Fenwick, pers. comm.	Waihinau Bay in Pelorus Sound	N2, S1, S3	February 2002	F2, F3, N2, S1	
Malacostraca	Amphipoda	Corophiidae	*Apocorophium acutum*	*Corophium acutum*	(Barnard 1972)	Keneperu Sound	S1	Pre-1921	F2, NB, S1	
Chordata										
Actinopterygii	Salmoniformes	Salmonidae	*Oncorhynchus tshawytscha*		(Wards et al. 1991)		F1	early 1900's	F1, N3, SR1, SR2	
Cnidaria										
Hydrozoa	Hydroida	Eudendriidae	*Eudendrium generale*		(Inglis et al. 2006a)	Long Arm No 1, Picton Port	S1	2003	F3, S1	
Ochrophyta										
Phaeophyceae	Cutleriales	Cutleriaceae	*Cutleria multifida*		(Nelson 1999)	Mikhail Lermontov wreck at Port Gore, Marlborough Sounds; Picton;	D, F3, IR1, IR2	Pre-1870	D, F3, IR1, IR2	
Phaeophyceae	Ectocarpales	Chordariaceae	*Asperococcus bullosus*		(Nelson and Knight 1995)	Marlborough Sounds: Port Gore, Nikau Reach, Pelorus Sound, Hallam Cive Terawhiti Reach, Pelorus Sound. Also Oban & Rangaunu Harbour (Nelson & Knight 1995 & refs therein)	F3, IR1, IR2, NB	Pre-1957	D, F3, IR1, IR2	
Phaeophyceae	Ectocarpales	Chordariaceae	*Chnoospora minima*		(Nelson and Duffy 1991; Cranfield et al. 1998)		D, F3, IR1, IR2	Early 1800s	D, F3, IR1, IR2	

Phylum, Class	Order	Family	Taxon name	Name as given in literature record[1]	Reference	Nearby Records	Date of introduction, or detection (d)	Probable means of introduction to NZ	Probable means of spread within NZ	Recorded in port survey?
Phaeophyceae	Laminariales	Alariaceae	*Undaria pinnatifida*		(Nelson 1999)	Picton and Marlborough Sounds, and lots of other locations throughout country	D, F3, IR1, IR2	Pre-1987	D, F3, IR1, IR2	Yes
Rhodophyta										
Florideophyceae	Ceramiales	Ceramiaceae	*Griffithsia crassiuscula*		(Nelson 1999)	Lyall Bay, Wellington: Mikhail Lermontov wreck, Port Gore, Marlborough Sounds; Otago Harbour	D, F3, IR1, IR2	Pre-1954	D, F3, IR1, IR2	
Florideophyceae	Ceramiales	Rhodomelaceae	*Neosiphonia subtilissima*		(Nelson 1999)	Picton	D, F3, IR1, IR2	Pre-1974	D, F3, IR1, IR2	
Florideophyceae	Ceramiales	Rhodomelaceae	*Polysiphonia senticulosa*		(Nelson and Maggs 1996)	Picton	D, F3, IR1, IR2	Pre-1993	D, F3, IR1, IR2	

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

Phylum, Class	Order	Family	Taxon name	Reference	Nearby Records	Date of introduction, or detection (d)	Probable means of introduction to NZ	Probable means of spread within NZ	Recorded in port survey?
Chordata									
Ascidiacea	Enterogona	Didemnidae	*Didemnum vexillum*	Barry Forrest, Cawthron Institute (pers. comm. to Anna Bradley/Mike Page)		S1	2001	F3, NB, N2, S1	
Cnidaria									
Hydrozoa	Hydroida	Campanulinidae	*Phialella quadrata*	(Bouillon 1995)		S1	Probably post 1998	F2, F3, S1	
Hydrozoa	Hydroida	Haleciidae	*Halecium delicatulum*	(Vervoort and Watson 2003)	French Pass	S1	Pre-1876	F2, F3, S1	
Myzozoa									
Dinophyceae	Gymnodiniales	Gymnodiniaceae	*Gymnodinium catenatum*	(Taylor and MacKenzie 2001)		F2	2000	F2, N1, S3	Yes
Dinophyceae	Peridiniales	Gonyaulacaceae	*Alexandrium minutum*	(Chang et al. 1999)	Anakoha Bay and Croisilles Harbour, Marlborough Sounds	F2	1993	F2, N1, S3	
Dinophyceae	Peridiniales	Gonyaulacaceae	*Alexandrium ostenfeldii*	(MacKenzie et al. 1996)	Marlborough Sounds - various locations	F2	1992	F2, N1, S3	
Ochrophyta									
Raphidophyceae	Chattonellales	Chattonellaceae	*Heterosigma akashiwo*	(Ayers et al. 2005)	Whangakoko Hbr, Marlborough Sounds	F2	1989	F2, N2, S3	

Table 9: Indeterminate taxa recorded during the desktop review of existing marine species records from Port Underwood and nearby areas. Also indicated is whether the taxon was subsequently recorded in the Port Underwood baseline survey (this report).

Phylum, Class	Order	Family	Taxon name	Reference	Probable means of introduction to NZ	Date of introduction, or detection (d)	Recorded in port survey?
Myzozoa							
Dinophyceae	Peridiniales	Peridiniaceae	*Scrippsiella* sp.	(Rhodes and Thomas 1997)	Unknown	Unknown	Yes

Table 10: The Chapman and Carlton (1994) criteria (C1 – C9) that each NIS and C1 taxon from the Port Underwood desktop review and port survey meets. Criteria were assigned following expert advice or are based on those give by Cranfield et al. (1998).

			C1:	C2:	C3:	C4:	C5:	C6:	C7:	C8:	C9:
Species	Bio-securit y Status	Source of record	Has the species suddenly appeared locally where it has not been found before?	Has the species spread subsequently?	Is the species' distribution associated with human mechanisms of dispersal?	Is the species associated with, or dependent on, other introduced species?	Is the species prevalent in, or restricted to, new or artificial environments?	Is the species' distribution restricted compared to natives?	Does the species have a disjunct worldwide distribution?	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?	Is the species isolated from the genetically and morphologically most similar species elsewhere in the world?
Caprella mutica	NIS	Desktop review	yes	no	yes	no	no	yes	yes	yes	yes
Apocorophium acutum	NIS	Desktop review	no	no	yes	no	no	yes	no	yes	yes
Bugula flabellata	NIS	Port survey	yes	yes	yes	no	yes	yes	yes	yes	no
Cryptosula pallasiana	NIS	Port survey	yes	yes	yes	yes	yes	yes	yes	yes	no
Watersipora subtorquata	NIS	Port survey	yes	yes	yes	no	yes	yes	yes	yes	yes
Bowerbankia gracilis	NIS	Port survey	yes	yes	yes	no	yes	yes	yes	yes	no
Oncorhynchus tshawytscha	NIS	Desktop review	no	no	no	no	no	no	no	no	no
Ascidiella aspersa	NIS	Port survey	no	no	yes	no	yes	yes	yes	yes	yes
Didemnum vexillum	C1	Desktop review	yes	yes	yes	no	yes	yes	no	no	yes
Didemnum sp.	C1	Port survey	Unable to assess criteria for the genus as a whole.	no	no	no	no	no	no	no	no
Corella eumyota	C1	Port survey	yes	yes	yes	no	yes	no	yes	yes	no
Botrylloides leachi	C1	Port survey	yes	yes	yes	no	yes	yes	yes	yes	no
Bougainvillia muscus	C1	Port survey	no	no	no	no	no	no	no	no	no
Phialella quadrata	C1	Desktop review	yes	no	yes	no	no	Possibly	yes	Unsure	Unsure
Eudendrium generale	NIS	Desktop review	yes	no	yes	no	yes	yes	yes	yes	no
Halecium delicatulum	C1	Desktop review	yes	yes	yes	no	no	no	no	no	no
Plumularia setacea	C1	Port survey	yes	yes	yes	no	no	no	no	no	no
Theora lubrica	NIS	Port survey	yes	yes	no	no	yes	yes	yes	yes	yes
Gymnodinium catenatum	C1	Desktop review	yes	yes	no	no	no	no	no	no	no

			C1:	C2:	C3:	C4:	C5:	C6:	C7:	C8:	C9:
Alexandrium minutum	C1	Desktop review	yes	no	no	no	no	no	no	no	no
Alexandrium ostenfeldii	C1	Desktop review	yes	no	no	no	no	no	no	no	no
Cutleria multifida	NIS	Desktop review	yes	yes	yes	no	yes	yes	yes	yes	yes
Asperococcus bullosus	NIS	Desktop review	no	no	yes	no	no	yes	yes	yes	yes
Chnoospora minima	NIS	Desktop review	no	no	yes	no	no	yes	yes	yes	yes
Undaria pinnatifida	NIS	Desktop review	yes	yes	yes	no	yes	yes	yes	yes	yes
Undaria pinnatifida	NIS	Port survey	yes	yes	yes	no	yes	yes	yes	yes	yes
Heterosigma akashiwo	C1	Desktop review	yes	Unsure	Possibly	yes	no	no	no	no	no
Heterosigma akashiwo	C1	Port survey	yes	Unsure	Possibly	yes	no	no	no	no	no
Griffithsia crassiuscula	NIS	Desktop review	yes	yes	no	no	no	yes	no	yes	yes
Neosiphonia subtilissima	NIS	Desktop review	yes	yes	no	no	yes	yes	yes	yes	yes
Polysiphonia senticulosa	NIS	Desktop review	yes	no	yes	no	yes	yes	yes	yes	yes

Table 11: Physical characteristics of the sites sampled during the first port baseline survey of Port Underwood.

Site name	Maximum recorded depth (m)	Secchi depth (m)	Salinity (ppt)	Water temperature (°C)	Sea state (Beaufort scale)
Fighting Bay 1	14.1	5.9	31	13.8	2
Fighting Bay 2	7	8.4	31.5	14	1
Hakana Bay Anchorage 1	10.5	2.35	30	14.9	1
Hakana Bay Anchorage 2	12.6	3.7	31.5	15	0
Kaikoura Bay	14.2	8.9	32	15.1	1
Karake Pt	13	5.2	30.5	15.4	1
Kingfish Bay	12.9	5.75	31.5	14.7	1
Ocean Bay	6.5	3.85	32	14.2	1
Opihi Bay	8.8	4.7	33.5	15.1	1
Oyster Bay	8	3.87	32	14.5	1
Pipi Bay Anchorage 1	12.1	4.6	32	15	1
Pipi Bay Anchorage 2	13.2	3.55	32.5	14.7	1
Inner Harbour 1	17.9	3.55	32.5	13.9	2
Inner Harbour 2	15.1	7.15	32	14.8	1
Inner Harbour 3	18.5	8.15	32.5	15	1
Robertson Pt	16.4	5.6	31.5	14.3	1
Robin Hood Bay	7.7	1	28	14.4	1
Rununder Point	60.8	5.4	32	13.8	2
The Knobbye	21.1	8.3	30.5	15	1
Whataroa Bay	16.6	8.8	32.5	15.2	1
Average across all sites	**15.35**	**5.44**	**31.58**	**14.64**	**1.1**
SE of average across all sites	**2.56**	**0.50**	**0.26**	**0.11**	**0.1**

Table 12: Sediment particle sizes at 15 sites sampled during the first port baseline survey of Port Underwood. 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
Fighting Bay	0.01	5.73	94.26	0.00	0.00
The Knobbye	1.36	63.07	35.58	0.00	0.00
Pipi Bay Anchorage	1.08	75.35	23.01	0.57	0.00
Kaikoura Bay	0.86	55.71	43.04	0.38	0.00
Whataroa Bay	1.08	62.84	36.02	0.07	0.00
Hakana Bay Anchorage 1	1.33	69.85	28.78	0.05	0.00
Hakana Bay Anchorage 2	0.73	61.23	38.06	0.00	0.00
Kingfish Bay	0.59	58.99	40.40	0.00	0.00
Opihi Bay	0.94	61.74	37.33	0.00	0.00
Oyster Bay	0.29	28.77	68.26	2.68	0.00
Ocean Bay	0.06	17.16	82.79	0.00	0.00
Robin Hood Bay	0.01	4.55	95.44	0.00	0.00
Inner Harbour 1	0.21	52.71	47.09	0.00	0.00
Inner Harbour 2	0.70	79.59	19.71	0.00	0.00
Inner Harbour 3	1.46	71.80	26.08	0.65	0.00

Table 13: Native taxa recorded from Port Underwood in the first port baseline survey. Also indicated is whether the taxon was recorded from the desktop review of existing marine species records from Port Underwood and nearby locations. None of the taxa represents a new record for New Zealand.

Phylum & Class	Order	Family	Taxon name	Recorded in desktop review
Annelida				
Polychaeta	Eunicida	Onuphidae	*Onuphis aucklandensis*	
Polychaeta	Phyllodocida	Aphroditidae	*Aphrodita talpa*	
Polychaeta	Phyllodocida	Glyceridae	*Glycera lamelliformis*	
Polychaeta	Phyllodocida	Goniadidae	*Glycinde trifida*	
Polychaeta	Phyllodocida	Hesionidae	*Ophiodromus angustifrons*	
Polychaeta	Phyllodocida	Nephtyidae	*Aglaophamus macroura*	
Polychaeta	Phyllodocida	Nephtyidae	*Aglaophamus verrilli*	
Polychaeta	Phyllodocida	Nereididae	*Nereis falcaria*	
Polychaeta	Phyllodocida	Nereididae	*Perinereis amblyodonta*	
Polychaeta	Phyllodocida	Nereididae	*Perinereis camiguinoides*	
Polychaeta	Phyllodocida	Nereididae	*Perinereis pseudocamiguina*	
Polychaeta	Phyllodocida	Nereididae	*Platynereis Platynereis_australis*_group	
Polychaeta	Phyllodocida	Polynoidae	*Harmothoe macrolepidota*	
Polychaeta	Phyllodocida	Polynoidae	*Lepidonotus polychromus*	
Polychaeta	Phyllodocida	Sigalionidae	*Labiosthenolepis laevis*	
Polychaeta	Phyllodocida	Sigalionidae	*Pelogenia antipoda*	
Polychaeta	Sabellida	Oweniidae	*Owenia petersenae*	
Polychaeta	Sabellida	Sabellidae	*Demonax aberrans*	
Polychaeta	Sabellida	Sabellidae	*Megalomma suspiciens*	
Polychaeta	Sabellida	Serpulidae	*Galeolaria hystrix*	
Polychaeta	Sabellida	Serpulidae	*Spirobranchus cariniferus*	
Polychaeta	Scolecida	Maldanidae	*Asychis trifilosus*	
Polychaeta	Scolecida	Maldanidae	*Euclymene insecta*	
Polychaeta	Scolecida	Maldanidae	*Maldane theodori*	
Polychaeta	Scolecida	Orbiniidae	*Phylo novazealandiae*	
Polychaeta	Spionida	Spionidae	*Paraprionospio Paraprionospio*-A	
Polychaeta	Spionida	Spionidae	*Prionospio tridentata*	
Polychaeta	Spionida	Spionidae	*Spio readi*	
Polychaeta	Terebellida	Acrocirridae	*Acrocirrus trisectus*	
Polychaeta	Terebellida	Cirratulidae	*Timarete anchylochaetus*	
Polychaeta	Terebellida	Pectinariidae	*Pectinaria australis*	
Polychaeta	Terebellida	Sternaspidae	*Sternaspis scutata*	
Polychaeta	Terebellida	Terebellidae	*Pista pegma*	
Polychaeta	Terebellida	Terebellidae	*Pseudopista rostrata*	
Polychaeta	Terebellida	Trichobranchidae	*Terebellides narribri*	
Arthropoda				
Malacostraca	Amphipoda	Dexaminidae	*Paradexamine pacifica*	
Malacostraca	Amphipoda	Liljeborgiidae	*Liljeborgia akaroica*	
Malacostraca	Amphipoda	Phoxocephalidae	*Torridoharpinia hurleyi*	
Malacostraca	Cumacea	Botriidae	*Cyclaspsis laevis*	
Malacostraca	Decapoda	Callianassidae	*Callianassa filholi*	
Malacostraca	Decapoda	Cancridae	*Metacarcinus novaezelandiae*	
Malacostraca	Decapoda	Crangonidae	*Philocheras australis*	
Malacostraca	Decapoda	Diogenidae	*Paguristes setosus*	
Malacostraca	Decapoda	Goneplacidae	*Neommatocarcinus huttoni*	
Malacostraca	Decapoda	Grapsidae	*Hemigrapsus crenulatus*	
Malacostraca	Decapoda	Hippolytidae	*Hippolyte bifidirostris*	
Malacostraca	Decapoda	Hymenosomatidae	*Halicarcinus innominatus*	

Phylum & Class	Order	Family	Taxon name	Recorded in desktop review
Malacostraca	Decapoda	Hymenosomatidae	*Halicarcinus ovatus*	
Malacostraca	Decapoda	Hymenosomatidae	*Halicarcinus varius*	
Malacostraca	Decapoda	Laomediidae	*Jaxea novaezelandiae*	
Malacostraca	Decapoda	Majidae	*Notomithrax minor*	
Malacostraca	Decapoda	Majidae	*Notomithrax peronii*	
Malacostraca	Decapoda	Ocypodidae	*Macrophthalmus hirtipes*	
Malacostraca	Decapoda	Ogyrididae	*Ogyrides delli*	
Malacostraca	Decapoda	Paguridae	*Pagurus novizealandiae*	
Malacostraca	Decapoda	Paguridae	*Pagurus traversi*	
Malacostraca	Decapoda	Palemonidae	*Palaemon affinis*	
Malacostraca	Decapoda	Palemonidae	*Periclimenes yaldwyni*	
Malacostraca	Decapoda	Porcellanidae	*Petrolisthes elongatus*	
Malacostraca	Decapoda	Porcellanidae	*Petrolisthes novaezelandiae*	
Malacostraca	Decapoda	Portunidae	*Ovalipes catharus*	
Malacostraca	Isopoda	Chaetiliidae	*Macrochiridothea uncinata*	
Malacostraca	Isopoda	Cirolanidae	*Natatolana rossi*	
Malacostraca	Isopoda	Sphaeromatidae	*Cassidina typa*	
Malacostraca	Isopoda	Sphaeromatidae	*Isocladus reconditus*	
Malacostraca	Stomatopoda	Squillidae	*Pterygosquilla schizodontia*	
Maxillopoda	Pedunculata	Lepadidae	*Lepas australis*	
Maxillopoda	Sessilia	Archaeobalanidae	*Austrominius modestus*	
Maxillopoda	Sessilia	Archaeobalanidae	*Notobalanus vestitus*	
Maxillopoda	Sessilia	Balanidae	*Notomegabalanus decorus*	
Ostracoda	Myodocopida	Cylindroleberididae	*Leuroleberis zealandica*	
Bacillariophyta				
Bacillariophyceae	Bacillariales	Bacillariaceae	*Cylindrotheca cloisterium*	
Bacillariophyceae	Bacillariales	Bacillariaceae	*Nitzschia closterium*	
Bacillariophyceae	Bacillariales	Bacillariaceae	*Nitzschia longissima*	
Bacillariophyceae	Bacillariales	Bacillariaceae	*Pseudo-nitzschia australis*	Yes
Bacillariophyceae	Naviculales	Naviculaceae	*Meuniera membranacea*	
Coscinodiscophyceae	Asterolamprales	Asterolampraceae	*Asteromphalus flabellatus*	
Coscinodiscophyceae	Chaetocerotales	Chaetocerotaceae	*Chaetoceros affinis*	
Coscinodiscophyceae	Chaetocerotales	Chaetocerotaceae	*Chaetoceros concavicornis*	
Coscinodiscophyceae	Chaetocerotales	Chaetocerotaceae	*Chaetoceros convolutus*	
Coscinodiscophyceae	Chaetocerotales	Chaetocerotaceae	*Chaetoceros decipiens*	
Coscinodiscophyceae	Chaetocerotales	Chaetocerotaceae	*Chaetoceros didymus*	
Coscinodiscophyceae	Coscinodiscales	Coscinodiscaceae	*Coscinodiscus wailesii*	
Coscinodiscophyceae	Hemiaulales	Hemiaulaceae	*Cerataulina pelagica*	
Coscinodiscophyceae	Hemiaulales	Hemiaulaceae	*Eucampia zoodiacus*	
Coscinodiscophyceae	Lithodesmidales	Lithodesmiaceae	*Ditylum brightwelli*	
Coscinodiscophyceae	Rhizosoleniales	Rhizosoleniaceae	*Guinardia flaccida*	
Coscinodiscophyceae	Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia alata*	
Coscinodiscophyceae	Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia imbricata*	
Coscinodiscophyceae	Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia robusta*	
Coscinodiscophyceae	Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia setigera*	
Coscinodiscophyceae	Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia stolterfothii*	
Coscinodiscophyceae	Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia styliformis*	
Coscinodiscophyceae	Thalassiosirales	Lauderiaceae	*Lauderia annulata*	
Coscinodiscophyceae	Thalassiosirales	Thalassiosiraceae	*Thalassiosira decipiens*	
Coscinodiscophyceae	Thalassiosirales	Thalassiosiraceae	*Thalassiosira hyalina*	
Coscinodiscophyceae	Thalassiosirales	Thalassiosiraceae	*Thalassiosira rotula*	
Coscinodiscophyceae	Triceratiales	Triceratiaceae	*Odontella mobiliensis*	
Coscinodiscophyceae	Triceratiales	Triceratiaceae	*Odontella sinensis*	
Fragilariophyceae	Fragilariales	Fragillariaceae	*Asterionella gracialis*	
Fragilariophyceae	Thalassionemales	Thalassionemataceae	*Thalassionema frauenfeldii*	
Fragilariophyceae	Thalassionemales	Thalassionemataceae	*Thalassionema nitzschioides*	
Brachiopoda				

Phylum & Class	Order	Family	Taxon name	Recorded in desktop review
Rhynchonellata	Terebratulida	Terebratulidae	*Calloria inconspicua*	
Rhynchonellata	Terebratulida	Terebratulidae	*Terebratella sanguinea*	
Bryozoa				
Gymnolaemata	Cheilostomata	Arachnopusiidae	*Arachnopusia unicornis*	
Gymnolaemata	Cheilostomata	Beaniidae	*Beania bilaminata*	
Gymnolaemata	Cheilostomata	Beaniidae	*Beania magellanica*	
Gymnolaemata	Cheilostomata	Beaniidae	*Beania plurispinosa*	
Gymnolaemata	Cheilostomata	Beaniidae	*Beania* sp.	
Gymnolaemata	Cheilostomata	Bitectiporidae	*Bitectipora rostrata*	
Gymnolaemata	Cheilostomata	Bitectiporidae	*Schizosmittina cinctipora*	
Gymnolaemata	Cheilostomata	Bugulidae	*Dimetopia cornuta*	
Gymnolaemata	Cheilostomata	Calloporidae	*Valdemunitella fraudatrix*	
Gymnolaemata	Cheilostomata	Calloporidae	*Valdemunitella valdemunita*	
Gymnolaemata	Cheilostomata	Candidae	*Bugulopsis monotrypa*	
Gymnolaemata	Cheilostomata	Candidae	*Caberea rostrata*	
Gymnolaemata	Cheilostomata	Candidae	*Caberea zelandica*	
Gymnolaemata	Cheilostomata	Catenicellidae	*Catenicella pseudoelegans*	
Gymnolaemata	Cheilostomata	Catenicellidae	*Orthoscuticella fissurata*	
Gymnolaemata	Cheilostomata	Catenicellidae	*Scalicella crystallina*	
Gymnolaemata	Cheilostomata	Cellariidae	*Cellaria immersa*	
Gymnolaemata	Cheilostomata	Celleporidae	*Celleporina proximalis*	
Gymnolaemata	Cheilostomata	Chaperiidae	*Chaperia cf. granulosa*	
Gymnolaemata	Cheilostomata	Chaperiidae	*Chaperiopsis cervicornis*	
Gymnolaemata	Cheilostomata	Electridae	*Electra oligopora*	
Gymnolaemata	Cheilostomata	Flustridae	*Carbasea indivisa*	
Gymnolaemata	Cheilostomata	Hippopodinidae	*Cosciniopsis vallata*	
Gymnolaemata	Cheilostomata	Hippothoidae	*Antarctothoa bathamae*	
Gymnolaemata	Cheilostomata	Hippothoidae	*Antarctothoa delta*	
Gymnolaemata	Cheilostomata	Hippothoidae	*Antarctothoa tongima*	
Gymnolaemata	Cheilostomata	Microporellidae	*Calloporina angustipora*	
Gymnolaemata	Cheilostomata	Microporellidae	*Fenestrulina incompta*	
Gymnolaemata	Cheilostomata	Microporellidae	*Microporella discors*	
Gymnolaemata	Cheilostomata	Romancheinidae	*Escharoides angela*	
Gymnolaemata	Cheilostomata	Romancheinidae	*Exochella armata*	
Gymnolaemata	Cheilostomata	Romancheinidae	*Exochella levinseni*	
Gymnolaemata	Cheilostomata	Schizoporellidae	*Chiastosella watersi*	
Gymnolaemata	Cheilostomata	Smittinidae	*Smittina rosacea*	
Gymnolaemata	Cheilostomata	Smittinidae	*Smittoidea maunganuiensis*	
Gymnolaemata	Cheilostomata	Steginoporellidae	*Steginoporella magnifica*	
Gymnolaemata	Ctenostomata	Penetrantiidae	*Penetrantia irregularis*	
Stenolaemata	Cyclostomata	Margarettidae	*Margaretta barbata*	
Cephalorhynca				
Priapulida	Priapulidae	Priapula	*Priapulopsis australis*	
Chlorophyta				
Ulvophyceae	Caulerpales	Caulerpaceae	*Caulerpa brownii*	
Chordata				
Actinopterygii	Perciformes	Scorpidinae	*Helicolenus percoides*	
Actinopterygii	Perciformes	Tripterygiidae	*Forsterygion lapillum*	
Actinopterygii	Perciformes	Tripterygiidae	*Grahamina capito*	
Actinopterygii	Perciformes	Tripterygiidae	*Grahamina nigripenne*	
Actinopterygii	Perciformes	Tripterygiidae	*Ruanoho decemdigitatus*	
Actinopterygii	Pleuronectiformes	Pleuronectidae	*Peltorhamphus novaezeelandiae*	Yes
Actinopterygii	Tetradontiformes	Monocanthidae	*Parika scaber*	
Ascidiacea	Enterogona	Polyclinidae	*Aplidium benhami*	
Ascidiacea	Pleurogona	Molgulidae	*Eugyra novaezelandiae*	
Ascidiacea	Pleurogona	Pyuridae	*Pyura picta*	
Ascidiacea	Pleurogona	Pyuridae	*Pyura rugata*	

Phylum & Class	Order	Family	Taxon name	Recorded in desktop review
Ascidiacea	Pleurogona	Pyuridae	*Pyura spinosissima*	
Ascidiacea	Pleurogona	Styelidae	*Asterocarpa cerea*	
Ascidiacea	Pleurogona	Styelidae	*Cnemidocarpa bicornuta*	
Ascidiacea	Pleurogona	Styelidae	*Cnemidocarpa madagascariensis*	
Ascidiacea	Pleurogona	Styelidae	*Cnemidocarpa nisiotis*	
Cnidaria				
Anthozoa	Actiniaria	Edwardsiidae	*Edwardsia neozelanica*	
Hydrozoa	Hydroida	Sertulariidae	*Symplectoscyphus subarticulatus*	
Echinodermata				
Asteroidea	Forcipulatida	Asteriidae	*Allostichaster insignis*	
Asteroidea	Forcipulatida	Asteriidae	*Coscinasterias muricata*	
Asteroidea	Valvatida	Asterinidae	*Patiriella regularis*	
Echinoidea	Spatangoida	Loveniidae	*Echinocardium cordatum*	
Holothuroidea	Aspidochirotida	Stichopodidae	*Stichopus mollis*	
Holothuroidea	Dendrochirotida	Heterothyonidae	*Heterothyone alba*	
Holothuroidea	Dendrochirotida	Phyllophoridae	*Pentadactyla longidentis*	
Ophiuroidea	Ophiurida	Amphiuridae	*Amphipholis squamata*	
Ophiuroidea	Ophiurida	Amphiuridae	*Amphiura spinipes*	
Ophiuroidea	Phrynophiurida	Ophiomyxidae	*Ophiomyxa brevirima*	
Haptophyta				
Mollusca				
Bivalvia	Myoida	Corbulidae	*Corbula zelandica*	
Bivalvia	Myoida	Hiatellidae	*Hiatella arctica*	
Bivalvia	Mytiloida	Mytilidae	*Aulacomya maoriana*	
Bivalvia	Mytiloida	Mytilidae	*Mytilus galloprovincialis*	
Bivalvia	Mytiloida	Mytilidae	*Perna canaliculus*	
Bivalvia	Mytiloida	Mytilidae	*Xenostrobus pulex*	
Bivalvia	Nuculoida	Malletiidae	*Neilo australis*	
Bivalvia	Nuculoida	Nuculanidae	*Leionucula strangei*	
Bivalvia	Nuculoida	Nuculidae	*Nucula hartvigiana*	
Bivalvia	Ostreoida	Ostreidae	*Ostrea chilensis*	Yes
Bivalvia	Pterioida	Pectinidae	*Pecten novaezelandiae*	
Bivalvia	Pterioida	Pectinidae	*Talochlamys zelandiae*	
Bivalvia	Veneroida	Cardiidae	*Pratulum pulchellum*	
Bivalvia	Veneroida	Carditidae	*Pleuromeris zelandica*	
Bivalvia	Veneroida	Mactridae	*Scalpomactra scalpellum*	
Bivalvia	Veneroida	Mactridae	*Zenatia acinaces*	
Bivalvia	Veneroida	Semelidae	*Leptomya retiaria*	
Bivalvia	Veneroida	Veneridae	*Austrovenus stutchburyi*	
Bivalvia	Veneroida	Veneridae	*Dosina zelandica*	
Bivalvia	Veneroida	Veneridae	*Dosinia greyi*	
Bivalvia	Veneroida	Veneridae	*Ruditapes largillierti*	
Bivalvia	Veneroida	Veneridae	*Tawera spissa*	
Cephalopoda	Octopoda	Octopodidae	*Octopus huttoni*	
Gastropoda	Docoglossa	Lottiidae	*Notoacmea elongata*	
Gastropoda	Docoglossa	Lottiidae	*Patelloida corticata*	
Gastropoda	Neogastropoda	Buccinidae	*Austrofusus glans*	
Gastropoda	Neogastropoda	Buccinidae	*Buccinulum linea*	
Gastropoda	Neogastropoda	Buccinidae	*Cominella adspersa*	
Gastropoda	Neogastropoda	Buccinidae	*Cominella glandiformis*	
Gastropoda	Neogastropoda	Buccinidae	*Penion sulcatus*	
Gastropoda	Neogastropoda	Muricidae	*Poirieria zelandica*	
Gastropoda	Neogastropoda	Olividae	*Amalda australis*	
Gastropoda	Neogastropoda	Terebridae	*Pervicacia tristis*	
Gastropoda	Neogastropoda	Volutidae	*Alcithoe arabica*	
Gastropoda	Neogastropoda	Volutidae	*Alcithoe fusus*	
Gastropoda	Neotaenioglossa	Struthiolariidae	*Struthiolaria papulosa*	

Phylum & Class	Order	Family	Taxon name	Recorded in desktop review
Gastropoda	Neotaenioglossa	Turritellidae	*Maoricolpus roseus*	
Gastropoda	Vetigastropoda	Fissurellidae	*Emarginula striatula*	
Gastropoda	Vetigastropoda	Fissurellidae	*Scutus breviculus*	
Gastropoda	Vetigastropoda	Trochidae	*Antisolarium egenum*	
Gastropoda	Vetigastropoda	Trochidae	*Cantharidus purpureus*	
Gastropoda	Vetigastropoda	Trochidae	*Diloma zelandica*	
Gastropoda	Vetigastropoda	Trochidae	*Melagraphia aethiops*	
Gastropoda	Vetigastropoda	Trochidae	*Micrelenchus dilatatus*	
Gastropoda	Vetigastropoda	Trochidae	*Trochus tiaratus*	
Gastropoda	Vetigastropoda	Trochidae	*Trochus viridis*	
Gastropoda	Vetigastropoda	Turbinidae	*Turbo smaragdus*	
Polyplacophora	Acanthochitonina	Acanthochitonidae	*Acanthochitona zelandica*	
Polyplacophora	Ischnochitonina	Chitonidae	*Sypharochiton pelliserpentis*	
Polyplacophora	Lepidopleurina	Leptochitonidae	*Leptochiton inquinatus*	
Polyplacophora	Neoloricata	Acanthochitonidae	*Notoplax rubiginosa*	
Polyplacophora	Neoloricata	Chitonidae	*Chiton glaucus*	
Dinophyceae	Dinophysiales	Dinophysiaceae	*Dinophysis acuminata*	Yes
Dinophyceae	Dinophysiales	Dinophysiaceae	*Dinophysis acuta*	Yes
Dinophyceae	Dinophysiales	Dinophysiaceae	*Dinophysis tripos*	
Dinophyceae	Gymnodiniales	Gymnodiniaceae	*Akashiwo sanguinea*	
Dinophyceae	Gymnodiniales	Gymnodiniaceae	*Gyrodinium spirale*	
Dinophyceae	Peridiniales	Ceratiaceae	*Ceratium buceros*	
Dinophyceae	Peridiniales	Ceratiaceae	*Ceratium furca*	
Dinophyceae	Peridiniales	Ceratiaceae	*Ceratium fusus*	Yes
Dinophyceae	Peridiniales	Ceratiaceae	*Ceratium tripos*	
Dinophyceae	Peridiniales	Oxytoxaceae	*Oxytoxum sp.*	
Dinophyceae	Peridiniales	Peridiniaceae	*Scrippsiella trochoidea*	
Dinophyceae	Peridiniales	Peridiniaceae	*Protoperidinium avellana*	
Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium claudicans*	
Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium depressum*	
Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium divergens*	
Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium leonis*	
Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium pentagonum*	
Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium pyroforme*	
Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium subinerme*	
Dinophyceae	Prorocentrales	Prorocentraceae	*Prorocentrum micans*	
Dinophyceae	Pyrocystales	Pyrocystaceae	*Pyrocystis lunula*	
Peridinea	Gonyaulacida	Ceratiidae	*Ceratium porrectum*	
Ochrophyta				
Dictyochophyceae	Dictyochales	Dictyochaceae	*Dictyocha fibula*	
Dictyochophyceae	Dictyochales	Dictyochaceae	*Distephanus speculum*	
Phaeophyceae	Cutleriales	Cutleriaceae	*Microzonia velutina*	
Phaeophyceae	Ectocarpales	Scytosiphonaceae	*Colpomenia peregrina*	
Phaeophyceae	Ectocarpales	Splachnidiaceae	*Splachnidium rugosum*	
Phaeophyceae	Fucales	Cystoseiraceae	*Cystophora retroflexa*	
Phaeophyceae	Fucales	Durvillaeaceae	*Durvillaea antarctica*	
Phaeophyceae	Fucales	Hormosiraceae	*Hormosira banksii*	
Phaeophyceae	Fucales	Sargassaceae	*Carpophyllum flexuosum*	
Phaeophyceae	Fucales	Sargassaceae	*Carpophyllum maschalocarpum*	
Phaeophyceae	Fucales	Seirococcaceae	*Marginariella boryana*	
Phaeophyceae	Fucales	Seirococcaceae	*Marginariella urvilliana*	
Phaeophyceae	Laminariales	Alariaceae	*Ecklonia radiata*	
Phaeophyceae	Laminariales	Lessoniaceae	*Macrocystis pyrifera*	
Phaeophyceae	Sphacelariales	Stypocaulaceae	*Halopteris funicularis*	
Phaeophyceae	Sporochnales	Sporochnaceae	*Carpomitra costata*	
Platyhelminthes				
Porifera				

Phylum & Class	Order	Family	Taxon name	Recorded in desktop review
Demospongiae	Haplosclerida	Chalinidae	*Haliclona* cf. *punctata*	
Rhodophyta				
Florideophyceae	Bonnemaisonales	Bonnemaisonaceae	*Asparagopsis armata*	
Florideophyceae	Ceramiales	Ceramiaceae	*Anotrichium crinitum*	
Florideophyceae	Ceramiales	Ceramiaceae	*Antithamnionella adnata*	
Florideophyceae	Ceramiales	Ceramiaceae	*Ceramium apiculatum*	
Florideophyceae	Ceramiales	Ceramiaceae	*Ceramium discorticatum*	
Florideophyceae	Ceramiales	Ceramiaceae	*Ceramium flaccidum*	
Florideophyceae	Ceramiales	Ceramiaceae	*Ceramium rubrum*	
Florideophyceae	Ceramiales	Ceramiaceae	*Euptilota formosissima*	
Florideophyceae	Ceramiales	Ceramiaceae	*Pterothamnion confusum*	
Florideophyceae	Ceramiales	Ceramiaceae	*Spyridia dasyoides*	
Florideophyceae	Ceramiales	Dasyaceae	*Heterosiphonia squarrosa*	
Florideophyceae	Ceramiales	Delesseriaceae	*Acrosorium venulosum*	
Florideophyceae	Ceramiales	Delesseriaceae	*Apoglossum oppositifolium*	
Florideophyceae	Ceramiales	Delesseriaceae	*Hymenena palmata*	
Florideophyceae	Ceramiales	Delesseriaceae	*Hymenena variolosa*	
Florideophyceae	Ceramiales	Delesseriaceae	*Nancythalia humilis*	
Florideophyceae	Ceramiales	Delesseriaceae	*Phycodrys quercifolia*	
Florideophyceae	Ceramiales	Rhodomelaceae	*Adamsiella angustifolia*	
Florideophyceae	Ceramiales	Rhodomelaceae	*Adamsiella chauvinii*	
Florideophyceae	Ceramiales	Rhodomelaceae	*Dasyclonium incisum*	
Florideophyceae	Ceramiales	Rhodomelaceae	*Herposiphonia ceratoclada*	
Florideophyceae	Ceramiales	Rhodomelaceae	*Polysiphonia decipiens*	
Florideophyceae	Ceramiales	Rhodomelaceae	*Polysiphonia strictissima*	
Florideophyceae	Ceramiales	Rhodomelaceae	*Pterosiphonia pennata*	
Florideophyceae	Corallinales	Corallinaceae	*Corallina officinalis*	
Florideophyceae	Gelidiales	Gelidiaceae	*Gelidium caulacantheum*	
Florideophyceae	Gigartinales	Cystocloniaceae	*Craspedocarpus erosus*	
Florideophyceae	Gigartinales	Cystocloniaceae	*Rhodophyllis acanthocarpa*	
Florideophyceae	Gigartinales	Cystocloniaceae	*Rhodophyllis membranacea*	
Florideophyceae	Gigartinales	Phyllophoraceae	*Gymnogongrus humilis*	
Florideophyceae	Gracilariales	Gracilariaceae	*Gracilaria truncata*	
Florideophyceae	Gracilariales	Gracilariceae	*Gracilaria chilensis*	
Florideophyceae	Nemaliales	Gelidiaceae	*Pterocladia lucida*	
Florideophyceae	Plocamiales	Plocamiaceae	*Plocamium cartilagineum*	
Florideophyceae	Plocamiales	Plocamiaceae	*Plocamium microcladioides*	
Florideophyceae	Rhodymeniales	Champiaceae	*Champia novae-zelandiae*	
Florideophyceae	Rhodymeniales	Rhodymeniaceae	*Rhodymenia linearis*	
Rhodophyceae	Ceramiales	Florideophyceae	*Haraldiophyllum crispatum*	

Table 14: Cryptogenic category one (C1) taxa recorded from Port Underwood in the first baseline survey. Also indicated are the probable means of introduction to New Zealand and spread within New Zealand (see Appendix 6), the date of introduction or detection (d) in New Zealand, and whether the taxon was recorded from the desktop review of existing marine species records from Port Underwood and nearby locations. None of the C1 taxa represents a new record or range extension for New Zealand.

Phylum & Class	Order	Family	Taxon name	Date of introduction, or detection (d)	Probable means of introduction to NZ	Probable means of spread within NZ	Recorded in desktop review
Chordata							
Ascidiacea	Enterogona	Didemnidae	*Didemnum* sp. #	Not available	S1	F3, NB, N2, S1	
Ascidiacea	Enterogona	Rhodosomatidae	*Corella eumyota*	Early 1900s	Not Available		
Ascidiacea	Pleurogona	Botryllinae	*Botrylloides leachi*	Pre-1900	S1	S1	
Cnidaria							
Hydrozoa	Hydroida	Bougainvilliidae	*Bougainvillia muscus*	Not available	Not Available	Not Available	
Hydrozoa	Hydroida	Plumulariidae	*Plumularia setacea*	Pre-1896	S1	F2, F3, S1	
Ochrophyta							
Raphidophyceae	Chattonellales	Chattonellaceae	*Heterosigma akashiwo*	1989	F2, N1, S3	F2, N2, S3	Yes

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

Table 15: Cryptogenic category two (C2) taxa recorded from Port Underwood in the first baseline survey. None of the C2 taxa represents a new record or range extension for New Zealand, nor were any recorded from the desktop review of existing marine species records from Port Underwood and nearby locations.

Phylum & Class	Order	Family	Taxon name
Annelida			
Polychaeta	Phyllodocida	Phyllodocidae	*Pirakia Pirakia*-A
Polychaeta	Scolecida	Maldanidae	*Asychis Asychis*-B
Polychaeta	Spionida	Spionidae	*Scolelepis Scolelepi*s-A
Polychaeta	Spionida	Chaetopteridae	*Chaetopterus chaetopterus*-B
Polychaeta	Spionida	Chaetopteridae	*Phyllochaetopterus Phyllochaetopterus*-A
Polychaeta	Spionida	Longosomatidae	*Heterospio heterospio*-A
Polychaeta	Terebellida	Terebellidae	*Artacama Artacama*-A
Porifera			
Demospongiae	Haplosclerida	Chalinidae	*Adocia* new sp. 1
Demospongiae	Haplosclerida	Chalinidae	*Chalinula* new sp. 3
Demospongiae	Haplosclerida	Chalinidae	*Haliclona* new sp. 9
Demospongiae	Haplosclerida	Callyspongiidae	*Callyspongia* new sp. 8
Demospongiae	Haplosclerida	Callyspongiidae	*Dactylia* new sp. 1
Demospongiae	Dictyoceratida	Dysideidae	*Euryspongia* new sp. 1
Demospongiae	Poecilosclerida	Microcionidae	*Dictyociona* cf. *atoxa*

Table 16: **Non-indigenous marine species recorded from Port Underwood during the baseline surveys. Likely vectors of introduction to, and spread within New Zealand are largely derived from Hayes et al. (2005), (see Appendix 6). For those species for which information is scarce, we provide dates of first detection rather than probable dates of introduction.**

Phylum & Class	Order	Family	Taxon name	Date of introduction, or detection (d)	Probable means of introduction to NZ	Probable means of spread within NZ	Recorded in desktop review
Bryozoa							
Gymnolaemata	Cheilostomata	Bugulidae	*Bugula flabellata*	Pre-1949	D, S1	D, F3, NB, S1	
Gymnolaemata	Cheilostomata	Cryptosulidae	*Cryptosula pallasiana*	1890s	S1	D, F1, F2, F3	
Gymnolaemata	Cheilostomata	Watersiporidae	*Watersipora subtorquata*	Pre-1982	S1	D, NB, N2, S1	
Gymnolaemata	Ctenostomata	Vesiculariidae	*Bowerbankia gracilis*	Pre-1965	D, S1, S3	F1, F2, F3, S1	
Chordata							
Ascidiacea	Enterogona	Ascidiidae	*Ascidiella aspersa*	1900s	F3, S1	NB, N1, N2, S1	
Mollusca							
Bivalvia	Veneroida	Semelidae	*Theora lubrica*	1971	S3	N1, RE, S3, S5	
Ochrophyta							
Phaeophyceae	Laminariales	Alariaceae	*Undaria pinnatifida*	Pre-1987	D, F3, IR1, IR2	D, F3, IR1, IR2	Yes

Table 17: Indeterminate taxa recorded from Port Underwood in the first port survey. Also indicated is whether the taxon was recorded from the review of existing marine species records from Port Underwood and nearby locations.

Phylum & Class	Order	Family	Taxon name	Recorded in desktop review?
Annelida				
Polychaeta			Polychaeta	
Polychaeta	Eunicida	Lumbrineridae	Lumbrineridae Indet.	
Polychaeta	Phyllodocida	Glyceridae	*Glycera* sp.	
Polychaeta	Phyllodocida	Polynoidae	*Lepidonotus* sp.	
Polychaeta	Phyllodocida	Polynoidae	Polynoidae Indet.	
Polychaeta	Sabellida	Serpulidae	Serpulidae Indet.	
Polychaeta	Scolecida	Maldanidae	*Euclymene* sp.	
Polychaeta	Scolecida	Maldanidae	*Euclymenin*-unplaced *euclymenin*-A	
Polychaeta	Scolecida	Maldanidae	Maldanidae Indet.	
Polychaeta	Scolecida	Orbiniidae	Orbiniidae Indet.	
Polychaeta	Spionida	Spionidae	*Boccardia* sp.	
Polychaeta	Terebellida	Cirratulidae	Cirratulidae Indet.	
Polychaeta	Terebellida	Flabelligeridae	Flabelligeridae	
Polychaeta	Terebellida	Terebellidae	Terebellidae Indet.	
Arthropoda				
Malacostraca	Amphipoda	Ampeliscidae	*Ampelisca* sp.	
Malacostraca	Amphipoda	Isaeidae	*Gammaropsis* sp.	
Malacostraca	Amphipoda	Lysianassidae	*Parawaldeckia* sp.	
Malacostraca	Decapoda	Palemonidae	*Periclimenes* sp.	
Malacostraca	Isopoda		Isopoda	
Malacostraca	Isopoda	Sphaeromatidae	*Exosphaeroma* sp.	
Malacostraca	Isopoda		*Ischyromene* sp.	
Malacostraca	Tanaidacea	Apseudidae	*Apseudes* sp.	
Pycnogonida			Pycnogonida	
Bacillariophyta				
Bacillariophyceae	Achnanthales	Cocconeidaceae	*Cocconeis* sp.	
Bacillariophyceae	Bacillariales	Bacillariaceae	*Nitzschia* sp.	
Bacillariophyceae	Bacillariales	Bacillariaceae	*Pseudo-nitzschia* sp.	
Bacillariophyceae	Naviculales	Naviculaceae	*Diploneis* sp.	
Bacillariophyceae	Naviculales	Naviculaceae	*Navicula* sp.	
Bacillariophyceae	Naviculales	Pleurosigmataceae	*Gyrosigma* sp.	
Bacillariophyceae	Naviculales	Pleurosigmataceae	*Pleurosigma* sp.	
Coscinodiscophyceae	Chaetocerotales	Chaetocerotaceae	*Chaetoceros* sp.	
Coscinodiscophyceae	Leptocylindrales	Leptocylindraceae	*Leptocylindrus* sp.	
Coscinodiscophyceae	Melosirales	Melosiraceae	*Melosira* sp.	
Coscinodiscophyceae	Rhizosoleniales	Rhizosoleniaceae	*Rhizosolenia* sp.	
Coscinodiscophyceae	Thalassiosirales	Skeletonemaceae	*Detonula* sp.	
Coscinodiscophyceae	Thalassiosirales	Thalassiosiraceae	*Thalassiosira* sp.	
Fragilariophyceae	Licmophorales	Licmophoraceae	*Licmophora* sp.	
Bryozoa				
Gymnolaemata	Cheilostomata	Beaniidae	*Beania* new sp. cf. *inermis*	
Gymnolaemata	Cheilostomata	Celleporidae	*Celleporina* sp.	
Gymnolaemata	Cheilostomata	Celleporidae	*Osthimosia* sp.	
Gymnolaemata	Cheilostomata	Chaperiidae	*Chaperiopsis* sp.	
Gymnolaemata	Cheilostomata	Microporidae	*Micropora* sp.	
Stenolaemata	Cyclostomata	Hastingsiidae	*Hastingsia* new sp.	
Stenolaemata	Cyclostomata	Tubuliporidae	*Tubulipora* sp.	
Chlorophyta				
Prasinophyceae	Pyramimonadales	Polyblepharidaceae	*Pyramimonas* sp.	

Phylum & Class	Order	Family	Taxon name	Recorded in desktop review?
Ulvophyceae	Bryopsidales	Codiaceae	*Codium* sp.	
Ulvophyceae	Ulvales	Ulvaceae	*Ulva* sp.	
Chordata				
Actinopterygii	Perciformes	Gobiidae	*Eviota* sp.	
Ascidiacea			Ascidiacea	
Ascidiacea	Enterogona	Didemnidae	*Diplosoma* sp.	
Ascidiacea	Pleurogona	Styelidae	*Botryllus* sp.	
Cnidaria				
Anthozoa			Anthozoa	
Scyphozoa			Scyphozoa	
Echinodermata				
Ophiuroidea	Ophiurida	Ophiodermatidae	*Ophiopeza* sp.	
Mollusca				
Bivalvia			Bivalvia	
Gastropoda			Gastropoda	
Gastropoda	Neogastropoda	Buccinidae	*Buccinulum* sp.	
Myzozoa				
Dinophyceae	Gymnodiniales	Gymnodiniaceae	*Gymnodinium* sp.	
Dinophyceae	Gymnodiniales	Gymnodiniaceae	*Gyrodinium* sp.	
Dinophyceae	Peridinales	Kolkwitziellaceae	*Oblea* sp.	
Dinophyceae	Peridiniales	Ceratiaceae	*Ceratium* sp.	
Dinophyceae	Peridiniales	Gonyaulacaceae	*Gonyaulax* sp.	
Dinophyceae	Peridiniales	Peridiniaceae	*Scrippsiella* sp.	Yes
Dinophyceae	Peridiniales	Protoperidiniaceae	*Protoperidinium* sp.	
Ochrophyta				
Dictyochophyceae	Dictyochales	Dictyochaceae	*Distephanus* sp.	
Phaeophyceae	Fucales	Sargassaceae	*Carpophyllum* sp.	
Phaeophyceae	Sphacelariales	Stypocaulaceae	*Halopteris* sp.	
Platyhelminthes				
			Platyhelminthes	
Rhodophyta				
Florideophyceae	Ceramiales	Ceramiaceae	*Callithamnion* sp.	
Florideophyceae	Ceramiales	Ceramiaceae	*Ceramium* sp.	
Florideophyceae	Ceramiales	Ceramiaceae	*Griffithsia* sp.	
Florideophyceae	Ceramiales	Dasyaceae	*Dasya* sp.	
Florideophyceae	Ceramiales	Delesseriaceae	*Delesseria* sp.	
Florideophyceae	Ceramiales	Delesseriaceae	*Hymenena affinis*	
Florideophyceae	Ceramiales	Delesseriaceae	*Hymenena* sp.	
Florideophyceae	Ceramiales	Delesseriaceae	*Schizoseris* sp.	
Florideophyceae	Ceramiales	Rhodomelaceae	*Adamsiella* sp.	
Florideophyceae	Ceramiales	Rhodomelaceae	*Polysiphonia* sp.	
Florideophyceae	Corallinales		*Corallinales* sp. (non-geniculate)	
Florideophyceae	Plocamiales	Plocamiaceae	*Plocamium* sp.	
Unidentified				
			Unidentified invertebrates	
			Unknown taxon	
			Unidentified algae	

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

Taxon name	Biosecurity Status	Method*	>0	<0 to -5	<-5 to -10	<-10 to -15	<-15 to -20	<-20	Total
Ascidiella aspersa	NIS	ANCH			1	1			**2**
Botrylloides leachi	C1	ANCH				2			**2**
		BSLD				1	1		**2**
		SEINE		1					**1**
Bougainvillia muscus	C1	BSLD		1					**1**
Bowerbankia gracilis	NIS	ANCH					1		**1**
		PSC		1					**1**
Bugula flabellata	NIS	BSLD				1			**1**
Corella eumyota	C1	BSLD				1			**1**
Cryptosula pallasiana	NIS	PSC		1					**1**
Didemnum sp.	C1	ANCH			1	5	2		**8**
		BSLD			1	2	1		**4**
		VISD			1				**1**
		WRACK	2						**2**
Heterosigma akashiwo	C1	PHYT					1		**1**
Plumularia setacea	C1	BSLD				1			**1**
Theora lubrica	NIS	ANCH			8	11	8	2	**29**
		BSLD		1	7	12	3		**23**
Undaria pinnatifida	NIS	PSC		1					**1**
		PSCM		3					**3**
Watersipora subtorquata	NIS	PSC		7					**7**
		PSCM		3					**3**
Total number of NIS & C1 specimens			**2**	**19**	**19**	**37**	**17**	**2**	**96**
Proportion of all NIS & C1 specimens (%)			**2.1**	**19.8**	**19.8**	**38.5**	**17.7**	**2.1**	**100**
Total number of NIS & C1 taxa			**0**	**0**	**0**	**0**	**0**	**0**	**0**
Proportion of all NIS & C1 taxa (%)			**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**#**

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

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

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

Taxon name	Method*	>0 m	<0 to -5 m	<-5 to -10 m	<-10 to -15 m	<-15 to -20 m	<-20 m	Total
Acanthochitona zelandica	PSC		1					**1**
Acrocirrus trisectus	VISD			1				**1**
Acrosorium venulosum	BSLD		2		1	1		**4**
Adamsiella angustifolia	ANCH			2				**2**
	BSLD				1	1		**2**
Adamsiella chauvinii	ANCH			1				**1**
Aglaophamus macroura	ANCH			2				**2**
	BSLD		1					**1**
Aglaophamus verrilli	ANCH					1	2	**3**
	BSLD			1				**1**
Akashiwo sanguinea	PHYT			1				**1**
Alcithoe arabica	VISD			1				**1**
Alcithoe fusus	ANCH				1			**1**
Allostichaster insignis	BSLD				1			**1**
	PSC		2					**2**
	PSCM		1					**1**
Amalda australis	ANCH			1		1		**2**
	BSLD		2	1	2			**5**
Amphipholis squamata	ANCH						1	**1**
	BSLD		1					**1**
Amphiura spinipes	VISD			1				**1**
Anotrichium crinitum	ANCH			1		1		**2**
	BSLD		2		1	1		**4**
Antarctothoa bathamae	BSLD					2		**2**
Antarctothoa delta	BSLD		1					**1**
Antarctothoa tongima	BSLD					1		**1**
	PSC		1					**1**
Antisolarium egenum	BCOR			3				**3**
Antithamnionella adnata	BSLD					1		**1**
Aphrodita talpa	ANCH				1			**1**
Aplidium benhami	VISD			1				**1**
Apoglossum oppositifolium	ANCH				1	1		**2**
	VISD			1				**1**
Arachnopusia unicornis	BSLD					2		**2**
	PSC		1					**1**
Asparagopsis armata	BSLD				1			**1**
Asterionella gracialis	PHYT			2	2	2		**6**
Asterocarpa cerea	ANCH				1			**1**
Asteromphalus flabellatus	PHYT				1			**1**
Asychis trifilosus	ANCH			3	10	6	2	**21**
Aulacomya maoriana	PSC		3					**3**
Austrofusus glans	ANCH			2		1		**3**
	BSLD				3			**3**
	PSC		1					**1**
Austrominius modestus	PSC		11					**11**
	PSCM		1					**1**
	SEINE		2					**2**
Austrovenus stutchburyi	BSLD		1	1				**2**

Taxon name	Method*	>0 m	<0 to -5 m	<-5 to -10 m	<-10 to -15 m	<-15 to -20 m	<-20 m	Total
	SEINE		4					**4**
Beania bilaminata	BSLD		1		1			**2**
Beania magellanica	BSLD					1		**1**
Beania plurispinosa	ANCH					2		**2**
Beania sp.	BSLD					1		**1**
Bitectipora rostrata	ANCH				1	2		**3**
Buccinulum linea	PSC		1					**1**
Bugulopsis monotrypa	VISD			1				**1**
Caberea rostrata	BSLD					1		**1**
Caberea zelandica	ANCH					1		**1**
	BSLD				1	1		**2**
Callianassa filholi	BSLD				2			**2**
Calloporina angustipora	BSLD					1		**1**
Calloria inconspicua	ANCH			1				**1**
Cantharidus purpureus	VISD			1				**1**
Carbasea indivisa	VISD			1				**1**
Carpomitra costata	VISD			1				**1**
Carpophyllum flexuosum	ANCH				1			**1**
Carpophyllum maschalocarpum	WRACK	3						**3**
	SEINE		1					**1**
Cassidina typa	BSLD					1		**1**
Catenicella pseudoelegans	BSLD		1					**1**
Caulerpa brownii	BSLD		1			1		**2**
	VISD			1				**1**
Cellaria immersa	BSLD					2		**2**
Celleporina proximalis	ANCH					1		**1**
	BSLD					1		**1**
Ceramium apiculatum	BSLD			1				**1**
Ceramium discorticatum	WRACK	1						**1**
Ceramium flaccidum	BSLD		1					**1**
Ceramium rubrum	SEINE		1					**1**
Cerataulina pelagica	PHYT			1		3		**4**
Ceratium buceros	PHYT			1				**1**
Ceratium furca	PHYT			4	7	5		**16**
Ceratium fusus	PHYT			4	5	5		**14**
Ceratium porrectum	PHYT				1			**1**
Ceratium tripos	PHYT			5	2	2		**9**
Chaetoceros affinis	PHYT			3	5	4		**12**
Chaetoceros concavicornis	PHYT				1	2		**3**
Chaetoceros convolutus	PHYT			3	8	5		**16**
Chaetoceros decipiens	PHYT			4	14	9	1	**28**
Chaetoceros didymus	PHYT			3	9	7		**19**
Champia novae-zelandiae	VISD			1				**1**
Chaperia cf. granulosa	BSLD		1					**1**
Chaperiopsis cervicornis	ANCH					1		**1**
	PSC		1					**1**
	PSCM		1					**1**
Chiastosella watersi	BSLD					1		**1**
Chiton glaucus	VISD			1				**1**
	SEINE		1					**1**
Cnemidocarpa bicornuta	ANCH				1			**1**
	BSLD					1		**1**

Taxon name	Method*	>0 m	<0 to -5 m	<-5 to -10 m	<-10 to -15 m	<-15 to -20 m	<-20 m	Total
	VISD			1				**1**
Cnemidocarpa madagascariensis	ANCH				1			**1**
Cnemidocarpa nisiotis	ANCH			1				**1**
	PSC		1					**1**
	VISD			1				**1**
Colpomenia peregrina	SEINE		2					**2**
Cominella adspersa	ANCH			1				**1**
Cominella glandiformis	SEINE		1					**1**
Corallina officinalis	SEINE		2					**2**
Corbula zelandica	ANCH			1				**1**
	BSLD					1		**1**
	VISD			1				**1**
Coscinasterias muricata	BSLD				1			**1**
Cosciniopsis vallata	BSLD					2		**2**
Coscinodiscus wailesii	PHYT			7	17	9	2	**35**
Craspedocarpus erosus	BSLD					1		**1**
	VISD			1				**1**
Cyclaspsis laevis	ANCH				1			**1**
	BCOR			1				**1**
Cylindrotheca cloisterium	PHYT					1		**1**
Cystophora retroflexa	SEINE		1					**1**
Dasyclonium incisum	BSLD		2			1		**3**
	SEINE		1					**1**
Demonax aberrans	VISD			1				**1**
Dictyocha fibula	PHYT			1				**1**
Diloma zelandica	SEINE		2					**2**
Dimetopia cornuta	VISD			1				**1**
Dinophysis acuminata	PHYT			6	11	6		**23**
Dinophysis acuta	PHYT			2	3			**5**
Dinophysis tripos	PHYT			1				**1**
Distephanus speculum	PHYT			6	14	7		**27**
Ditylum brightwelli	PHYT			5	15	9	3	**32**
Dosina zelandica	ANCH				2			**2**
Dosinia greyi	ANCH			2	8	3	2	**15**
	BSLD			1				**1**
Durvillaea antarctica	WRACK	1						**1**
Echinocardium cordatum	ANCH				1		1	**2**
Ecklonia radiata	VISD			1				**1**
Edwardsia neozelanica	ANCH						1	**1**
Electra oligopora	BSLD		1					**1**
Emarginula striatula	BSLD				1			**1**
Escharoides angela	BSLD					2		**2**
Eucampia zoodiacus	PHYT				3			**3**
Euclymene insecta	ANCH				1	1		**2**
Eugyra novaezelandiae	ANCH			1	5	1		**7**
Euptilota formosissima	BSLD		2			1		**3**
Exochella armata	BSLD		1			2		**3**
Exochella levinseni	BSLD					1		**1**
Fenestrulina incompta	BSLD					1		**1**
Forsterygion lapillum	PSC		3					**3**
Galeolaria hystrix	VISD			1				**1**
Gelidium caulacantheum	SEINE		1					**1**

Taxon name	Method*	>0 m	<0 to -5 m	<-5 to -10 m	<-10 to -15 m	<-15 to -20 m	<-20 m	Total
Glycera lamelliformis	ANCH			1	2	1		**4**
Glycinde trifida	ANCH			1	1	1		**3**
	BSLD					1		**1**
Gracilaria chilensis	SEINE		3					**3**
Gracilaria truncata	BSLD		1			1		**2**
Grahamina capito	BSLD				1			**1**
	SEINE		3					**3**
Grahamina nigripenne	SEINE		1					**1**
Guinardia flaccida	PHYT			1		1		**2**
Gymnogongrus humilis	SEINE		2					**2**
Gyrodinium spirale	PHYT			1				**1**
Halicarcinus innominatus	ANCH			1				**1**
	PSC		3					**3**
Halicarcinus ovatus	VISD			1				**1**
Halicarcinus varius	ANCH			3	5	1		**9**
	BSLD				2			**2**
	SEINE		1					**1**
Haliclona cf. *punctata*	BSLD		1					**1**
Halopteris funicularis	BSLD		2			1		**3**
Haraldiophyllum crispatum	ANCH			1				**1**
	BSLD		1					**1**
	PSCM		1					**1**
Harmothoe macrolepidota	ANCH				1			**1**
	BSLD			1				**1**
	SEINE		1					**1**
Helicolenus percoides	POIS			1				**1**
Hemigrapsus crenulatus	SEINE		1					**1**
Herposiphonia ceratoclada	BSLD		1					**1**
Heterosiphonia squarrosa	BSLD		1			2		**3**
Heterothyone alba	ANCH					1		**1**
Hiatella arctica	BSLD				1			**1**
Hippolyte bifidirostris	ANCH				1			**1**
	BSLD			1	2	1		**4**
Hormosira banksii	ANCH					1		**1**
	WRACK	1						**1**
	SEINE		2					**2**
Hymenena palmata	BSLD		1			1		**2**
Hymenena variolosa	ANCH				3			**3**
	BSLD				1			**1**
	SHRTP				1			**1**
Isocladus reconditus	BSLD					1		**1**
Jaxea novaezelandiae	ANCH			1		1	1	**3**
Labiosthenolepis laevis	ANCH			10	6	7	1	**24**
	BSLD		2	8	7	2		**19**
Lauderia annulata	PHYT			5	16	9	2	**32**
Leionucula strangei	ANCH			4	8	2		**14**
	BSLD		1	2	1			**4**
Lepas australis	WRACK	1						**1**
Lepidonotus polychromus	BSLD					1		**1**
	PSC		1					**1**
	VISD			1				**1**
Leptochiton inquinatus	ANCH				1	1		**2**
Leptomya retiaria	ANCH		1	3	3			**7**

Taxon name	Method*	>0 m	<0 to -5 m	<-5 to -10 m	<-10 to -15 m	<-15 to -20 m	<-20 m	Total
	BSLD				1			**1**
Leuroleberis zealandica	BSLD			1				**1**
Liljeborgia akaroica	WRACK	1						**1**
Macrochiridothea uncinata	ANCH			2				**2**
	BSLD		2					**2**
Macrocystis pyrifera	WRACK	1						**1**
Macrophthalmus hirtipes	ANCH			8	8	7	1	**24**
	BSLD			7	6	2		**15**
	SEINE		1					**1**
Maldane theodori	ANCH			2	11	5	2	**20**
	BSLD				3	1		**4**
Maoricolpus roseus	ANCH			5	7	2		**14**
	BSLD		1	4	9	2		**16**
	PSC		1					**1**
	BCOR			4				**4**
Margaretta barbata	VISD			1				**1**
Marginariella boryana	SEINE		1					**1**
Marginariella urvilliana	VISD			1				**1**
	WRACK	1						**1**
Megalomma suspiciens	ANCH				1			**1**
Melagraphia aethiops	ANCH				2			**2**
	BSLD				1			**1**
	PSC		1					**1**
	CRBTP				1			**1**
	SEINE		2					**2**
Metacarcinus novaezelandiae	BSLD			1				**1**
	SEINE		1					**1**
Meuniera membranacea	PHYT			1				**1**
Micrelenchus dilatatus	BCOR			1				**1**
Microporella discors	BSLD					2		**2**
Microzonia velutina	BSLD		1					**1**
	SEINE		1					**1**
Mytilus galloprovincialis	PSC		10					**10**
	PSCM		1					**1**
Nancythalia humilis	SEINE		1					**1**
Natatolana rossi	ANCH			6	5	8	1	**20**
	SHRTP				6			**6**
	BCOR			1				**1**
Neilo australis	ANCH			1	8			**9**
	BSLD				2			**2**
Neommatocarcinus huttoni	ANCH					1		**1**
	BSLD				1			**1**
	BCOR			1				**1**
Nereis falcaria	BSLD					2		**2**
Nitzschia closterium	PHYT				1	1		**2**
Nitzschia longissima	PHYT			1	3	2		**6**
Notoacmea elongata	PSC		6					**6**
Notobalanus vestitus	BSLD					2		**2**
Notomegabalanus decorus	BSLD					1		**1**
	SEINE		1					**1**
Notomithrax minor	ANCH				1			**1**

Taxon name	Method*	>0 m	<0 to -5 m	<-5 to -10 m	<-10 to -15 m	<-15 to -20 m	<-20 m	Total
	BSLD				1			**1**
Notomithrax peronii	BSLD		1	1				**2**
Notoplax rubiginosa	BSLD					1		**1**
Nucula hartvigiana	ANCH			7	11	5		**23**
	BSLD		2	3	6	2		**13**
	VISD			1				**1**
Octopus huttoni	BSLD					1		**1**
Odontella mobiliensis	PHYT			6	8	4		**18**
Odontella sinensis	PHYT			1	2			**3**
Ogyrides delli	ANCH			1				**1**
	BSLD			1				**1**
Onuphis aucklandensis	ANCH			3	6	7	2	**18**
Ophiodromus angustifrons	BSLD				1			**1**
Ophiomyxa brevirima	ANCH				3			**3**
	BSLD				1			**1**
	CRBTP				1			**1**
Orthoscuticella fissurata	VISD			1				**1**
Ostrea chilensis	ANCH			1				**1**
	BSLD		1			1		**2**
	PSC		1					**1**
	PSCM		1					**1**
Ovalipes catharus	BSLD		1					**1**
Owenia petersenae	ANCH			1				**1**
Oxytoxum sp.	PHYT				1			**1**
Paguristes setosus	ANCH					1		**1**
Pagurus novizealandiae	BSLD					3		**3**
Pagurus traversi	ANCH				2			**2**
	BSLD				1			**1**
	VISD			1				**1**
	CRBTP				6			**6**
Palaemon affinis	BSLD					1		**1**
	BCOR			2				**2**
Paradexamine pacifica	BSLD					2		**2**
	VISD			1				**1**
Paraprionospio Paraprionospio-A	ANCH			2				**2**
	BSLD			1	1			**2**
Parika scaber	BSLD			1				**1**
Patelloida corticata	PSC		1					**1**
Patiriella regularis	ANCH			2				**2**
	BSLD		1	1	4	1		**7**
	PSC		4					**4**
	PSCM		1					**1**
Pecten novaezelandiae	ANCH				1			**1**
Pectinaria australis	ANCH			1				**1**
	BSLD			2				**2**
Pelogenia antipoda	VISD			1				**1**
Peltorhamphus novaezeelandiae	BSLD			1				**1**
	SEINE		4					**4**
Penetrantia irregularis	BSLD					1		**1**
Penion sulcatus	BSLD			1				**1**
Pentadactyla longidentis	ANCH			2	3			**5**

Taxon name	Method*	>0 m	<0 to -5 m	<-5 to -10 m	<-10 to -15 m	<-15 to -20 m	<-20 m	Total
Periclimenes yaldwyni	BSLD				1			**1**
Perinereis amblyodonta	PSC		1					**1**
Perinereis camiguinoides	PSC		1					**1**
Perinereis pseudocamiguina	PSC		2					**2**
Perna canaliculus	PSC		4					**4**
Pervicacia tristis	ANCH		1					**1**
Petrolisthes elongatus	PSC		12					**12**
	PSCM		1					**1**
Petrolisthes novaezelandiae	VISD			1				**1**
Philocheras australis	ANCH				3			**3**
	BSLD		3	1	5	2		**11**
	SEINE		5					**5**
Phycodrys quercifolia	ANCH			1	3			**4**
	BSLD				1			**1**
	SHRTP				1			**1**
Phylo novazealandiae	ANCH			4	5			**9**
	BSLD				1			**1**
Pista pegma	BSLD				1			**1**
Platynereis Platynereis_australis_group	BSLD		1					**1**
Pleuromeris zelandica	ANCH				2	1		**3**
Plocamium cartilagineum	SEINE		1					**1**
Plocamium microcladioides	BSLD		1			1		**2**
Poirieria zelandica	ANCH				2	2		**4**
	BSLD			1	1			**2**
Polysiphonia decipiens	VISD			1				**1**
Polysiphonia strictissima	ANCH				1			**1**
	BSLD		2		1	1		**4**
	WRACK	1						**1**
Pratulum pulchellum	ANCH			1	2	3		**6**
	BSLD			2	1	2		**5**
Priapulopsis australis	ANCH			3	3	4	1	**11**
Prionospio tridentata	BCOR			3				**3**
Prorocentrum micans	PHYT			1	1	4		**6**
Protoperidinium avellana	CYST	1					1	**2**
Protoperidinium claudicans	PHYT			1		1		**2**
Protoperidinium depressum	PHYT			1	2			**3**
Protoperidinium divergens	PHYT			1	2			**3**
Protoperidinium leonis	PHYT			2		1		**3**
Protoperidinium pentagonum	PHYT				5	2		**7**
Protoperidinium pyroforme	PHYT				1			**1**
Protoperidinium subinerme	PHYT			3				**3**
Pseudo-nitzschia australis	PHYT			7	18	9	3	**37**
Pseudopista rostrata	ANCH			2				**2**
Pterocladia lucida	VISD			1				**1**
Pterosiphonia pennata	BSLD		1					**1**
Pterothamnion confusum	BSLD					1		**1**
Pterygosquilla schizodontia	ANCH					1		**1**
Pyrocystis lunula	PHYT			1				**1**
Pyura picta	PSC		1					**1**
Pyura rugata	BSLD		1			1		**2**
Pyura spinosissima	PSCM		1					**1**
Rhizosolenia alata	PHYT					1		**1**

Taxon name	Method*	>0 m	<0 to -5 m	<-5 to -10 m	<-10 to -15 m	<-15 to -20 m	<-20 m	Total
Rhizosolenia imbricata	PHYT			6	17	9	3	**35**
Rhizosolenia robusta	PHYT			1				**1**
Rhizosolenia setigera	PHYT			5	10	9	3	**27**
Rhizosolenia stolterfothii	PHYT			4	11	8		**23**
Rhizosolenia styliformis	PHYT			1		1		**2**
Rhodophyllis acanthocarpa	BSLD					1		**1**
Rhodophyllis membranacea	BSLD		2			1		**3**
Rhodymenia linearis	ANCH			1				**1**
	BSLD		1			1		**2**
Ruanoho decemdigitatus	PSC		1					**1**
Ruditapes largillierti	ANCH			2	1			**3**
	BSLD			1				**1**
Scalicella crystallina	VISD			1				**1**
Scalpomactra scalpellum	ANCH			1				**1**
	BSLD				1			**1**
Schizosmittina cinctipora	BSLD					2		**2**
Scrippsiella trochoidea	PHYT			1				**1**
Scutus breviculus	BSLD			1		1		**2**
Smittina rosacea	ANCH					3		**3**
Smittoidea maunganuiensis	ANCH				2			**2**
	BSLD				1			**1**
Spio readi	BCOR			1				**1**
Spirobranchus cariniferus	PSC		3					**3**
Splachnidium rugosum	WRACK	2						**2**
Spyridia dasyoides	BSLD		2	1		2		**5**
Steginoporella magnifica	BSLD					2		**2**
Sternaspis scutata	ANCH					1		**1**
Stichopus mollis	BSLD					2		**2**
	VISD			1				**1**
Struthiolaria papulosa	ANCH			3	3			**6**
	BSLD			1				**1**
Symplectoscyphus subarticulatus	BSLD				1	1		**2**
Sypharochiton pelliserpentis	ANCH				1			**1**
	BSLD			1	1	1		**3**
	PSC		4					**4**
Talochlamys zelandiae	BSLD					2		**2**
Tawera spissa	ANCH						1	**1**
	BSLD			1		1		**2**
Terebellides narribri	ANCH			5	4	1		**10**
	BSLD			2	2			**4**
Terebratella sanguinea	ANCH						1	**1**
Thalassionema frauenfeldii	PHYT			1	4	1		**6**
Thalassionema nitzschioides	PHYT			7	16	8	3	**34**
Thalassiosira decipiens	PHYT			1	3	1	1	**6**
Thalassiosira hyalina	PHYT			1	1			**2**
Thalassiosira rotula	PHYT			6	16	9	2	**33**
Timarete anchylochaetus	ANCH				1			**1**
Torridoharpinia hurleyi	ANCH		1	6	4	5	2	**18**
	BSLD		2	1	4	1		**8**
	BCOR			5				**5**
Trochus tiaratus	BSLD				1	1		**2**
	CRBTP				1			**1**

Taxon name	Method*	>0 m	<0 to -5 m	<-5 to -10 m	<-10 to -15 m	<-15 to -20 m	<-20 m	Total
Trochus viridis	ANCH			1			1	**2**
	PSCM		1					**1**
Turbo smaragdus	ANCH			1	1			**2**
	BSLD		2	1				**3**
	PSC		5					**5**
	CRBTP				1			**1**
	PSCM		1					**1**
	SEINE		1					**1**
Valdemunitella fraudatrix	BSLD					1		**1**
Valdemunitella valdemunita	BSLD					1		**1**
Xenostrobus pulex	PSC		3					**3**
Zenatia acinaces	ANCH					1		**1**
Total number of Native specimens		**14**	**217**	**358**	**540**	**352**	**47**	**1528**
Proportion of all Native specimens (%)		**0.9**	**14.2**	**23.4**	**35.3**	**23.0**	**3.1**	**100.0**
Total number of Native taxa		**11**	**99**	**150**	**115**	**138**	**28**	**301**
Proportion of all Native taxa (%)		**3.7**	**32.9**	**49.8**	**38.2**	**45.8**	**9.3**	**#**

* Survey methods: ANCH = Anchor box dredge for benthic infauna; BCOR = large hand corer for benthic infauna; BSLD = benthic sled; PSC = quadrat scrapings on wharf pilings; VISD = qualitative diver visual survey; VISS: opportunistic visual survey from above water; CYST = dinoflagellate cyst core; CRBTP = crab trap, SHRTP = shrimp trap; PHYT = phytoplankton net tow; POIS = fish poison station; SEINE = beach seine netting; WRACK = beach wrack survey
# The proportion of taxa in each depth class sums to greater than 100%, as some taxa were recorded from more than one depth class

Appendices

Appendix 1: Sampling procedures for ZBS2005-19 surveys.

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

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

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

1.0 Dinoflagellates

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

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

1.2. Sediment preparation and cyst identification

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

1.3. Cyst germination

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

1.4. Plankton sampling and culture

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

1.5. Toxicity testing

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

2.0 Crabs, Macroalgae, Seastars

2.1. Trapping

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

2.2. Visual searches – wharves and marinas

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

2.3 Visual searches – other regions

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

3.0 Zooplankton

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

4.0 Hard Substrate Invertebrates and Plants

4.1 Wharf pile communities

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

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

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

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

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

4.2. Breakwaters

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

5.0 Soft Substrate Invertebrates and Plants

5.1. Epibenthos

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

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

5.2. Benthic Infauna

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

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

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

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

6.0 Fish

6.1. Poison Stations

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

6.2. Nets

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

7.0 Environmental Data

7.1. Temperature, salinity and dissolved oxygen

A submersible data logger (SDL) equipped with pressure, conductivity and temperature sensors will be used to record data on salinity and water temperature at 0.5 m intervals from the surface to near bottom. Light levels will be estimated from Secchi disk readings. The researchers undertaking this work should also endeavour to collect existing salinity, water temperature and dissolved oxygen information from the region to provide a seasonal and temporal overview of the salinity and water temperature. It is expected that collected and existing data will be analysed and reported upon within the survey report. Field data is recorded on boat data sheets.

7.2. Sediment Analysis

7.2.1 Sediment Collection

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

7.2.2 Particle Size Analysis

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

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

7.2.3 Organic Content

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

8.0 References

Bolch, C. J. and Hallegraeff, G. M. 1990. Dinoflagellate cysts in recent marine sediments from Tasmania, Australia. Botanica Marina 33: 173-192.

Hewitt, C. L. and Martin, R. B. 1996. Port Surveys for Introduced Marine Species – Background Considerations and Sampling Protocols. CRIMP Technical Report 4. CSIRO Division of fisheries, Hobart.

Hewitt, C. L. and Martin, R. B. 2001. Revised Protocols for Port baseline Surveys for Introduced Marine Species – Survey Design, Sampling Protocols and Specimen Handling. CRIMP Technical Report 22. CSIRO Marine Research, Hobart.

Loeblich, A. R. 1975. A seawater medium for dinoflagellates and the nutrition of *Cachinina niei*. Journal of Phycology 11: 80-86.

Oshima, Y., Sugino, K., Yasumoto, T. 1989. Latest advances in HPLC analysis of paralytic shellfish toxins. pp 319-326. In: Natori, S., Hashimoto, K., Ueno, Y. (eds.). Mycotoxins and Phycotoxins '88. Elsevier Science Publishing Co., New York.

Appendix 2. Geographic locations (NZGD49) of sample sites in the Port Underwood baseline port survey

Site number	Site name	Easting	Northing	Survey method*	Number of sample units
22	Rununder Point	2614108	5987006	BCOR	6
22	Rununder Point	2614108	5987006	CYST	6
22	Rununder Point	2613881	5986749	PHYT	1
22	Rununder Point	2614108	5987006	PHYT	1
22	Rununder Point	2614212	5987037	PHYT	1
22	Rununder Point	2614108	5987006	VISD	1
22	Rununder Point	2613882	5986682	ZOOP	1
22	Rununder Point	2613991	5986734	ZOOP	1
22	Rununder Point	2614176	5986882	ZOOP	1
23	Fighting Bay 1	2611103	5987194	BCOR	6
23	Fighting Bay 1	2611103	5987194	CYST	6
23	Fighting Bay 1	2611026	5986850	PHYT	1
23	Fighting Bay 1	2611040	5986927	PHYT	1
23	Fighting Bay 1	2611061	5986932	PHYT	1
23	Fighting Bay 1	2611103	5987194	SEDIMENT	2
23	Fighting Bay 1	2611103	5987194	VISD	1
23	Fighting Bay 1	2610984	5987005	ZOOP	1
23	Fighting Bay 1	2610985	5987004	ZOOP	1
23	Fighting Bay 1	2610992	5987008	ZOOP	1
24	Fighting Bay 2	2609954	5987050	POIS	1
24	Fighting Bay 2	2610488	5987793	SEINE	1
24	Fighting Bay 2	2610507	5987789	SEINE	1
24	Fighting Bay 2	2610571	5987788	SEINE	1
24	Fighting bay 2	2609946	5987049	VISD	1
24	Fighting Bay 2	2610488	5987793	WRACK	1
24	Fighting Bay 2	2610508	5987787	WRACK	2
25	The Knobbye	2607175	5988308	ANCH	1
25	The Knobbye	2607187	5988368	ANCH	1
25	The Knobbye	2607211	5988268	ANCH	1
25	The Knobbye	2607327	5988275	BSLD	1
25	The Knobbye	2607378	5988270	BSLD	1
25	The Knobbye	2607168	5988376	CYST	1
25	The Knobbye	2607177	5988311	CYST	1
25	The Knobbye	2607211	5988268	CYST	1
25	The Knobbye	2607350	5988234	PHYT	1
25	The Knobbye	2607353	5988266	PHYT	1
25	The Knobbye	2607404	5988251	PHYT	1
25	The Knobbye	2607175	5988308	SEDIMENT	1
25	The Knobbye	2607211	5988268	SEDIMENT	1
25	The Knobbye	2607489	5988175	VISD	1
25	The Knobbye	2607367	5988263	ZOOP	1
25	The Knobbye	2607371	5988244	ZOOP	1
25	The Knobbye	2607401	5988288	ZOOP	1
26	Robertson Pt	2603430	5983387	BSLD	1
26	Robertson Pt	2603444	5983261	BSLD	1
27	Karake Pt	2606655	5984303	BSLD	1
27	Karake Pt	2606679	5984206	BSLD	1
28	Pipi Bay Anchorage 1	2605246	5984908	ANCH	1
28	Pipi Bay Anchorage 1	2605266	5984876	ANCH	1
28	Pipi Bay Anchorage 1	2605270	5984876	ANCH	1
28	Pipi Bay Anchorage 1	2605259	5984973	BSLD	1
28	Pipi Bay Anchorage 1	2605263	5984984	BSLD	1

28	Pipi Bay Anchorage 1	2605240	5984913	CRBTP	3
28	Pipi Bay Anchorage 1	2605258	5984897	CRBTP	3
28	Pipi Bay Anchorage 1	2605218	5984896	CYST	1
28	Pipi Bay Anchorage 1	2605237	5984843	CYST	1
28	Pipi Bay Anchorage 1	2605248	5984865	CYST	1
28	Pipi Bay Anchorage 1	2605266	5984876	SEDIMENT	1
28	Pipi Bay Anchorage 1	2605270	5984876	SEDIMENT	1
28	Pipi Bay Anchorage 1	2605240	5984913	SHRTP	3
28	Pipi Bay Anchorage 1	2605258	5984897	SHRTP	3
28	Pipi Bay Anchorage 1	2605523	5984668	WRACK	3
29	Pipi Bay Anchorage 2	2605643	5985270	BSLD	1
29	Pipi Bay Anchorage 2	2605779	5985266	BSLD	1
29	Pipi Bay Anchorage 2	2605715	5985258	PHYT	1
29	Pipi Bay Anchorage 2	2605744	5985293	PHYT	1
29	Pipi Bay Anchorage 2	2605788	5985263	PHYT	1
29	Pipi Bay Anchorage 2	2605751	5985365	ZOOP	1
29	Pipi Bay Anchorage 2	2605782	5985274	ZOOP	1
29	Pipi Bay Anchorage 2	2605824	5985281	ZOOP	1
30	Kaikoura Bay	2606198	5986211	ANCH	1
30	Kaikoura Bay	2606268	5986118	ANCH	1
30	Kaikoura Bay	2606290	5986143	ANCH	1
30	Kaikoura Bay	2604157	5986261	BSLD	1
30	Kaikoura Bay	2606194	5986228	BSLD	1
30	Kaikoura Bay	2606110	5986209	CYST	1
30	Kaikoura Bay	2606112	5986209	CYST	1
30	Kaikoura Bay	2606130	5986210	CYST	1
30	Kaikoura Bay	2606098	5986230	PHYT	1
30	Kaikoura Bay	2606132	5986301	PHYT	1
30	Kaikoura Bay	2606167	5986258	PHYT	1
30	Kaikoura Bay	2606198	5986211	SEDIMENT	1
30	Kaikoura Bay	2606268	5986118	SEDIMENT	1
30	Kaikoura Bay	2606295	5985908	WRACK	2
30	Kaikoura Bay	2606301	5985902	WRACK	1
30	Kaikoura Bay	2606103	5986259	ZOOP	1
30	Kaikoura Bay	2606110	5986303	ZOOP	1
30	Kaikoura Bay	2606142	5986247	ZOOP	1
31	Whataroa Bay	2606857	5986107	ANCH	1
31	Whataroa Bay	2606890	5986104	ANCH	1
31	Whataroa Bay	2606938	5986112	ANCH	1
31	Whataroa Bay	2606887	5986105	BSLD	1
31	Whataroa Bay	2606900	5986061	BSLD	1
31	Whataroa Bay	2606866	5986050	CYST	1
31	Whataroa Bay	2606873	5986062	CYST	1
31	Whataroa Bay	2606878	5986082	CYST	1
31	Whataroa Bay	2606874	5986129	PHYT	1
31	Whataroa Bay	2606892	5986065	PHYT	1
31	Whataroa Bay	2606898	5986082	PHYT	1
31	Whataroa Bay	2606857	5986107	SEDIMENT	1
31	Whataroa Bay	2606938	5986112	SEDIMENT	1
31	Whataroa Bay	2606784	5985860	SEINE	1
31	Whataroa Bay	2606814	5985866	SEINE	1
31	Whataroa Bay	2606814	5985867	SEINE	1
31	Whataroa Bay	2606884	5985879	WRACK	2
31	Whataroa Bay	2606892	5985879	WRACK	1
31	Whataroa Bay	2606899	5986105	ZOOP	1
31	Whataroa Bay	2606904	5986099	ZOOP	1
31	Whataroa Bay	2606917	5986089	ZOOP	1
32	Hakana Bay Anchorage 1	2608927	5989359	ANCH	1

32	Hakana Bay Anchorage 1	2608942	5989393	ANCH	1
32	Hakana Bay Anchorage 1	2608950	5989385	ANCH	1
32	Hakana Bay Anchorage 1	2608067	5989628	BSLD	1
32	Hakana Bay Anchorage 1	2609182	5989536	BSLD	1
32	Hakana Bay Anchorage 1	2608930	5989330	CYST	1
32	Hakana Bay Anchorage 1	2608931	5989345	CYST	1
32	Hakana Bay Anchorage 1	2608951	5989422	CYST	1
32	Hakana Bay Anchorage 1	2609114	5989547	PHYT	1
32	Hakana Bay Anchorage 1	2609161	5989563	PHYT	1
32	Hakana Bay Anchorage 1	2609205	5989568	PHYT	1
32	Hakana Bay Anchorage 1	2608942	5989393	SEDIMENT	1
32	Hakana Bay Anchorage 1	2608950	5989385	SEDIMENT	1
32	Hakana Bay anchorage 1	2609573	5989607	SEINE	3
32	Hakana Bay anchorage 1	2609237	5989344	WRACK	3
32	Hakana Bay Anchorage 1	2609140	5989540	ZOOP	1
32	Hakana Bay Anchorage 1	2609175	5989534	ZOOP	1
32	Hakana Bay Anchorage 1	2609183	5989544	ZOOP	1
33	Hakana Bay Anchorage 2	2609020	5989964	ANCH	1
33	Hakana Bay Anchorage 2	2609028	5989952	ANCH	1
33	Hakana Bay Anchorage 2	2609035	5989963	ANCH	1
33	Hakana Bay Anchorage 2	2608863	5990073	BSLD	1
33	Hakana Bay Anchorage 2	2608864	5990081	BSLD	1
33	Hakana Bay Anchorage 2	2609020	5989964	CYST	1
33	Hakana Bay Anchorage 2	2609023	5989962	CYST	1
33	Hakana Bay Anchorage 2	2609035	5989963	CYST	1
33	Hakana Bay Anchorage 2	2609020	5989964	SEDIMENT	1
33	Hakana Bay Anchorage 2	2609028	5989952	SEDIMENT	1
34	Kingfish Bay	2605505	5988307	ANCH	1
34	Kingfish Bay	2605509	5988272	ANCH	1
34	Kingfish Bay	2605538	5988309	ANCH	1
34	Kingfish Bay	2605325	5988346	BSLD	1
34	Kingfish Bay	2605446	5988368	BSLD	1
34	Kingfish Bay	2605505	5988331	CYST	1
34	Kingfish Bay	2605510	5988354	CYST	1
34	Kingfish Bay	2605514	5988351	CYST	1
34	Kingfish Bay	2605385	5988339	PHYT	1
34	Kingfish Bay	2605391	5988364	PHYT	1
34	Kingfish Bay	2605393	5988360	PHYT	1
34	Kingfish Bay	2605505	5988307	SEDIMENT	1
34	Kingfish Bay	2605538	5988309	SEDIMENT	1
34	Kingfish Bay	2605636	5988287	WRACK	3
34	Kingfish Bay	2605379	5988360	ZOOP	1
34	Kingfish Bay	2605380	5988347	ZOOP	1
34	Kingfish Bay	2605387	5988387	ZOOP	1
35	Opihi Bay	2605915	5990466	ANCH	1
35	Opihi Bay	2605965	5990545	ANCH	1
35	Opihi Bay	2605989	5990613	ANCH	1
35	Opihi Bay	2606007	5990625	BSLD	1
35	Opihi Bay	2606067	5990518	BSLD	1
35	Opihi Bay	2605975	5990593	CYST	1
35	Opihi Bay	2605985	5990613	CYST	1
35	Opihi Bay	2605989	5990623	CYST	1
35	Opihi Bay	2605915	5990466	SEDIMENT	1
35	Opihi Bay	2605989	5990613	SEDIMENT	1
36	Oyster Bay	2603427	5988866	ANCH	1
36	Oyster Bay	2603430	5988891	ANCH	1
36	Oyster Bay	2603433	5988869	ANCH	1
36	Oyster Bay	2603470	5988889	BSLD	1

36	Oyster Bay	2603511	5988915	BSLD	1
36	Oyster Bay	2603436	5988849	CYST	1
36	Oyster Bay	2603457	5988906	CYST	1
36	Oyster Bay	2603457	5988927	CYST	1
36	Oyster Bay	2603501	5988966	PHYT	1
36	Oyster Bay	2603507	5988966	PHYT	1
36	Oyster Bay	2603509	5988920	PHYT	1
36	Oyster Bay	2603374	5988885	PSC	4
36	Oyster Bay	2603376	5988897	PSC	8
36	Oyster Bay	2603374	5988885	PSCM	3
36	Oyster Bay	2603430	5988891	SEDIMENT	1
36	Oyster Bay	2603433	5988869	SEDIMENT	1
36	Oyster Bay	2603261	5989183	SEINE	1
36	Oyster Bay	2603287	5989214	SEINE	1
36	Oyster Bay	2603385	5989201	SEINE	1
36	Oyster Bay	2603240	5989190	WRACK	3
36	Oyster Bay	2603475	5988950	ZOOP	1
36	Oyster Bay	2603477	5988946	ZOOP	1
36	Oyster Bay	2603501	5988937	ZOOP	1
37	Ocean Bay	2602148	5985358	ANCH	1
37	Ocean Bay	2602243	5985468	ANCH	1
37	Ocean Bay	2602268	5985276	ANCH	1
37	Ocean Bay	2602055	5985373	BSLD	1
37	Ocean Bay	2602160	5985311	BSLD	1
37	Ocean Bay	2602286	5985396	CYST	1
37	Ocean Bay	2602319	5985408	CYST	1
37	Ocean Bay	2602322	5985319	CYST	1
37	Ocean Bay	2602135	5985386	PHYT	1
37	Ocean Bay	2602139	5985325	PHYT	1
37	Ocean Bay	2602150	5985366	PHYT	1
37	Ocean Bay	2602148	5985358	SEDIMENT	1
37	Ocean Bay	2602243	5985468	SEDIMENT	1
37	Ocean Bay	2602116	5985365	ZOOP	1
37	Ocean Bay	2602117	5985373	ZOOP	1
37	Ocean Bay	2602152	5985323	ZOOP	1
38	Robin Hood Bay	2600092	5982624	ANCH	1
38	Robin Hood Bay	2600105	5982567	ANCH	1
38	Robin Hood Bay	2600180	5982636	ANCH	1
38	Robin Hood Bay	2600106	5982757	BSLD	1
38	Robin Hood Bay	2600115	5982853	BSLD	1
38	Robin Hood Bay	2600092	5982624	CYST	2
38	Robin Hood Bay	2600105	5982567	CYST	1
38	Robin Hood Bay	2600092	5982624	SEDIMENT	1
38	Robin Hood Bay	2600105	5982567	SEDIMENT	1
39	Port Underwood Inner HbrApp1	2602769	5983701	ANCH	1
39	Port Underwood Inner HbrApp1	2602787	5983800	ANCH	1
39	Port Underwood Inner HbrApp1	2602888	5983605	ANCH	1
39	Port Underwood Inner HbrApp1	2602714	5983586	BSLD	1
39	Port Underwood Inner HbrApp1	2602834	5983666	BSLD	1
39	Port Underwood Inner HbrApp1	2602871	5983690	CYST	1
39	Port Underwood Inner HbrApp1	2602882	5983689	CYST	1
39	Port Underwood Inner HbrApp1	2602891	5983680	CYST	1
39	Port Underwood Inner HbrApp1	2602840	5983586	PHYT	1
39	Port Underwood Inner HbrApp1	2602840	5983757	PHYT	1
39	Port Underwood Inner HbrApp1	2602842	5983664	PHYT	1
39	Port Underwood Inner HbrApp1	2602769	5983701	SEDIMENT	1
39	Port Underwood Inner HbrApp1	2602888	5983605	SEDIMENT	1
39	Port Underwood Inner HbrApp1	2602853	5983602	ZOOP	1

39	Port Underwood Inner HbrApp1	2602860	5983634	ZOOP	1
39	Port Underwood Inner HbrApp1	2602887	5983587	ZOOP	1
40	Port Underwood Inner HbrApp2	2604232	5986415	ANCH	1
40	Port Underwood Inner HbrApp2	2604254	5986569	ANCH	1
40	Port Underwood Inner HbrApp2	2604285	5986522	ANCH	1
40	Port Underwood Inner HbrApp2	2604081	5986341	BSLD	1
40	Port Underwood Inner HbrApp2	2604222	5986432	BSLD	1
40	Port Underwood Inner HbrApp2	2604052	5986485	CYST	1
40	Port Underwood Inner HbrApp2	2604097	5986405	CYST	1
40	Port Underwood Inner HbrApp2	2604152	5986413	CYST	1
40	Port Underwood Inner HbrApp2	2604028	5986266	PHYT	1
40	Port Underwood Inner HbrApp2	2604047	5986225	PHYT	1
40	Port Underwood Inner HbrApp2	2604095	5986230	PHYT	1
40	Port Underwood Inner HbrApp2	2604232	5986415	SEDIMENT	1
40	Port Underwood Inner HbrApp2	2604285	5986522	SEDIMENT	1
40	Port Underwood Inner HbrApp2	2604029	5986265	ZOOP	1
40	Port Underwood Inner HbrApp2	2604050	5986246	ZOOP	1
40	Port Underwood Inner HbrApp2	2604079	5986231	ZOOP	1
41	Port Underwood Inner HbrApp3	2606026	5987249	ANCH	1
41	Port Underwood Inner HbrApp3	2606060	5987307	ANCH	1
41	Port Underwood Inner HbrApp3	2606168	5987322	ANCH	1
41	Port Underwood Inner HbrApp3	2606128	5987270	BSLD	1
41	Port Underwood Inner HbrApp3	2606213	5987220	BSLD	1
41	Port Underwood Inner HbrApp3	2606070	5987308	CYST	1
41	Port Underwood Inner HbrApp3	2606159	5987320	CYST	1
41	Port Underwood Inner HbrApp3	2606168	5987322	CYST	1
41	Port Underwood Inner HbrApp3	2606053	5987277	PHYT	1
41	Port Underwood Inner HbrApp3	2606061	5987265	PHYT	1
41	Port Underwood Inner HbrApp3	2606082	5987299	PHYT	1
41	Port Underwood Inner HbrApp3	2606026	5987249	SEDIMENT	1
41	Port Underwood Inner HbrApp3	2606060	5987307	SEDIMENT	1
41	Port Underwood Inner HbrApp3	2606053	5987289	ZOOP	1
41	Port Underwood Inner HbrApp3	2606079	5987269	ZOOP	1
41	Port Underwood Inner HbrApp3	2606081	5987256	ZOOP	1

*Survey methods: ANCH = anchor box dredge; BCOR = large benthic hand corer; CRBTP = crab trap; CYST = dinoflagellate cyst core; PHYT = phytoplankton net; POIS = fish poison station; PSC = pile scrape quadrats and diver observations on wharf pilings and hard substrata; SEDIMENT = sediment samples; SEINE = beach seine net; SHRTP = shrimp trap; VISD = visual diver transects; WRACK = beach wrack walks; ZOOP = zooplankton net. Photo stills and videos are not listed – these were conducted at the same locations as the PSC locations.

Appendix 3: Sampling site and method combinations specified by MAF Biosecurity New Zealand that were not conducted

Site number	Site name	Sampling method	Replicates	Reason for not sampling
22	Rununder Point	Benthic core	1-6	Too much current Dive aborted; couldn't collect remotely with anchor box dredge because inside Cable Protection Zone
		Cyst core	1-6	Too much current Dive aborted; couldn't collect remotely with javelin spear because inside Cable Protection Zone
		Formal diver visual search	1	Too much current Dive aborted; couldn't do BSLD instead because inside Cable Protection Zone
24	Fighting Bay 2	Beach wrack search	10 m	not sampled because tide not low enough
30	Kaikoura Bay	Beach wrack search	10 m	not sampled because tide not low enough
31	Whataroa Bay	Beach wrack search	10 m	not sampled because tide not low enough
34	Kingfish Bay	Beach wrack search	5 & 10 m	not sampled because tide not low enough
36	Oyster Bay	Beach wrack search	10 m	not sampled because tide not low enough

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

Port Underwood

Media Release **11 April 2007**

Port Underwood to be surveyed for marine pests

Researchers from the National Institute of Water & Atmospheric Research (NIWA) will be surveying Port Underwood, Karaka Bay, and Fighting Bay for foreign marine organisms next week (17 – 23 April).

A similar survey is planned for Kaikoura in May.

The surveys are being carried out as part of Biosecurity New Zealand's national biological baseline survey and resurvey programme.

The programme is designed to determine which non-native marine species have already become established in New Zealand and to develop a baseline for the detection of new pests.

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

The surveys will be weather-dependent and may be postponed if conditions are not favourable.

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

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

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

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

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

For further information, please contact:

Dr Graeme Inglis
NIWA Science
Tel: 03-03 343 8036
Mob: 021 656 773
g.inglis@niwa.co.nz

Mr Brendan Gould

Senior Marine Advisor
Biosecurity New Zealand
Tel: 04 894 0548
brendan.gould@maf.govt.nz

Additional Information

The survey will cover the following sites:

Rununder Point
Fighting Bay
The Knobbye
Robertson Point
Karake Bay
Pipi Bay anchorage
Kaikoura Bay
Whataroa Bay
Hakana Bay anchorage
Kingfish Bay
Opihi Bay
Oyster Bay
Ocean Bay
Robin Hood Bay

Appendix 5: Generic descriptions of representative groups of the main marine phyla collected during sampling

Phylum Annelida

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

Phylum Arthropoda

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

Crustaceans: The crustaceans (including Classes Malacostra, Cirripedia and other smaller classes) represent one of the sea's most diverse groups of organisms, including shrimps, crabs, lobsters, amphipods, tanaids and several other groups. Most crustaceans are motile (capable of movement) although there are also a variety of sessile species (e.g. barnacles). All crustaceans are protected by an external carapace, and most can be recognised by having two pairs of antennae.

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

Phylum Bacillariophyta

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

Phylum Brachiopoda

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

Phylum Bryozoa

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

Phyla Chlorophyta, Rhodophyta and Ochrophyta

Macroalgae: Marine macroalgae are highly diverse and are grouped under several phyla. The green algae are in phylum Chlorophyta; red algae are in phylum Rhodophyta, and the brown algae are in phylum Ochrophyta. Whilst the green and red algae fall under Kingdom Plantae, the brown algae (Phylum Ochrophyta) are grouped in the Kingdom Chromista. Despite their disparate systematics, most red, green and brown algae perform many similar ecological functions. Large macroalgae were sampled that live attached to submerged natural and artificial surfaces including rocks, pilings, ropes and the shells or carapaces of other species.

Phylum Chordata

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

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

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

Phylum Cyanobacteria

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

Phylum Cnidaria

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

Hydrozoa: The class Hydrozoa includes hydroids, fire corals and many medusae. Of these, only hydroids were recorded in the port surveys. Hydroids can easily be mistaken for erect and branching bryozoans. They are also sessile organisms that live attached to submerged natural and artificial surfaces including rocks, pilings, ropes and the shells or carapaces of other species. All hydroids are colonial, with individual colonies consisting of hundreds of individual 'polyps'. Like bryozoans, they feed by filtering small food particles from the water column.

Scyphozoa: Scyphozoans are the true jellyfish.

Phylum Echinodermata

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

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

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

Phylum Magnoliophyta
Seagrasses: The Magnoliophyta are the flowering plants, or angiosperms. Most of these are terrestrial, but the Magnoliophyta also include marine representatives – the seagrasses.

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

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

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

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

Phylum Platyhelminthes

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

Phylum Porifera

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

Phylum Sipuncula

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

Appendix 6: Species information sheets for each non-indigenous species recorded from the Port Underwood survey or desktop review of existing marine species records.

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

Pathways for introduction and dispersal

Likely pathways for the introduction and spread of each species are classified according to the 22 vector categories used by Hayes et al. (2005) in recent risk profiling of priority Australian marine pests (Table 1). Three additional categories – N1, N2, N3 – have been added to describe different pathways for natural spread of the species within New Zealand. For each species, the likely pathways of introduction to New Zealand are largely derived from Cranfield et al. (1998), published information, or expert opinion. The categories met by any given species are indicated in its species information sheet.

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

Code	Description
B1	Biocontrol: deliberate translocation as a biocontrol agent
B2	Biocontrol: accidental translocation with deliberate biocontrol release
C	Canals: natural range expansion through man-made canals
D	Debris: transport of species on human generated debris
F1	Fisheries: deliberate translocations of fish or shellfish to establish or support fishery
F2	Fisheries: accidental with deliberate translocations of fish or shellfish
F3	Fisheries: accidental with fishery products, packing or substrate
F4	Fisheries: accidental as bait
IR1	Individual release: deliberate release by individuals
IR2	Individual release: accidental release by individuals (e.g. aquarium discards)
NB	Navigation buoys and marina floats: accidental as attached or free-living fouling organisms
P1	Plant introductions: deliberate translocation of plant species (e.g. for erosion control)
P2	Plant introductions: accidental with deliberate plant translocations
RE	Recreational equipment: accidental with recreational equipment
S1	Ships: accidental as attached or free-living fouling organisms
S2	Ships: accidental with solid ballast (e.g. rocks, sand, etc)
S3	Ships: accidental with ballast water, sea water systems, live wells or other deck basins
S4	Ships: accidental associated with cargo
S5	Ships: accidental associated with dredge spoil
SP	Seaplanes: accidental as attached or free-living fouling organisms
SR1	Scientific research: deliberate release with research activities
SR2	Scientific research: accidental release with research activities
U	Unknown
N1	Natural: planktonic dispersal
N2	Natural: rafting of adults on biogenic substrata
N3	Natural: long-distance movement of adults

Potential impacts

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

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

Impact category	Code	Description
Human health	H1	Human health
Economic	M1	Aquatic transport
Economic	M2	Water abstraction/nuisance fouling
Economic	M3	Loss of aquaculture/commercial/recreational harvest
Economic	M4	Loss of public/tourist amenity
Economic	M5	Damage to marine structures/archaeology
Environmental	E1	Detrimental habitat modification
Environmental	E2	Alters trophic interactions and food-webs
Environmental	E3	Dominates/out competes and limits resources of native species.
Environmental	E4	Predation of native species
Environmental	E5	Introduces/facilitates new pathogens, parasites or other NIS
Environmental	E6	Alters bio-geochemical cycles
Environmental	E7	Induces novel behavioral or eco-physiological responses
Environmental	E8	Genetic impacts: hybridisation and introgression
Environmental	E9	Herbivory

Distribution maps

We followed the approach used by the Australian National Introduced Marine Pest Information System (NIMPIS) to present information on the global distribution of each species. NIMPIS uses a bioregional classification of the world's oceans developed by The World Conservation Union (IUCN) to define areas for conservation purposes (Kelleher et al. 1995). A conservative approach has been adopted whereby a species is considered present in all areas of a bioregion if it has been recorded from any location within that bioregion's boundaries[1]. Since bioregions represent environmentally similar geographic areas, if a species is present in one portion of a bioregion, there is a strong likelihood that it could spread via natural processes to other areas in that bioregion. Nonetheless, the species does not necessarily occur throughout the entire bioregion. In preparing the maps, published distribution information was not always precise, so if a location record indicated a whole country or large area of coastline and provided no further information, all regions encompassing that country or coastline were shaded on our maps. Also note that the species could occur in other (unshaded) regions, but we have not seen records for these regions. The same conditions apply to the New Zealand distribution maps, which divides New Zealand and its offshore islands into 16 regions (after Francis 1996).

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

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

References

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.

Francis, M.P. (1996). Geographic distribution of marine reef fishes in the New Zealand region. *New Zealand Journal of Marine and Freshwater Research* 30: 35-55.

Kelleher, G., Bleakley, C. and Wells, S. (1995), A Global Representative System of Marine Protected Areas, The World Bank, Washington, USA

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

Appendix 7. Species x sample x site results for all taxa recorded by each method from the Port Underwood survey.

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

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