TECHNICAL PAPER

BIOSECURITY NEW ZEALAND

Port of Lyttelton

Second baseline survey for non-indigenous marine species (Research Project ZBS2000-04)

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Executive summary

- This report describes the results of a repeat port baseline survey of the Port of Lyttelton undertaken in November 2004. The survey provides a second inventory of native, non indigenous and cryptogenic marine species within the port and compares the biota with that recorded during an earlier port baseline survey of the Port of Lyttelton undertaken in March 2002.

- The survey is part of a nationwide investigation of native and non-native marine biodiversity in 13 international shipping ports and three marinas of first entry for yachts entering New Zealand from overseas.

- To allow a direct comparison between the initial baseline survey and the resurvey of the Port of Lyttelton, the survey used the same methodologies and sampled the same sites used in the initial baseline survey. To improve the description of the biota of the port, some additional survey sites were added during the repeat survey.

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

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

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

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

- A total of 245 species or higher taxa were identified in the first survey of the Port of Lyttelton in March 2002. They consisted of 147 native species, 18 non-indigenous species, 38 cryptogenic species (those whose geographic origins are uncertain) and 42 species indeterminata (taxa for which there is insufficient taxonomic or systematic information available to allow identification to species level).

- During the repeat survey, 269 species or higher taxa were recorded, including 151 native species, 23 non-indigenous species, 55 cryptogenic species and 40 species indeterminata. Many species were common to both surveys. Around 57% of the native species, 61% of non-indigenous species, and 44% of cryptogenic species recorded during the repeat survey were also found in the earlier survey.

- The 23 non-indigenous organisms found in the repeat survey of the Port of Lyttelton included representatives of 8 major taxonomic groups. The non-indigenous species detected were: (Annelida) *Polydora hoplura*, *Spirobranchus polytrema*; (Bryozoa) *Bugula flabellata*, *B. neritina*, *Conopeum seurati*, *Cryptosula pallasiana*, *Watersipora subtorquata*, (Cnidaria) *Monotheca pulchella*, *Symplectoscyphus subdichotomus*; (Crustacea) *Apocorophium acutum*, *Crassicorophium bonnellii*, *Jassa slatteryi*, *Monocorophium acherusicum*, *M. sextonae*; (Mollusca) *Theora lubrica*; (Macroalgae) *Griffithsia crassiuscula*, *Polysiphonia brodiaei*, *Polysiphonia senticulosa*, *Undaria pinnatifida*; (Porifera) *Halisarca dujardini*; (Urochordata) *Ascidiella aspersa*, *Ciona intestinalis*, and *Styela clava*. Nine of these species - *Polydora hoplura*, *Spirobranchus polytrema*, *Monotheca pulchella, Symplectoscyphus subdichotomus*, *Crassicorophium bonnellii*, *Polysiphonia senticulosa*, *Halisarca dujardini*, *Ascidiella aspersa*, and *Styela clava* - were not recorded in the earlier baseline survey of the Port of Lyttelton. In addition, three non-indigenous species that were present in the first survey – (Bryozoa) *Tricellaria inopinata*; (Crustacea) *Cancer gibbosulus* and (Macroalgae) *Polysiphonia subtilissima*– were not found during the repeat survey.

- Three *s*pecies recorded in the repeat survey were new records for New Zealand waters. Two of these were newly discovered non-indigenous species (an amphipod, *Crassicorophium bonnellii* and an ascidian, *Styela clava*). The other was a newly discovered sponge (*Haliclona* new sp. 17).

- Two species from the Port of Lyttelton are on the New Zealand register of unwanted organisms: the Asian kelp, *Undaria pinnatifida*, and the club-shaped ascidian, *Styela clava*. *Undaria* is now widely distributed in southern and eastern New Zealand.

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

- Approximately 78 % (18 of 23 species) of NIS in the Port of Lyttelton are likely to have been introduced in hull fouling assemblages, 4 % (1 species) via ballast water and 18 % (4 species) could have been introduced by either ballast water or hull fouling vectors.

- The predominance of hull fouling species in the introduced biota of the Port of Lyttelton (as opposed to ballast water introductions) is consistent with findings from similar port baseline studies overseas

Introduction

Introduced (non-indigenous) plants and animals are now recognised as one of the most serious threats to the natural ecology of biological systems worldwide (Wilcove et al. 1998; Mack et al. 2000). Growing international trade and trans-continental travel mean that humans now intentionally and unintentionally transport a wide range of species outside their natural biogeographic ranges to regions where they did not previously occur. A proportion of these species are capable of causing serious harm to native biodiversity, industries and human health. Recent studies suggest that coastal marine environments may be among the most heavily invaded ecosystems, as a consequence of the long history of transport of marine species by international shipping (Carlton and Geller 1993; Grosholz 2002). Ocean-going vessels transport marine species in ballast water, in sea chests and other recesses in the hull structure, and as fouling communities attached to submerged parts of their hulls (Carlton 1985; Carlton 1999; AMOG Consulting 2002; Coutts et al. 2003). Transport by shipping has enabled hundreds of marine species to spread worldwide and establish populations in shipping ports and coastal environments outside their natural range (Cohen and Carlton 1995; Hewitt et al. 1999; Eldredge and Carlton 2002; Leppakoski et al. 2002).

Like many other coastal nations, New Zealand is just beginning to document the numbers, identity, distribution and impacts of non-indigenous species in its coastal waters. A review of existing records suggested that by 1998, at least 148 marine species had been recorded from New Zealand, with around 90 % of these establishing permanent populations (Cranfield et al. 1998). Since that review, an additional 41 non-indigenous species or suspected non-indigenous species (i.e. Cryptogenic type 1 – see "Definitions of species categories", in methods section) have been recorded from New Zealand waters. To manage the risk from these and other non-indigenous species, better information is needed on the current diversity and distribution of species present within New Zealand.

BIOLOGICAL BASELINE SURVEYS FOR NON-INDIGENOUS MARINE SPECIES

In 1997, the International Maritime Organisation (IMO) released guidelines for ballast water management (Resolution A868-20) encouraging countries to undertake biological surveys of port environments for potentially harmful non-indigenous aquatic species. As part of its comprehensive five-year Biodiversity Strategy package on conservation, environment, fisheries, and biosecurity released in 2000, the New Zealand Government funded a national series of baseline surveys. These surveys aimed to determine the identity, prevalence and distribution of native, cryptogenic and non-indigenous species in New Zealand's major shipping ports and other high risk points of entry for vessels entering New Zealand from overseas. The government department responsible for biosecurity in the marine environment at the time, the New Zealand Ministry of Fisheries (MFish), commissioned NIWA to undertake biological baseline surveys in 13 ports and three marinas that are first ports of entry for vessels entering New Zealand from overseas (Figure 1). Marine biosecurity functions are now vested in MAF Biosecurity New Zealand.

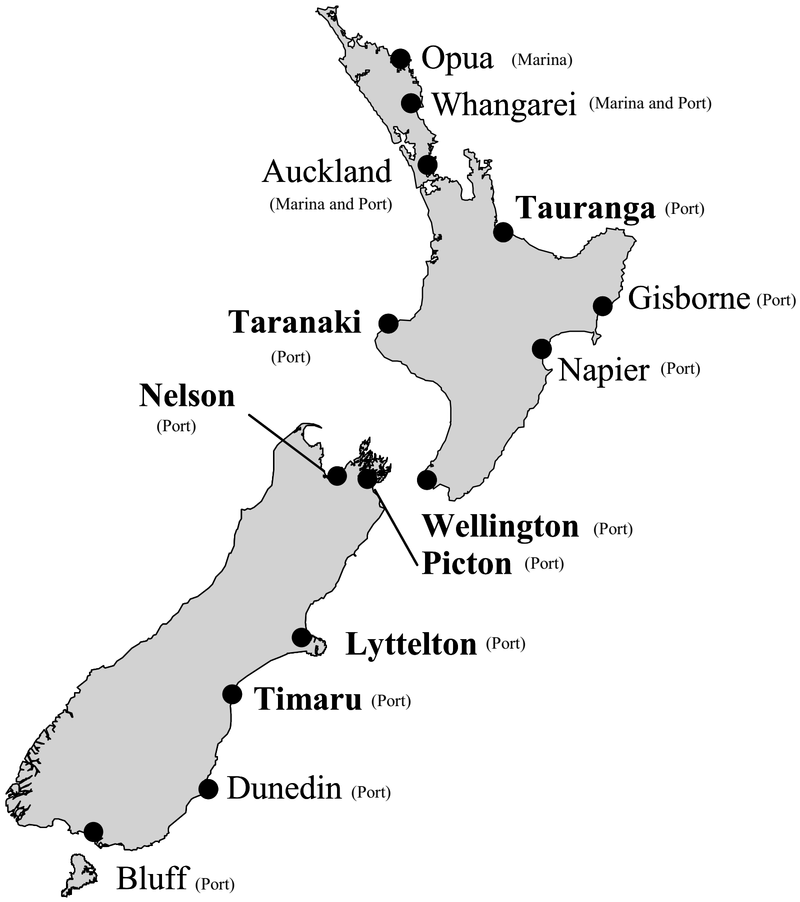

Figure 1: Commercial shipping ports in New Zealand where baseline non-indigenous species surveys have been conducted. Group 1 ports surveyed in the summer of 2001/2002 and re-surveyed in the summer of 2004/2005 are indicated in bold and Group 2 ports surveyed in the summer of 2002/2003 are indicated in plain font. Marinas were also surveyed for NIS in Auckland, Opua and Whangarei in 2002/2003.

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

The surveys have two stated objectives:

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

Initial surveys were completed in New Zealand's 13 major shipping ports and 3 marinas of first entry during the summers of 2001/2002 and 2002/2003 (Figure 1). These surveys recorded more than 1300 species; 124 of which were known or suspected to have been

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

introduced to New Zealand. At least 18 of the non-indigenous species were recorded for the first time in New Zealand in the port baseline surveys. In addition, 106 species that are potentially new to science were discovered during the surveys and await more formal taxonomic description.

Worldwide, port surveys based on the CRIMP protocols have been completed in at least 37 Australian ports, at demonstration sites in China, Brasil, the Ukraine, Iran, South Africa, India, Kenya, and the Seychelles Islands, at six sites in the United Kingdom, and are underway at 10 sites in the Mediterranean (Raaymakers 2003). Despite their wide use, there have been few evaluations of the survey methods or survey design to determine their sensitivity for individual unwanted species or to determine the completeness of biodiversity inventories based upon them. Inglis et al. (2003) used a range of biodiversity metrics to evaluate the adequacy of sample effort and distribution during the initial New Zealand survey of the Port of Wellington and compared the results with those from seven Australian port baseline surveys. In general, they concluded that the surveys provided an adequate description of the richness of the assemblage of non-indigenous species present in the ports, but that the total richness of native and cryptogenic species present in the survey area was likely to be under estimated. The authors made a number of recommendations for future surveys that included increasing the sample effort for benthic infauna, maximising dispersion of samples throughout the survey area (rather than allocation based on CRIMP priorities) and modification of survey methods or design components which had high complementarity in species composition. Both Inglis et al. (2003) and a more recent study by Hayes et al. (2005) on the sensitivity of the survey methods concluded that generalised port surveys, such as these, are likely to under-sample species that are very rare or which have restricted distributions within the port environments and, as such, should not be considered surveys for early detection of unwanted species.

Instead, the port surveys are intended to provide a baseline for monitoring the rate of new incursions by non-indigenous marine species in port environments, and to assist international risk profiling of problem species through the sharing of information with other shipping nations (Hewitt and Martin 2001). Despite the large number of ports that have been surveyed using modifications of the CRIMP protocols, no ports have been completely re-surveyed. This means that there has been no empirical determination of the background rate of new arrivals or of the surveys' ability to detect temporal changes in the composition of native and non-indigenous assemblages.

This report describes the results of a second, repeat survey of the Port of Lyttelton undertaken in November 2004, approximately 3 years after the initial baseline survey. In the manner of the first survey report (Inglis et al. 2006a) we provide an inventory of species recorded during the survey and their biogeographic status as either native, introduced ("non-indigenous") or cryptogenic. Organisms that could not be identified to species level are also listed as species indeterminata (see "Definitions of species categories", in methods section).

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

DESCRIPTION OF THE PORT OF LYTTELTON

General features

The Port of Lyttelton on the east coast of the South Island is located on the northern side of Lyttelton Harbour, a narrow embayment 15 km long on the northern coast of Banks Peninsula, south of the city of Christchurch (Figure 2). The entrance to Lyttelton Harbour is almost 2 km wide and approximately 16 m deep, with a dredged channel (maintained to 11.6 m) leading westwards to the Port (www.lpc.co.nz). Lyttelton Port is one of New Zealand's busiest shipping ports, and the major hub port in the South Island (Inglis 2001).

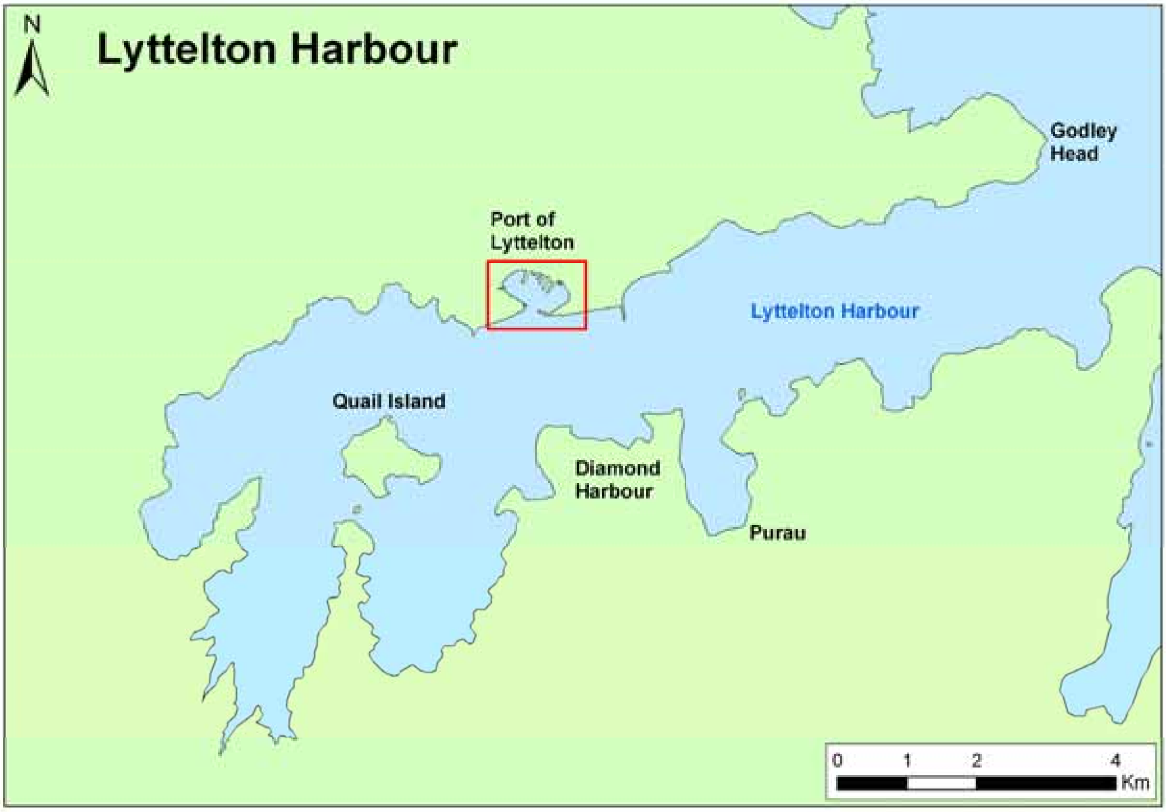

Figure 2: Lyttelton Harbour

Lyttelton Harbour was settled by Māori around 800-900 A.D. The original inhabitants called the harbour area Te-Whaka-raupo. In the early 1800's, European whalers and sealers found Ngai Tahu settlements near Lyttelton. In 1849, the town of Lyttelton was established as a recognised port and the first wharf constructed. In 1877, the Lyttelton Harbour Board was established and the port was progressively developed with a network of wharves, dry dock and stone moles for port protection (Rice 2004). In the 1960's, a nightly inter-island steamer express linked Lyttelton and Wellington (www.teara.govt.nz). The Harbour Board was disestablished in 1988 with the Port Companies Act.

The shoreline of Lyttelton Harbour includes basalt outcrops that extend below waterline to form intertidal and subtidal rocky reefs. The predominantly rocky shore is interspersed with sandy or muddy beaches in numerous embayments. Fine loess from the surrounding hills is the major source of seabed sediments in Lyttelton Harbour. An extensive area of shallow water and mudflats occupies the western end of the harbour, while coarse sand containing a large proportion of crushed shell extends through the middle of the harbour. Currents maintain coarse sand habitats in the middle of the harbour by carrying lighter sediment away

(Royds Garden Ltd. 1993), and mud covers the majority of other parts of the harbour, including the harbour entrance.

Lyttelton Harbour has a mean tidal range of 1.67 m (neap tides) to 1.94 m (spring tides), and a mean tidal velocity of 0.22 m per sec. The tidal circulation observed in the harbour is not completely documented, however it is known that large-scale tidal 'gyres' exist in the eastern half of the harbour, turning clockwise on ebb and counter-clockwise on flood tides. A clockwise eddy forms on ebb tide behind the Cashin Quay breakwater, so that velocities during flood and ebb are persistently westward along the shore and southward along the breakwater (Spigel 1993). The mean volume of water in Lyttelton Port itself has been calculated at 4,666,888 m^3 (Knox 1983). During a mean spring tide approximately 838,272 m^3 of this water is exchanged, which equates to a mean volume exchange of 18 %. On a mean neap tide the volume exchanged is 729,122 m^3, or around 16 % (Royds Garden Ltd. 1992).

Port operation, development and maintenance activities

The Port of Lyttelton, known commercially as Lyttelton Port of Christchurch (www.lpc.co.nz), has a total of 15 main wharves that can accommodate ships of a wide variety of sizes (Figure 3). There is also a public ferry terminal near the tug jetties. Berth construction is a mixture of concrete and wood decking on predominantly Australian hardwood piles. Details of the berthing facilities available in the Port are provided in Table 1. The port has MAF inspection and quarantine, and customs clearance facilities.

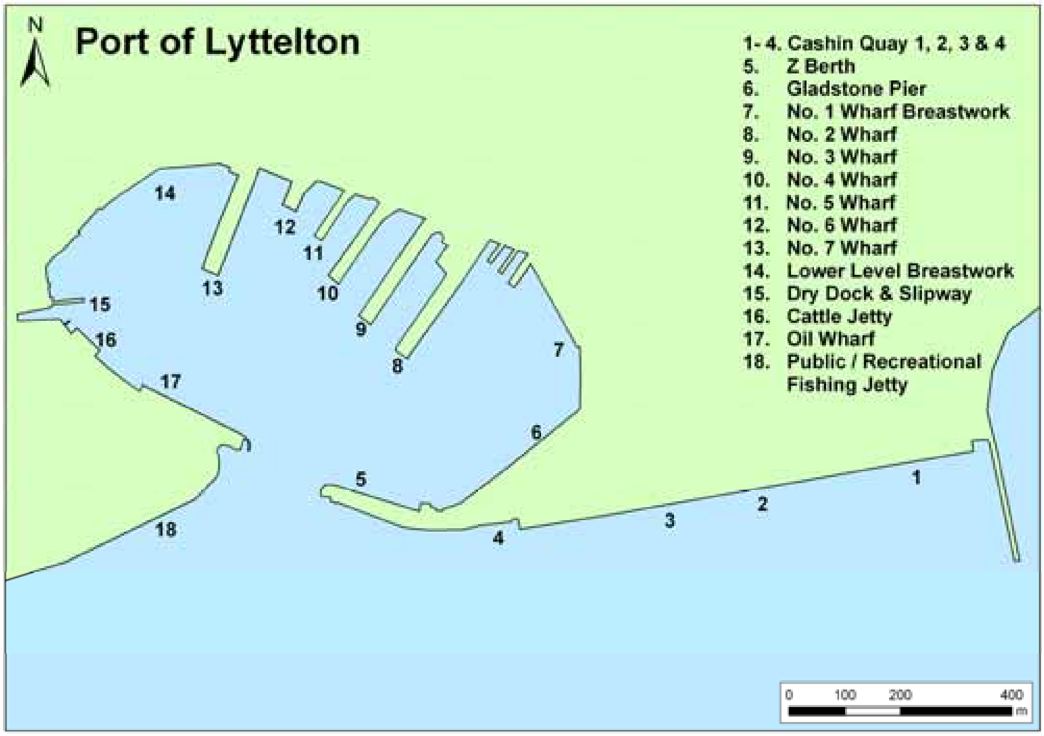

Figure 3: Port of Lyttelton map

Vessels unable to be berthed immediately in the Port may anchor off 1.5 nautical miles north-east of Godley Head in 16.5 m of water. Alternative anchorage for vessels of 8.5 m draught or less is available in Camp Bay in 11 m of water. Pilotage is compulsory on vessels over 500 GRT or over 40 m LOA, unless they have pilot exemption (www.lpc.co.nz).

Maintenance dredging has been conducted in the Port for around 40 years (N. McLennan, Lyttelton Port Company, pers comm.). Approximately 500,000 to 1 million m^3 is dredged annually. This spoil is deposited on-shore on the northern side of the Harbour from Gollans Bay up to the Heads to aid in wave refraction away from the port. There has been no capital dredging conducted since the initial port baseline survey in March 2002 (N. McLennan, pers comm.).

Capital works conducted in the Port area since March 2002 have not included any changes to in-water structures, except the demolition of the B Jetty and its replacement in late 2005 (after the second baseline survey). The B Jetty, located near the tug jetties, had consisted of approximately 40 wooden piles and was replaced by a new floating jetty anchored with four steel piles (N. McLennan, pers comm.). This jetty is used for the public ferries.

Imports and exports

The Port of Lyttelton is the main conduit for Canterbury's export and import activity. In 2003, the Port of Lyttelton shipped 60 % of Canterbury's and 8 % of New Zealand's total merchandise exports and handled 67 % of Canterbury's and 6 % of New Zealand's total merchandise imports (www.lpc.co.nz).

The Port is currently the largest export gateway for coal in New Zealand, with over 2 million tonnes moving through the port each year. It also handles a wide variety of cargoes, including petroleum, fertiliser, gypsum, conventional break-bulk, vehicles, farm machinery, fishing and other cargoes.

In the 2004-2005 financial year, the numbers of containers through the container terminal increased by 10 %, from 161,200 TEU[2] to 177,400 TEU, consisting of 91,620 TEU for imports, 81,110 TEU for export and the remaining for trans-ships, empties and other movements. Total international and domestic containers through the port grew 3 % from 202,800 TEU to 208,600 TEU (Lyttelton Port Company 2005).

The volumes and value of goods imported and exported through the Port of Lyttelton are summarised below. These data describe only cargo being loaded for, or unloaded from, overseas ports and do not include domestic cargo (Statistics New Zealand 2006b). Also available from Statistics New Zealand (2006a) was a breakdown of cargo value by country of origin or destination and by commodity for each calendar year; we analysed the data for the period 2002 to 2005 inclusive (i.e. the period between the first and second baseline surveys).

Imports

Both the weight and value of overseas cargo unloaded at the Port of Lyttelton has increased each year since the 2002 initial baseline survey, with 1,500,909 tonnes gross weight valued at $2,304 million being unloaded in the year ended June 2005 (Statistics New Zealand 2006b). This represents an increase in weight of 24 % and in value of almost 11 % compared to the year ending June 2002 (Table 2). Overseas cargo unloaded at the Port of Lyttelton accounted for around 8 % both by weight and by value of the total overseas cargo unloaded at New Zealand's seaports (Table 2).

The Port of Lyttelton imported cargo in 96 different commodity categories between 2002 and 2005 inclusive (Statistics New Zealand 2006a). The dominant commodities by value imported at the Port of Lyttelton during this time were vehicles (21 % of total value of imports), boilers, machinery and mechanical appliances (10 %), mineral fuels, oils, and products (8 %), plastics and plastic articles (5 %), and paper and paperboard and articles thereof (5 %; Figure 4). These five commodities ranked among the top five imports each year from 2002 to 2005,

[2] TEU = twenty foot equivalent unit. This is a standard size of container and a common measure of capacity in the container logistics business.

with vehicles ranking first each year. Machinery ranked second and mineral fuels and oils ranked third each year, except in 2005 when their ranks were reversed. Plastics ranked fourth and paper ranked fifth each year, except in 2003 when their ranks were reversed (Statistics New Zealand 2006a). Major import commodities by volume, in contrast to value, were reported by the Lyttelton Port Company (2005) to have included fuel (1.1 million tonnes), fertiliser (400,000 tonnes), food and beverage (53,000 tonnes imported), and motor vehicles (51,800 vehicles) during the 2004-2005 financial year.

The Port of Lyttelton received imports from 152 countries of initial origin[3] between 2002 and 2005 inclusive (Statistics New Zealand 2006a). During this time, most imported cargo by value came from Australia (29 %), Japan (20 %) and the People's Republic of China (11 %; Figure 5). These rankings were consistent each year. Singapore ranked fourth each year except in 2002 when it was replaced by Germany, and the USA ranked fifth each year (Statistics New Zealand 2006a).

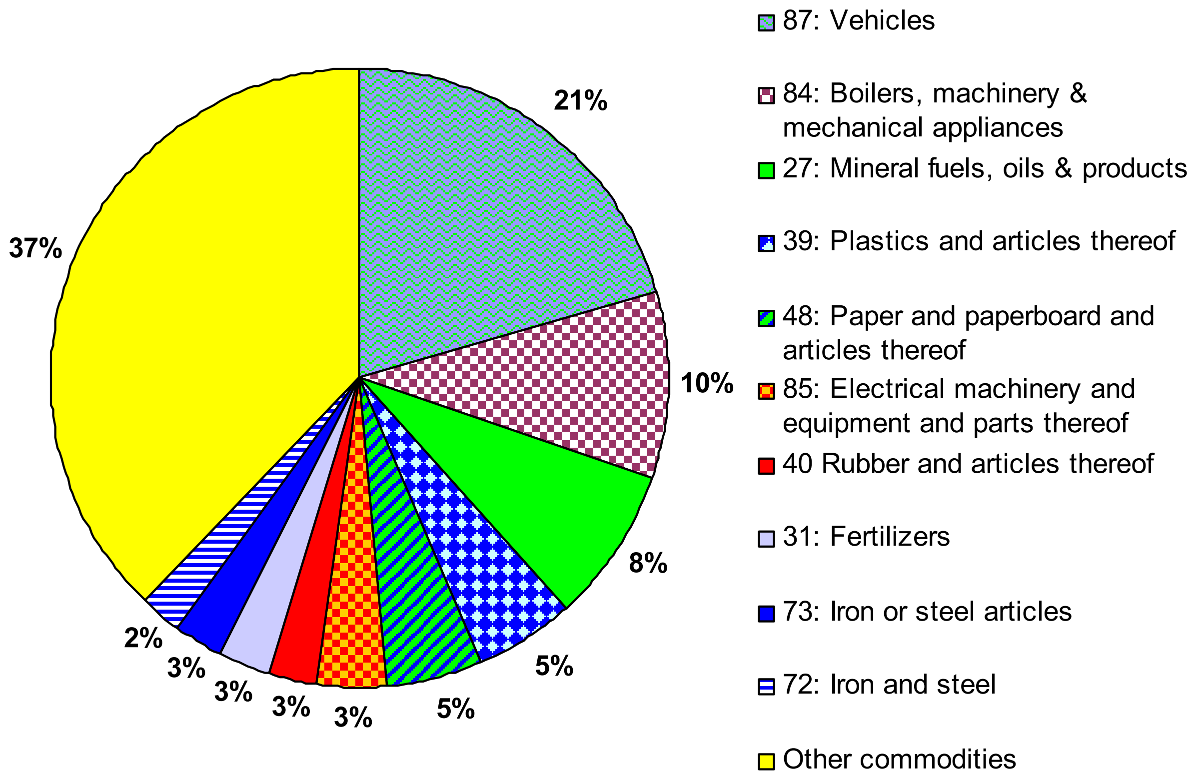

Figure 4: Top 10 commodities by value unloaded at the Port of Lyttelton summed over the period January 2002 to December 2005 inclusive (data sourced from Statistics New Zealand 2006a). Commodity category descriptions have been summarised for brevity; category numbers are provided in the legend and full descriptions are available at Statistics New Zealand (2006a).

[3] The country of initial origin is not necessarily the country that the ship carrying the commodity was in immediately before arriving at the Port of Lyttelton; for ship movements see the section on "Shipping movements and ballast discharge patterns"

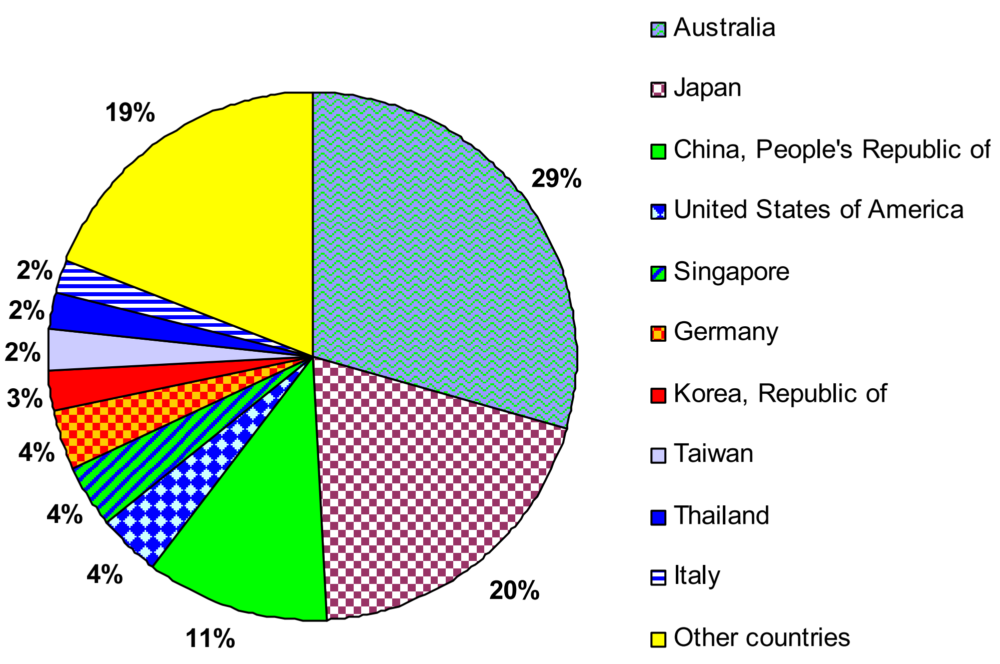

Figure 5: Top 10 countries of initial origin that cargo was unloaded from at the Port of Lyttelton. The data are percentages of the total volume of cargo unloaded in the period January 2002 to December 2005 inclusive (data sourced from Statistics New Zealand 2006a).

Exports

In the year ending June 2005, the Port of Lyttelton loaded 3,086,893 tonnes of cargo for export (Statistics New Zealand 2006b). This represented a 0.2 % decline on the previous year but an increase of 5.5 % compared to the year ending June 2002 (Table 3). The value of this cargo declined almost 22 % since the year ending June 2002, with a value of $2,264 million in the year ending June 2005. For the financial years ending June 2002 to 2005, overseas cargo loaded at the Port of Lyttelton accounted for 12 to 14 % by weight and 9 to 10 % by value of the total overseas cargo loaded at New Zealand's seaports (Table 3).

The Port of Lyttelton exported cargo in 94 different commodity categories between 2002 and 2005 inclusive (Statistics New Zealand 2006a). The dominant commodity categories by value loaded at the Port of Lyttelton for export during this time were wool and animal hair (13 %), dairy produce, bird's eggs, natural honey and other edible animal products (12 %), meat and edible meat offal (10 %), fish, crustaceans, molluscs and other aquatic invertebrates (9 %) and confidential items (8 %; Figure 6). The same five commodities ranked in the top five each year. Dairy and wool ranked first or second each year except in 2005, when Confidential items ranked first with wool ranking second and dairy third. Meat ranked third each year and fish fourth, except in 2005 when they ranked fourth and fifth respectively. Confidential items ranked fifth each year except 2005 (Statistics New Zealand 2006a). Major export commodities by volume are similar to those ranked by value, and were reported by the Lyttelton Port Company (2005) to have included coal (2.1 million tonnes), fish (110,000 tonnes), meat (60,000 tonnes of beef, lamb and venison), wool (60,000 tonnes) and timber (19 % of all containerised exports) during the 2004-2005 financial year..

The Port of Lyttelton loaded cargo for export to 154 countries of final destination[4] between 2002 and 2005 inclusive (Statistics New Zealand 2006a). During this time, the Port of Lyttelton exported most of its overseas cargo by value to Australia (27 %), Japan (13 %) and the People's Republic of China (11 %; Figure 7). These rankings were the same each year, and are similar to the trends for imports at this port (Figure 6).

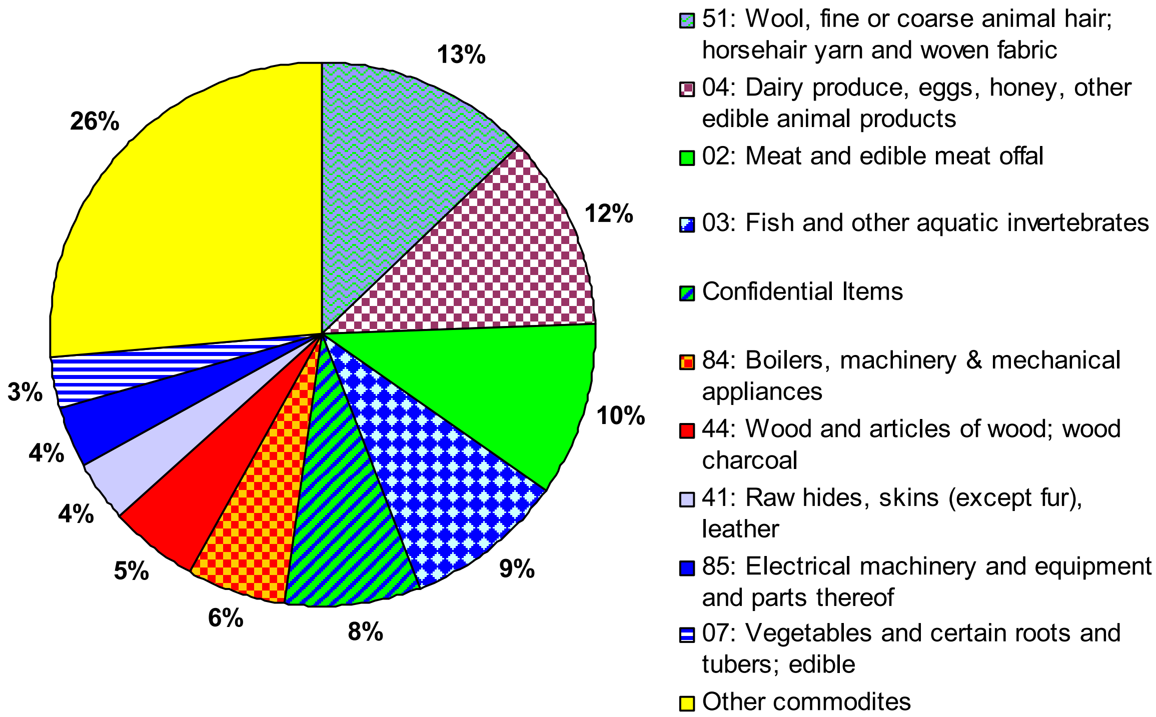

Figure 6: Top 10 commodities by value loaded at the Port of Lyttelton summed over the period January 2002 to December 2005 inclusive (data sourced from Statistics New Zealand 2006a). Commodity category descriptions have been summarised for brevity; category numbers are provided in the legend and full descriptions are available at Statistics New Zealand (2006a).

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

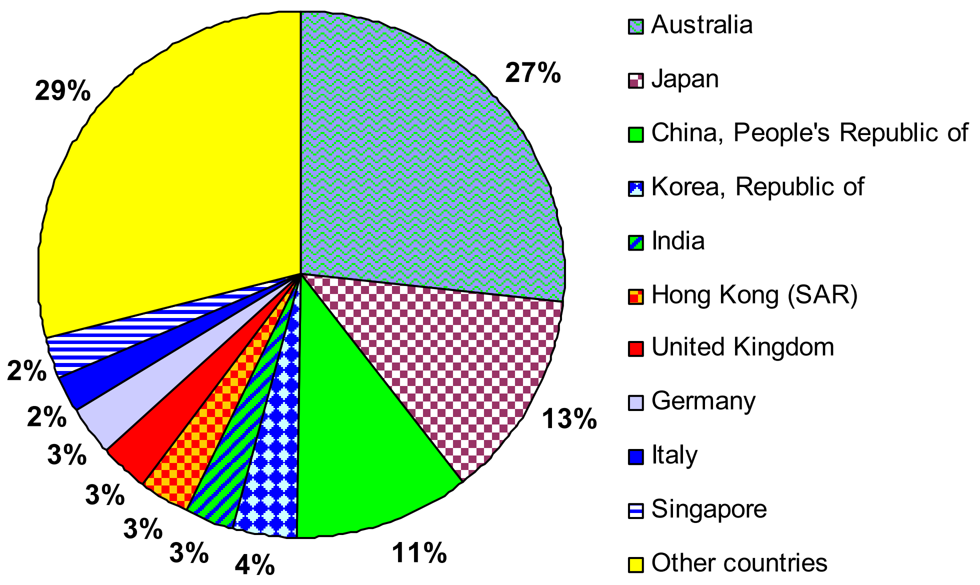

Figure 7: Top 10 countries of final destination that cargo was loaded for at the Port of Lyttelton. The data are percentages of the total cargo loaded at the port for the period January 2002 to December 2005 inclusive (data sourced from Statistics New Zealand 2006a).

Shipping movements and ballast discharge patterns

According to Inglis (2001), a total volume of 354,670 m^3 of ballast water was reported discharged in the Port of Lyttelton in 1999, with the largest country-of-origin volumes of 153,376 m^3 from Japan, 45,396 m^3 from Australia, 36,073 m^3 from Taiwan, and 77,887 m^3 unspecified. Since June 2005, vessels have been required to comply with the Import Health Standard for Ships' Ballast Water from All Countries (www.fish.govt.nz/sustainability/biosecurity). No ballast water is allowed to be discharged without the express permission of an MAF (Ministry of Agriculture and Forestry) inspector. To allow discharge, vessels Masters are responsible for providing the inspector with evidence of either: discharging ballast water at sea (200 nautical miles from the nearest land, and at least 200m depth); demonstrating ballast water is fresh (2.5 ppt sodium chloride) or having the ballast water treated by a MAF approved treatment system.

The Lyttelton Port Company recorded 1,288 domestic and international ship arrivals in the 2004-2005 financial year, including, amongst others, 344 container ships, 116 car ships and 23 cruise liners (many of which made more than one visit, Lyttelton Port Company 2005). The number of ship visits was slightly lower than the 1,293 arrivals in the previous year, and Lyttelton Port Company recently noted that with increasing liner consolidation, it seems highly likely that there will be an increase in ship size and decrease in numbers of port calls in the future (Lyttelton Port Company 2005).

To gain a more detailed understanding of international and domestic vessel movements to and from the Port of Lyttelton between 2002 and 2005 inclusive, we analysed a database of vessel movements generated and updated by Lloyds Marine Intelligence Unit (LMIU), called 'SeaSearcher.com'. Drawing on real-time information from a network of Lloyd's agents and other sources around the world, the database contains arrival and departure details of all ocean going merchant vessels larger than 99 gross tonnes for all of the ports in the Group 1 and Group 2 surveys. The database does not include movement records for domestic or international ferries plying scheduled routes, small domestic fishing vessels or recreational vessels. Cruise ships, coastal cargo vessels and all other vessels over 99 gross tonnes are included in the database. The database therefore gives a good indication of the movements of international and domestic vessels involved in trade. Definitions of geographical area and vessel type categories are given in Appendix 1.

International vessel movements

Based on an analysis of the LMIU database, there were 654 vessel arrivals to the Port of Lyttelton from overseas ports between 2002 and 2005 inclusive (Table 4). These came from 44 different countries represented by most regions of the world. The greatest number of overseas arrivals during this period came from the following areas: Australia (201), Pacific Islands (141), the northwest Pacific (107) and Japan (76; Table 4). The previous ports of call for 19 of the international arrivals were not stated in the database. Vessels arriving from Australia came mostly from ports in Victoria (81 arrivals), Queensland (54) and New South Wales (29; Table 5). The major vessel types arriving from overseas at the Port of Lyttelton were bulk /cement carriers (206 arrivals), container ships and ro/ro (133) and general cargo (126; Table 4).

According to the LMIU database, during the same period 979 vessels departed from the Port of Lyttelton to 44 different countries, also represented by most regions of the world. The greatest number of departures for overseas went to Australian ports as their next port of call (323 movements) followed by Japan (228), east Asian seas (142) and the northwest Pacific (135; Table 6). The major vessel types departing to overseas ports from the Port of Lyttelton were container ships and ro/ro (324 movements), passenger / vehicle / livestock carriers (229), and bulk / cement carriers (210; Table 6).

Domestic vessel movements

The LMIU database contains movement records for 3,291 vessel arrivals to the Port of Lyttelton from New Zealand ports between 2002 and 2005 inclusive. These arrived from 17 different ports in both the North and South Islands (Table 7). The greatest number of domestic arrivals during this period came from Wellington (784 arrivals), Auckland (517 arrivals), Tauranga (434 arrivals), Lyttelton (ie. closed-loop trips; 313 arrivals), and Napier (293 arrivals). Container ships and ro/ro's were by far the dominant vessel type arriving at the Port of Lyttelton from New Zealand ports (1336 arrivals) followed by passenger / vehicle / livestock carriers (501 arrivals), general cargo vessels (484 arrivals), tankers (256 arrivals) and bulk / cement carriers (251 arrivals; Table 7).

During the same period, the LMIU database contains movement records for 2,923 vessel departures from the Port of Lyttelton to 19 New Zealand ports in both the North and South Islands. The most domestic movements departed the Port of Lyttelton for Wellington (613 movements), Nelson (494 movements), Dunedin (464), Lyttelton (ie. closed-loop trips; 313 departures) and New Plymouth (270; Table 8). Container ships and ro/ro's dominated the vessel types leaving the Port of Lyttelton on domestic voyages (1142 departures), followed by general cargo vessels (515 movements), passenger / vehicle / livestock carriers (346 arrivals) and bulk / cement carriers (249 movements; Table 8).

EXISTING BIOLOGICAL INFORMATION

Existing published biological studies that describe marine communities in Lyttelton Harbour are not plentiful. However, the supplement of information from the initial NIWA baseline survey of Lyttelton Harbour (Inglis et al. 2006a) has made a valuable addition to the biological information available in the area. This is explained further in the next section. In addition, the NIWA Client Report by Inglis et al. (Inglis et al. 2006b) describes marine communties in Lyttelton Harbour, with particular emphasis on surveillance for early detection of unwanted organisims in New Zealand Ports.

Over the last three decades a number of biological surveys have been carried out in Lyttelton Harbour and Port, although none of these surveys has specifically focused on collecting and identifying non-indigenous species. We briefly review these studies and their findings below.

Knight (1974) examined benthic communities in the inner two thirds of the harbour, with some of his sampling stations located in the small bay behind the Cashin Quay breakwater. He described four main sediment types in the harbour: sand, muddy sand, predominantly mud and dumped dredged sediments; and attributed different benthic communities to these substrata. A total of 110 species were recorded from the benthic communities, dominated by polychaetes, gastropods and bivalves (Knight 1974).

Knox (1983) surveyed the distribution of rocky intertidal organisms at nine stations from Cashin Quay breakwater into the inner harbour. Three stations were located on the breakwater itself - two on the outer side and one on the inner side. A total of 73 species was recorded from these three stations, consisting of 24 algal and 49 animal species. Knox (1983) also examined the distribution of biota on wharf piles and sampled five stations within the Port in the region of a proposed reclamation near Gladstone Pier. Fourteen species were recorded, with the number of individuals ranging from 496 to 2,088 per m^2, and a mean of 1,199 per m^2. These densities were low compared with values for similar communities elsewhere in New Zealand, and the author suggested this was probably the result of continuous disturbance of sediments by maintenance dredging.

Knox (1993) was commissioned by Royds Garden Ltd to report on the benthic and intertidal assemblages in the vicinity of the Lyttelton sewage outfall in the bay behind Cashin Quay breakwater. The intertidal component of the study involved re-sampling three stations along Cashin Quay sampled by Knox in 1983, and examining five additional sites in the bay behind Cashin Quay breakwater. A total of 49 species was recorded – mainly algae, gastropods and bivalves. It was concluded that this area of the harbour had been greatly impacted by the discharge of sewage, with many animal species virtually eliminated and the shore now dominated by algae. Benthic sampling was undertaken by divers, who took cores at six stations in the small bay behind Cashin Quay, and at a seventh site in an adjacent bay. They described the sediments as fine mud and silt with small pebbles and shell gravel present in most areas. It was noted that the original sediments in the area probably consisted entirely of mud, but that the input of coarse sediments and wind blown sediments from the Port may have modified the composition of the seafloor. A total of benthic 21 species was recorded, and the assemblage was dominated by polychaetes.

Stevens and Forrest (1996) examined chemical contaminants in sediments around the dry dock and slipway areas in the Port. Substrate descriptions were given for each of the 42 sampling stations, along with macrofaunal information relating to taxon richness and abundance at three of these sites. Sediment contaminant levels (copper, mercury, TBT and semi-volatile organic compounds) were greatest adjacent to the dry dock discharge, the patent slip and the boat ramp. Levels were also elevated in front of the engineering workshop, probably due to this area being used as a slipway for about 50 years prior to 1990. Contaminant levels generally decreased with increasing distance from these areas.

A single collection of the introduced Australian brown alga *Dictyota furcellata* was revealed through a herbarium investigation to have been collected from Charteris Bay, opposite the Port of Lyttelton, in 1938 (Nelson et al. 2004). *Dictyota furcellata* was also collected from the upper subtidal zone of Manukau Harbour, Auckland, in April 2000, representing the first reporting of this species from New Zealand waters (the Charteris Bay specimen had been originally identified as *D. dichotoma* var. *implexa*).

The invasive kelp *Undaria pinnatifida* was identified in the Port of Lyttelton in 1991 and has since become abundant throughout the port and much of Lyttelton Harbour (Handley et al. 2000; Sinner et al. 2000; Forrest and Taylor 2002).

Handley et al. (2000) undertook a biological survey of the operations area of the Port of Lyttelton. The fauna and flora of the sub-tidal soft sediment communities and intertidal rocky shores were described and species lists determined. The artificial structures of the Port were found to be well colonised by intertidal and sub-tidal species, and there was a high diversity of species considering the modified habitats present. Some of the sub-tidal benthic species were non-indigenous organisms, including the mollusc *Theora lubrica*, the algae *Undaria pinnatifida*, and the bryozoan *Bugula neritina*. Sub-tidal sediments were well-aerated, soft mud. Fenwick (2003) repeated the study in 2003 with very similar results including the same total number of taxa, although some species were found only in one of the two surveys.

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

Canterbury Regional Council (now Environment Canterbury) commissioned Woodward-Clyde to investigate the contamination of sediments on the seabed at the Port in 2001 (Woodward-Clyde Ltd. 2001). The study reviewed the degree of sediment contamination and the potential for the contaminated sediment to migrate within and outside the Port. They concluded that sediment contamination levels in the inner harbour adjacent to the dry dock generally exceeded ER-M values, i.e. the concentrations at which the United State's National Oceanic and Atmospheric Administration (NOAA) estimated that there is a 50 % probability of toxicity to biota (Long et al. 1995). The outer harbour displayed levels tending below the ER-L concentration (concentration at which NOAA determined approximately 10 % probability of toxicity. Toxicity tests confirmed that sediments at several locations within both the inner and outer harbour were toxic to benthic species.

As part of the environmental monitoring of the impacts of dredging and spoil dumping in Lyttelton Harbour, Thompson and Barter (2005) sampled for species abundance of benthic macrofauna at 12 sites in the Harbour, and described the intertidal habitats at White Patch Point, an area of rock cliff face adjacent to a major spoil dumping area, and at Rapaki Bay, an area of productive intertidal flats in the upper harbour. Two non-indigenous taxa (the Asian kelp *Undaria pinnatifida* and the bivalve *Theora lubrica*) and one cryptogenic species (the colonial ascidian *Diplosoma listerianum*) were reported from the survey. *Undaria pinnatifida* was reported as being abundant in the low tide zone at White Patch Point and common in the low tide zone of Rapaki Bay. *Theora lubrica* was reported from six of the twelve macrofaunal monitoring sites (Godley Head Light, Godley Head, Gollans Bay, Quail Island East, Quail Island North and Rapaki Bay). *Diplosoma listerianum* was reported only from the low tide zone of White Patch Point, where it was sparsely distributed (Thompson and Barter 2005). The twelve macrofaunal monitoring sites sites fell into five distinct groupings based on their benthic macrofaunal community composition, with key distinguishing characteristics between groups being the presence / absence and relative abundance of polychaete worms (such as *Heteromastus filiformis, Cossura consimilis, Sphaerosyllis hirsula* and *Armandia maculata*), the small bivalve *Arthritica bifurca*, nematodes, and tanaid shrimps (Thompson and Barter 2005). The report also noted a high degree of variability in species abundance and diversity between surveys and suggested this was mostly due to natural sedimentation processes in the Harbour, but may also be affected by the changing sedimentation patterns resulting from the ongoing maintenance dredging in the port. Species abundance lists are provided in the report for each sampling site.

Bottom sediments in the vicinity of the Port of Lyttelton Oil Terminal Wharf were sampled in October 2005 for benthos and petroleum residues (G. Fenwick and C. Chague-Goff, NIWA, pers. comm.). Suggestions of contamination by polycyclic aromatic hydrocarbons (PAH) from a source close to or at the western end of the Oil Wharf were found. Lower densities were found of total benthic fauna and of most major benthic invertebrate taxonomic groups compared to the 2003 monitoring survey (Fenwick 2003), suggesting a negative effect of some event since 2003, particularly closer to the Oil Wharf compared to further away in the mid-harbour. Taxa were identified to Order or higher for this sampling and the presence or absence of non-indigenous species was not considered (G. Fenwick and C. Chague-Goff, pers. comm.).

A technical review is currently being prepared of the existing marine ecological data for Lyttelton Harbour (L. Bolton-Ritchie, pers. comm.). Species lists containing 156 intertidal taxa and 208 subtidal taxa have been compiled from the existing data for the harbour. However, differences in sampling and sample processing methodologies, differences in numbers of replicate samples and differences in taxonomic resolution between studies have made it difficult to compare data between studies and over time (L. Bolton-Ritchie, pers. comm.). The list includes the non-indigenous species *Amathia distans, Bugula neritina, Bugula sp., Watersipora sp.* (bryozoans), *Cliona celata* (a sponge), *Theora lubrica* (a bivalve mollusc), *Corophium acherusicum* (an amphipod crustacean), *Ascidiella aspersa, Ciona intestinalis* (ascidians), and *Undaria pinnatifida* (a brown alga). The list also includes the cryptogenic (see "Definitions of species categories", below) species *Halecium delicatulum, Plumularia setacea* (hydroids), *Hymeniacidon perleve* (a sponge)*, Asterocarpa cerea, Botryllus schlosseri and Diplosoma listerianum* (ascidians). The species *Codium fragile* was also listed. There are native and non-indigenous subspecies of this species in New Zealand. Their growth form is very similar and the subspecies are indistinguishable without microscopic examination. The non-indigenous subspecies has not been reported from Lyttelton.

RESULTS OF THE FIRST BASELINE SURVEY

An initial baseline survey of the Port of Lyttelton was completed in March 2002 (Inglis et al. 2006a). The report identified a total of 246 species or higher taxa. They consisted of 150 native species, 20 non-indigenous species, 22 cryptogenic species (those whose geographic origins are uncertain) and 54 species indeterminata (taxa for which there is insufficient taxonomic or systematic information available to allow identification to species level). Fourteen species of marine organisms collected from the Port of Lyttelton had not previously been described from New Zealand waters. One of these was a non-indigenous crab (*Cancer gibbosulus*) and a second, the ascidian *Cnemidocarpa* sp., was thought to be non-indigenous. The 12 other new species were considered cryptogenic. They included seven species of amphipods and five species of sponge which did not match existing species descriptions and may have been new to science.

Since the first survey was completed, several species recorded in it have been re-classified as a result of new information or re-examination of specimens during identification of material from the repeat baseline survey. For example, the ascidian, *Cnemidocarpa* sp., was subsequently re-identified as a native species (*Cnemidocarpa nisiotus*). A second species, listed as non-indigenous (the amphipod *Stenothoe* sp. aff. *S. gallensis*) in the initial report, is suspected of being the cosmopolitan amphipod, *S. gallensis*, but its identity cannot be confirmed from the specimens available and, as such, it is more appropriately classified in our "Cryptogenic Type 1" category (see below). The revised summary statistics for the Port of Lyttelton following re-classification were 147 native species, 18 non-indigenous species, 38 cryptogenic species and 42 species indeterminata. These revisions have been incorporated into the comparison of data from the two surveys below.

The 18 non-indigenous organisms described from the Port of Lyttelton included representatives of six major taxonomic groups. The non-indigenous species detected were: *Bugula flabellata, Bugula neritina, Tricellaria inopinata, Cryptosula pallasiana, Conopeum seurati, Watersipora subtorquata* (Bryozoa), *Haliplanella lineata* (Cnidaria), *Apocorophium acutum, Monocorophium acherusicum, Monocorophium sextonae, Jassa slatteryi, Cancer gibbosulus* (Crustacea), *Theora lubrica* (Mollusca), *Undaria pinnatifida, Griffithsia crassiuscula, Polysiphonia brodiaei, Polysiphonia subtilissima* (Macroalgae), and *Ciona intestinalis* (Urochordata). The only species on the New Zealand register of unwanted organisms found in the Port of Lyttelton initial baseline survey was the Asian kelp, *Undaria pinnatifida*. This alga is known to now have a wide distribution in southern and eastern New Zealand. Approximately 78 % (14 of 18 species) of non-indigenous species recorded in the Port of Lyttelton initial baseline survey were likely to have been introduced in hull fouling assemblages, 5 % (one species) via ballast water and 17 % (3 species) could have been introduced by either ballast water or hull fouling vectors.

Methods

SURVEY METHOD DEVELOPMENT

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

The sampling methods used in this survey were based on the CSIRO Centre for Research on Introduced Marine Pests (CRIMP) protocols developed for baseline port surveys in Australia (Hewitt and Martin 1996; Hewitt and Martin 2001). CRIMP protocols have been adopted as a standard by the International Maritime Organisation's Global Ballast Water Management Programme (GloBallast). Variations of these protocols are being applied to port surveys in many other nations. A group of New Zealand marine scientists reviewed the CRIMP protocols and conducted a workshop in September 2001 to assess their feasibility for surveys in this country (Gust et al. 2001). A number of recommendations for modifications to the protocols ensued from the workshop and were implemented in surveys throughout New Zealand. The modifications were intended to ensure cost effective and efficient collection of baseline species data for New Zealand ports and marinas. The modifications made to the CRIMP protocols and reasons for the changes are summarised in Table 9. Further details are provided in Gust et al. (2001).

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. Below, we describe the methods and sampling effort used for the re-survey of the Port of Lyttelton. The survey was undertaken from 1st-5th November 2004.

DIVER OBSERVATIONS AND COLLECTIONS ON WHARF PILES

Fouling assemblages were sampled on four pilings at each berth. Selected pilings were separated by 10 – 15 m and comprised two pilings on the outer face of the berth and, where possible, two inner pilings beneath the berth (Gust et al. 2001). On each piling, four quadrats (40 cm x 25 cm) were fixed to the outer surface of the pile at water depths of approximately -0.5 m, -1.5 m, -3.0 m and -7 m. A diver descended slowly down the outer surface of each pile and filmed a vertical transect from approximately high water to the base of the pile, using a digital video camera in an underwater housing. On reaching the sea floor, the diver then ascended slowly and captured high-resolution still images of each quadrat using the photo capture mechanism on the video camera. Because of limited visibility, four overlapping still images, each covering approximately ¼ of the area of the quadrat were taken for each quadrat. A second diver then removed fouling organisms from the piling by scraping the organisms inside each quadrat into a 1-mm mesh collection bag, attached to the base of the quadrat (Figure 8). Once scraping was completed, the sample bag was sealed and returned to the laboratory for processing. The second diver also made a visual search of each piling for potential invasive species and collected samples of large conspicuous organisms not represented in quadrats. Opportunistic visual searches were also made of breakwalls and rock facings within the commercial port area. Divers swam vertical profiles of the structures and collected specimens that could not be identified reliably in the field.

BENTHIC FAUNA

Benthic infauna was sampled using a Shipek grab sampler deployed from a research vessel moored adjacent to the berth (Figure 9), with samples collected from within 5 m of the edge of the berth. The Shipek grab removes a sediment sample of ~3 *l* and covers an area of approximately 0.04 m^2 on the seafloor to a depth of about 10 cm. It is designed to sample unconsolidated sediments ranging from fine muds and sands to hard-packed clays and small cobbles. Because of the strong torsion springs and single, rotating scoop action, the Shipek grab is generally more efficient at retaining samples intact than conventional VanVeen or Smith McIntyre grabs with double jaws (Fenwick *pers obs*). Three grab samples were taken at haphazard locations along each sampled berth. Sediment samples were washed through a 1-mm mesh sieve and animals retained on the sieve were returned to the field laboratory for sorting and preservation.

Figure 8: Diver sampling organisms on pier piles.

Figure 9: Shipek grab sampler: releasing benthic sample into bucket

EPIBENTHOS

Larger benthic organisms were sampled using an Ocklemann sled (hereafter referred to as a “sled”). The sled is approximately one meter long with an entrance width of ~0.7 m and height of 0.2 m. A short yoke of heavy chain connects the sled to a tow line (Figure 10). 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.

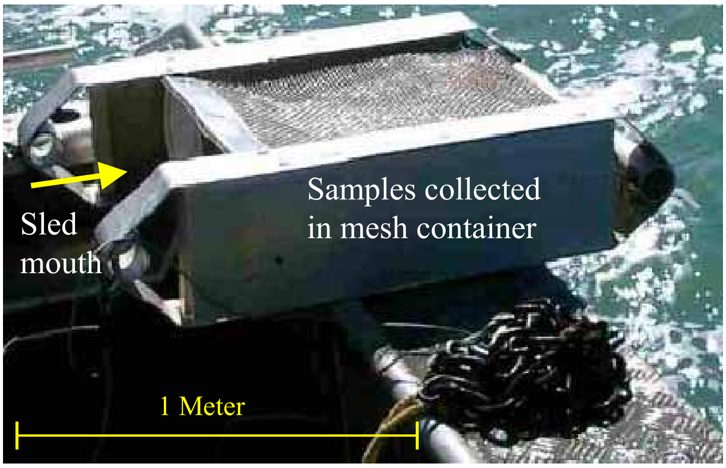

Figure 10: Benthic sled

SEDIMENT SAMPLING FOR CYST-FORMING SPECIES

A TFO gravity corer (hereafter referred to as a “javelin corer”) was used to take small sediment cores for dinoflagellate cysts (Figure 11). The corer consists of a 1.0-m long x 1.5-cm diameter hollow stainless steel shaft with a detachable 0.5-m long head (total length = 1.5 m). Directional fins on the shaft ensure that the javelin travels vertically through the water so that the point of the sampler makes first contact with the seafloor. The detachable tip of the javelin is weighted and tapered to ensure rapid penetration of unconsolidated sediments to a depth of 20 to 30 cm. A thin (1.2 cm diameter) sediment core is retained in a perspex tube within the hollow spearhead. In muddy sediments, the corer preserves the vertical structure of the sediments and fine flocculant material on the sediment surface more effectively than hand-held coring devices (Matsuoka and Fukuyo 2000). The javelin corer is deployed and retrieved from a small research vessel. Cyst sample sites were not constrained to the berths sampled by pile scraping and trapping techniques. Sampling focused on high sedimentation areas within the Port and avoided areas subject to strong tidal flow. On retrieval, the perspex tube was removed from the spearhead and the top 5 cm of sediment retained for analysis. Sediment samples were kept on ice and refrigerated prior to culturing. Culture procedures generally followed those described by Hewitt and Martin (2001).

MOBILE EPIBENTHOS

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

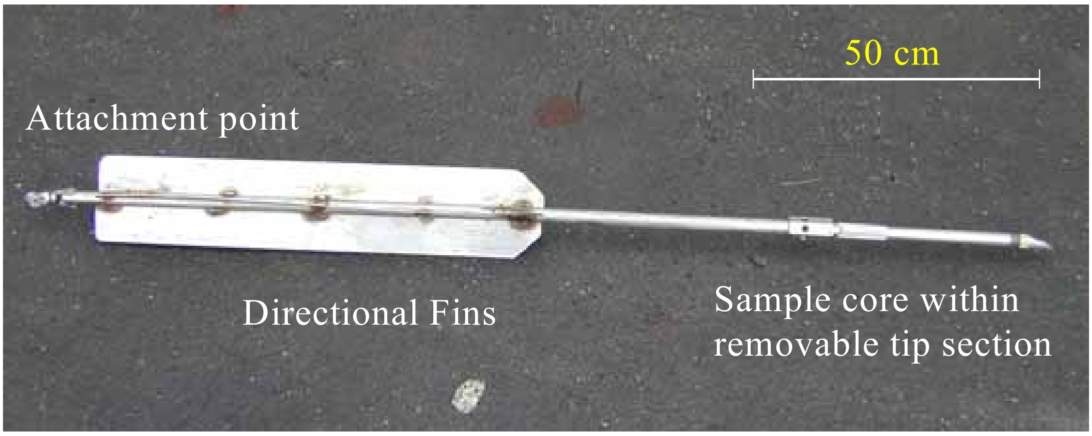

Figure 11: Javelin corer

Opera house fish traps

Opera house fish traps (1.2 m long x 0.8 m wide x 0.6 m high) were used to sample fishes and other bentho-pelagic scavengers (Figure 12). These traps were covered in 1-cm^2 mesh netting and had entrances on each end consisting of 0.25 m long tunnels that tapered in diameter from 40 to 14 cm. The trap was baited with two dead pilchards (*Sardinops neopilchardus*) held in plastic mesh suspended in the centre of the trap. Two trap lines, each containing two opera house traps were set for a period of 1 hour at each site before retrieval. Previous studies have shown opera house traps to be more effective than other types of fish trap and that consistent catches are achieved with soak times of 20 to 50 minutes (Ferrell et al. 1994; Thrush et al. 2002).

Box traps

Fukui-designed box traps (63 cm x 42 cm x 20 cm) with a 1.3 cm mesh netting were used to sample mobile crabs and other small epibenthic scavengers (Figure 12). A central mesh bait holder containing two dead pilchards was secured inside the trap. Organisms attracted to the bait enter the traps through slits in inward sloping panels at each end. Two trap lines, each containing two box traps, were set on the sea floor at each site and left to soak overnight before retrieval.

Starfish traps

Starfish traps designed by Whayman-Holdsworth were used to catch asteroids and other large benthic scavengers (Figure 12). These are circular hoop traps with a basal diameter of 100 cm and an opening on the top of 60 cm diameter. The sides and bottom of the trap are covered with 26-mm mesh and a plastic, screw-top bait holder is secured in the centre of the trap entrance (Andrews et al. 1996). Each trap was baited with two dead pilchards. Two trap lines, each with two starfish traps were set on the sea floor at each site and left to soak overnight before retrieval.

Shrimp traps

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

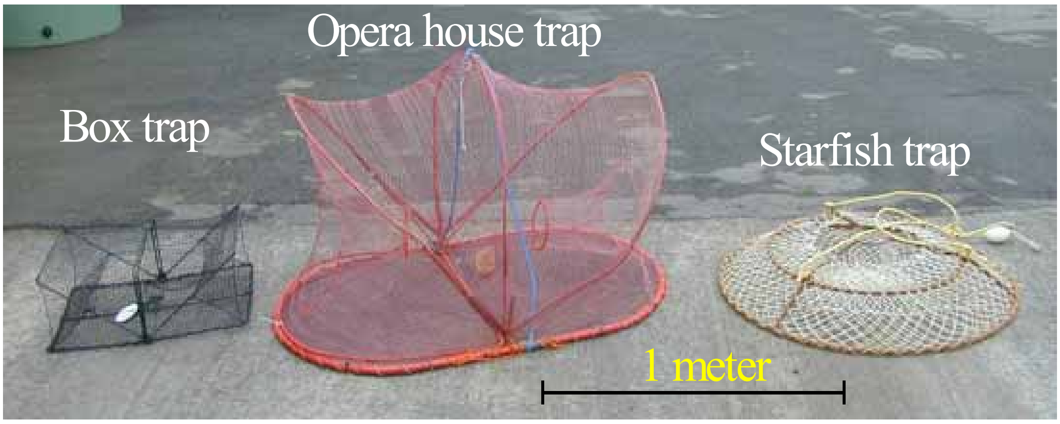

Figure 12: Trap types deployed in the port.

SAMPLING EFFORT

A summary of sampling effort during the second baseline survey of the Port of Lyttelton is provided in Table 10, and the exact geographic locations of sample sites are given in Appendix 2. The distribution of effort aimed to maximise spatial coverage and represent the diversity of active berthing sites within the area. Total sampling effort was constrained by the costs of processing and identifying specimens obtained during the survey.

During the initial baseline survey, most sample effort was concentrated around five berths - Cashin Quay 3, Gladstone Pier, Oil Wharf, Wharf 2, and Wharf 4 - that were spread throughout the port and that represented a range of active berths and lay-up areas (Figure 3). Additional trap and benthic sled samples were taken near the Cattle Jetty and duplicate javelin cores were taken from four sites distributed throughout the port basin and Cashin Quay (Inglis et al. 2006a). These same locations were sampled during the re-survey of the port, except trapping and benthic grabs were conducted at Cashin Quay 4 instead of Cashin Quay 3 in the re-survey, due to a ship being berthed in Cashin Quay 3 at the time of the survey, and pile scraping was conducted at Wharf 3 instead of Wharf 2 for the same reason. To improve description of the flora and fauna in the resurvey, we increased replication by adding an additional berth site for all survey techniques (Wharf 7) and through the addition of four additional sites each for trapping, benthic sled and grab samples. Five sites were sampled for dinoflagellate cysts using the javelin corer.

The spatial distribution of sampling effort for each of the sample methods is indicated in the following figures: diver pile scrapings (Figure 13), benthic sledding (Figure 14), box, starfish and shrimp trapping (Figure 15), opera house fish trapping (Figure 16), shipek grab sampling (Figure 17) and javelin cyst coring (Figure 18).

SORTING AND IDENTIFICATION OF SPECIMENS

Each sample collected in the survey was allocated a unique code on waterproof labels and transported to a nearby field laboratory where it was sorted by a team into broad taxonomic groups (e.g. ascidians, barnacles, sponges etc.). These groups were then preserved and individually labelled. Details of the preservation techniques varied for many of the major taxonomic groups collected, and the protocols adopted and preservative solutions used are indicated in Table 11. Specimens were subsequently sent to over 25 taxonomic experts (Appendix 3) 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 12) and the marine pest list produced by the Australian Ballast Water Management Advisory Council (Table 13).

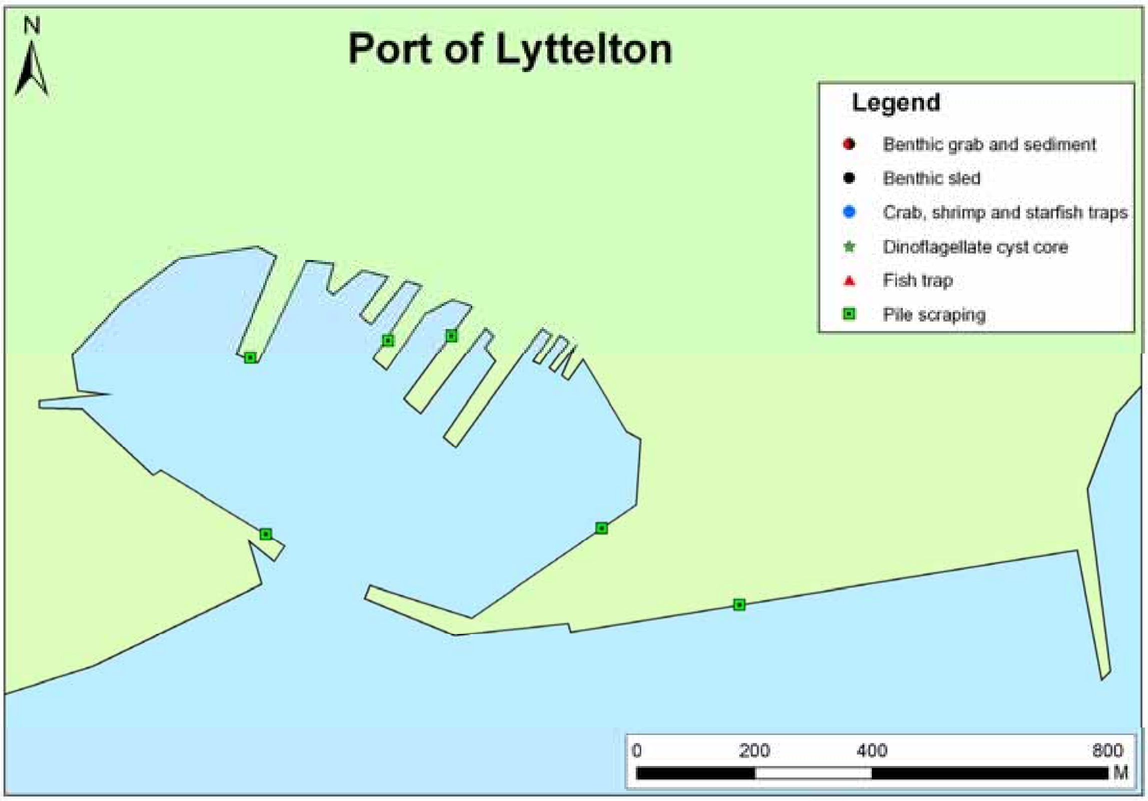

Figure 13: Diver pile scraping sites

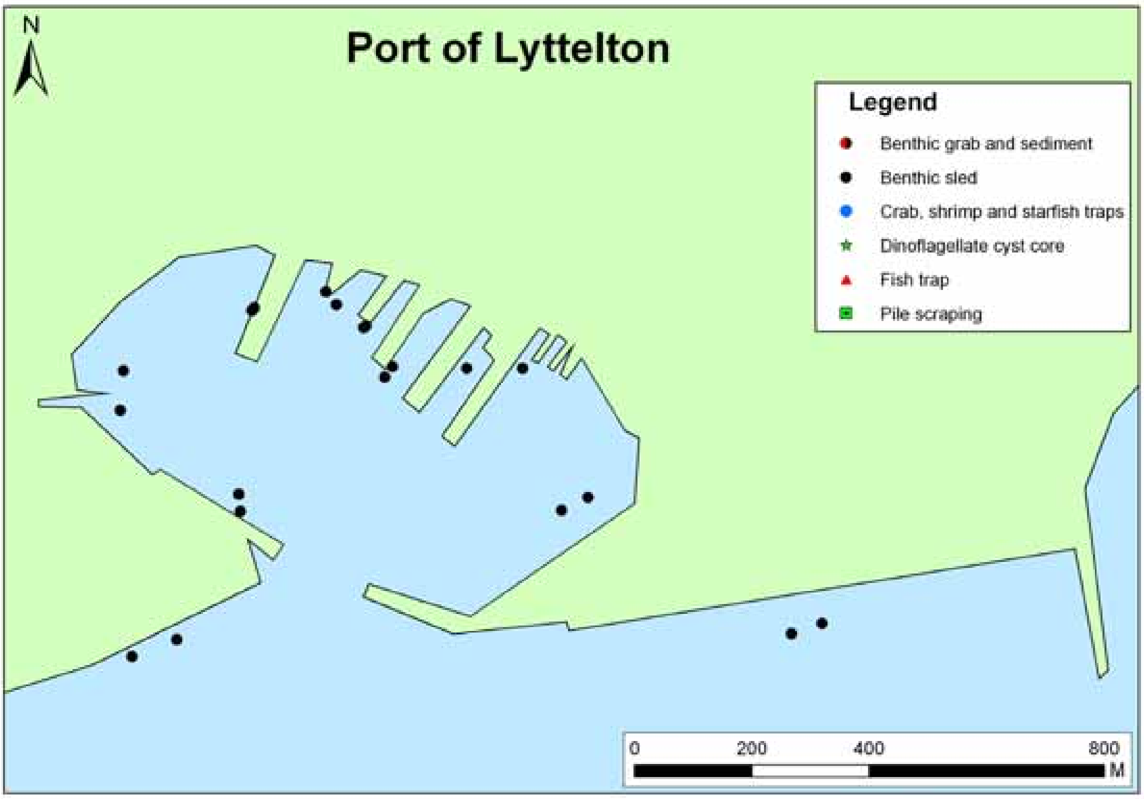

Figure 14: Benthic sled sites

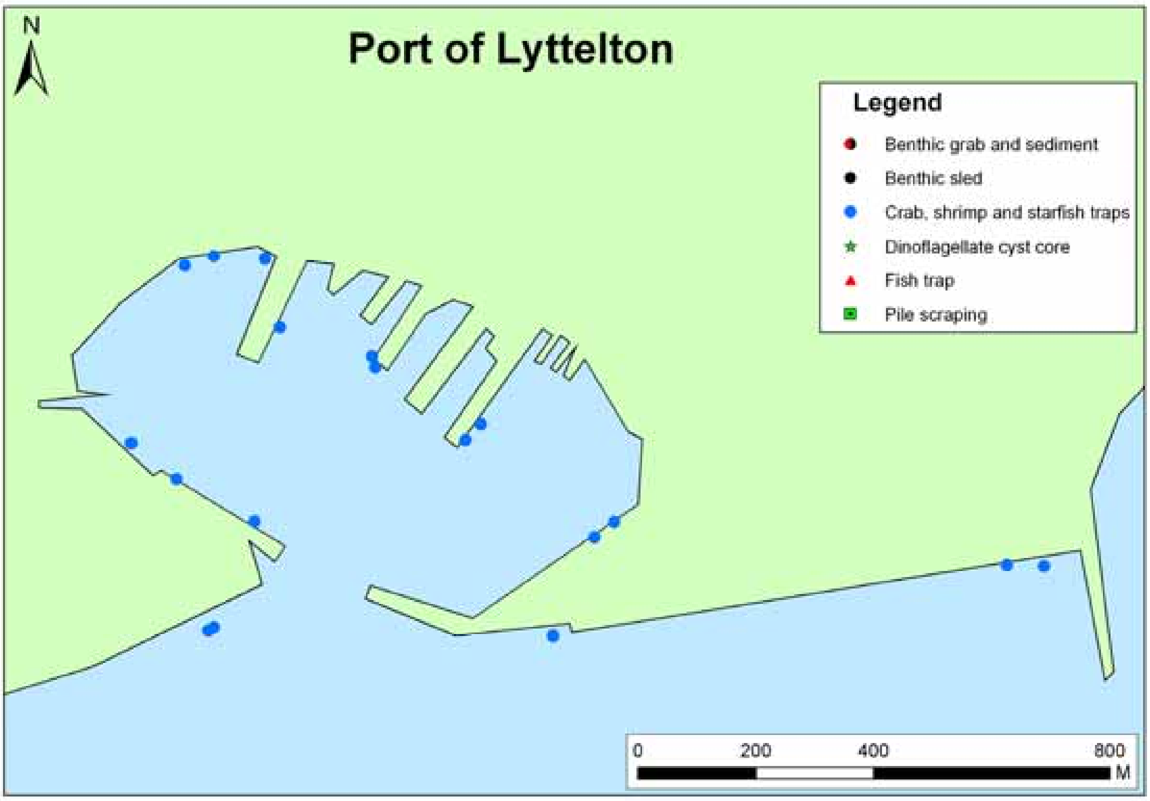

Figure 15: Sites trapped using box (crab), shrimp and starfish traps

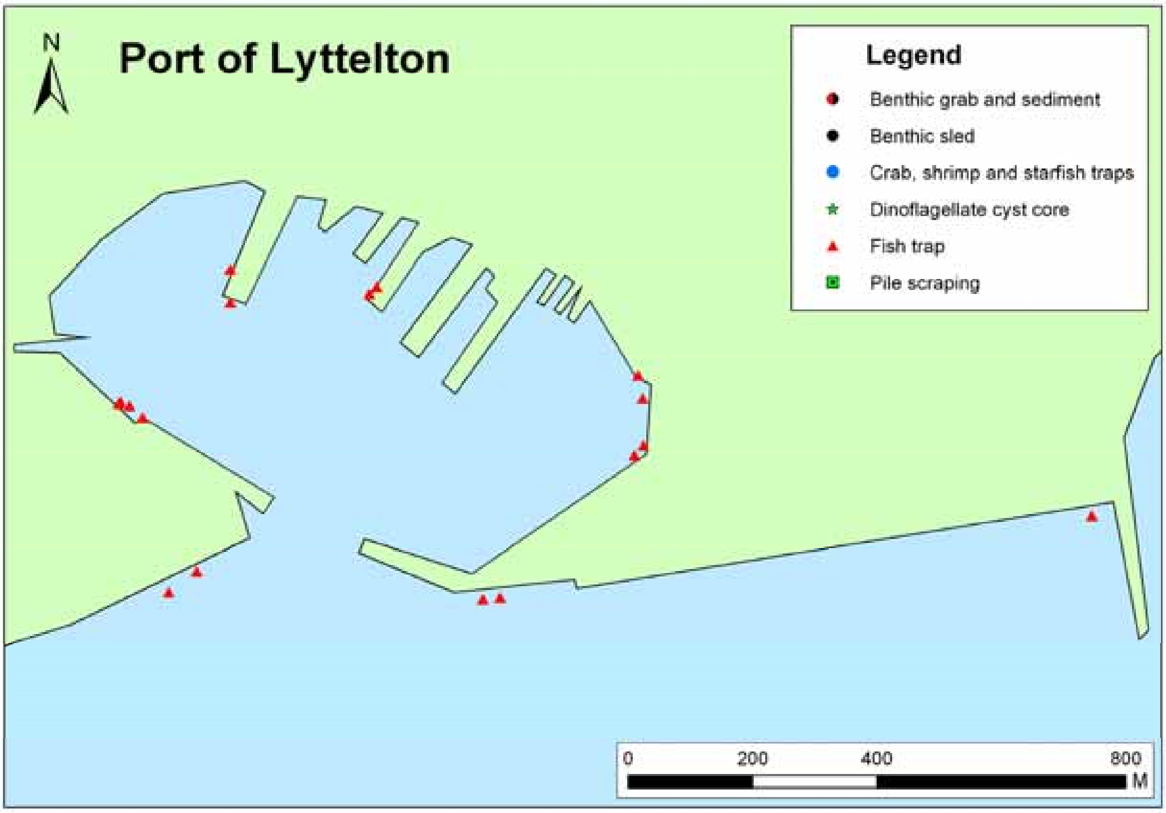

Figure 16: Opera house (fish) trapping sites

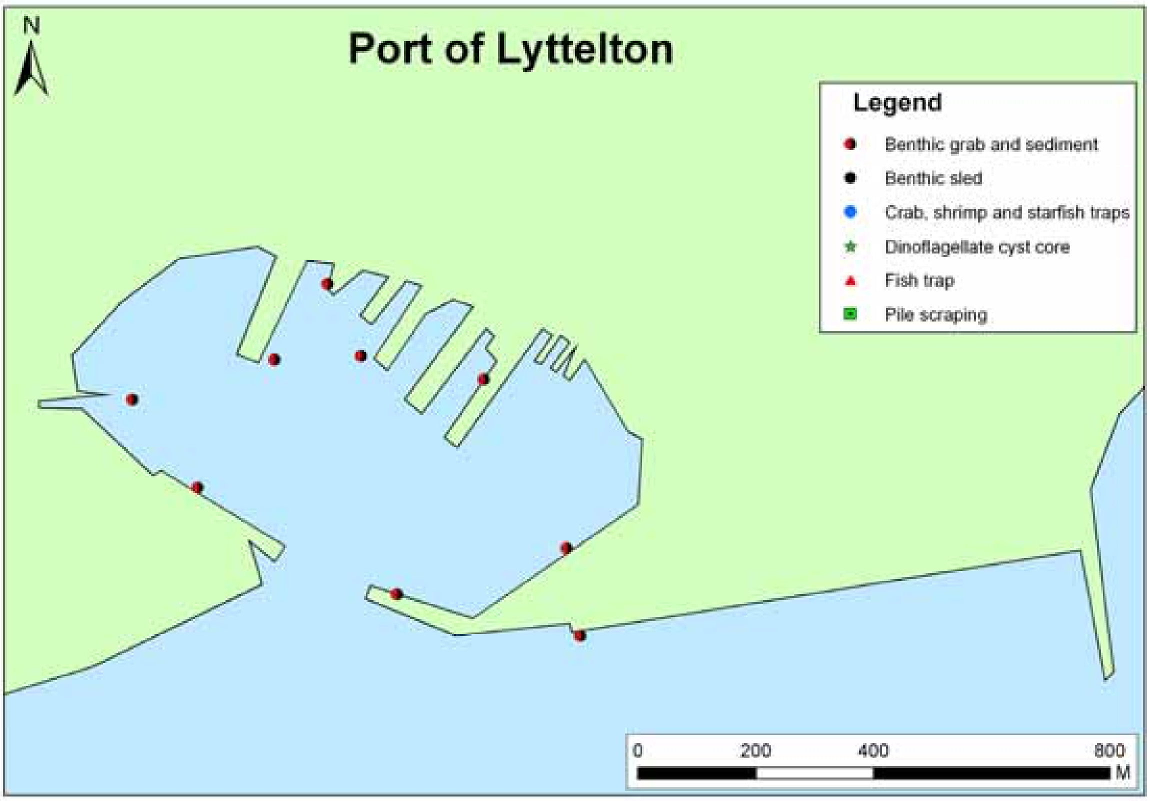

Figure 17: Shipek benthic grab sites

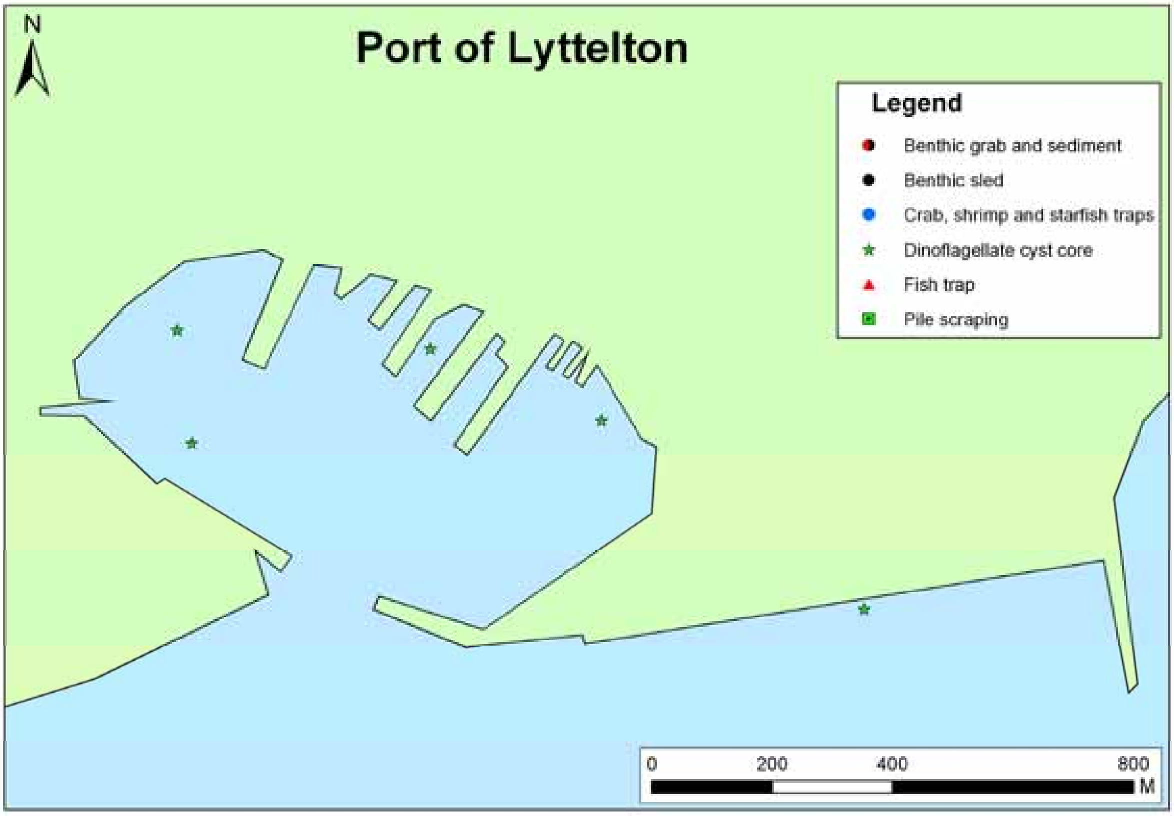

Figure 18: Javelin core (cyst sampling) sites

DEFINITIONS OF SPECIES CATEGORIES

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

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

Native species

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

Non-indigenous species (NIS)

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

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

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

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

Cryptogenic species Category 1

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

Cryptogenic species Category 2

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

Species indeterminata

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

DATA ANALYSIS

Comparison with the initial baseline survey

Several approaches were used to compare the results of the current survey with the earlier baseline survey of the Port of Lyttelton, completed in 2002 (Inglis et al. 2006a).

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

Tanaidacea (tanaids), Class Scyphozoa (jellyfish), Phylum Platyhelminthes (flatworms) and Class Anthozoa (sea anemones)) were specifically excluded from analyses as, at the time the reports were prepared, we had been unable to secure identification of specimens from the resurvey.

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

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

Sample-based rarefaction curves

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

Separate curves were computed for each of six methods: pile scraping, benthic sleds, benthic grabs, crab traps, fish traps and starfish traps. The remaining methods did not usually recover enough taxa to allow meaningful analyses. For pile scrapes, only quadrat samples were used; specimens collected on qualitative visual searches of piles were not included. Since the purpose of the port surveys is primarily inventory of non-indigenous species, we generated separate curves for native species, cryptogenic category 2 species, and the combined species pool of non-indigenous and cryptogenic category 1 taxa, where there were sufficient numbers of taxa to produce meaningful curves (arbitrarily set at > 8 taxa per category). This was possible for pile scrapes and benthic sleds; for the other survey methods, all taxa (excluding species indeterminata) were pooled in order to have sufficient numbers of taxa.

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

Estimates of total species richness

Estimates of total species richness (or more appropriately total "species density") in each survey were calculated using the Chao 2 estimator. This is a non-parametric estimate of the true number of species in an assemblage that is calculated using the numbers of rare species (those that occur in just one or two sample units) in the sample (Colwell and Coddington 1994). That is, it estimates the total number of species present, including the proportion that was present, but not detected by the survey ("unseen" species). As recommended by Chao (in Colwell 2005), we used the bias-corrected Chao 2 formula, except when the CV > 0.5, in which case the estimates were recalculated using the Chao 2 classic formula, and the higher of the Chao 2 classic and the ICE (Incidence-based Coverage Estimator)was reported.

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

Similarity analyses

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

Survey results

A total of 269 species or higher taxa were identified from the re-survey of the Port of Lyttelton. This collection consisted of 151 native (Table 14), 55 cryptogenic (Table 15), and 23 non-indigenous species (Table 16), with the remaining 40 taxa being made up of species indeterminata (Table 17, Figure 19). In comparison, 245 taxa were recorded from the initial survey of the port in March 2002, comprising 147 native species, 38 cryptogenic species,18 non-indigenous species and 42 species indeterminata.

The biota in the re-survey included a diverse array of organisms from 13 major taxonomic groups (Figure 20). For general descriptions of the main groups of organisms (major taxonomic groups) encountered during this study refer to Appendix 4, and for detailed species lists collected using each method refer to Appendix 6.

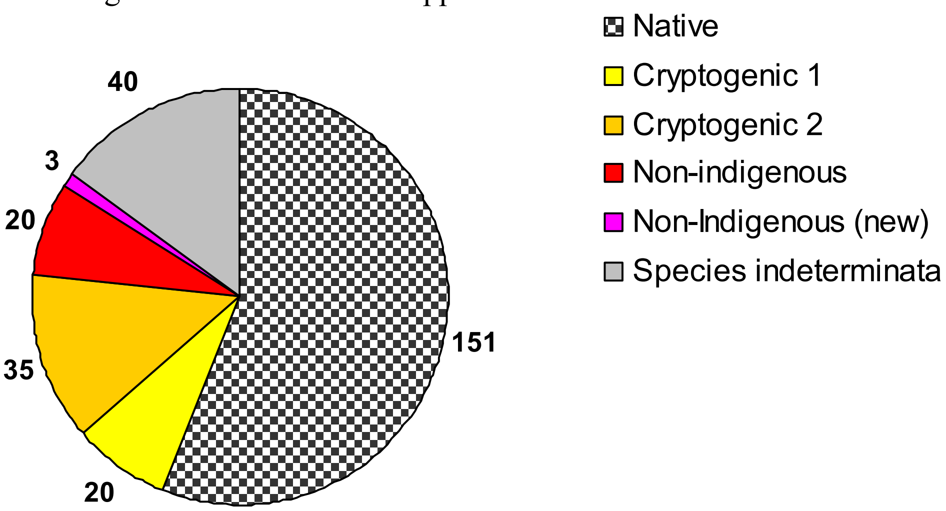

Figure 19: Diversity of marine species sampled in the Port of Lyttelton. Values indicate the number of taxa in each category.

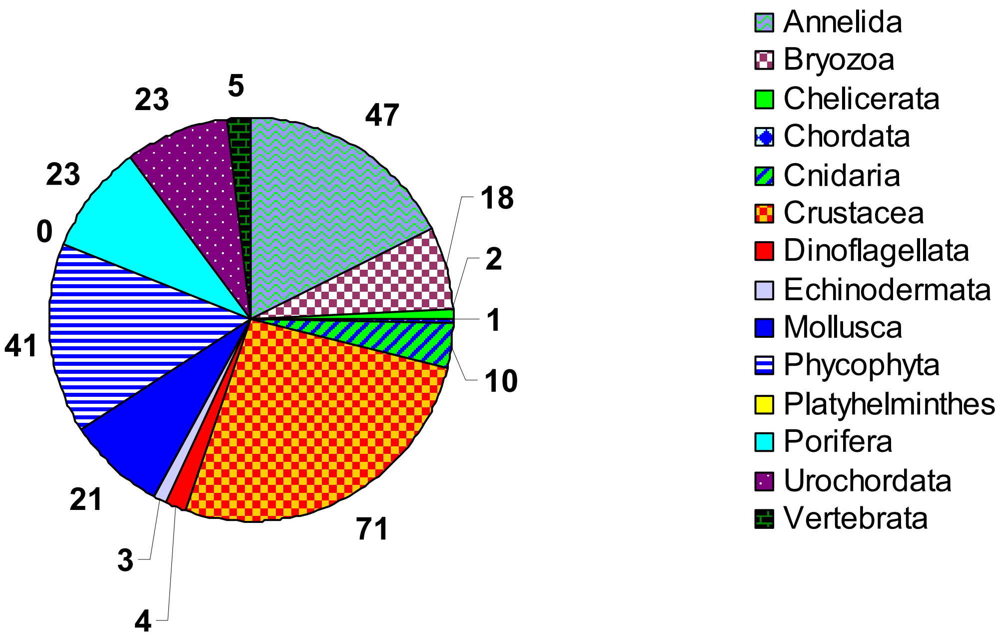

Figure 20: Major taxonomic groups sampled in the Port of Lyttelton. Values indicate the number of taxa in each of the major taxonomic groups.

NATIVE SPECIES

The 151 native species recorded during the resurvey of the Port of Lyttelton represented 56 % of all species identified from this location (Table 14) and included diverse assemblages of annelids (28 species), algae (14 species), crustaceans (46 species), molluscs (18 species), bryozoans (11 species), porifera (9 species) and urochordates (11 species). A number of other less diverse major taxonomic groups including echinoderms, vertebrates, pycnogonids, dinoflagellates and cnidarians were also recorded from the Port (Table 14).

CRYPTOGENIC SPECIES

Cryptogenic species (n = 55) represented 20% of all species or higher taxa identified from the Port. The cryptogenic organisms identified included 20 Category 1 and 35 Category 2 species as defined in "Definitions of species categories" above. These organisms included 13 annelids, 1 bryozoan, 6 cnidaria, 14 crustaceans, 2 molluscs, 13 sponges and 6 ascidian species (Table 15). Nine of the Category 1 cryptogenic species (the bryozoan *Scruparia ambigua*; the hydroids *Bougainvillia muscus*, *Clytia hemisphaerica*, and *Phialella quadrata*; the amphipods *Stenothoe ?miersii*, *Stenothoe valida*; the molluscs *Mytilus galloprovincialis* and *Polycera hedgpathi*; and the ascidian *Diplosoma listerianum*) were not recorded in the initial baseline survey of the port. Only 2 of the 13 Category 1 species recorded in the initial baseline survey of the Port of Lyttelton were not found during the re-survey (the amphipod *Stenothoe* sp. aff. *S. gallensis* and the ascidian *Styela plicata*). Several of the Category 1 cryptogenic species (e.g the ascidians *Astereocarpa cerea*, *Botrylloides leachii* and *Corella eumyota*) have been present in New Zealand for more than 100 years but have distributions outside New Zealand that suggest non-native origins (Cranfield et al. 1998).

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

Specimens of *Didemnum* obtained during the initial port baseline surveys were examined by the world authority on this group, Dr Patricia Kott (Queensland Museum). She identified *D. vexillum* among specimens taken from the initial baseline surveys of Nelson and Tauranga, and *D. incanum* from the ports of Tauranga, Picton and Bluff. A third species, *D. tuberatum*, which Dr Kott described as native to New Zealand, was also recorded from Bluff. None of these species was recorded from Lyttelton. Several specimens of *Didemnum* were recovered from Lyttelton during the initial survey, but these did not fit any of the existing descriptions and were identified only to genus level. At the time that this report was prepared, we had been unable to secure Dr Kott's services to examine specimens from the repeat-baseline surveys, and all *Didemnum* specimens were identified only to genus level. We have reported these species collectively, as a species group (*Didemnum* sp.; Table 15). During the second baseline survey of the Port of Lyttelton, *Didemnum* sp. was recorded on wharf pilings at Gladstone Pier, Cashin Quay 3, the Oil Wharf, Wharf 3 and Wharf 4.

NON-INDIGENOUS SPECIES

The 23 non-indigenous species (NIS) recorded in the re-survey of the Port of Lyttelton included 2 annelid worms, 5 bryozoans, 2 hydroids, 5 crustacea, 1 mollusc, 4 phycophytes, 1 poriferan and 3 ascidians (Table 16). Nine species found in the re-survey were not recorded during the initial baseline survey in March 2002. These were: the polychaetes *Polydora hoplura* and *Spirobranchus polytrema*, the amphipod *Crassicorophium bonnellii*, the hydroids *Monotheca pulchella* and *Symplectoscyphus subdichotomus*, the alga *Polysiphonia senticulosa*, the sponge *Halisarca dujardini* and the ascidians *Ascidiella aspersa* and *Styela clava*. Only three NIS recorded in the initial survey (the bryozoan *Tricellaria inopinata,* the crab *Cancer gibbosulus* and the alga *Polysiphonia subtilissima*) were not recorded in the re-survey. Each of these species was present in just a single sample in the initial baseline survey.

Three of the NIS (the amphipod *Crassicorophium bonnellii*, the ascidian *Styela clava*, and the polychaete worm *Spirobranchus polytrema*) are new records for New Zealand. *Spirobranchus polytrema* was recorded for the first time during the initial baseline port surveys of Dunedin, Napier and Wellington (see the species description below). *Styela clava* was identified for the first time in New Zealand from Viaduct Harbour in 2005, but this collection from Lyttelton pre-dates that finding. *S. clava* has since been shown to be more widespread (see the species description below). This is the first record of *Crassicorophium bonnellii* in New Zealand. A list of Chapman and Carlton's (1994) criteria (see "Definitions of species categories", above) that were met by the non-indigenous species sampled in this survey is given in Appendix 5.

Below we summarise available information on the biology of each of these species, providing images where available, and indicate what is known about their distribution, habitat preferences and impacts. This information was sourced from published literature, the taxonomists listed in Appendix 3 and from regional databases on non-indigenous marine species in Australia (National Introduced Marine Pest Information System, Hewitt et al. 2002) and the USA (National Exotic Marine and Estuarine Species Information System, Fofonoff et al. 2003). Distribution maps for each NIS in the port are composites of multiple replicate samples. Where overlayed presence and absence symbols occur on the map, this indicates the NIS was found in at least one, but not all replicates at that GPS location. NIS are presented below by major taxonomic groups in the same order as Table 16.

Polydora hoplura Claparède, 1870

Image: Read (2004)

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

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

Polydora hoplura had previously been recorded from Wellington and the Marlborough Sounds (Cranfield et al. 1998) and was recorded from Whangarei (Marsden Point), Tauranga, Wellington, Picton, Nelson and Dunedin during the initial baseline port surveys (Table 18). During the second baseline surveys of Group 1 ports it was recorded from the ports of Wellington, Lyttelton and Timaru. In the Port of Lyttelton this species occurred in pile scrape samples taken at Cashin Quay (Figure 21).

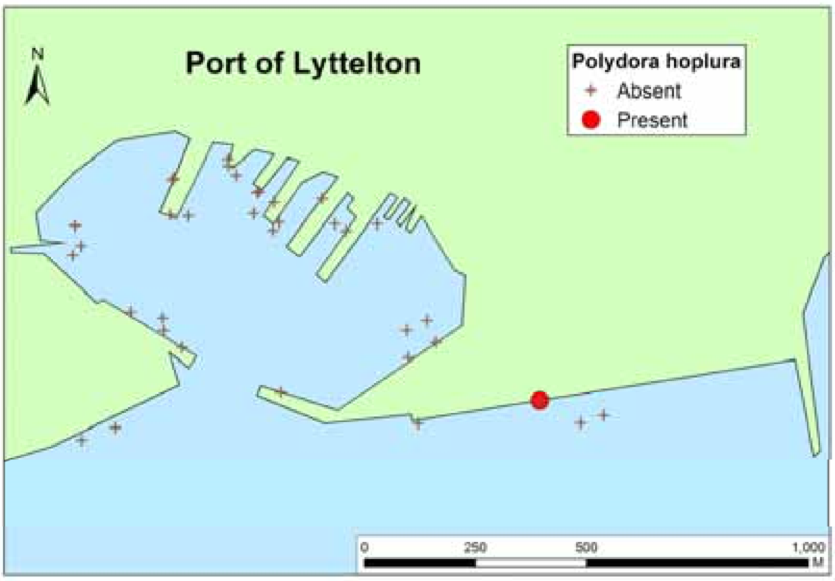

Figure 21: *Polydora hoplura* distribution in the re-survey of the Port of Lyttelton (November 2004)

***Spirobranchus polytrema* (Philippi, 1844)**

No image available.

Spirobranchus polytrema is a serpulid tubeworm most commonly found along the continental shelf, intertidal, rock bottom, and sublittoral habitats, and on the underside of stones around the low water mark (Australian Faunal Directory 2005). Its impacts are unknown. *S. polytrema* is widely distributed, with a recorded distribution from Australia, Lord Howe Island, Solomon Islands, Sri Lanka, Japan, the Indo-west Pacific and the Mediterranean. The type specimen for this species was recorded from the Mediterranean, but there is continued uncertainty over the synonomy of Mediterranean and Indo-Pacific forms of this species complex. During the initial port baseline surveys, *S. polytrema* was recorded from the ports of Wellington, Napier and Dunedin (Table 18). These findings were the first time the species had been identified in New Zealand (G. Read, NIWA, pers. comm.). During the second baseline surveys of Group 1 ports it was recorded from the ports of Wellington, Picton, Lyttelton and Timaru. In the Port of Lyttelton this species occurred in pile scrape samples from the Gladstone Pier and the Oil Wharf (Figure 22).

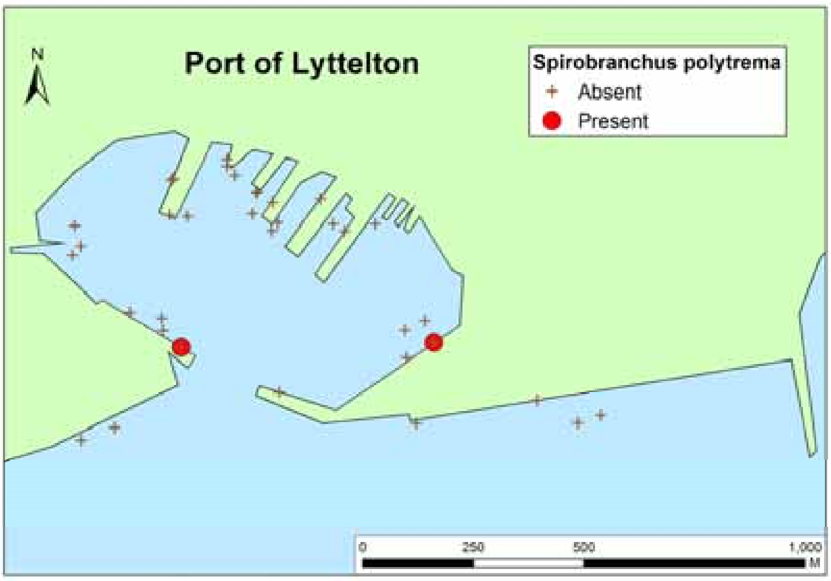

Figure 22: ***Spirobranchus polytrema*** **distribution in the re-survey of the Port of Lyttelton (November 2004).**

Bugula flabellata **(Thompson in Gray, 1848)**

Image and information: NIMPIS (2002b)

Bugula flabellata is an erect bryozoan with broad, flat branches. It is a colonial organism and consists of numerous 'zooids' connected to one another. It is pale pink and can grow to about 4 cm high and attaches to hard surfaces such as rocks, pilings and pontoons or the shells of other marine organisms. It is often found growing with other erect bryozoan species such as *B. neritina* (see below) or growing on encrusting bryozoans. Vertical, shaded, sub-littoral rock surfaces also form substrata for this species. It has been recorded down to 35 m. *Bugula flabellata* is native to the British Isles and North Sea and has been introduced to Chile, Florida and the Caribbean and the northern east and west coasts of the USA, as well as Australia and New Zealand. It is cryptogenic on the Atlantic coasts of Spain, Portugal and France. *Bugula flabellata* is a major fouling bryozoan in ports and harbours, particularly on vessel hulls, pilings and pontoons and has also been reported from offshore oil platforms. *Bugula flabellata* has been present in New Zealand since at least 1949 and is present in most New Zealand ports. There have been no recorded impacts from *B. flabellata.* During the initial port baseline surveys it was recorded from Opua marina, Whangarei (Marsden Point and Whangarei Port), and the ports of Auckland, Tauranga, Napier, Taranaki, Wellington, Picton, Nelson, Lyttelton, Timaru, Dunedin and Bluff (Table 18). In the Port of Lyttelton, it was recorded at the Oil Wharf, Cashin Quay, Gladstone Pier, Wharf 2, and Wharf 4 during the initial baseline survey (Figure 23). During the second baseline surveys of Group 1 ports *B.*

flabellata was recorded from the ports of Tauaranga, Taranaki, Wellington, Picton, Nelson, Lyttelton and Timaru. In the Port of Lyttelton *B. flabellata* occurred in pile scrape samples taken from the Oil Wharf, Cashin Quay 3, Gladstone Pier, Wharf 3, Wharf 4, Wharf 5, and Wharf 7 (Figure 24).

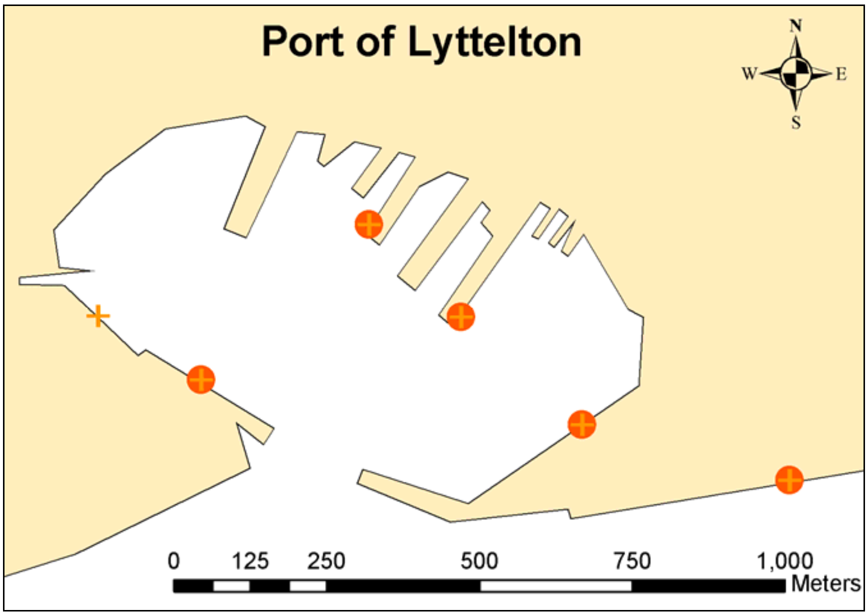

Figure 23: ***Bugula flabellata* distribution in the initial baseline survey of the Port of Lyttelton (March 2002).**

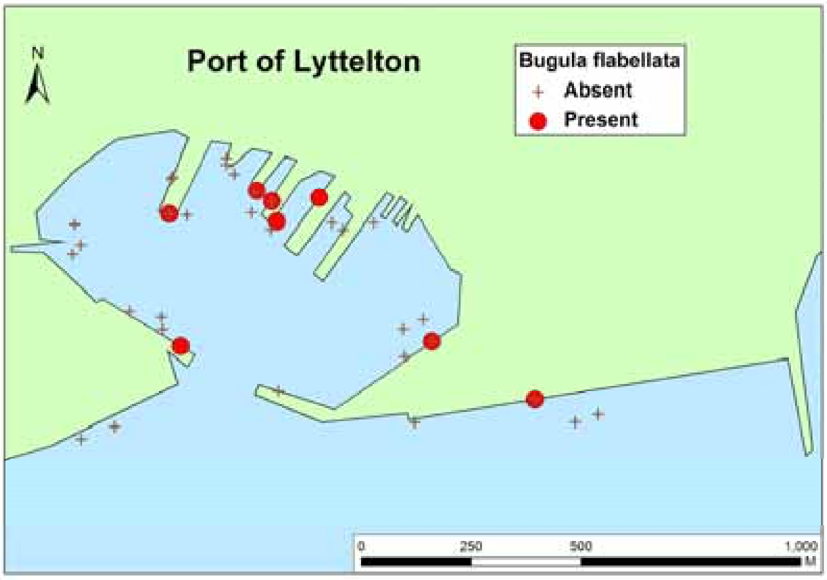

Figure 24: ***Bugula flabellata* distribution in the re-survey of the Port of Lyttelton (November 2004).**

Bugula neritina (Linnaeus, 1758)

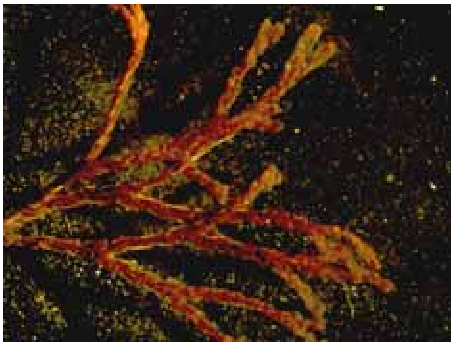

Image and information: NIMPIS (2002c)

Bugula neritina is an erect, bushy, red-purple-brown bryozoan. Branching is dichotomous (in series of two) and zooids alternate in two rows on the branches. Unlike all other species of *Bugula*, *B. neritina* has no avicularia (defensive structures) or spines, but there is a single pointed tip on the outer corner of zooids. Ovicells (reproductive structures) are large, globular and white. They often appear in such high numbers that they resemble small snails or beads. *Bugula neritina* is native to the Mediterranean Sea. It has been introduced to most of North America, Hawaii, India, the Japanese and China Seas, Australia and New Zealand. It is cryptogenic in the British Isles. *Bugula neritina* is one of the most abundant bryozoans in ports and harbours and an important member of the fouling community. The species colonises any available substratum and can form extensive monospecific growths. It grows well on pier piles, vessel hulls, buoys and similar submerged surfaces. It even grows heavily in ships' intake pipes and condenser chambers. In North America, *B. neritina* occurs on rocky reefs and seagrass leaves. In Australia, it occurs primarily on artificial substrata. *B. neritina* occurs in all New Zealand ports (Gordon and Mawatari 1992). During the initial port baseline surveys it was recorded from the Opua and Gulf Harbour marinas, Whangarei Harbour (Marsden Point, Whangarei Port and Town Basin marina), and the ports of Tauranga, Taranaki, Napier, Gisborne, Lyttelton, Timaru and Dunedin (Table 18). In the Port of Lyttelton, it was recorded at the Oil Wharf, Gladstone Pier, Wharf 2, and Wharf 4 during the initial baseline survey (Figure 25). In the repeat baseline surveys of Group 1 ports it was recorded from the ports of Tauranga, Taranaki, Picton, Lyttelton and Timaru. In the Port of Lyttelton it occurred in pile scrape samples taken from the Oil Wharf, Gladstone Pier, Wharf 3, Wharf 4 and Wharf 7 (Figure 26).

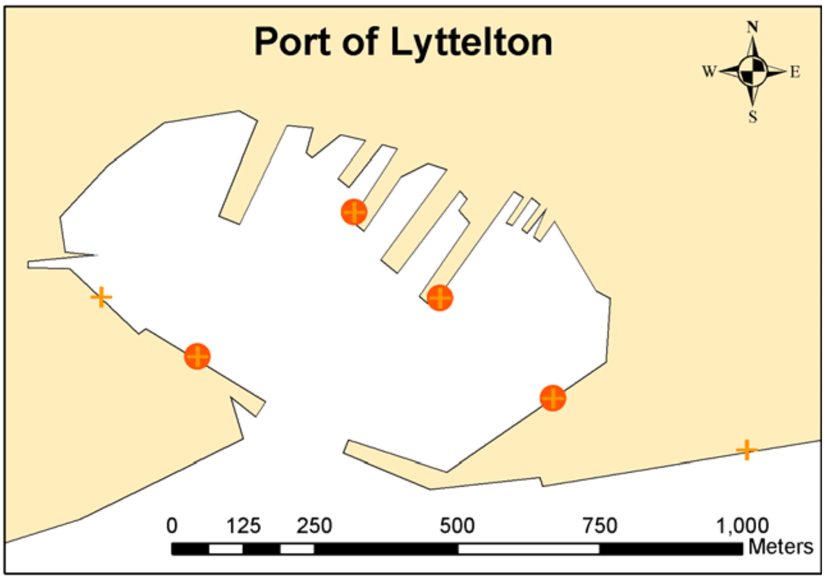

Figure 25: ***Bugula neritina* distribution in the initial baseline survey of the Port of Lyttelton (March 2002).**

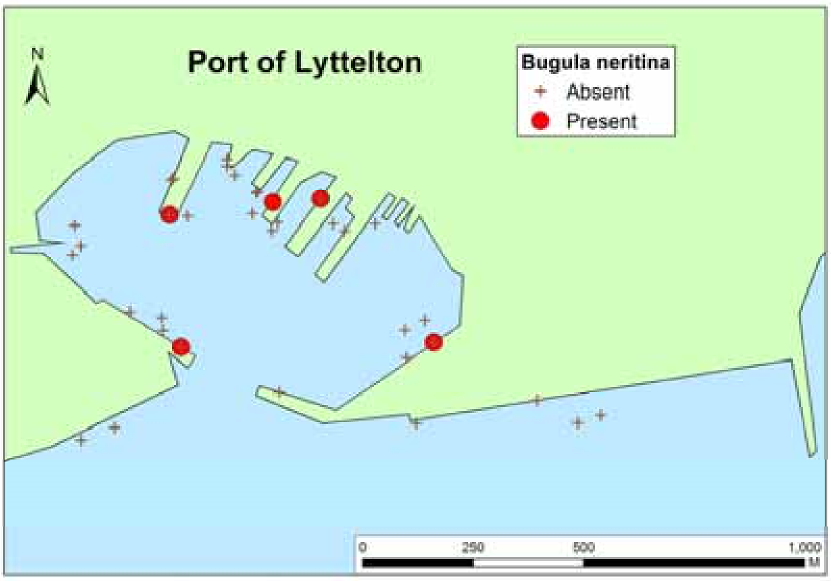

Figure 26: ***Bugula neritina* distribution in the re-survey of the Port of Lyttelton (November 2004).**

***Conopeum seurati* (Canu, 1928)**

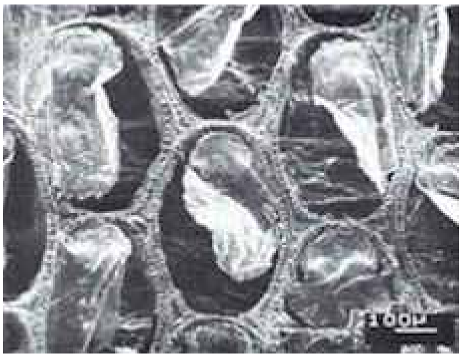

Image: Smithsonian Marine Station at Fort Pierce (2001)

Information: Gordon and Matawari (1992), Cranfield et al. (1998), Smithsonian Marine Station at Fort Pierce (2001)

Conopeum seurati is an encrusting bryozoan that forms small whitish colonies on seagrasses and other substrata. The zooids are oval in shape and measure approximately 0.55 x 0.33 mm. Each zooid has a single pair of long, distal spines and the lateral spines, if present, are highly variable in number. The lophophore measures approximately 0.621 mm in diameter and bears an average of 15 tentacles. The native range of *Conopeum seurati* includes the Caspian, Azov and Mediterranean Seas. The species has been introduced to New Zealand and Florida's east coast. It has been present in New Zealand since at least 1963 (Gordon and Matawari 1992). *C. seurati* is a fouling organism that can be found on hard surfaces, marine animals, and plants in estuarine environments. Its impacts on native organisms are unknown.

In New Zealand, *C. seurati* has been recorded from Opua, Whangarei, Auckland, Manukau, Gisborne, Napier, Nelson and Lyttelton. During the initial port baseline surveys it was recorded from Whangarei (Town Basin Marina), Nelson and Lyttelton (Table 18). In Lyttelton it occurred in pile scrape samples taken from Cashin Quay (Figure 27). During the second baseline surveys of Group 1 ports it was recorded only from the port of Lyttelton, where it occurred in pile scrape samples taken from Wharf 7 (Figure 28).

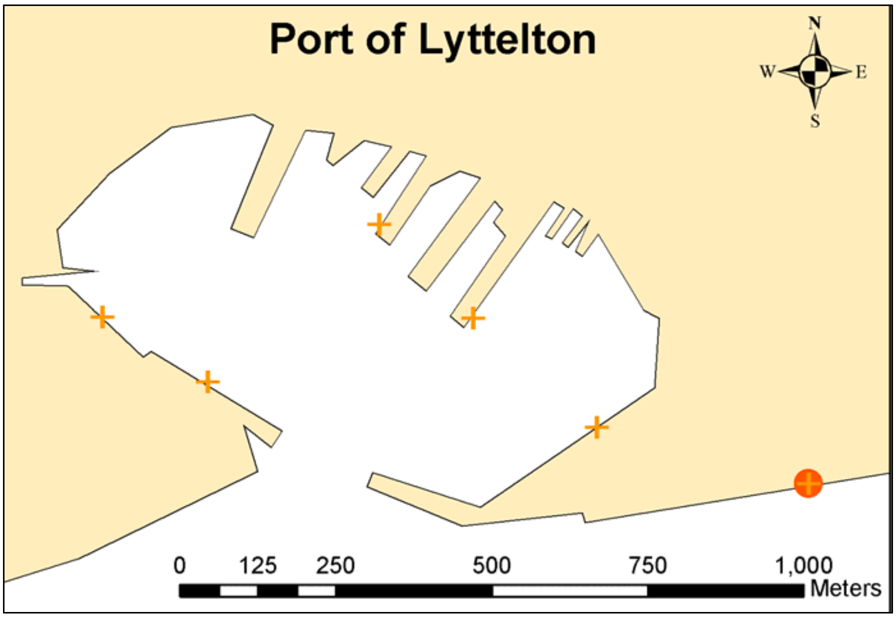

Figure 27: ***Conopeum seurati*** **distribution in the initial baseline survey of the Port of Lyttelton (March 2002).**

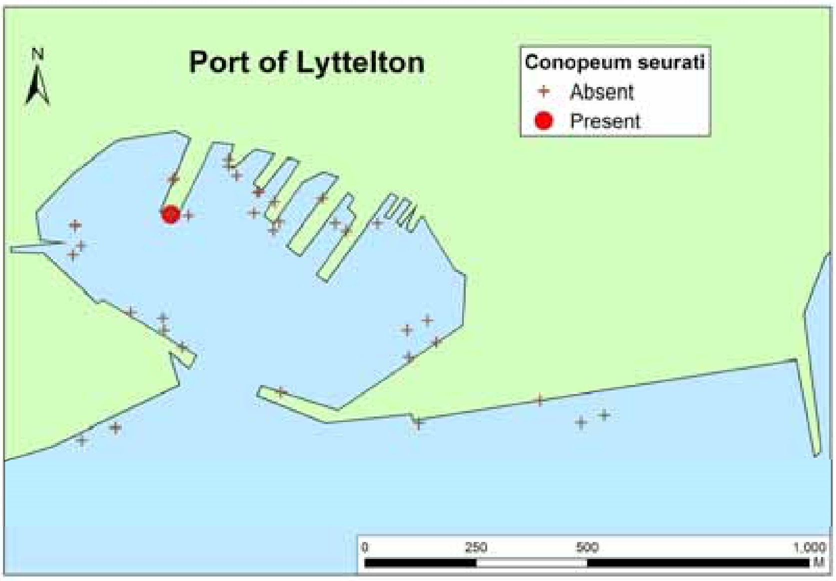

Figure 28: ***Conopeum seurati*** **distribution in the re-survey of the Port of Lyttelton (November 2004).**

Cryptosula pallasiana **(Moll, 1803)**

Image and information: NIMPIS (2002e)

Cryptosula pallasiana is an encrusting bryozoan, white-pink with orange crusts. The colonies sometimes rise into frills towards the edges. Zooids are hexagonal in shape, measuring on average 0.8 mm in length and 0.4 mm in width. The frontal surface of the zooid is heavily calcified, and has large pores set into it. Colonies may sometimes appear to have a beaded surface due to zooids having a suboral umbo (ridge). The aperture is bell shaped, and occasionally sub-oral avicularia (defensive structures) are present. There are no ovicells (reproductive structures) or spines present on the colony. *Cryptosula pallasiana* is native to Florida, the east coast of Mexico and the northeast Atlantic. It has been introduced to the northwest coast of the USA, the Japanese Sea, Australia and New Zealand. It is cryptogenic in the Mediterranean. *Cryptosula pallasiana* is a common fouling organism on a wide variety of substrata. Typical habitats include seagrasses, drift algae, oyster reef, artificial structures such as piers and breakwaters, man-made debris, rock, shells, ascidians, glass and vessel hulls. It has been reported from depths of up to 35 m. There have been no recorded impacts of *Cryptosula pallasiana* throughout its introduced range. However, in the USA, it has been noted as one of the most competitive fouling organisms in ports and harbours it occurs in. Within Australia, colonies generally do not reach a large size or cover large areas of substrata.

C. pallasiana has been known in New Zealand waters since at last the 1890's (Gordon and Mawatari 1992) and has been recorded from all New Zealand ports (Cranfield et al. 1998). During the initial port baseline surveys it was recorded from Whangarei (Marsden Point), Taranaki, Gisborne, Wellington, Nelson, Lyttelton, Timaru and Dunedin (Table 18). In Lyttelton, it occurred in pile scrape samples taken from Cashin Quay, Gladstone Pier, Wharf 2 and Wharf 4 (Figure 29). During the second baseline surveys of Group 1 ports it was recorded from the ports of Taranaki, Wellington, Picton, Nelson, Lyttelton and Timaru. In the re-survey of Lyttelton *C. pallasiana* occurred only in pile scrape samples taken from Wharf 7 (Figure 30).

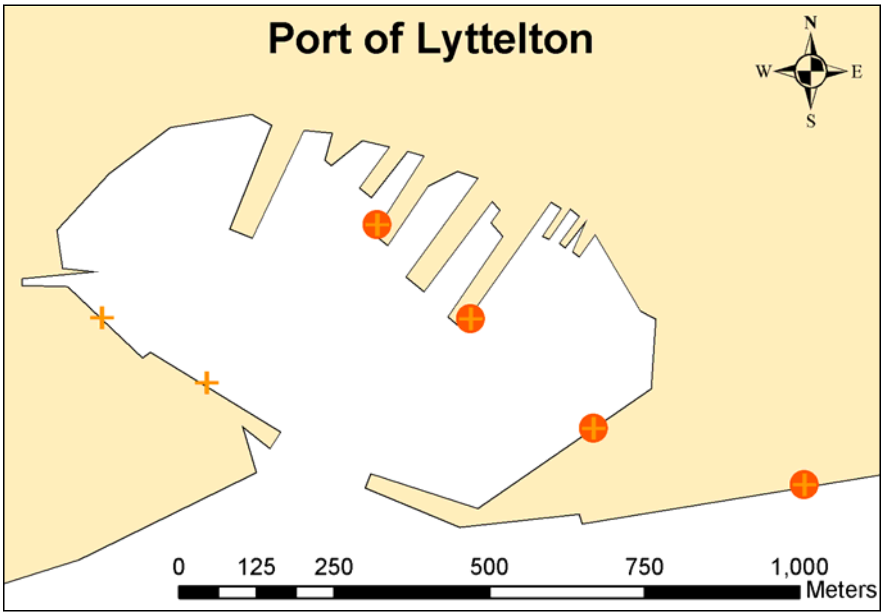

Figure 29: ***Cryptosula pallasiana* distribution in the initial baseline survey of the Port of Lyttelton (March 2002).**

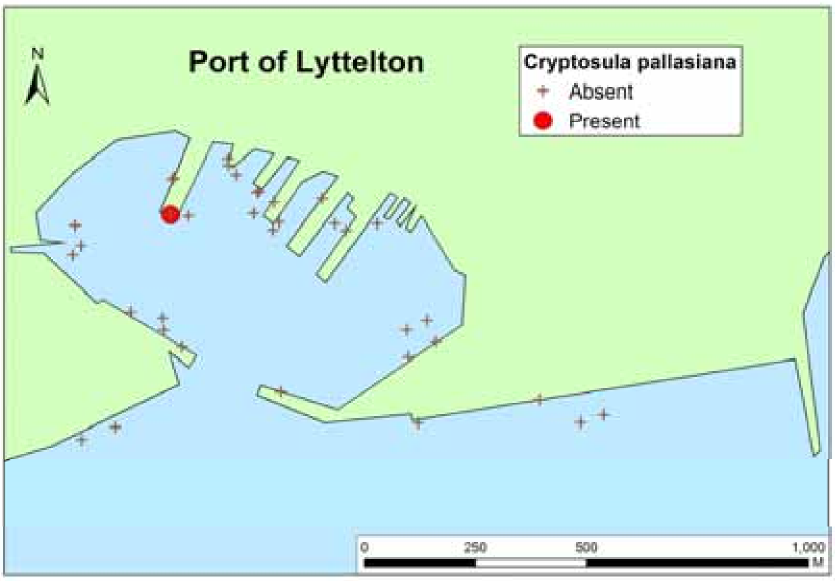

Figure 30: ***Cryptosula pallasiana* distribution in the re-survey of the Port of Lyttelton (November 2004).**

Watersipora subtorquata (d'Orbigny, 1852)

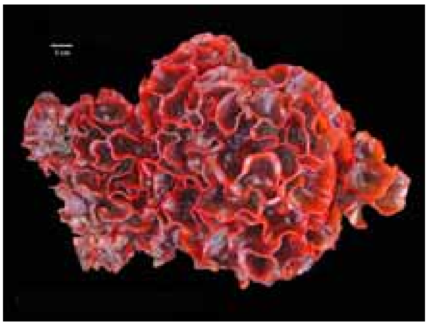

Image: Cohen (2005)
Information: Gordon and Matawari (1992)

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

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

Watersipora subtorquata has been present in New Zealand since at least 1982 and is now present in most ports from Opua to Bluff (Gordon and Matawari 1992). During the initial port baseline surveys, it was recorded from the Opua and Gulf Harbour marinas, Whangarei Harbour (Marsden Point and Whangarei Port) and the ports of Tauranga, Gisborne, Napier, Taranaki, Wellington, Picton, Nelson, Lyttelton, Timaru, Dunedin and Bluff (Table 18). In the Port of Lyttelton survey, it was found at Cashin Quay, Gladstone Pier, the Oil Wharf, Wharf 2 and Wharf 4 (Figure 31). During the second baseline surveys of Group 1 ports *W. subtorquata* was recorded from the ports of Tauranga, Taranaki, Wellington, Picton, Nelson, Lyttelton and Timaru. In the Port of Lyttelton it occurred in pile scrape samples taken from Cashin Quay 3, Gladstone Pier, the Oil Wharf, Wharf 3, Wharf 4, and Wharf 7 (Figure 32).

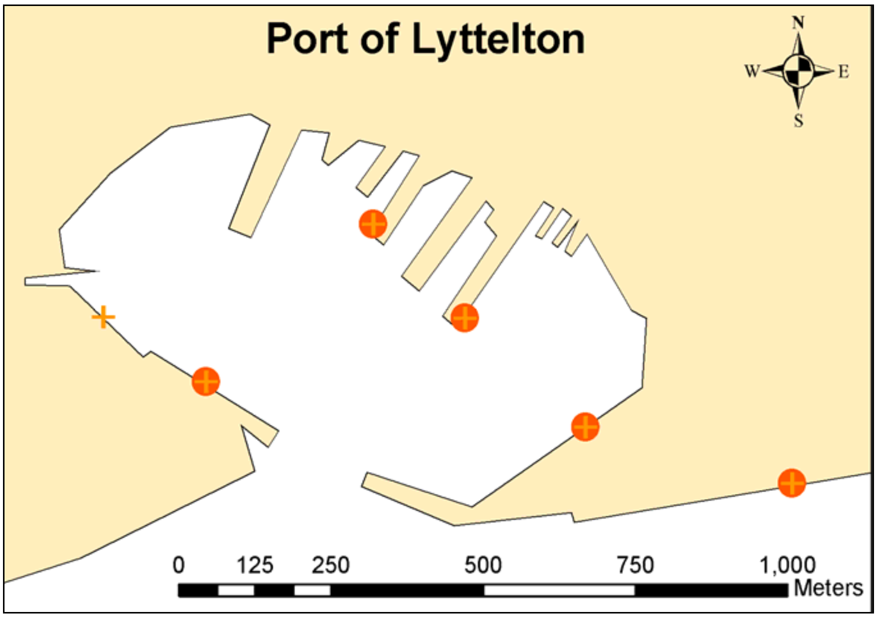

Figure 31: *Watersipora subtorquata* distribution in the initial baseline survey of the Port of Lyttelton (March 2002).

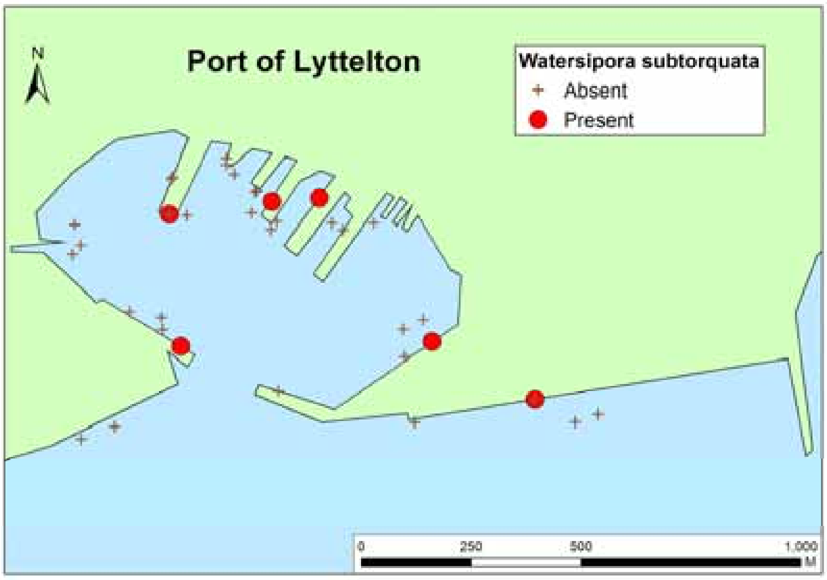

Figure 32: *Watersipora subtorquata* distribution in the re-survey of the Port of Lyttelton (November 2004).

***Monotheca pulchella* (Bale, 1882)**
No image available.

Monotheca pulchella is a hydroid in the family Plumulariidae. It forms fine, flexible, monosiphonic, occasionally branched colonies 10 to 15 mm high, rising from tubular stolons (Vervoort and Watson 2003). It attaches to algae, bryozoans and other hydroids. The type locality is Queenscliff, Victoria, Australia. Its distribution is in temperate and subtropical parts of eastern and western Atlantic including the Mediterranean, South African coastal waters, coastal waters of southern Australia and eastern coastal waters of New Zealand (Vervoort and Watson 2003). It was first recorded in New Zealand from Bluff in 1928 (see Vervoort and Watson 2003). *Monotheca pulchella* was not recorded during the initial port baseline surveys. During the second baseline surveys of Group 1 ports it was recorded from the ports of Tauranga, Taranaki, Wellington, Lyttelton and Timaru (Table 18). None of these records are extensions to the known range of the species in New Zealand. In the Port of Lyttelton it occurred in pile scrape samples taken from the Oil Wharf (Figure 33).

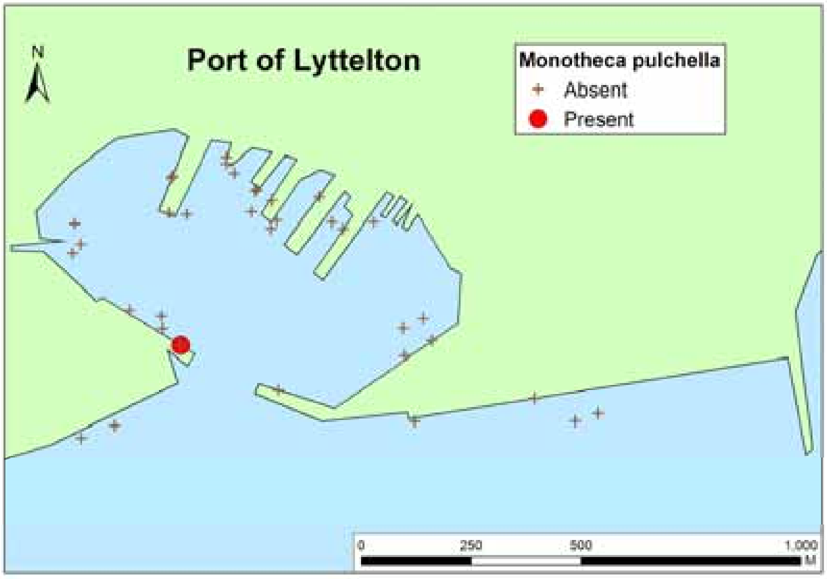

Figure 33: *Monotheca pulchella* distribution in the re-survey of the Port of Lyttelton (November 2004).

***Symplectoscyphus subdichotomus* (Kirchenpauer, 1884)**
No image available.

Symplectoscyphus subdichotomus is a hydroid in the family Sertulariidae. Colonies vary from small, straggling colonies on fixed objects to bigger, more or less reticulate colonies of strongly interwoven, repeatedly branched stems (Vervoort and Watson 2003). The type locality is Bass Strait, Australia. Records based on well identified material come from the Bass Strait and seas bordering southeast Australia, and from New Zealand waters. Less reliable records are from the Magellan Strait, South America and South Africa (Vervoort and Watson 2003). Records from New Zealand include off Norfolk Island, Three Kings region, off North Cape, off East Cape, Otago Peninsula and Chatham Islands, in depths from 23 to 183 m (Vervoort and Watson 2003). *S. subdichotomus* was not recorded during the initial baseline surveys. During the second baseline surveys of Group 1 ports it was recorded from the ports of Lyttelton and Timaru (Table 18). All specimens recorded were infertile except one from Lyttelton, obtained from a benthic grab at Cashin Quay. Both records of this species from the Port of Lyttelton came from near Cashin Quay (Figure 34).

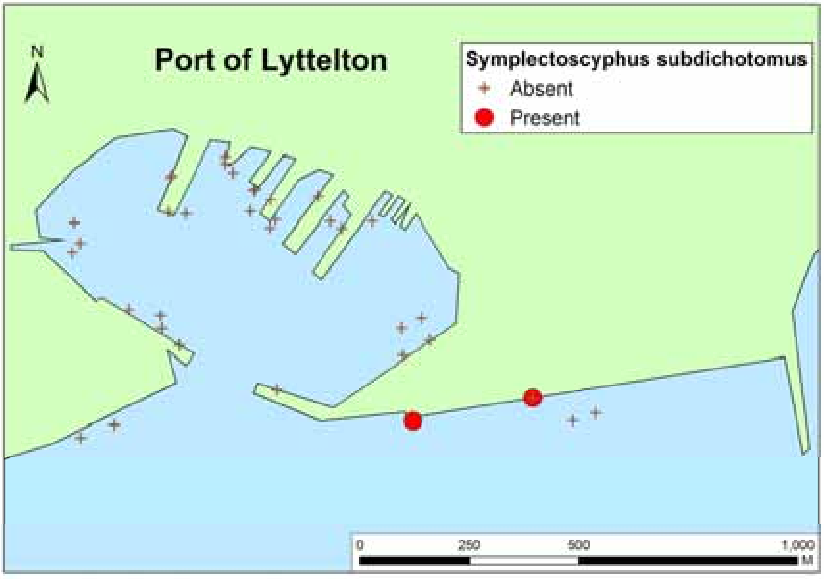

Figure 34: ***Symplectoscyphus subdichotomus*** **distribution in the re-survey of the Port of Lyttelton (November 2004).**

Apocorophium acutum (Chevreux, 1908)

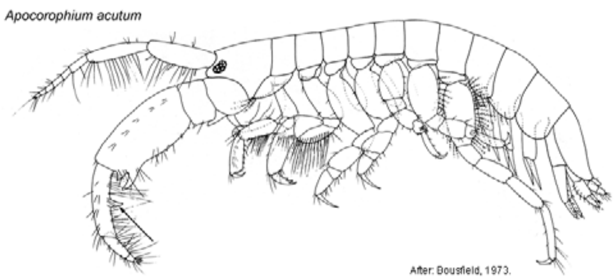

Image and information: Myers et al. (2006)

Apocorophium acutum is a corophiid amphipod, known from the Atlantic Ocean (England, France, North America, Brazil, South Africa), Pacific Ocean (New Zealand) and the Mediterranean Sea. The native range of this species is not known, although the type specimen of this species was described from the southern Mediterranean. *Apocorophium acutum* inhabits marine sediments in estuarine mudflats and brackish water and fouling assemblages where it builds muddy tubes. It has no known documented impacts. During the initial port baseline surveys *A. acutum* was recorded from the ports of Tauranga, Lyttelton, Timaru and Dunedin, and from Gulf Harbour and Opua marinas (Table 18). In the Port of Lyttelton, it was recorded from Gladstone Pier, the Oil Wharf, Wharf 2 and Wharf 4(Figure 35). During the second baseline surveys of Group 1 ports it was recorded from the ports of Lyttelton and Timaru. In the re-survey of Lyttelton, *A. acutum* occurred in pile scrape samples taken from the No. 3, No. 7 and Oil Wharves, Cashin Quay 3, and Gladstone Pier (Figure 36).

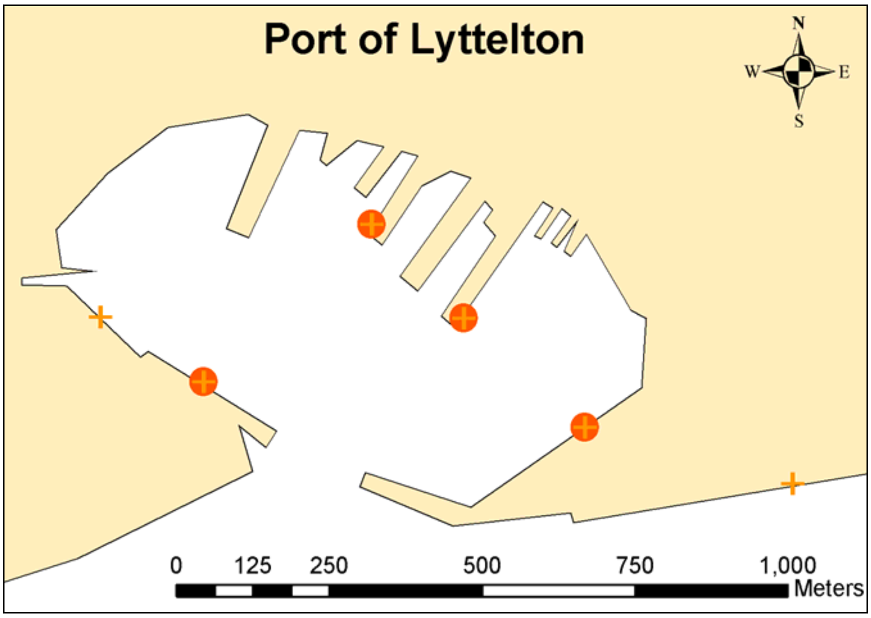

Figure 35: ***Apocorophium acutum*** **distribution in the initial baseline survey of the Port of Lyttelton (March 2002).**

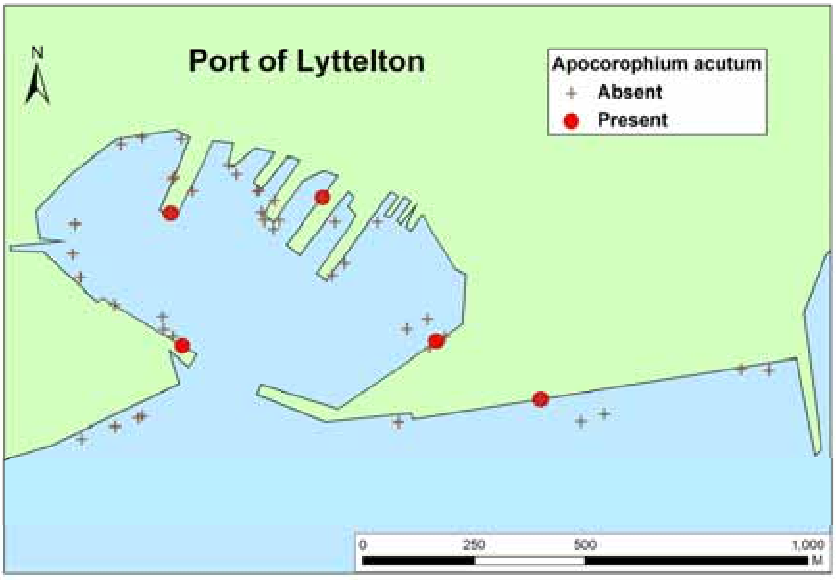

Figure 36: ***Apocorophium acutum*** **distribution in the re-survey of the Port of Lyttelton (November 2004).**

***Crassicorophium bonnellii* (Milne-Edwards, 1830)**

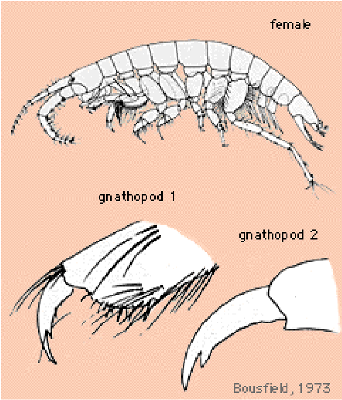

Image and information: de Kluijver and Ingalsuo (2004)

Crassicorophium bonnellii is a corophiid amphipod, of which only the female is known, reaching up to 5.5 mm in length. It builds tubes of mud on stones, hydroids and other organisms in the shallow subtidal and lower intertidal. *C. bonnellii* has a cosmopolitan distribution including the north Atlantic (American and European coasts), the south Atlantic (Falkland Islands), south Pacific (Chile) and the Behring Sea. It has also been recorded from Tasmania, Australia (OBIS 2006), but has not previously been recorded in New Zealand (G. Fenwick, pers. comm.). *C. bonnellii* was not recorded during the initial baseline surveys of Group 1 and Group 2 ports, and was recorded only from the Port of Lyttelton during the second baseline surveys of Group 1 ports (Table 18). It occurred in pile scrape samples taken from Cashin Quay (Figure 37).

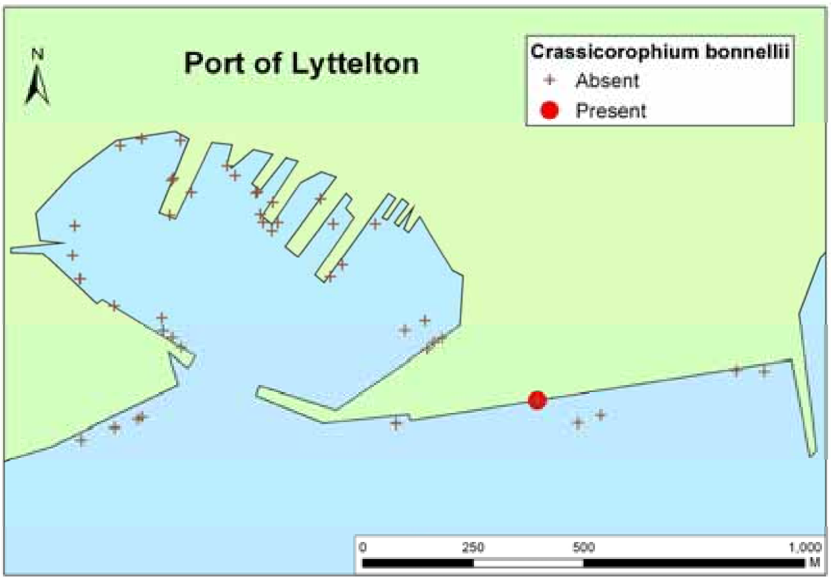

Figure 37: *Crassicorophium bonnellii* distribution in the re-survey of the Port of Lyttelton (November 2004)

***Jassa slatteryi* Conlan, 1990**

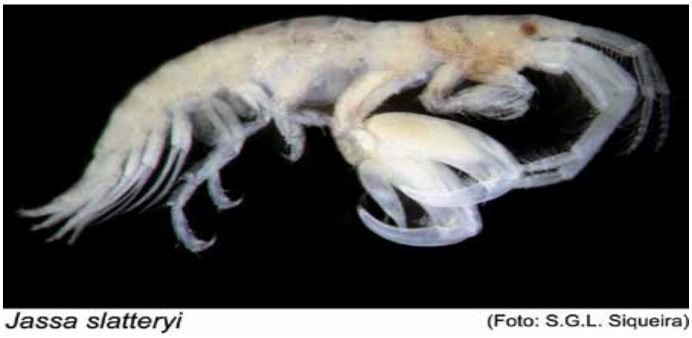

Image: Instituto de Biologia (no date)

Jassa slatteryi is an amphipod in the family Ischyroceridae. It is a cosmopolitan species. The type specimen was recorded from California, but it is known to be present in the Atlantic and Pacific Oceans and the Mediterranean Sea, and in south-east Australia and New Zealand (Australian Faunal Directory 2005). Its habitat requirements and impacts are unknown. During the initial baseline port surveys it was recorded from Whangarei (Marsden Point), Lyttelton and Timaru (Table 18). In Lyttelton, it occurred in pile scrape samples taken from Cashin Quay (Figure 38). During the second baseline surveys of Group 1 ports it was again recorded from the ports of Lyttelton and Timaru. During the re-survey of Lyttelton, it occurred in pile scrape samples taken from Cashin Quay (Figure 39).

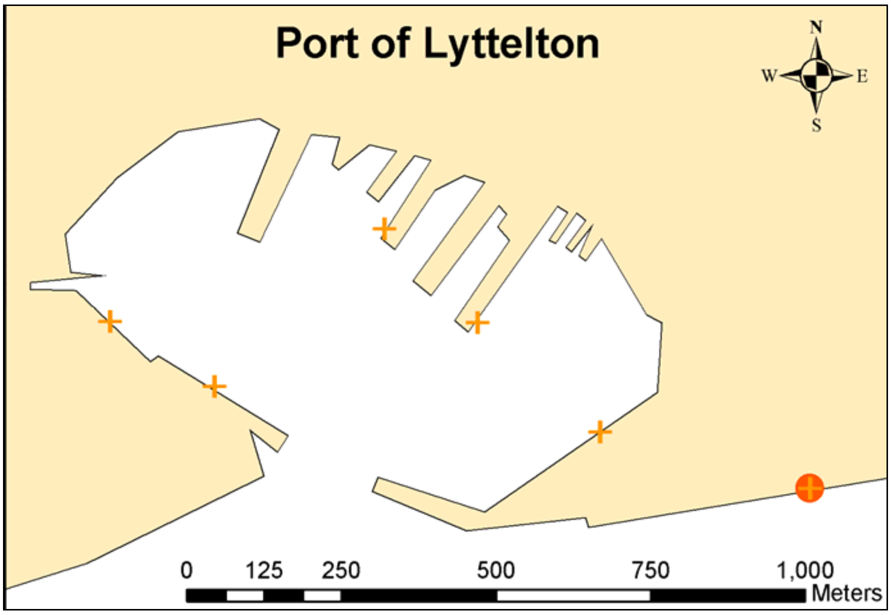

Figure 38: ***Jassa slatteryi* distribution in the initial baseline survey of the Port of Lyttelton (March 2002).**

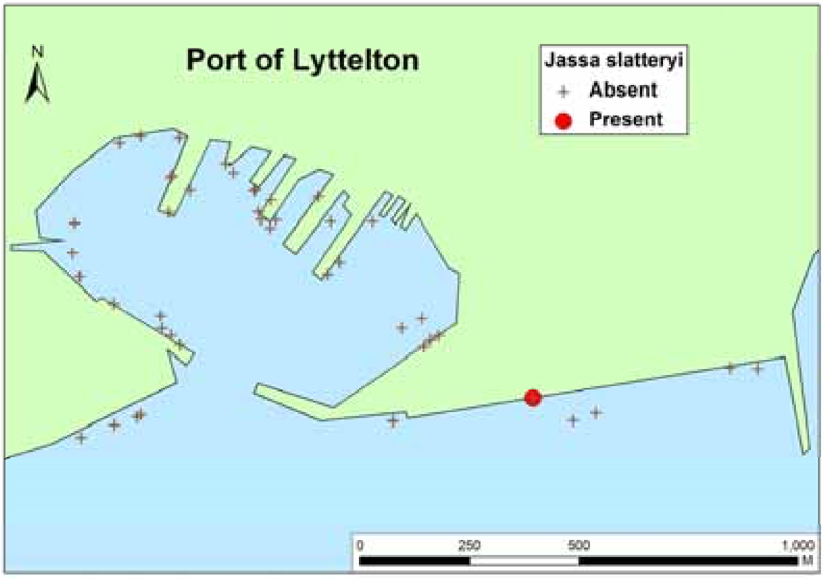

Figure 39: *Jassa slatteryi* distribution in the re-survey of the Port of Lyttelton (November 2004).

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

Image and information: NIMPIS (2002f)

Monocorophium acherusicum is a flat, yellowish-brown amphipod crustacean that lives amongst assemblages of marine invertebrates and plants or in soft-bottom habitats, and feeds by grazing on bacteria on sediment particles or on organic matter suspended in the water column. It is native to the northeast Atlantic, the Mediterranean and the northwest African coast and has been introduced to Brazil, southeast Africa, India, the Japanese and China Seas, Australia and New Zealand. It is cryptogenic in the Baltic Sea, the Caribbean and the east and northwest coasts of the USA. *Monocorophium acherusicum* occurs subtidally on sediments or where silt and detritus accumulate among fouling communities such as algae, ascidians and bryozoans, and man-made installations e.g. wharf pylons, rafts and buoys. It is a tube building species constructing conspicuous, fragile U-shaped tubes of silk, mud and sand particles. It can reach high abundances and can tolerate a wide range of salinities. Pilisuctorid ciliates are parasites on this species in the Black Sea, but it is unknown whether these parasites could transfer to native species and cause negative impacts in New Zealand. During the initial port baseline surveys, *M. acheruscium* was recorded from the ports of Tauranga, Gisborne, Lyttelton, Timaru, Dunedin and the Whangarei Town Basin Marina (Table 18). In the Port of Lyttelton, it occurred in pile scrape samples taken from Cashin Quay, Gladstone Pier, the Oil Wharf, Wharf 2 and Wharf 4 (Figure 40). During the second baseline surveys of Group 1 ports *M. acherusicum* was recorded from the ports of Wellington, Timaru and Lyttelton. In the re-survey of the Port of Lyttelton it occurred in pile scrape samples taken from the No. 3, No. 4, and No. 7 Wharves, Cashin Quay, and Gladstone Pier (Figure 41).

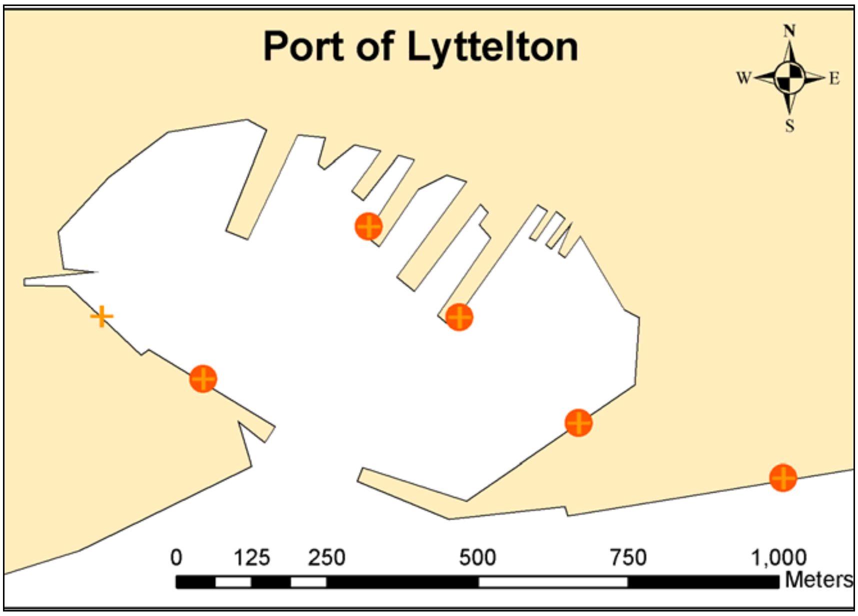

Figure 40: ***Monocorophium acherusicum*** **distribution in the initial baseline survey of the Port of Lyttelton (March 2002).**

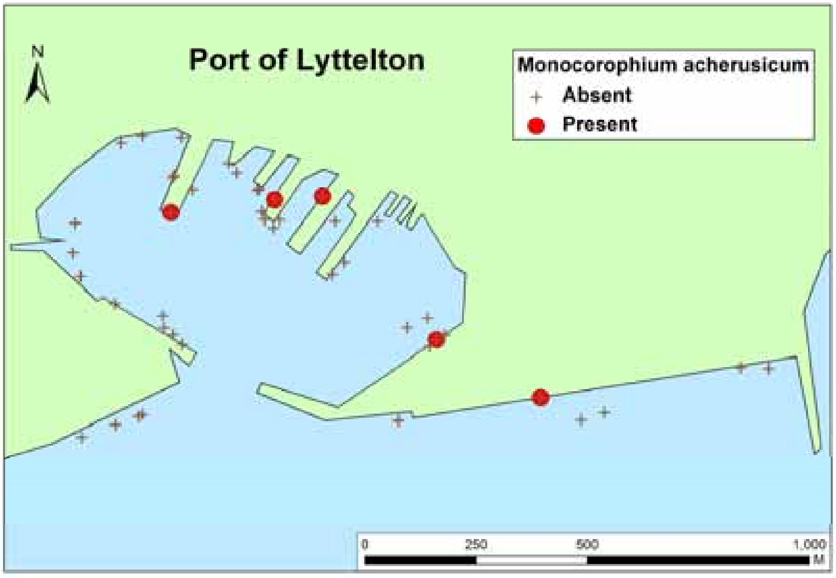

Figure 41: ***Monocorophium acherusicum*** **distribution in the re-survey of the Port of Lyttelton (November 2004).**

Monocorophium sextonae (Crawford, 1937)

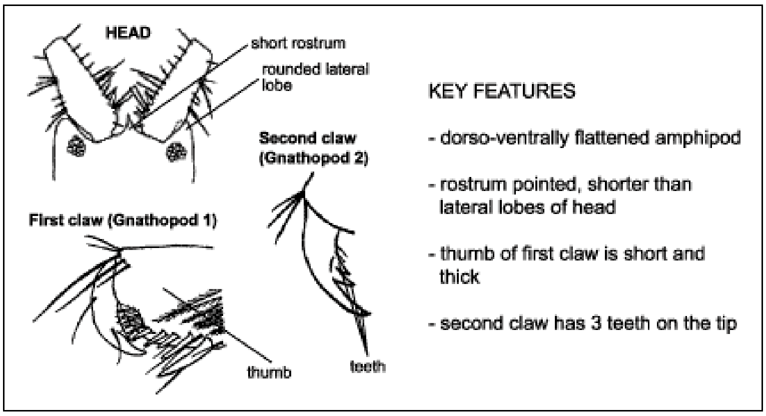

Diagram adapted from Myers 1982, Bousfield & Hoover 1997

Image and information: NIMPIS (2002g)

Monocorophium sextonae is a flat-looking amphipod that is whitish grey, with two dark bars across each segment, antennae and head. It lives amongst assemblages of marine invertebrates and plants or in soft-bottom habitats, and feeds by grazing on bacteria on sediment particles or on organic matter suspended in the water column. The native range of *M. sextonae* is largely unknown, although it is cryptogenic to the northeast Atlantic and Mediterranean and has been introduced to New Zealand and Australia. It builds mud tubes on fouling species such as hydroids, sponges, algae and kelp holdfasts in the subtidal zone from just above low water mark to ~50 m depth. It is tolerant of slow flowing water and large quantities of inorganic material and fouls surfaces such as harbour pylons, rafts and buoys by building mud tubes. It can reach high abundances on sediments or where silt and detritus accumulate among fouling communities. *M. sextonae* has been present in New Zealand since at least 1921 and is known from Lyttelton and Dunedin (Cranfield et al. 1998). During the initial port baseline surveys, *M. sextonae* was recorded only from the Port of Lyttelton, where it occurred in pile scrape samples taken from Gladstone Pier and the Oil Wharf (Figure 42). During the second baseline surveys of Group 1 ports it was again recorded from the Port of Lyttelton and was also recorded from the Port of Taranaki, which is a new distribution record for this species (Table 18). In the Port of Lyttelton, it occurred in pile scrape samples taken from Cashin Quay (Figure 43).

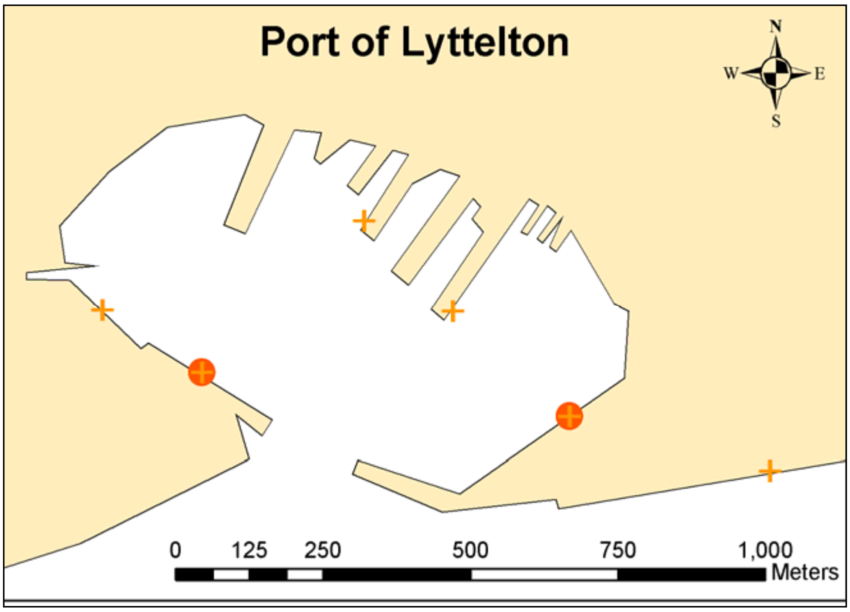

Figure 42: *Monocorophium sextonae* distribution in the initial baseline survey of the Port of Lyttelton (March 2002).

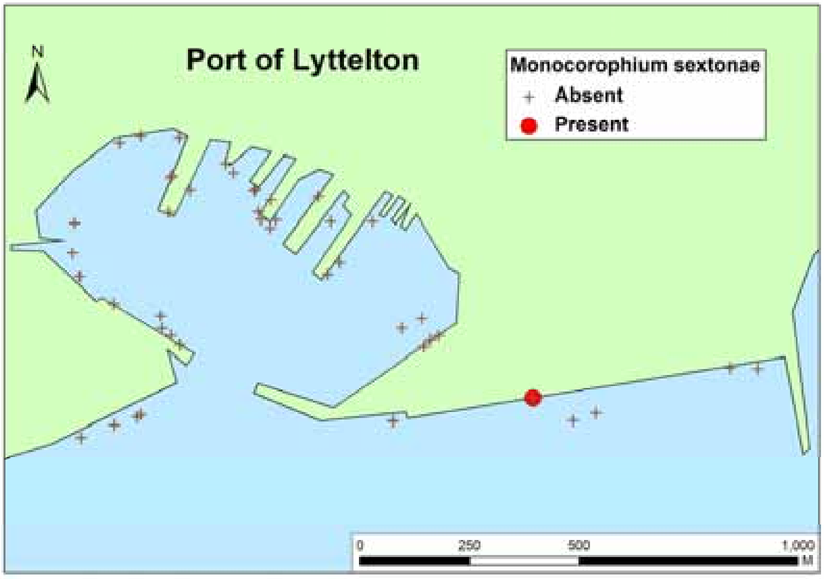

Figure 43: ***Monocorophium sextonae*** **distribution in the re-survey of the Port of Lyttelton (November 2004).**

Theora lubrica **Gould, 1861**

Image and information: NIMPIS (2002j)

Theora lubrica is a small bivalve with an almost transparent shell. The shell is very thin, elongated and has fine concentric ridges. *T. lubrica* grows to about 15 mm in size, and is characterised by a fine elongate rib extending obliquely across the internal surface of the shell. *Theora lubrica* is native to the Japanese and China Seas. It has been introduced to the west coast of the USA, Australia and New Zealand. *Theora lubrica* typically lives in muddy sediments from the low tide mark to 50 m, however it has been found at 100 m. In many localities, *T. lubrica* is an indicator species for eutrophic and anoxic areas. *T. lubrica* has been present in New Zealand since at least 1971 (Cranfield et al. 1998). It occurs in estuaries of the northeast coast of the North Island, including the Bay of Islands, Whangarei Harbour, Waitemata Harbour, Wellington and Pelorus Sound. During the initial port baseline surveys, it was recorded from Opua marina, Whangarei port and marina, Gulf Harbour marina, and the ports of Auckland, Gisborne, Napier, Taranaki, Wellington, Nelson, and Lyttelton (Table 18). In the Port of Lyttelton, it occurred in benthic sled and benthic grab samples taken near Wharf 2 (Figure 44). During the second baseline surveys of Group 1 ports, *T. lubrica* was recorded from the ports of Taranaki, Wellington, Picton, Nelson and Lyttelton. In the Port of Lyttelton it occurred in benthic grab samples from Wharf 7 and benthic sled samples taken near Cashin Quay, the Cattle Jetty, Gladstone Pier, the Oil Wharf, the Recreational Fishing Jetty, Wharf 4, Wharf 5 and Wharf 7 (Figure 45).

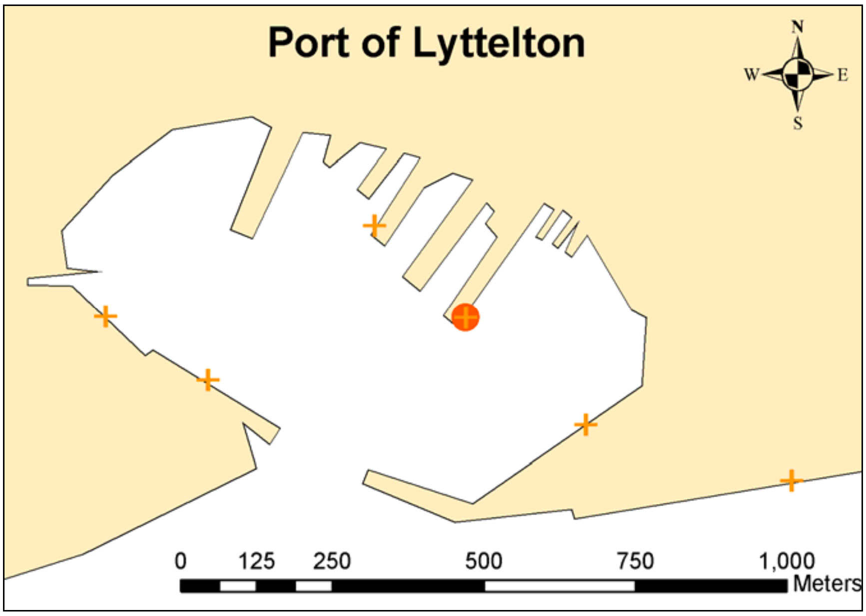

Figure 44: ***Theora lubrica*** **distribution in the initial baseline survey of the Port of Lyttelton (March 2002).**

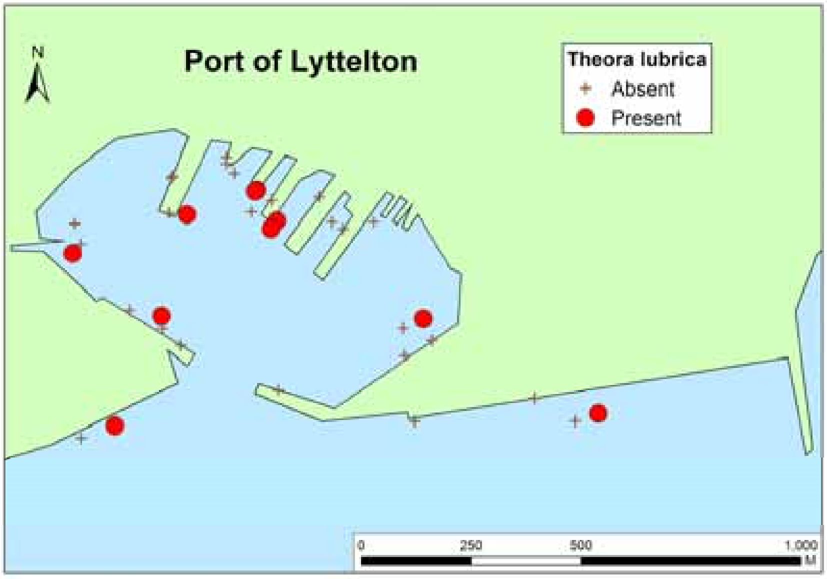

Figure 45: ***Theora lubrica*** **distribution in the re-survey of the Port of Lyttelton (November 2004).**

***Griffithsia crassiuscula* C.Agardh 1824**

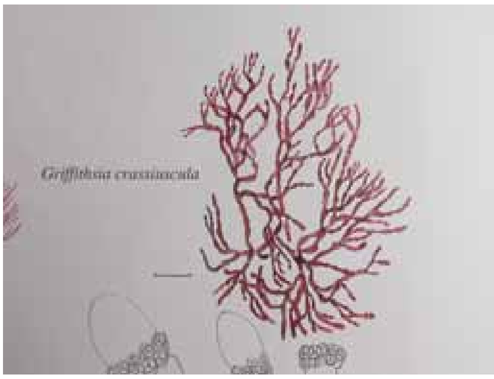

Image and information: Adams (1994)

Griffithsia crassiuscula is a small filamentous red alga. Plants are up to 10 cm high, dichotomously branched, with holdfasts of copious rhizoids. This species is bright rosy red to pink and of a turgid texture. Its native origin is thought to be southern Australia. *Griffithsia crassiuscula* is found subtidally and is mainly epiphytic on other algae and shells, but can also be found on rocks and pebbles. It has no known impacts. During the initial port baseline surveys, *G. crassiuscula* was recorded from the ports of Taranaki (an extension of its known range), Wellington, Picton, Lyttelton, Timaru and Bluff (Table 18). In Lyttelton, it occurred in samples taken from Gladstone Pier and Wharf 4 (Figure 46). During the second baseline surveys of Group 1 ports it was recorded from the ports of Taranaki, Wellingon, Picton, Lyttelton and Timaru. In the Port of Lyttelton, it occurred in pile scrape samples taken from the Oil Wharf and Wharf 3 (Figure 47).

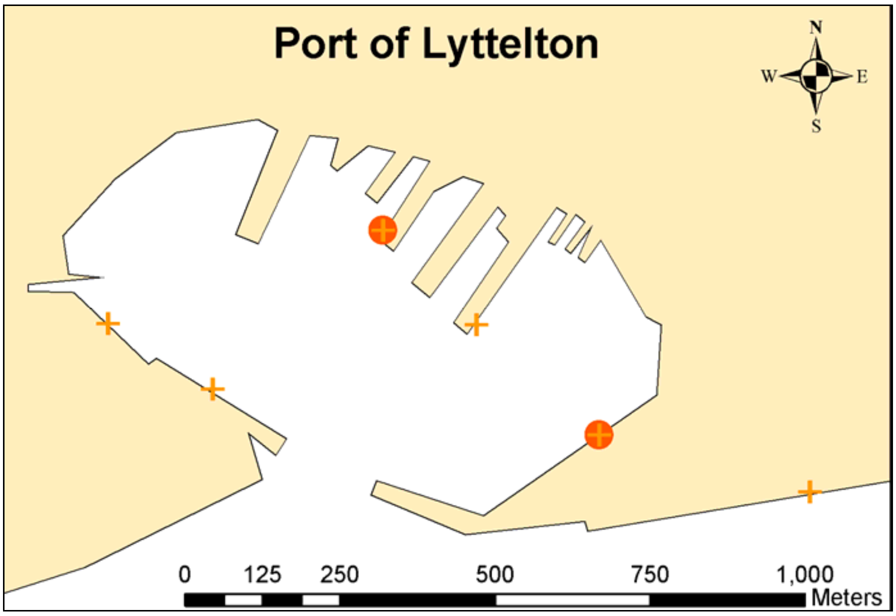

Figure 46: ***Griffithsia crassiuscula* distribution in the initial baseline survey of the Port of Lyttelton (March 2002).**

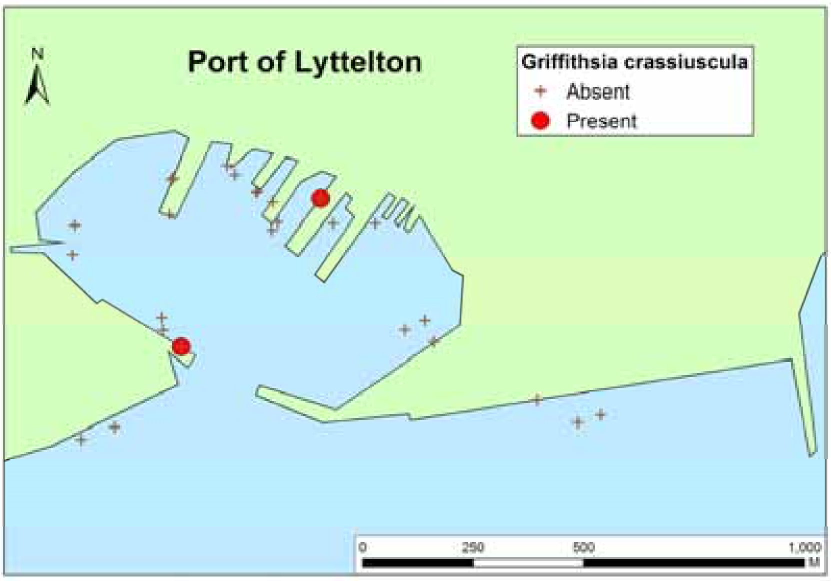

Figure 47: ***Griffithsia crassiuscula*** **distribution in the re-survey of the Port of Lyttelton (November 2004).**

Polysiphonia brodiei **(Dillwyn) Sprengel, 1827**

Image and information: NIMPIS (2002h)

Polysiphonia brodiei is a dark reddish brown alga, typically 4-12 cm high, but occasionally growing to 40 cm. It has many soft branches arising from one or several main stems that grow from a holdfast. *Polysiphonia brodiei* is native to the Mediterranean and northeastern Atlantic down to the equatorial coast of west Africa. It is introduced in New Zealand, southern Australia, the northeast and northwest coasts of north America, and cryptogenic in Japan and Korea. *Polysiphonia brodiei* is found in the subtidal zone just below low tide level where it colonises wooden structures, floating structures including ropes, buoys and vessels, and other fouling species, such as mussels. *Polysiphonia brodiei* seems to prefer moderately exposed localities. In Australia, New Zealand and California, specimens have been collected mostly from port environments where the species is frequently found fouling the hulls of slow moving vessels, such as barges. It also occurs as nuisance fouling on ropes, buoys and other harbour structures such as pylons and boat ramps. Within New Zealand, *P. brodiei* is known from Wellington, Golden Bay, Nelson, Lyttelton, Timaru, Fiordland (Dusky, Doubtful and George Sounds) and Stewart Island (Cranfield et al. 1998, W. Nelson, pers. comm.). During the initial baseline port surveys, it was recorded from the ports of Lyttelton, Dunedin and Bluff (Table 18). The records from Dunedin and Bluff probably represent extensions to the known range of this species in New Zealand (W. Nelson, pers. comm.). *P. brodiei* was recorded in pile scrape samples taken from Gladstone Pier during the initial baseline survey of Lyttelton (Figure 48). During the second baseline surveys of Group 1 ports it was again recorded from the Port of Lyttelton, where it occurred in pile scrape samples taken from Cashin Quay (Figure 49).

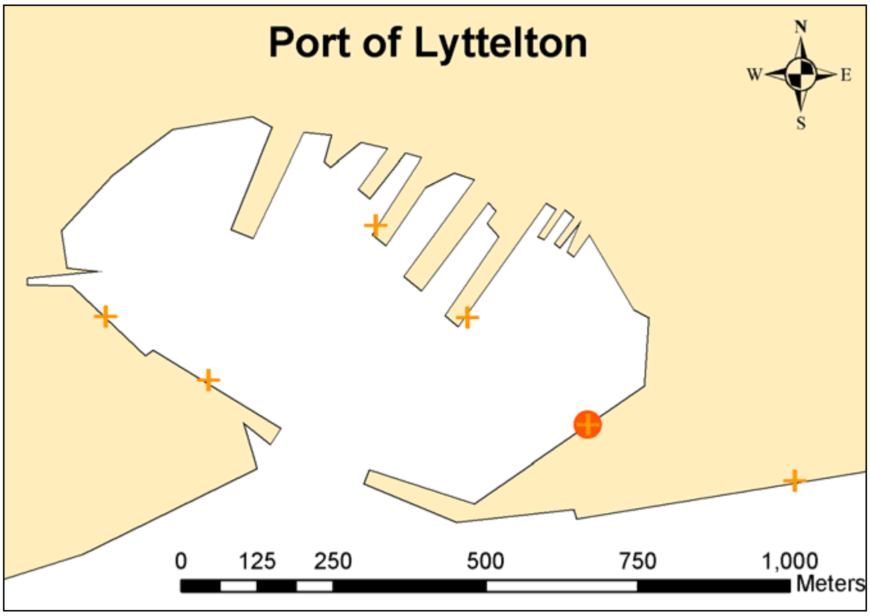

Figure 48: ***Polysiphonia brodiei* distribution in the initial baseline survey of the Port of Lyttelton (March 2002).**

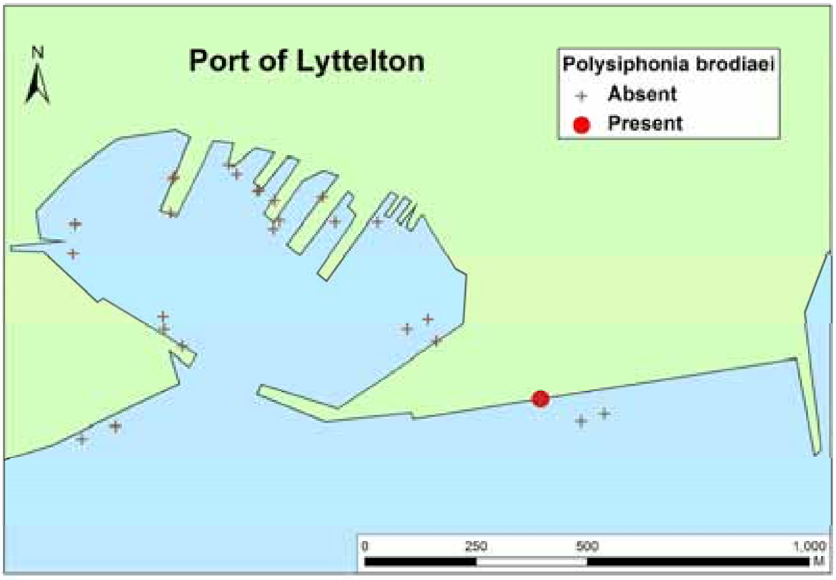

Figure 49: ***Polysiphonia brodiei* distribution in the re-survey of the Port of Lyttelton (November 2004).**

***Polysiphonia senticulosa* Harv. 1862**

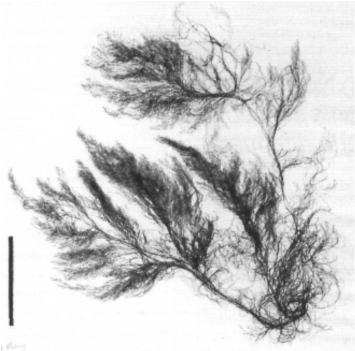

Image and information: Nelson and Maggs (1996)

Scale bar = 5 cm

Polysiphonia senticulosa is a red alga in the order Ceramiales. It is red to brownish purple and has been found growing both epiphytically (on other plants) and epilithically (on rocks). *P. senticulosa* was first described from Orcas Island, Washington DC, and has been reported from the northeast and northwest Pacific. Its synonym *P. pungens* has also been recorded from Port Phillip Bay, Victoria, Australia, where it is suspected to have been introduced via shipping. It was first reported in New Zealand (as *P. pungens*) from Greta Point, Evans Bay (Wellington Harbour) and has since been observed in earlier collections from Picton and other parts of Wellington Harbour (Nelson and Maggs 1996). It is particularly abundant in New Zealand from August to October. *P. senticulosa* was not recorded during the initial baseline surveys of Group 1 and Group 2 ports. During the second baseline surveys of Group 1 ports it was recorded only from the Port of Lyttelton (Table 18). The finding of *P. senticulosa* in the Port of Lyttelton represents an extension of its known range in New Zealand (W. Nelson, pers. comm.). In the Port of Lyttelton it occurred in pile scrape samples taken from Cashin Quay, Gladstone Pier, Wharf 3 and Wharf 7 (Figure 50).

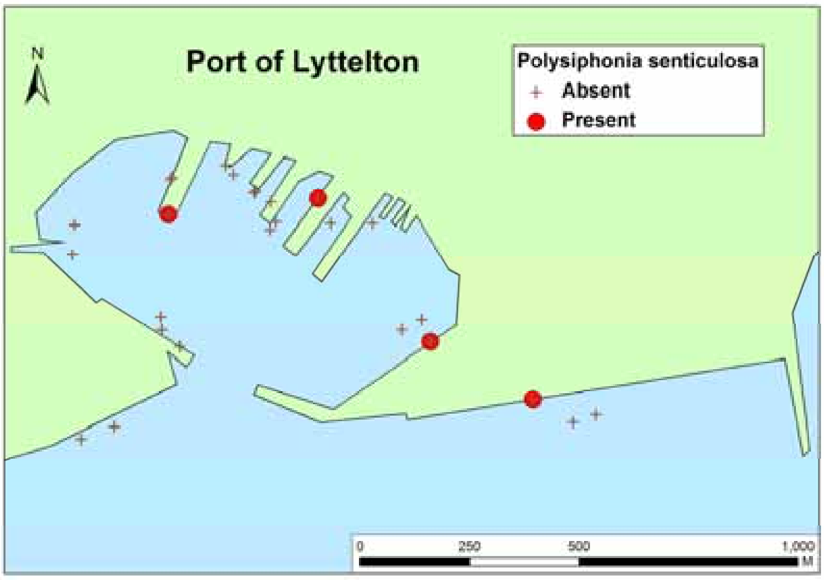

Figure 50: *Polysiphonia senticulosa* distribution in the re-survey of the Port of Lyttelton (November 2004).

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

Image: NIMPIS (2002k)
Information: NIMPIS (2002k), Fletcher and Farrell (1999)

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

Undaria pinnatifida is an opportunistic alga that has the ability to rapidly colonise disturbed or new surfaces. It grows from the intertidal zone down to the subtidal zone to a depth of 15-20 metres, particularly in sheltered reef areas subject to oceanic influence. It does not tend to become established successfully in areas with high wave action, exposure and abundant local vegetation. *U. pinnatifida* is highly invasive, grows rapidly and has the potential to overgrow and exclude native algal species. The effects on the marine communities it invades are not yet well understood, although its presence may alter the food resources of herbivores that would normally consume native species. In areas of Tasmania (Australia) it has become very common, growing in large numbers in areas where sea urchins have depleted stocks of native algae. It can also become a problem for marine farms by increasing labour costs due to fouling problems. *U. pinnatifida* is known to occur in a range of ports and marinas throughout eastern New Zealand, from Gisborne to Stewart Island. During the initial port baseline surveys, it was recorded from the ports of Gisborne, Napier, Wellington, Picton, Lyttelton, Timaru and Dunedin (Table 18). In the Port of Lyttelton *U. pinnatifida* was recorded from Cashin Quay, Gladstone Pier, the Oil Wharf, Wharf 2 and Wharf 4 (Figure 51). During the second baseline surveys of Group 1 ports *U. pinnatifida* was recorded from the ports of Taranaki, Wellington, Picton, Nelson, Lyttelton, Waitemata Harbour, Auckland, Tauranga Harbour and Timaru. In the re-survey of Lyttelton, *U. pinnatifida* was observed by divers and occurred in pile scrape samples from the No. 3, No. 4, No. 7 and Gladstone Pier (Figure 52).

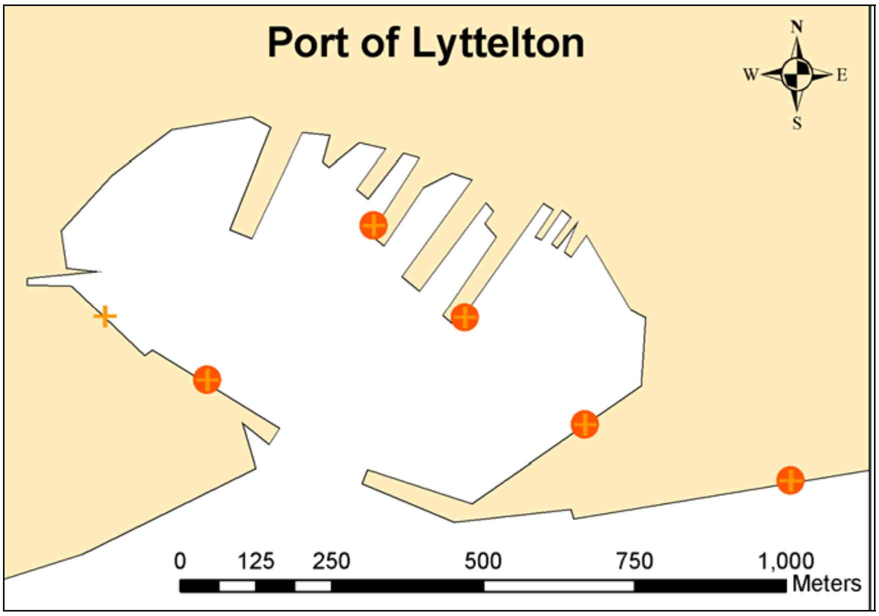

Figure 51: ***Undaria pinnatifida*** **distribution in the initial baseline survey of the Port of Lyttelton (March 2002).**

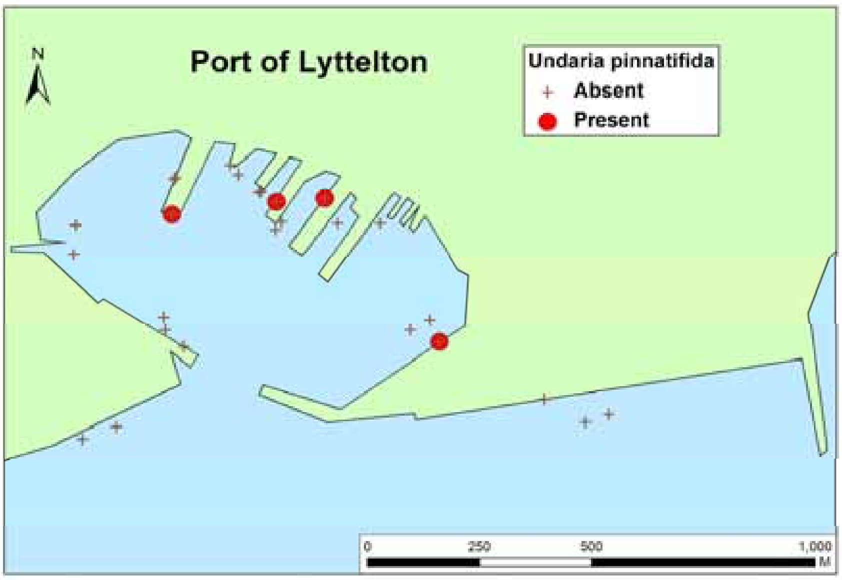

Figure 52: ***Undaria pinnatifida*** **distribution in the re-survey of the Port of Lyttelton (November 2004).**

Halisarca dujardini (Johnston, 1842)

Image and information: Picton and Morrow (2005)

Halisarca dujardini is an encrusting cold-water sponge. It is a cosmopolitan species with a wide distribution that includes the Arctic and Antarctic, the Subantarctic Islands, Australia, New Zealand, Chile, England, the Atlantic and the Mediterranean. It occurs from the shallow subtidal to a depth of 450 m. It has no known impacts. During the initial port baseline surveys *H. dujardini* was recorded from Auckland, Taranaki, Wellington, Picton, Dunedin and Bluff (Table 18). During the re-surveys of Group 1 ports, *H. dujardini* was recorded from Lyttelton and Picton. In Lyttelton it occurred in pile scrape samples taken from Cashin Quay (Figure 53).

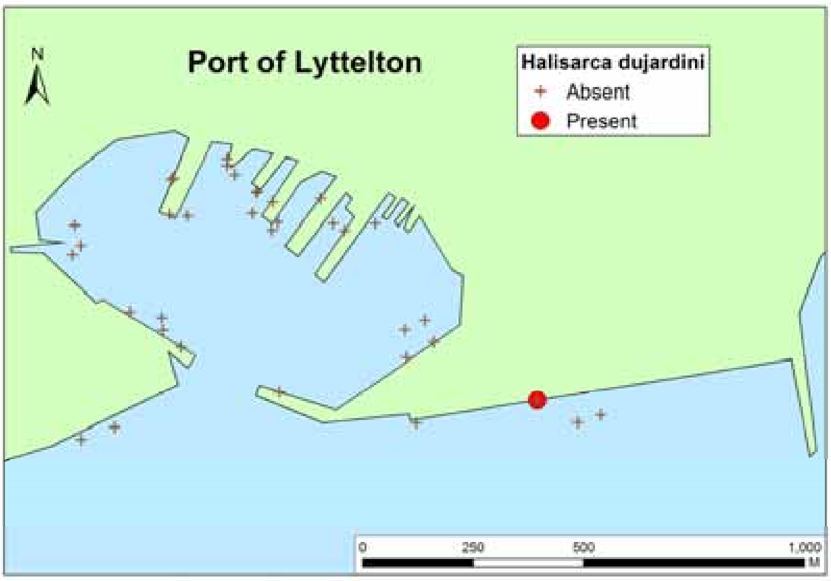

Figure 53: _Halisarca dujardini_ distribution in the re-survey of the Port of Lyttelton (November 2004)

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

Image and information: NIMPIS (2002a)

Ascidiella aspersa is a solitary ascidian that is native to northwest Europe, the British Isles, the Mediterranean Sea and the northwest African coasts. It has been introduced to India, Australia and New Zealand, and is cryptogenic to the east coast of the USA. *Ascidiella aspersa* attaches to the substratum by its entire left side and grows up to 130 mm in length. The inhalant (branchial) siphon is positioned at the top of the body and is conical in shape. The exhalent (atrial) siphon is positioned around one third of the way down the body and both siphons are ridged. The body wall (test) is firm and is transparent with numerous papillae scattered over the surface. Small amounts of pink or orange may be visible inside the siphons. *Ascidiella aspersa* is found from intertidal to shallow subtidal waters to 50m depth attached to clay, stones, rocks, algae and wharf piles, where it can be the dominant fouling species. In the southern hemisphere, populations are particularly abundant in the inner-reaches of estuaries and harbours in protected or semi-enclosed marine embayments. Although it is a solitary ascidian (i.e. not colonial) it is often found in dense clumps. It has no known documented impacts. During the initial baseline surveys it was recorded from the Group 2 ports of Gisborne and Napier, and from Gulf Harbour Marina (Table 18). These are likely to be extensions to the range of this species in New Zealand (M. Page, pers. comm.), as published records of its occurrence in New Zealand are for Christchurch, Portobello and Stewart Island (Millar 1982). During the second baseline surveys of Group 1 ports *Ascidiella aspersa* was recorded only from the Port of Lyttelton, where it occurred in pile scrape samples taken from Gladstone Pier and Wharf 3 (Figure 54).

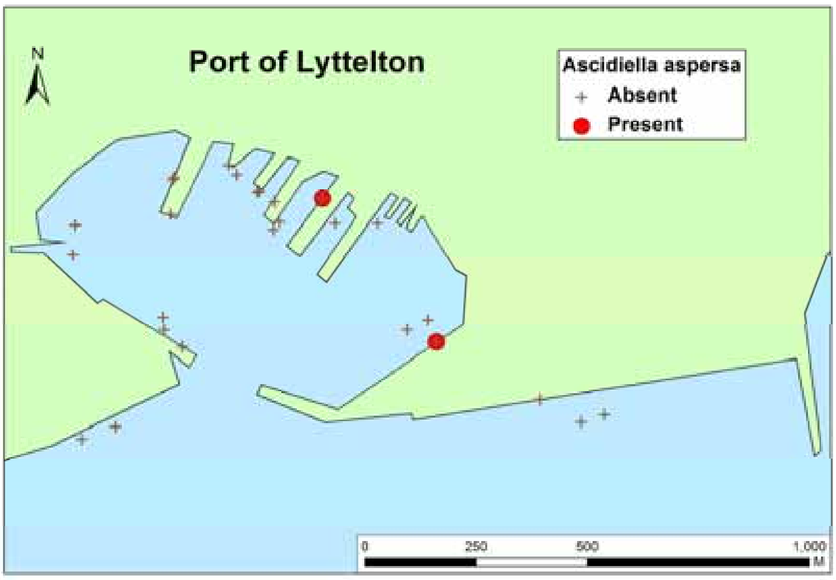

Figure 54: *Ascidiella aspersa* distribution in the re-survey of the Port of Lyttelton (November 2004)

***Ciona intestinalis* (Linnaeus, 1767)**

Image and information: NIMPIS (2002d)

Ciona intestinalis is a solitary ascidian, commonly found in dense aggregations on rocks, algal holdfasts, seagrass, shells and artificial structures such as pylons, buoys and ships hulls. It usually hangs vertically upside-down in the water column, attached to hard surfaces. It is cylindrical, and 100-150 mm in length with distinctive inhalant and exhalant apertures (siphons) having yellow margins and orange/red spots. The body wall is generally soft and translucent with the internal organs visible. They can also be hard and leathery due to heavy fouling. Short projections (villi) at its base anchor the animal to the substratum.

The type specimen of *C. intestinalis* was described from Europe by Linnaeus in 1767. It is thought to have been introduced to Chile and Peru, the northern west coast of the USA, equatorial West Africa and South Africa, Australia and New Zealand. *Ciona intestinalis* is considered cryptogenic to Alaska, the east coast of the USA and Canada, Greenland, Iceland, Japan, China and southeast Asia. It is often found in enclosed and semi-protected marine embayments and estuaries and although it occurs in the low intertidal and shallow subtidal zones, *C. intestinalis* clearly decreases in abundance with depth. Australian populations appear to be in decline, disappearing from port areas where the species had previously dominated in the 1950s-1960s and the same phenomenon has been observed in New England, USA. Its high filtration rates and large numbers can reduce water turbidity and food availability in shallow waters and it can out-compete native species for food and space. Since it appeared in southern California in 1917, native species of ascidians previously found in the harbours have disappeared or have become much rarer. It is known to be a nuisance fouling species in aquaculture facilities such as mussel rope culture, oyster farms and suspended scallop ropes in Nova Scotia and other parts of North America, the Mediterranean, South Africa, Korea and Chile, and recently in the Marlborough Sounds, New Zealand. During the initial port baseline surveys it was recorded from the ports of Napier, Nelson, Lyttelton and Timaru (Table 18). In Lyttelton it occurred in samples taken from Gladstone Pier, the Oil Wharf, Wharf 2 and Wharf 4 (Figure 55). During the second baseline surveys of Group 1 ports it was recorded from the ports of Lyttelton and Timaru. *C. intestinalis* was noticeably more abundant in Lyttelton during the second survey, occurring in more than 40 pile scrape samples from Gladstone Pier, the Oil Wharf, Wharf 3, Wharf 4, and Wharf 7. It also was recorded from benthic sled samples taken near Wharves 4, 5, 6 and 7 and from a crab trap set near Wharf 4 (Figure 56).

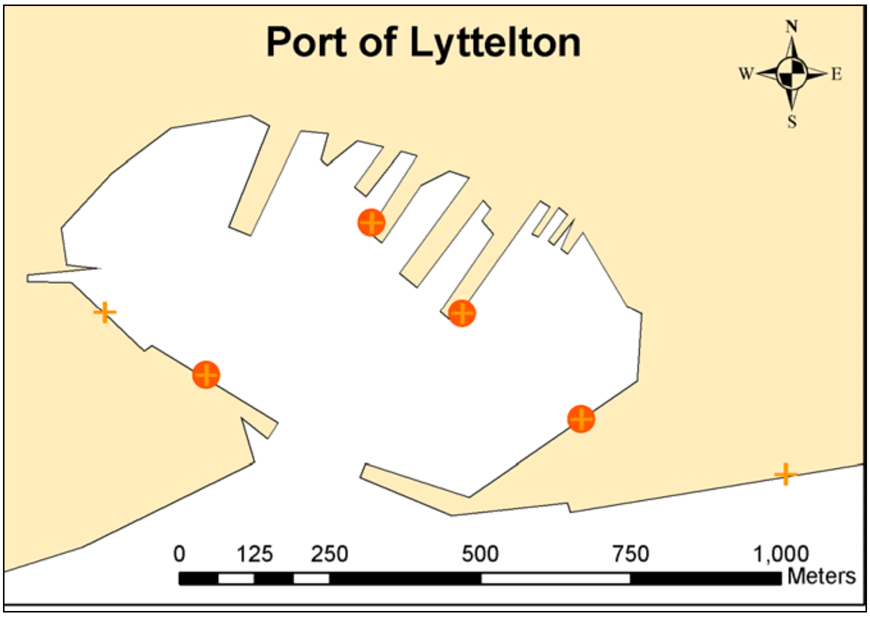

Figure 55: ***Ciona intestinalis*** **distribution in the initial baseline survey of the Port of Lyttelton (March 2002).**

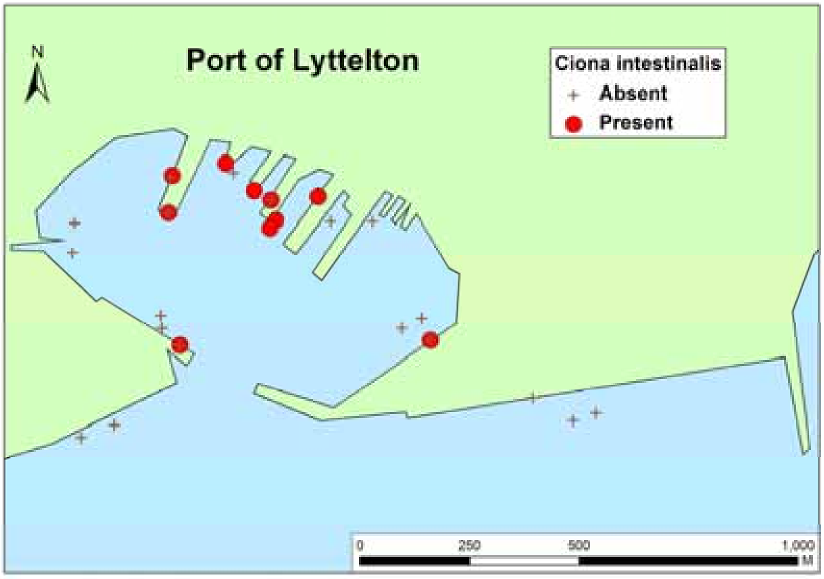

Figure 56: ***Ciona intestinalis*** **distribution in the re-survey of the Port of Lyttelton (November 2004).**

***Styela clava* Herdman, 1881**

Image and information: NIWA (2006)

Styela clava is a club-shaped, solitary ascidian with a leathery cylindrical body. It has two short siphons and tapers to a basal stalk, although juveniles may not be stalked. The stalk is shorter than the stalk of the similar native species *Pyura pachydermatina* (Biosecurity New Zealand 2005). Individuals of *S. clava* can grow up to 160 mm long, and are whitish-yellow, yellow-brown or reddish-brown. *S. clava* is native to the northwest Pacific (Japan, Korea, northern China and Siberia). It has been introduced to the eastern and western coasts of North America, Europe, and southern Australia (northern Tasmania, southern New South Wales and Victoria). *S. clava* can tolerate a wide range of salinity and temperature, and can breed in water temperatures above 15^{o}C and salinities above 25-26 ppt (NIMPIS 2002i). It is found from low tide to at least 25 m depth and prefers sheltered waters. It settles on rocks, seaweed, shellfish and man-made structures including wharves, docks, boat hulls, mooring lines, buoys and aquaculture structures. *S. clava* is capable of rapid proliferation and can achieve very large densities of 500 to 1,500 individuals per square metre. In Canada, it is having a significant impact on mussel aquaculture through fouling of equipment, overgrowth of mussel lines and competition with mussels for nutrients.

Styela clava was not recorded during the initial baseline surveys of Group 1 and Group 2 ports. It was first identified in New Zealand in September 2005 from specimens collected in Viaduct Harbour by a visiting scientist. Soon after (October 2005), identification was completed of the ascidians collected during the repeat baseline survey of Lyttelton in November 2004. This collection contained a single specimen of *S. clava* that occurred in a pile scraping taken at Gladstone Pier (Table 18, Figure 57). Lyttelton was the only port that *S. clava* was recorded from during the repeat baseline surveys of Group 1 ports. Subsequent delimitation surveys commissioned by MAF Biosecurity New Zealand have shown that *S. clava* is widely distributed in the Hauraki Gulf and is present in Tutukaka marina (Northland) and Magazine Bay Marina in Lyttelton Harbour (Gust et al. 2006a). Re-examination of stored ascidian specimens collected by other researchers prior to this survey confirm that it has been present in Lyttelton since at least 2002 and may have been present in the Hauraki Gulf for ten years or more.

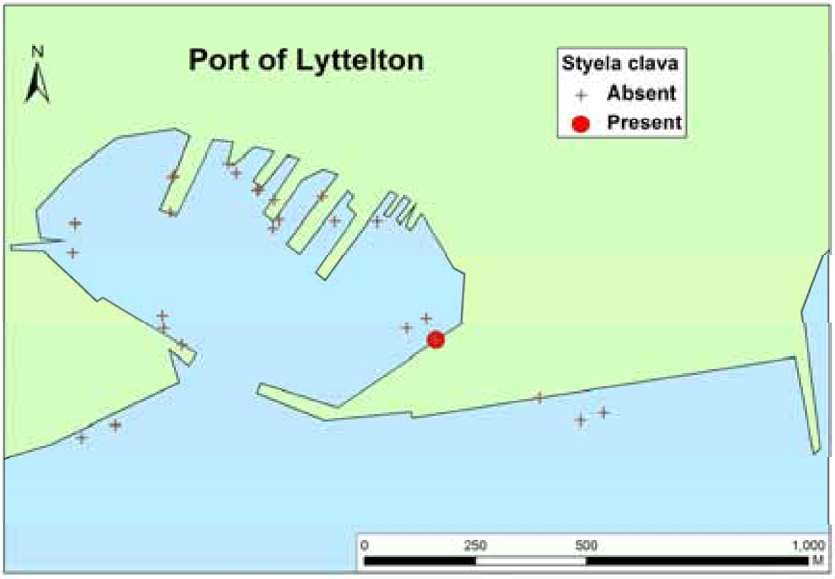

Figure 57: ***Styela clava*** **distribution in the re-survey of the Port of Lyttelton (November 2004)**

SPECIES INDETERMINATA

Forty organisms from the Port of Lyttelton were classified as species indeterminata. If each of these organisms is considered a species of unresolved identity, then together they represent 15% of all species collected from this survey (Figure 19). Species indeterminata from the Port of Lyttelton included 4 annelid worms, 1 bryozoan, 1 pycnogonid, 6 crustaceans, 1 dinoflagellate, 23 algae, 3 ascidians and one fish (Table 17).

NOTIFIABLE AND UNWANTED SPECIES

Two species recorded from the Port of Lyttelton, the Asian seaweed, *Undaria pinnatifida* and the club-shaped ascidian *Styela clava*, are currently listed on the New Zealand Register of Unwanted Organisms (Table 12). None of the species listed on the ABWMAC Australian list of marine pest species was recorded from the re-survey of the Port of Lyttelton (Table 13).

Australia has recently prepared an expanded list of priority marine pests that includes 53 non-indigenous species that have already established in Australia and 37 potential pests that have not yet reached its shores (Hayes et al. 2004). A similar watch list for New Zealand is currently being prepared by Biosecurity NZ. Twelve of the 53 Australian priority domestic pests are present in the Port of Lyttelton. These are listed in descending order of the impact potential ranking attributed to them by Hayes et al. (2004): *Ciona intestinalis*, *Bugula neritina*, *Polysiphonia brodiei*, *Bugula flabellata*, *Undaria pinnatifida*, *Watersipora subtorquata*, *Styela clava*, *Halisarca dujardini*, *Cryptosula pallasiana*, *Bouganvillia muscus*, *Apocorophium acutum*, and *Monocorophium acherusicum*. None of the 37 priority international pests identified by Hayes et al. (2004) was present in the Port of Lyttelton.

PREVIOUSLY UNDESCRIBED SPECIES IN NEW ZEALAND

Three species recorded from the re-survey of the Port of Lyttelton are new records from New Zealand waters: the non-indigenous amphipod, *Crassicorophium bonnellii*, the non-indigenous ascidian *Styela clava* and the sponge *Haliclona* new sp. 17. A further 16 species were described for the first time during the initial port baseline surveys. These were the polychaete *Spirobranchus polytrema*, the amphipods *Acontiostoma* n. sp., *Leucothoe* sp. 1, and *Monocorophium* sp. aff. *M. insidiosum*, and 12 species of sponge: *Adocia* new sp. 2, *Euryspongia* new sp. 1, *Halichondria* new sp. 2, *Haliclona* new sp. 1, *Haliclona* new sp. 11, *Haliclona* new sp. 13, *Haliclona* new sp. 4, *Haliclona* new sp. 6, *Paraesperella* new sp. 1 (macrosigma), *Phorbas* cf. *anchorata*, *Phorbas* new sp. 2, *Suberitidae* new g. new sp. 1. Five of these species – *Leucothoe* sp. 1, *Monocorophium* sp. aff. *M. insidiosum*, *Euryspongia* new sp. 1, *Paraesperella* new sp. 1 (macrosigma), and *Suberitidae* new g. new sp. 1 – were recorded during the earlier port baseline survey of the Port of Lyttelton. The remainder represent new records for this location.

CYST-FORMING SPECIES

Cysts of four species of dinoflagellate were collected during this survey. Three of these are considered native species (Table 14) and one is indeterminate (Table 17). None of the species recorded are known to produce toxins (Hay et al. 2000; Faust and Gulledge 2002; New Zealand Food Safety Authority 2003).

COMPARISON OF RESULTS FROM THE INITIAL AND REPEAT BASELINE SURVEYS OF THE PORT OF LYTTELTON

Pile scrape samples

Native species

Rarefaction curves and estimates of total species richness in pile scrape samples taken from the two baseline surveys of the Port of Lyttelton are presented in Figure 58a. Curves for the native species assemblage were concordant in each survey, with very similar rates of species accumulation relative to sampling effort. In each case, the observed richness increased steadily as more samples were taken and did not approach an asymptote. The 30% increase in sample effort in the second survey captured ~17 % more species than the initial baseline survey and was consistent with the rate of species accumulation observed in the first survey. Estimates of total species richness in each survey also continued to increase with sample size and did not plateau or converge with observed richness, indicating a high proportion of unsampled species in the assemblages. Indeed, as sample size increased, more unique species (i.e. those that occurred in only one sample) were added to the survey. These ‘rare’ species comprised large proportions of the sampled assemblage. Thirty-two percent and 40 % of the native species observed in each survey, respectively, occurred in just a single sample (Table 19). The large number of uniques had a strong influence on the estimated number of unsampled species in the assemblage, which varied between 32 % in the first survey (ie. 35 unsampled species out of 109 observed) and 46 % in the re-survey (ie. 59 unsampled species of 127 observed; Figure 58a).

Despite the correspondence between the rarefaction curves for the two surveys, the species composition of the assemblages in each survey was quite different. Only 69 species (41 % of the total number) were recorded in both surveys (Table 19). Again, this reflects the large number of comparatively rare species in the assemblage, with non-detection of many of these probably accounting for much of the difference observed between the two surveys. For example, the classic Jaccard and Sorenson measures of compositional similarity indicate very low similarity between the assemblages recorded in the initial and repeat baseline surveys of Lyttelton (0.413 and 0.585, respectively). In contrast, the new Chao similarity indices, which adjust for the effects of non-detection of rare species, suggest much closer resemblance of the two samples (Chao bias-adjusted Jaccard = 0.768; Chao bias-adjusted Sorenson = 0.807; Table 19).

Cryptogenic category 2 species

The observed richness of cryptogenic category two species also did not reach an asymptote in either survey, but did converge with the estimated richness, suggesting relatively complete inventories of this group in each survey (Figure 58b). A greater density of cryptogenic category 2 species was observed in the repeat survey, with the total number of observed species (33) exceeding the estimated total richness of the first survey (Chao 2 estimate = 26.6). It is unclear what caused the differences in species density and estimated species richness between surveys, but they may be associated with temporal variation in the abundance of species within the assemblage or immigration of new species into it.

There was comparatively high turn-over in cryptogenic category 2 species composition between the two surveys. Only 13 of the 44 species in this category (30%) recorded from the Port of Lyttelton were common to both surveys (Table 19). This is reflected in comparatively low similarity between the assemblages, even when adjustment is made for undetected rare species (Chao bias-adjusted Jaccard = 0.484; Chao bias-adjusted Sorenson = 0.618; Table 19).

Non-indigenous and cryptogenic category 1 species

The re-survey of the Port of Lyttelton recorded a much larger number of non-indigenous and cryptogenic category 1 species (41 species) than the initial baseline survey (27 species). In the initial survey, the observed species density in this group appeared to have plateaued above 50 samples and, at 70 quadrat samples, was approaching the estimated total richness of 33 species (Figure 58c). The modest difference between the observed and estimated richness in the first survey (6 species) suggested a relatively complete inventory with a small proportion of uniques (19%) and, therefore, few undetected species (Table 19). In the second survey, the observed number of species did not approach an asymptote and continued to increase steeply with increasing sample effort (Figure 58c). The observed density of species was substantially greater than in the first survey. This was not solely attributable to increased sample effort in the second survey. By interpolating back to the number of samples used in the first survey (70 quadrat samples), we can show that, on average, an extra 10 species were discovered in the second survey for the same number of samples. Although the estimate of total species richness stabilised after about 54 samples (at around 58 species), it remained substantially higher than the observed species density (41 species; Table 19). This is an indication that, as more samples were taken, the rate of discovery of previously unsampled, rare species remained relatively constant, reflecting a potentially large pool of undiscovered species that was not evident in the first survey. Only 3 of the 26 species found in the first survey were not detected in the repeat survey (Table 19). As a result, the compositional similarity of the two assemblages was relatively high, once undetected species had been adjusted for (Chao bias-adjusted Jaccard = 0.93; Chao bias-adjusted Sorenson = 0.958; Table 19).

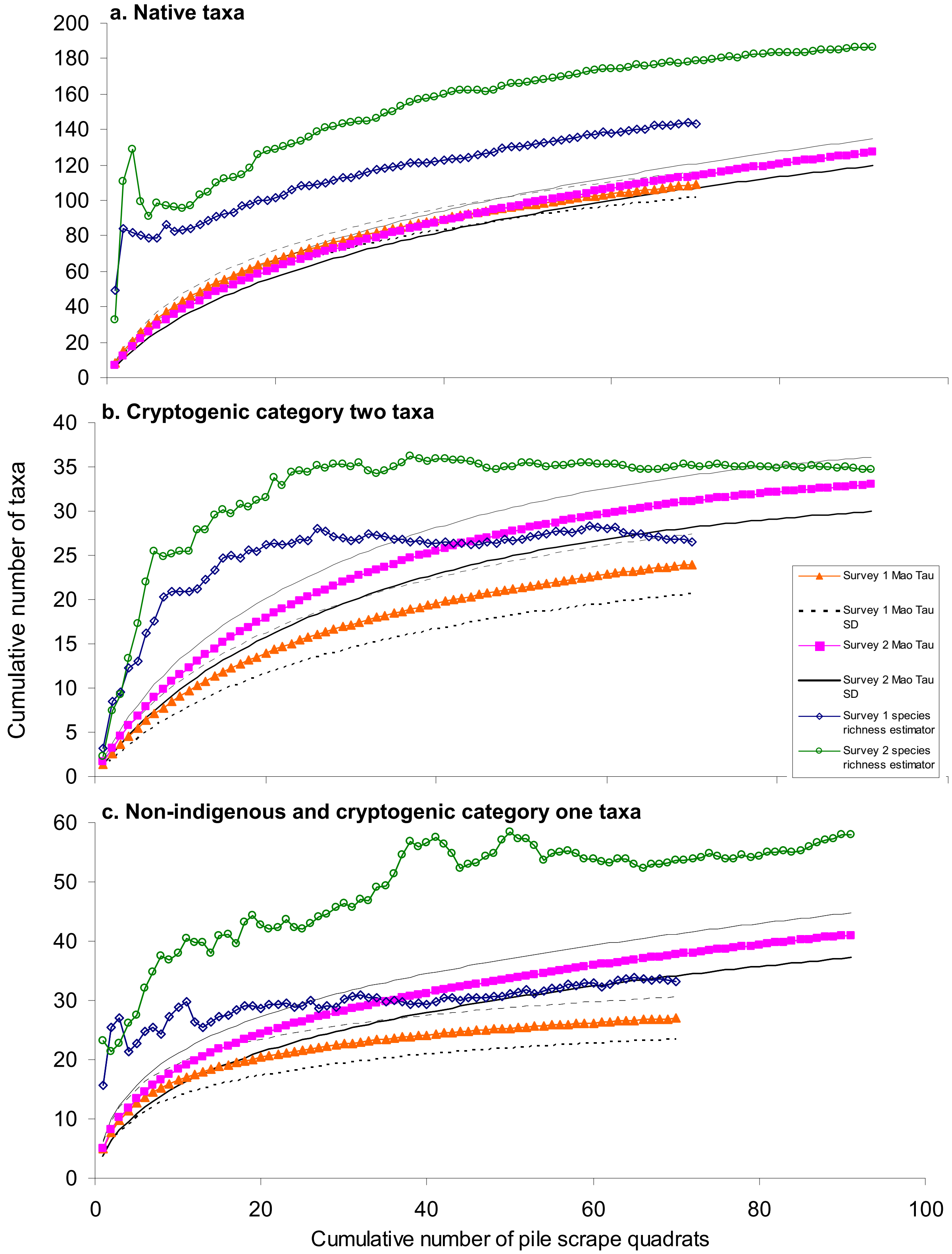

Figure 58: Rarefaction curves (Mao Tau) for native (top), cryptogenic category two (middle) and non-indigenous and cryptogenic category one (bottom) taxa collected from pile scrape quadrats for the first survey (full triangles, ± SD (dashed lines)) and second survey (full squares, ± SD (solid lines)). Species richness estimators are also shown for the first survey (empty diamonds) and second survey (empty circles); the ICE formula was used for native taxa in in the second survey, the Chao 2 classic formula was used for NIS & C1 taxa and the Chao 2 bias-corrected formula was used in all other instances.

Benthic sled samples

Native species

Survey effort for the benthic sled samples was doubled in the repeat baseline survey in an attempt to improve description of the epibenthic fauna of the port (Table 19). In the initial survey, samples taken using this method were dominated by uniques (55% of species), resulting in a comparatively large and unstable estimate of total species richness (Figure 59a). To some extent, this is a function of the small sample size in the initial survey, since a single sled sample represented 10% of the total survey effort. Nevertheless, the observed density of native species was greater in the initial baseline survey (38 species) than in the repeat survey (19 species) and exceeded the total estimated richness (29 species) in the repeat survey (Table 19). Despite the increased sample effort in the second survey the trajectory of the rarefaction curve was relatively flat, indicating slow accumulation of species with additional samples. At the rate indicated in Figure 59a, a further doubling of survey effort (i.e. ~40 samples) would be needed to capture the estimated species richness of the assemblage (ICE estimate = 29 species), although the estimate itself had not completely stabilised indicating that, as more samples were taken, the rate of discovery of unsampled, rare species remained relatively constant. Twelve of the 19 species recorded in the second survey (63 %) were also recorded in the initial survey, with moderate similarity between the two samples (Chao bias-adjusted Jaccard = 0.629; Chao bias-adjusted Sorenson = 0.676; Table 19).

Cryptogenic category 2 species

Too few species were recorded in this category for quantitative comparison of the two baseline surveys. Only two cryptogenic category 2 species were collected in each survey from the benthic sled samples (Table 19).

Non-indigenous and cryptogenic category 1 species

Rarefaction curves for the combined non-indigenous and cryptogenic category 1 species exhibited similar patterns to those described above for native species. Samples obtained during the first survey had a greater density of observed species (11 species vs 6 species for an equivalent sample of 10 sled tows) and a higher proportion of uniques (64 % vs 14 %) than those from the second survey, resulting in a steeper rarefaction curve and unstable (and very high) estimates of total richness (Figure 59b). In the second survey, the rarefaction curve converged with the estimated richness, suggesting relatively complete inventory of this group (Figure 59b). All of the species encountered in the repeat survey were recorded during the initial survey of the Port of Lyttelton (Table 19).

Benthic grab samples

Samples taken with the benthic grab contained relatively few non-indigenous and cryptogenic category 1 species (7 species in total) or cryptogenic category 2 species (3 species) in either survey (Table 19). For this reason, analysis was done on the pooled species assemblage (Figure 60).

As with the benthic sled samples, survey effort was increased substantially in the re-survey of the port to improve description of the fauna (Table 19). The shapes of rarefaction curves and richness estimates generated from the benthic grab samples are generally similar to those described above for the sled samples. Observed species density in the initial baseline survey was substantially greater than that recorded in the re-survey, with more than twice the number of species detected in the first survey (23 species and 10 species, respectively) from just over half the number of samples (15 grab samples vs 26 samples; Table 19). A consequence was that the rarefaction curve rose more steeply than that from the re-survey and showed no sign of reaching an asymptote. The large proportion of uniques in each survey (61% and 70% of each assemblage) meant that the species richness estimates were unstable and diverged markedly from the observed species number (Figure 60). There was also little overlap in species composition between the surveys. Only 4 of the 29 species recorded from the benthic grab samples (14%) were present in both surveys, resulting in low similarity of the two assemblages (Chao bias-adjusted Jaccard = 0.297; Chao bias-adjusted Sorenson = 0.444; Table 19). This suggests considerable undersampling of the assemblage, but the slow rate of accumulation of species in the second survey (fewer than 3 new species for every 10 samples) means that sampling effort would need to more than double again (~55 samples in total) to approach the estimated richness (35 species).

Crab trap samples

Samples obtained using baited crab traps were characterised by relatively few species (mean = 1.6 species per trap ± 0.1 S.E.). This was a feature of all of the passive trapping techniques (see below). In total, 14 species were sampled using the crab traps, over both surveys. Most of these were recorded in the second survey (13 of 14 species). Both species density and estimated richness were greater in samples taken during the second survey. The richness estimate increased steeply as more samples were taken (Figure 61), reflecting the high proportion of species that were recorded in only a single sample (8 of 13 species in the second survey; Table 19). Although the rate of species accumulation continued to increase as more samples were taken, the rate of increase was slow, with fewer than 4 species added to the inventory for every 20 traps set.

Fish trap samples

Only 11 species were captured in the fish traps, all of which were native (Table 19). Eight species were captured in each survey despite greater sample effort in the second survey (20 vs 36 samples respectively) and the rate of accumulation was roughly similar (Figure 62). Neither rarefaction curve approached an asymptote, but in the initial survey there was convergence between the observed and estimated richness. In samples from the second survey, however, the estimated richness continued to increase with sample effort at approximately the same rate as the observed species density and remained ~30 % higher. The rate of species accumulation was very slow with, on average, fewer than 2 extra species detected for every 20 traps set. The species composition of samples taken during each survey was quite similar (Chao bias-adjusted Jaccard = 0.783; Chao bias-adjusted Sorenson = 0.869; Table 19), probably due to the low species diversity captured in the fish traps. Just under half of the species (45%) were present in both surveys.

Starfish trap samples

Too few species were captured in the starfish traps to allow quantitative comparison of the two baseline surveys. Only two native species – the common cancrid crab, *Metacarcinus novaezelandiae* (formerly *Cancer novaezelandiae*) and the cushion star, *Patiriella regularis* – were recorded from the starfish traps (Table 19). Both species were recorded in each survey of the Port of Lyttelton.

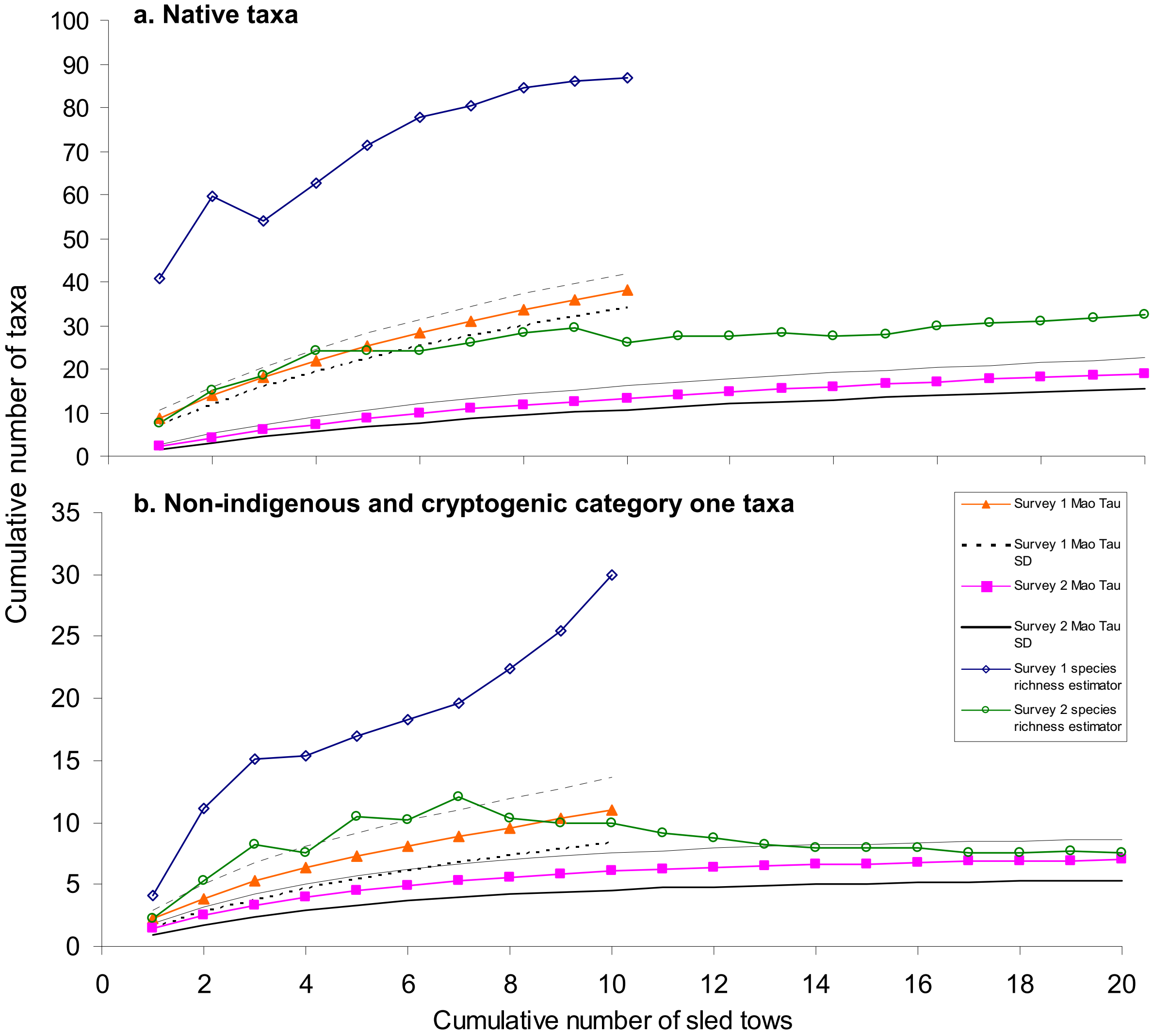

Figure 59: Rarefaction curves (Mao Tau) for native (top) and non-indigenous and cryptogenic category one (bottom) taxa combined collected in benthic sled tows for the first survey (full triangles, ± SD (dashed lines)) and second survey (full squares, ± SD (solid lines)). There were too few cryptogenic category two taxa encountered for a meaningful analysis of this group. Species richness estimators are also shown for the first survey (empty diamonds) and second survey (empty circles); the Chao 2 classic formula was used for NIS & C1 taxa in the first survey and for native taxa in the second survey. The ICE formula was used in both other instances.

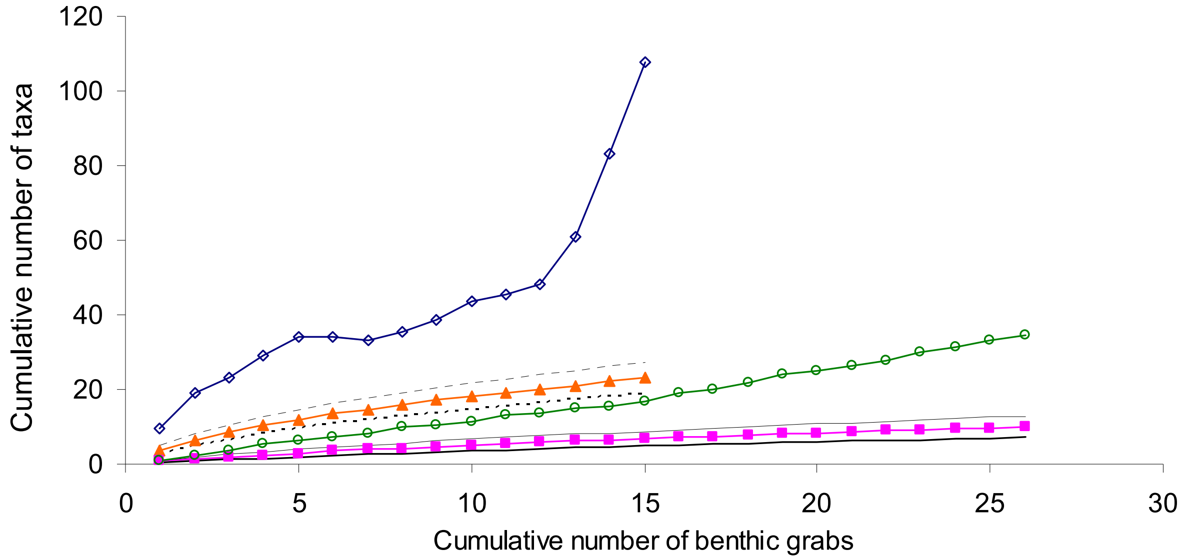

Figure 60: Rarefaction curves (Mao Tau) for native, cryptogenic and non-indigenous taxa combined collected in benthic grabs for the first survey (full triangles, ± SD (dashed lines)) and second survey (full squares, ± SD (solid lines)). Species richness estimators (Chao 2 classic formula) are also shown for the first survey (empty diamonds) and second survey (empty circles).

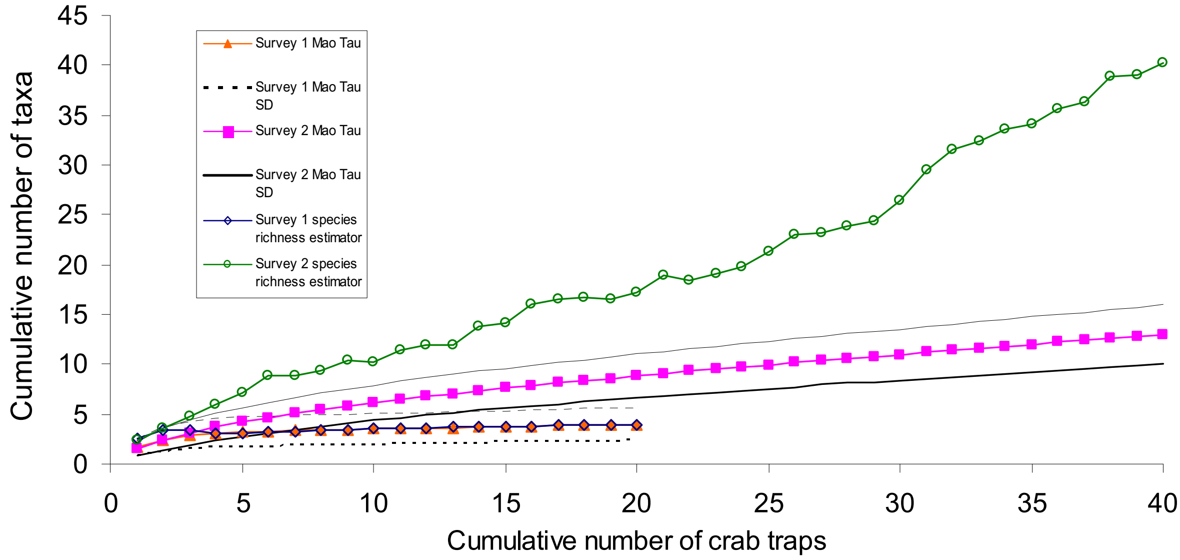

Figure 61: Rarefaction curves (Mao Tau) for native, cryptogenic and non-indigenous taxa combined collected in crab traps for the first survey (full triangles, ± SD (dashed lines)) and second survey (full squares, ± SD (solid lines)). Species richness estimators are also shown for the first survey (empty diamonds, Chao 2 bias-corrected formula) and second survey (empty circles, Chao 2 classic formula).

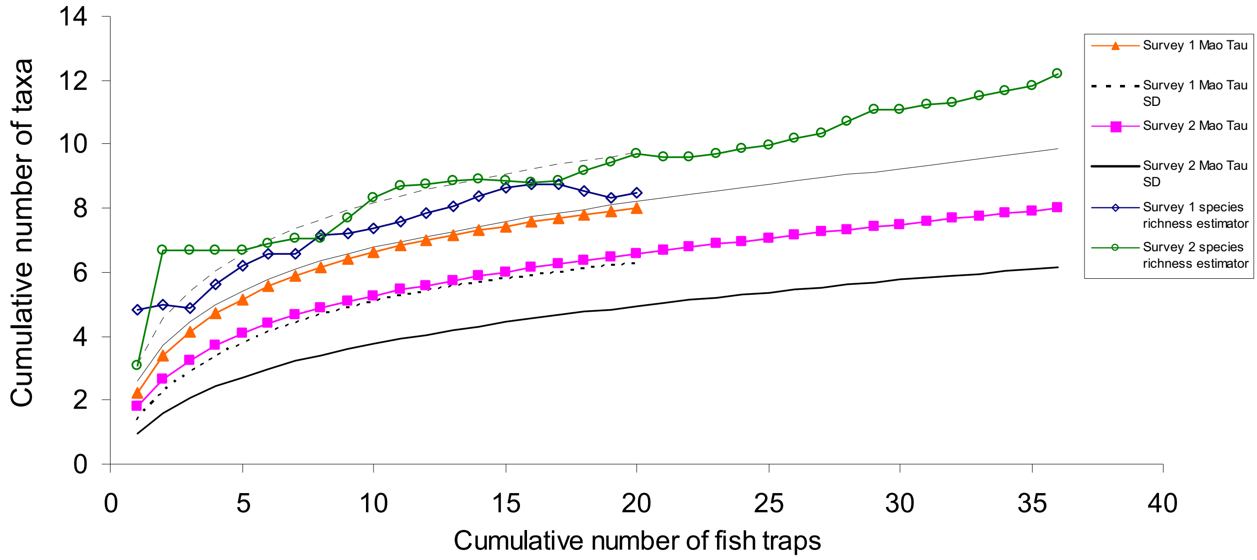

Figure 62: **Rarefaction curves (Mao Tau) for native taxa collected in fish traps for the first survey (full triangles, ± SD (dashed lines)) and second survey (full squares, ± SD (solid lines)). No non-indigenous or cryptogenic taxa were encountered in either survey. Species richness estimators are also shown for the first survey (empty diamonds, Chao 2 bias-corrected formula) and second survey (empty circles, ICE formula).**

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

The non-indigenous species located in the Port of Lyttelton are thought to have arrived in New Zealand via international shipping. They may have reached the Port of Lyttelton directly from overseas or through domestic spread (natural and/or anthropogenic) from other New Zealand ports. Table 16 indicates the possible vectors for the introduction of each NIS recorded from the Port of Lyttelton during the baseline port surveys. Likely vectors of introduction are largely derived from Cranfield et al. (1998) and expert opinion. They suggest that only 1 of the 27 NIS (4%) probably arrived via ballast water, 21 species (78%) were most likely to be associated with hull fouling, and 5 species (18%) could have arrived via either of these mechanisms.

Assessment of the risk of new introductions to the port

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

Between 2002 and 2005, there were 654 vessel arrivals from overseas to the Port of Lyttelton. The greatest number of these came from Australia (201, including 138 from southeastern Australia), the Pacific Islands (141), the northwest Pacific (107, predominantly from China, Korea, Russia and Taiwan) and Japan (76; Table 4). With the exception of the Pacific Islands, most of this trade is with ports from other temperate regions that have coastal environments similar to New Zealand's. Vessels from the Pacific Islands also present less of a risk not just because of differences in coastal environments, but also because most of these vessels are passenger vessels (cruise liners), general and container cargo vessels, which typically discharge relatively small volumes of ballast water. Bulk carriers and tankers that arrive empty carry the largest volumes of ballast water. In the Port of Lyttelton these came predominantly from Australia (85 visits), the northwest Pacific (58 visits), Japan (53 visits) and east Asian seas (24 visits; Table 4). Smaller, slower moving vessels, such as barges and fishing boats, tend to carry a greater density of fouling organisms than faster cargo vessels. In the port of Lyttelton, these also came predominantly from Australia, Japan and the northwest Pacific (Table 4).

Shipping from southern Australia, the northwest Pacific (predominantly China, Korea, Russia and Taiwan) and Japan present the greatest risk of introducing new non-indigenous species to the Port of Lyttelton. Because of the relatively short transit time, shipping originating in southern Australia (particularly Victoria and Tasmania) carries, perhaps, the greatest overall risk. Furthermore, six of the eight marine pests on the New Zealand Register of Unwanted Organisms are already present there (*Carcinus maenas*, *Asterias amurensis*, *Undaria pinnatifida*, *Sabella spallanzanii*, *Caulerpa taxifolia*, and *Styela clava*). The native range of other two species – *Eriocheir sinensis* and *Potamocorbula amurensis* – is the northwestern Pacific, including China and Japan.

Assessment of translocation risk for introduced species found in the port

Between 2002 and 2005, vessels departing from the Port of Lyttelton travelled to 19 ports throughout New Zealand. Wellington, Nelson, Dunedin and New Plymouth were the next ports of call for the most domestic vessel movements from Lyttelton (Table 8). Although many of the non-indigenous species found in the re-survey of the Port of Lyttelton have been recorded in other locations throughout New Zealand (Table 18), they were not detected in all of the other ports surveyed. There is, therefore, a risk that species established in the Port of Lyttelton could be spread to other New Zealand locations.

Of particular note are the two species present in Lyttelton that are on the New Zealand Register of Unwanted Species: the invasive alga *Undaria pinnatifida* and the club-shaped ascidian, *Styela clava*. *U. pinnatifida* has been present in New Zealand since at least 1987 and has spread through shipping and other vectors to 11 of the 16 ports and marinas surveyed during the baseline surveys (the exceptions being Opua, Whangarei Port and Marina, Gulf Harbour Marina and Tauranga Port). Until recently, it was absent from the Ports of Taranaki (New Plymouth) and Tauranga. Mature sporophytes were discovered in the Port of Taranaki during the repeat baseline port survey there in March 2005. Some isolated sporophytes have also been discovered independently on rocky reefs near the Port of Tauranga (Environment Bay of Plenty, pers. comm.), but the alga does not appear to be established in the port itself. LPG / LNG tankers and general cargo regularly ply between Lyttelton and the Port of Tauranga and, to a much lesser extent, ports north of Auckland where *U. pinnatifida* has not yet become established. There is, therefore, a risk that it could be spread to these locations by shipping from Lyttelton.

Lyttelton Harbour is one of only two locations nationwide that *Styela clava* has been recorded from outside the Hauraki Gulf; the other being Tutukaka Marina (Gust et al. 2006a). This species is considered a significant pest of aquaculture (particularly long-line mussel culture) and there is concern about the potential for it to spread to important mussel growing areas in the Marlborough Sounds and Coromandel. Although there are relatively few vessel movements between the Ports of Lyttelton and Picton (in the Marlborough Sounds), there is regular traffic from Lyttelton to nearby Nelson and Wellington by a range of vessel types (Table 8). Because they are fouling organisms, the risk of translocating *Undaria pinnatifida* and *S. clava* is highest for slow-moving vessels, such as yachts and barges, and vessels that have long residence times in port. In the Port of Lyttelton, cargo and bulk (including fuel) carriers, recreational craft, and seasonal fishing vessels that are laid up for significant periods of time pose a particular risk for the spread of these species.

Several other species recorded during the baseline re-survey have only been recorded from the Port of Lyttelton or have relatively restricted distributions nationwide and could, therefore, be spread from Lyttelton to other locations. These include the amphipods *Crassicorophium bonnellii*, *Jassa slatteryi* and *Monocorophium sextonae*, the hydroid *Symplectoscyphus subdichotomus*, and the alga *Polysiphonia senticulosa*. Information on the ecology of these species is limited, but none is known to have potential for significant impacts.

The small Japanese cancrid crab, *Cancer gibbosulus*, which was recorded from Lyttelton during the initial baseline survey, was not found during the re-survey. It is known only from a few specimens recovered from Lyttelton, Timaru and Wellington during the initial port baseline surveys. *C. gibbosulus* was not recovered from any of these locations during the recent re-surveys. At this stage it is unclear whether this is due to sampling error as a consequence of very small population densities in each port, or because the initial populations that were discovered were not viable. In either case, it appears a small risk of translocation at current levels of abundance.

Management of existing non-indigenous species in the port

More than half of the NIS detected in this survey appear to be well established in the port. However, there were ten NIS recorded in this survey that were recorded from only one site in this survey (Table 18). They included species that were not recorded during the intial baseline survey of Lyttelton (the ascidian *Styela clava,* the polychaete worm *Polydora hoplura*, the hydroid *Monotheca pulchella*, the amphipod *Crassicorophium bonnellii* and the sponge *Halisarca dujardini*), those that were present in only one or a few samples in the initial baseline survey of Lyttelton (the bryozoan *Conopeum seurati*, the amphipods *Jassa slatteryi* and *Monocorophium sextonae* and the alga *Polysiphonia brodiei*), and one (the bryozoan *Cryptosula pallasiana*) that was present in many samples in the initial survey and thus appears to have reduced its prevalence since that time. Furthermore, eight of the ten species (all except *C. bonnellii* and *J. slatteryi*) were recorded from only a single sample, and the specimen of *M. pulchella* was an infertile colony. These species may not be well established in the Port of Lyttelton (with the exception of *S. clava*, which is now known from other locations in the Port), and several of them (*S. clava, C. seurati, C. bonnellii, J. slatteryi, M. sextonae* and *P. brodiei*) have been recorded in no or few other New Zealand ports, and thus, based on survey results, do not appear to be well established in New Zealand, either. On this basis the control of these species may warrant particular attention before their populations become established and widespread, although control efforts should perhaps be scaled by the potential impacts of the species, where these are known.

For most marine NIS, eradication by physical removal or chemical treatment is not yet a cost-effective option. Local population controls are unlikely to be effective for species that are widespread in the Port of Lyttelton. They may be worth considering for the more restricted species noted above, but a more detailed delimitation survey is needed for these species to determine their current distribution and abundance more accurately before any control measures are considered. It is recommended that management activity be directed toward mitigating the spread of species established in the port to locations where they do not presently occur. This is particularly important for the two unwanted species, *Undaria pinnatifida* and *Styela clava*. MAF Biosecurity New Zealand is currently considering implementing population management trials for *S. clava* in the Port of Lyttelton. Such management will require better description of its distribution within the Port and of the location and frequency of movements of potential vectors that might spread it from Lyttelton to other domestic and international locations.

Prevention of new introductions

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

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

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

Conclusions and recommendations

The national biological baseline surveys have significantly increased our understanding of the identity, prevalence and distribution of introduced and native species in New Zealand's shipping ports. They represent a first step towards a comprehensive assessment of the risks posed to native coastal marine ecosystems from non-indigenous marine species. Although measures are being taken by the New Zealand government to reduce the rate of new incursions, foreign species are likely to continue to be introduced to New Zealand waters by shipping. There is a need for continued monitoring of non-indigenous marine species in port environments to allow for (1) early detection and control of harmful or potentially harmful non-indigenous species, (2) to provide on-going evaluation of the efficacy of management activities, and (3) to allow trading partners to be notified of species that may be potentially harmful.

The repeat survey of the Port of Lyttelton recorded 269 species or higher taxa, including 23 non-indigenous species. Although many species also occurred in the initial, March 2002 baseline survey of the port, the degree of overlap was not high. Around 43% of the native species, 39% of non-indigenous species, and 56% of cryptogenic species recorded during the repeat survey were not found in the earlier survey. This is not simply attributable to the greater sampling effort in the second survey. The species assemblage in each survey was characterised by high diversity, a comparatively large proportion of uncommon species, and patchy local distributions that are typical of marine biota. As a consequence, the estimated numbers of undetected species were comparatively high. In the initial baseline survey, for example, 7 of the 18 non-indigenous species (38%) were each found in just a single sample. The increased sampling effort in the second survey improved the rate of recovery of two of these species (*Theora lubrica* and *Jassa slatteryi*), but the other 5 species were either undetected in the second survey (3 species) or were again found in just a single sample. Furthermore, of the 9 non-indigenous species that were detected only in the second survey, 4 (44%) were present in just a single sample. This makes it difficult to determine if the new records in the second survey represent incursions that occurred after the first survey or, rather, are species that were present, but undetected during the first survey due to their sparse densities or distribution. Similarly, the absence of the non-indigenous bryozoan *Tricellaria inopinata*, the Japanese cancer crab *Cancer gibbosulus*, and the red alga *Polysiphonia subtilissima* in the second survey could be explained either by sampling error or local extinction since the initial baseline survey.

In each case, additional information can be used to address this problem. For example, re-examination of stored ascidian specimens collected by other researchers prior to this survey show that *Styela clava* has been present in Lyttelton since at least 2002. It is likely, therefore, that it was present at the time of the initial baseline survey, but occurred at such sparse densities (and distribution) that it was not detected by the survey. Five of the non-indigenous species recorded only in the second survey – *Ascidiella aspersa*, *Halisarca dujardini, Monotheca pulchella, Symplectoscyphus subdichotomus and Polydora hoplura* – have been present in New Zealand for more than 30 years (>100 years in the case of *A. aspersa*) and have either been recorded previously from Lyttelton Harbour (*A. aspersa, M. pulchella*) or are known from other, nearby ports (*H. dujardini, S. subdichotomus, P. hoplura*) (Cranfield et al. 1998; Vervoort and Watson 2003). Each of these species was present in fewer than 5 samples. It seems likely, therefore, that they were present in Lyttelton during the first survey, albeit at small densities, and were not detected by the survey because of their rarity. The remaining three species - *Spirobranchus polytrema, Crassicorophium bonnellii,* and *Polysiphonia senticulosa* - have been described only recently from New Zealand, have relatively limited national distributions and are new records for Lyttelton Harbour. Although the evidence is only circumstantial, these three species are the most likely to represent new incursions. Similarly, two of the three non-indigenous species that were not recorded in the second survey of Lyttelton – *T. inopinata* and *P. subtilissima* – have been recorded in other studies from Lyttelton Harbour (Gordon and Mawatari 1992; Cranfield et al. 1998) and are likely to have been present, but undetected during the repeat survey. The third – *C. gibbosulus* – was a new record for New Zealand, with only a single specimen being recovered from Lyttelton

Harbour. It is possible that this population has not persisted, although more detailed studies of its distribution and abundance are required to confirm this.

As several recent analyses have shown, the large area of habitat available for marine organisms within shipping ports and the logistic difficulties of sampling in these environments mean that detection probabilities are likely to be comparatively low for species with low prevalence, even when species-specific survey methods are used (Inglis 2003; Inglis et al. 2003; Hayes et al. 2005; Gust et al. 2006b; Inglis et al. in press). In generalised pest surveys, such as the baseline port surveys, this problem is compounded by the high cost of identifying all specimens (native and non-indigenous) which constrains the total number of samples that can be taken (Inglis 2003). A consequence is that a high proportion of comparatively rare species will remain undetected by any single survey. This problem is not limited to non-indigenous species, as up to 40% of native species recorded in the surveys also occurred in just a single sample. Nor is it unique to marine assemblages. These results reflect the spatial and temporal variability that are features of marine biological assemblages (Morrisey et al. 1992a, b) and the difficulties that are involved in characterising diversity within hyper-diverse assemblages (Gray 2000; Gotelli and Colwell 2001; Longino et al. 2002).

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

This survey, alone, cannot determine the threat to New Zealand's native ecosystems that is presented by the non-indigenous species encountered in this port. It does, however, provide a starting point for further investigations of the distribution, abundance and ecology of the species described within it. Non-indigenous marine species can have a range of adverse impacts through interactions with native organisms. These include competition with native species, predator-prey interactions, hybridisation, parasitism or toxicity and modification of the physical environment (Ruiz et al. 1999; Ricciardi 2001). Assessing the impact of a NIS in a given location ideally requires information on a range of factors, including the mechanism of their impact and their local abundance and distribution (Parker et al. 1999). To predict or quantify their impacts over larger areas or longer time scales requires additional information on the species' seasonality, population size and mechanisms of dispersal (Mack et al. 2000).

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Tables

Table 1: Berthage facilities in the Port of Lyttelton

Berth	Berth No.	Purpose	Construction	Length of Berth (m)	Depth (m below chart datum)
Cashin Quay	1	Multipurpose	Concrete deck/wood piles	230	13.0
	2	Multipurpose	Concrete deck/wood piles	215	13.0
	3, 4	Container Terminal berths	Concrete deck/concrete-filled steel tubular or concrete piles	410	13.0
Z Berth		General cargo, fishing operations	Concrete deck/wood piles	160	10.0
Gladstone Pier		Container cargo	Wood deck/wood piles	275	10.0
No. 1 Wharf Breastwork		General cargo, discharge of bulk cement	Wood deck/wood piles	159	9.5
No. 2 Wharf	East	Dry bulk import, general cargoes, export of logs	Concrete deck/wood piles	270	11.7
	West	Dry bulk import, general cargoes, export of logs	Concrete deck/wood piles	169	10.5
No. 3 Wharf	East	Dry bulk import, general cargoes, export of logs, lay-up	Wood deck/wood piles	195	10.0
	West	Dry bulk import, general cargoes, export of logs, lay-up	Wood deck/wood piles	223	10.8
No. 4 Wharf	East	Lay-up	Wood deck/wood piles	148	9.0
	West	Lay-up	Wood deck/wood piles	170	9.0
No. 7 Wharf	East	Quarter ramp and roll-on/roll-off vessels	Concrete deck/wood piles	217	10.5
	West	Quarter ramp and roll-on/roll-off vessels	Concrete deck/wood piles	187	10.7
Oil Wharf		Liquid bulk cargoes, bunkering	Wood deck/wood piles	202	12.5
Cattle Jetty		Bunkering of fishing vessels	Wood deck/wood piles	60	10.0

Table 2: Weight and value of overseas cargo unloaded at the Port of Lyttelton between the 2001-2002 and 2004-2005 financial years (data from Statistics New Zealand (2006b))

Year ended June	Gross weight (tonnes)	% weight change from previous year	Value (CIF[1]) ($million)	% value change from previous year	Proportion by weight of all NZ Seaports	Proportion by value of all NZ Seaports
2002	1,210,756		2,080		7.9	8.6
2003	1,268,545	4.8	2,085	0.2	7.9	8.4
2004	1,359,704	7.2	2,169	4.0	7.7	8.6
2005[P]	1,500,909	10.4	2,304	6.2	7.9	8.3
Change from 2002 to 2005	290,153	24.0	224	10.8		

[1] CIF: Cost including insurance and freight

[P] Provisional statistics – at the time of access, data for the final two months of the 2005 year were provisional

Table 3: Weight and value of overseas cargo loaded at the Port of Lyttelton between the 2001-2002 and 2004-2005 financial years (data from Statistics New Zealand (2006b))

Year ended June	Gross weight (tonnes)	% weight change from previous year	Value (FOB[1]) ($million)	% value change from previous year	Proportion by weight of all NZ Seaports	Proportion by value of all NZ Seaports
2002	2,925,284		2,894		11.9	10.3
2003	2,979,288	1.8	2,349	-18.8	11.8	9.2
2004	3,091,605	3.8	2,305	-1.9	13.7	9.0
2005[P]	3,086,893	-0.2	2,264	-1.8	14.2	8.6
Change from 2002 to 2005	161,609	5.5	-630	-21.8		

[1] FOB: Free on board

[P] Provisional statistics – at the time of access, data for the final two months of the 2005 year were provisional

Table 4: Number of vessel arrivals from overseas to the Port of Lyttelton by each general vessel type and previous geographical area, between 2002 and 2005 inclusive (data from LMIU "SeaSearcher.com" database)

Geographical area of previous port of call	Bulk/ cement carrier	Bulk/ oil carrier	Dredge	Fishing	General cargo	LPG / LNG	Passenger/ vehicle/ livestock	Other (inc pontoons, barges, mining, supply ships, etc)	Passenger ro/ro	Research	Tanker (inc chemical/ oil and ashphalt)	Container/ unitised carrier and ro/ro	Tug	Total
Australia	45			2	8	13	20			4	27	82		201
Pacific Islands				1	80	5	37		1	1		16		141
North-west Pacific	54			6	12		2	1		2	4	26		107
Japan	53			3	7		12	1						76
East Asian seas	16			1	5	1					7	8		38
Unknown (not stated in database)	4			10	1								4	19
South & East African coasts	11			1						1				13
West coast North America inc USA, Canada & Alaska	5			2	4						1			12
Antarctica and Southern Ocean					3		1			8				12
South America Pacific coast	1				4					3		1		9
Gulf States	8													8
South America Atlantic coast	3			2			1							6
U.S, Atlantic coast including part of Canada	1				1									2
Gulf of Mexico	2													2
Central America inc Mexico to Panama							1							1
North European Atlantic coast	1													1
United Kingdom inc Eire					1									1
North African coast	1													1
Scandinavia inc Baltic, Greenland, Iceland etc				1										1
European Mediterranean coast										1				1
N.E. Canada and Great Lakes				1										1
Central Indian Ocean	1													1
Total	206	0	0	30	126	19	74	2	1	20	39	133	4	654

Table 5: **Number of vessel arrivals to the Port of Lyttelton from Australia by each general vessel type and Australian state, between 2002 and 2005 inclusive (data from LMIU "SeaSearcher.com" database)**

Australian state of previous port of call	Bulk/ cement carrier	Bulk/ oil carrier	Dredge	Fishing	General cargo	LPG/ LNG	Passenger/ vehicle/ livestock	Other (inc pontoons, barges, mining & supply ships, etc)	Passenger ro/ro	Research	Tanker (inc chemical/ oil and ashphalt)	Container/ unitised carrier and ro/ro	Tug	Total
Victoria	6			1	3	5	14				17	35		81
Queensland	12					3	1				2	36		54
New South Wales	6				4	4	1			1	3	10		29
South Australia	16						1					1		18
Tasmania	1				1	1	3			3	1			10
Western Australia	4			1							4			9
Total	45	0	0	2	8	13	20	0	0	4	27	82	0	201

Table 6: Number of vessel departures from the Port of Lyttelton to overseas ports, by each general vessel type and next geographical area, between 2002 and 2005 inclusive (data from LMIU "SeaSearcher.com" database)

Geographical area of previous port of call	Bulk/ cement carrier	Bulk/ oil carrier	Dredge	Fishing	General cargo	LPG / LNG	Passenger/ vehicle/ livestock	Other (inc pontoons, barges, mining & supply ships, etc)	Passenger ro/ro	Research	Tanker (inc chemical/ oil and ashphalt)	Container / unitised carrier and ro/ro	Tug	Total
Australia	34				40	18	13	3			35	179	1	323
Japan	51				7		166				2	2		228
East Asian seas	35				8		5				24	70		142
North-west Pacific	34			2	3		32				3	61		135
South America Pacific coast	17				13					2		8		40
Pacific Islands				1	8	6	6			2	1	3		27
South & East African coasts	18						1							19
South America Atlantic coast	10				5		2							17
Antarctica and Southern Ocean					4		3			8				15
Central Indian Ocean	5										1			6
West coast North America inc USA, Canada & Alaska				1	4					1				6
European Mediterranean coast										4	1			5
North European Atlantic coast	1				1						1	1		4
Gulf States					1		1				1		1	4
Gulf of Mexico	2													2
Central America inc Mexico to Panama	1													1
U.S, Atlantic coast including part of Canada					1									1
United Kingdom inc Eire	1													1
N.E. Canada and Great Lakes	1													1
Scandinavia inc Baltic, Greenland, Iceland etc				1										1
Spain / Portugal inc Atlantic Islands										1				1
Total	210	0	0	5	95	24	229	3	0	18	69	324	2	979

Table 7: Number of vessel arrivals from New Zealand ports to the Port of Lyttelton by each general vessel type and previous port, between 2002 and 2005 inclusive (data from LMIU "SeaSearcher.com" database)

Previous port of call	Bulk/ cement carrier	Bulk/ oil carrier	Dredge	Fishing	General cargo	LPG/ LNG	Passenger/ vehicle/ livestock	Other (includes pontoons, barges, mining & supply ships, etc)	Passenger ro/ro	Research	Tanker (including chemical/ oil and ashphalt)	Container/ unitised carrier and ro/ro	Tug	Total
Wellington	18			8	161	3	321				74	198	1	784
Auckland	19				93		95	1			16	289	4	517
Tauranga	15				47		7				42	323		434
Lyttelton	6			165	2	4	3	19	1	2	2	106	3	313
Napier	34				52		6			1	13	187		293
Dunedin	24			1	33	17	55			1	9	122		262
New Plymouth	26		1	1	5	145		1			34	3		216
Nelson	21		1	15	12		5	1			21	33	2	111
Bluff	33				7						3	56		99
Timaru	11		2	32	8		1			1	7	17		79
Onehunga	7				62			1					2	72
Westport	21							16					11	48
Whangarei	9										34	1		44
Picton	4						7							11
Chatham Islands					2		1							3
Mount Maunganui	1										1	1		3
Gisborne	2													2
Total	251	0	4	222	484	169	501	39	1	5	256	1336	23	3291

Table 8: Number of vessel departures from the Port of Lyttelton to other New Zealand ports by each general vessel type and next port of call, between 2002 and 2005 inclusive (data from LMIU "SeaSearcher.com" database)

Next port of call	Bulk/ cement carrier	Bulk/ oil carrier	Dredge	Fishing	General cargo	LPG/ LNG	Passenger/ vehicle/ livestock	Other (includes pontoons , barges, mining & supply ships, etc)	Pa sse ng er ro/r o	Researc h	Tanker (includ ing chemic al/ oil and ashpha lt)	Container/ unitised carrier and ro/ro	Tug	Total
Wellington	18			9	22	1	71				40	448	4	613
Nelson	30		1	10	118		148	2			19	165	1	494
Dunedin	59				5	22	90				22	266		464
Lyttelton	6			165	2	4	3	19	1	2	2	106	3	313
New Plymouth	20		1	1	62	137					44	5		270
Tauranga	16				122		5				5	65		213
Napier	16				95		7				11	47		176
Auckland	13			4	49		11				3	25		105
Timaru	13		1	27	7		1			1	33	12		95
Bluff	7				6			1		2	32	1	1	50
Westport	25							12					9	46
Whangarei	13				11						15			39
Picton	9						9	1					1	20
Gisborne	2				11									13
Onehunga	2				3								1	6
Chatham Islands					2									2
Mount Maunganui												2		2
Greymouth													1	1
Milford Sound							1							1
Total	249	0	3	216	515	164	346	35	1	5	226	1142	21	2923

Table 9: Comparison of survey methods used in this study with the CRIMP protocols (Hewitt and Martin 2001), indicating modifications made to the protocols following recommendations from a workshop of New Zealand scientists. Full details of the workshop recommendations can be found in Gust et al. (2001).

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

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

Table 10: Summary of sampling effort in the Port of Lyttelton. Exact geographic locations of survey sites are provided in Appendix 2.

	Sampling method and survey (T1: first survey; T2: second survey)																			
	Crab traps		Fish traps		Shrimp traps		Starfish traps		Benthic grabs		Benthic sleds		Pile scrape quadrats		Photo stills and video		Qualitative visual searches (on pilings)		Javelin cores (for cysts)	
Site name	**T1**	**T2**	**T1**	**T2**	**T1**	**T2**	**T1**	**T2**	**T1**	**T2**	**T1**	**T2**	**T1**	**T2**	**T1**	**T2**	**T1**	**T2**	**T1**	**T2**
Cashin Quay 1		4		4		4		4												
Cashin Quay 2																				2
Cashin Quay 3	4		4		4		4		3		2	2	14	16	14	16	4	4		
Cashin Quay 4		4		4		4		4		3										
Cattle Jetty	4	4		4	4	4	4	4				2								
Gladstone Pier	4	4	4	4	4	4	4	4	3	3	2	2	14	15	14	15	4	4		
Lower Level Breastwork		4				4		4												2
Oil Wharf		4	4	4		4		4	3	3	2	2	14	16	14	16	4	4		2
Recreational Fishing Jetty		4		4		4		4				2								
Site 1																			2	
Site 2																			2	
Site 3																			2	
Site 4																			2	
Dry Dock & Slipway										3										
Wharf 1 Breastwork				4																2
Wharf 2	4	4	4		3	4	4	4	3	3	2	2	14		14	14	4	4		
Wharf 3														14						
Wharf 4	4	4	4	4	4	4	4	4	3	3	2	2	14	14	14	14	4	4		2
Wharf 5												2								
Wharf 6										3		2								
Wharf 7		4		4		4		4		3		2		16		16		4		
Z Berth										2										
Total	20	40	20	36	19	40	20	40	15	26	10	20	70	91	70	91	20	24	8	10

Table 11: Preservatives used for the major taxonomic groups of organisms collected during the port survey. [1] indicates photographs were taken before preservation, [2] indicates they were relaxed in menthol prior to preservation and [3] indicates a formalin fix was carried out before final preservation took place.

5 % Formalin solution	10 % Formalin solution	70 % Ethanol solution	80 % Ethanol solution	100 % Ethanol solution
Macroalgae	Ascidiacea (colonial) [1, 2]	Alcyonacea [2]	Ascidiacea (solitary) [1]	Bryozoa
	Asteroidea	Crustacea (small)		
	Brachiopoda	Holothuria [1, 2]		
	Crustacea (large)	Mollusca (with shell)		
	Ctenophora [1]	Mollusca [1, 2] (without shell)		
	Echinoidea	Platyhelminthes [1, 3]		
	Hydrozoa	Porifera [1]		
	Nudibranchia [1]	Zoantharia [1, 2]		
	Ophiuroidea			
	Polychaeta			
	Scleractinia			
	Scyphozoa [1, 2]			
	Vertebrata [1] (pisces)			

NB: Changes since the first survey:

Ascidians now considered separately as colonial and solitary species, and preserved in different solutions. The solitary species are no longer relaxed prior to preservation and the strength of preservative for these species has been increased. The colonials are now preserved in formalin as opposed to ethanol.

The Bryozoa are now initially preserved in 100% ethanol, then air dried at a later date prior to identification.

Platyhelminthes are now fixed in formalin, rather than relaxed, before preservation in ethanol.

Table 12: Marine pest species listed on the New Zealand register of Unwanted Organisms under the Biosecurity Act 1993.

Phylum	**Class**	**Order**	**Genus and Species**
Annelida	Polychaeta	Sabellida	*Sabella spallanzanii*
Arthropoda	Malacostraca	Decapoda	*Carcinus maenas*
Arthropoda	Malacostraca	Decapoda	*Eriocheir sinensis*
Echinodermata	Asteroidea	Forcipulatida	*Asterias amurensis*
Mollusca	Bivalvia	Myoida	*Potamocorbula amurensis*
Chlorophyta	Ulvophyceae	Caulerpales	*Caulerpa taxifolia*
Ochrophyta	Phaeophyceae	Laminariales	*Undaria pinnatifida*
Chordata	Ascidiacea	Pleurogona	*Styela clava*[1]

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

Table 13: Marine pest species listed on the Australian Ballast Water Management Advisory Council's (ABWMAC) schedule of non-indigenous pest species.

Major taxonomic group	Class/Order	Genus and Species
Annelida	Polychaeta	*Sabella spallanzanii*
Arthropoda	Decapoda	*Carcinus maenas*
Echinodermata	Asteroidea	*Asterias amurensis*
Mollusca	Bivalvia	*Corbula gibba*
Mollusca	Bivalvia	*Crassostrea gigas*
Mollusca	Bivalvia	*Musculista senhousia*
Macroalgae	Dinophyceae	*Alexandrium catenella*
Macroalgae	Dinophyceae	*Alexandrium minutum*
Macroalgae	Dinophyceae	*Alexandrium tamarense*
Macroalgae	Dinophyceae	*Gymnodinium catenatum*

Table 14: Native species recorded from the Port of Lyttelton in the first (T1) and second (T2) surveys.

Major taxonomic group, Class	Order	Family	Genus and species	T1*	T2*
Annelida					
Polychaeta	Eunicida	Dorvilleidae	*Dorvillea australiensis*	1	1
Polychaeta	Eunicida	Dorvilleidae	*Schistomeringos loveni*	1	1
Polychaeta	Eunicida	Lumbrineridae	*Lumbrineris sphaerocephala*	1	0
Polychaeta	Phyllodocida	Glyceridae	*Glycera lamelliformis*	1	0
Polychaeta	Phyllodocida	Goniadidae	*Glycinde trifida*	1	0
Polychaeta	Phyllodocida	Nephtyidae	*Aglaophamus verrilli*	1	1
Polychaeta	Phyllodocida	Nereididae	*Neanthes kerguelensis*	1	0
Polychaeta	Phyllodocida	Nereididae	*Nereis falcaria*	1	1
Polychaeta	Phyllodocida	Nereididae	*Perinereis amblyodonta*	1	1
Polychaeta	Phyllodocida	Nereididae	*Perinereis camiguinoides*	1	1
Polychaeta	Phyllodocida	Nereididae	*Platynereis Platynereis_australis_group*	1	1
Polychaeta	Phyllodocida	Phyllodocidae	*Eulalia microphylla*	0	1
Polychaeta	Phyllodocida	Polynoidae	*Harmothoe macrolepidota*	1	1
Polychaeta	Phyllodocida	Polynoidae	*Lepidasthenella comma*	0	1
Polychaeta	Phyllodocida	Polynoidae	*Lepidonotus polychromus*	1	1
Polychaeta	Phyllodocida	Polynoidae	*Ophiodromus angustifrons*	1	1
Polychaeta	Phyllodocida	Sigalionidae	*Labiosthenolepis laevis*	1	1
Polychaeta	Phyllodocida	Syllidae	*Haplosyllis spongicola*	0	1
Polychaeta	Phyllodocida	Syllidae	*Trypanosyllis zebra*	1	0
Polychaeta	Sabellida	Sabellidae	*Demonax aberrans*	1	1
Polychaeta	Sabellida	Sabellidae	*Megalomma kaikourense*	0	1
Polychaeta	Sabellida	Sabellidae	*Megalomma suspiciens*	0	1
Polychaeta	Sabellida	Sabellidae	*Pseudopotamilla laciniosa*	1	1
Polychaeta	Sabellida	Serpulidae	*Spirobranchus cariniferus*	1	1
Polychaeta	Scolecida	Opheliidae	*Armandia maculata*	1	1
Polychaeta	Scolecida	Orbiniidae	*Phylo novazealandiae*	0	1
Polychaeta	Spionida	Spionidae	*Scolecolepides benhami*	1	1
Polychaeta	Terebellida	Acrocirridae	*Acrocirrus trisectus*	0	1
Polychaeta	Terebellida	Cirratulidae	*Protocirrineris nuchalis*	1	1
Polychaeta	Terebellida	Cirratulidae	*Timarete anchylochaetus*	1	1
Polychaeta	Terebellida	Terebellidae	*Nicolea armilla*	1	1
Polychaeta	Terebellida	Terebellidae	*Nicolea maxima*	1	0
Polychaeta	Terebellida	Terebellidae	*Streblosoma toddae*	1	1
Polychaeta	Terebellida	Trichobranchidae	*Terebellides narribri*	1	1
Bryozoa					
Gymnolaemata	Cheilostomata	Calloporidae	*Valdemunitella valdemunita*	0	1
Gymnolaemata	Cheilostomata	Candidae	*Caberea helicina*	0	1
Gymnolaemata	Cheilostomata	Candidae	*Caberea new sp. (cf. guntheri)*	0	1
Gymnolaemata	Cheilostomata	Candidae	*Caberea zelandica*	1	1
Gymnolaemata	Cheilostomata	Candidae	*Scrupocellaria ornithorhyncus*	0	1
Gymnolaemata	Cheilostomata	Cellariidae	*Cellaria immersa*	1	1
Gymnolaemata	Cheilostomata	Cellariidae	*Cellaria tenuirostris*	1	0
Gymnolaemata	Cheilostomata	Celleporidae	*Celleporina proximalis*	1	1
Gymnolaemata	Cheilostomata	Hippothoidae	*Celleporella delta*	0	1
Gymnolaemata	Cheilostomata	Microporellidae	*Fenestrulina thyreophora*	0	1

Major taxonomic group, Class	Order	Family	Genus and species	T1*	T2*
Gymnolaemata	Cheilostomata	Romancheinidae	*Escharoides angela*	1	1
Gymnolaemata	Cheilostomata	Schizoporellidae	*Chiastosella watersi*	1	0
Stenolaemata	Cyclostomata	Crisiidae	*Crisia tenuis*	0	1
Chelicerata					
Pycnogonida	Pantopoda	Ammotheidae	*Achelia assimilis*	0	1
Pycnogonida	Pantopoda	Callipallenidae	*Callipallene novaezealandiae*	1	0
Chordata					
Chondrichthyes	Squaliformes	Squalidae	*Squalus acanthias*	1	1
Cnidaria					
Anthozoa	Actiniaria	Aiptasiomorphidae	*Aiptasiomorpha minima*	1	0
Anthozoa	Actiniaria	Bathyphelliidae	*Acraspedanthus elongatus*	1	0
Anthozoa	Actiniaria	Diadumenidae	*Diadumene neozelandica*	1	0
Anthozoa	Actiniaria	Sagartiidae	*Anthothoe vagrans*	1	0
Hydrozoa	Hydroida	Haleciidae	*Halecium beanii*	0	1
Hydrozoa	Hydroida	Phialellidae	*Opercularella humilis*	1	0
Hydrozoa	Hydroida	Plumulariidae	*Monotheca flexuosa*	1	0
Hydrozoa	Hydroida	Sertulariidae	*Amphisbetia bispinosa*	1	0
Hydrozoa	Hydroida	Sertulariidae	*Sertularella robusta*	0	1
Hydrozoa	Hydroida	Sertulariidae	*Sertularia unguiculata*	1	0
Hydrozoa	Hydroida	Sertulariidae	*Symplectoscyphus johnstoni*	1	0
Hydrozoa	Hydroida	Sertulariidae	*Symplectoscyphus subarticulatus*	1	0
Crustacea					
Cirripedia	Thoracica	Balanidae	*Austrominius modestus*	1	1
Cirripedia	Thoracica	Balanidae	*Notomegabalanus decorus*	1	1
Cirripedia	Thoracica	Chthamalidae	*Chaemosipho columna*	0	1
Malacostraca	Amphipoda	Amphilochidae	*Amphilochus filidactylus*	1	0
Malacostraca	Amphipoda	Amphilochidae	*Neocyproidea otakensis*	0	1
Malacostraca	Amphipoda	Aoridae	*Aora maculata*	1	1
Malacostraca	Amphipoda	Aoridae	*Haplocheira barbimana*	1	1
Malacostraca	Amphipoda	Caprellidae	*Caprella equilibra*	0	1
Malacostraca	Amphipoda	Caprellidae	*Pseudaeginella campbellensis*	0	1
Malacostraca	Amphipoda	Colomastigidae	*Colomastix magnirama*	1	0
Malacostraca	Amphipoda	Cyproideidae	*Peltopes peninsulae*	1	1
Malacostraca	Amphipoda	Dexaminidae	*Paradexamine pacifica*	1	1
Malacostraca	Amphipoda	Dexaminidae	*Polycheria obtusa*	0	1
Malacostraca	Amphipoda	Iphimediidae	*Anisoiphimedia haurakiensis*	1	1
Malacostraca	Amphipoda	Isaeidae	*Gammaropsis dentifera*	0	1
Malacostraca	Amphipoda	Isaeidae	*Gammaropsis haswelli*	1	0
Malacostraca	Amphipoda	Isaeidae	*Gammaropsis longimana*	1	1
Malacostraca	Amphipoda	Isaeidae	*Gammaropsis typica*	1	1
Malacostraca	Amphipoda	Ischyroceridae	*Ischyrocerus longimanus*	1	1
Malacostraca	Amphipoda	Ischyroceridae	*Ventojassa frequens*	1	1
Malacostraca	Amphipoda	Leucothoidae	*Leucothoe trailli*	1	1
Malacostraca	Amphipoda	Liljeborgiidae	*Liljeborgia akaroica*	1	1
Malacostraca	Amphipoda	Lysianassidae	*Parawaldeckia angusta*	1	0
Malacostraca	Amphipoda	Lysianassidae	*Parawaldeckia stephenseni*	1	1

Major taxonomic group, Class	Order	Family	Genus and species	T1*	T2*
Malacostraca	Amphipoda	Lysianassidae	*Parawaldeckia vesca*	1	1
Malacostraca	Amphipoda	Melitidae	*Mallacoota subcarinata*	1	1
Malacostraca	Amphipoda	Phoxocephalidae	*Torridoharpinia hurleyi*	1	1
Malacostraca	Amphipoda	Podoceridae	*Podocerus cristatus*	1	1
Malacostraca	Amphipoda	Podoceridae	*Podocerus karu*	1	1
Malacostraca	Amphipoda	Podoceridae	*Podocerus manawatu*	1	1
Malacostraca	Amphipoda	Podoceridae	*Podocerus wanganui*	1	1
Malacostraca	Amphipoda	Sebidae	*Seba typica*	1	0
Malacostraca	Anomura	Paguridae	*Lophopagurus (L.) lacertosus*	1	0
Malacostraca	Anomura	Porcellanidae	*Petrolisthes elongatus*	1	1
Malacostraca	Anomura	Porcellanidae	*Petrolisthes novaezelandiae*	1	1
Malacostraca	Brachyura	Cancridae	*Metacarcinus novaezelandiae*	1	1
Malacostraca	Brachyura	Grapsidae	*Helice crassa*	0	1
Malacostraca	Brachyura	Hymenosomatidae	*Halicarcinus varius*	1	1
Malacostraca	Brachyura	Hymenosomatidae	*Halicarcinus whitei*	0	1
Malacostraca	Brachyura	Majidae	*Notomithrax minor*	1	1
Malacostraca	Brachyura	Ocypodidae	*Macrophthalmus hirtipes*	1	1
Malacostraca	Brachyura	Pinnotheridae	*Pinnotheres novaezelandiae*	1	0
Malacostraca	Brachyura	Portunidae	*Nectocarcinus antarcticus*	1	0
Malacostraca	Brachyura	Portunidae	*Ovalipes catharus*	0	1
Malacostraca	Caridea	Crangonidae	*Pontophilus australis*	1	1
Malacostraca	Caridea	Palemonidae	*Palaemon affinis*	1	0
Malacostraca	Caridea	Palemonidae	*Periclimenes yaldwyni*	0	1
Malacostraca	Isopoda	Anthuridae	*Mesanthura affinis*	0	1
Malacostraca	Isopoda	Cirolanidae	*Eurylana arcuata*	0	1
Malacostraca	Isopoda	Cirolanidae	*Natatolana rossi*	1	1
Malacostraca	Isopoda	Paranthuridae	*Paranthura cf. flagellata*	1	0
Malacostraca	Isopoda	Pseudojaniridae	*Schottea sp.*	1	1
Malacostraca	Isopoda	Sphaeromatidae	*Cilicaea caniculata*	1	1
Malacostraca	Isopoda	Sphaeromatidae	*Ischyromene cordiforaminalis*	1	0
Malacostraca	Isopoda	Sphaeromatidae	*Pseudosphaeroma campbellensis*	1	1
Malacostraca	Ogyrididae	Ogyrididae	*Ogyrides delli*	0	1
Malacostraca	Palinura	Palinuridae	*Jasus edwardsi*	0	1
Dinophyta					
Dinophyceae	Gymnodiniales	Gymnodiniaceae	*Cochlodinium sp.*	1	0
Dinophyceae	Peridinales	Peridiniaceae	*Protoperidinium conicum*	1	1
Dinophyceae	Peridinales	Peridiniaceae	*Protoperidinium oblongum*	0	1
Dinophyceae	Peridinales	Peridiniaceae	*Scrippsiella trochoidea*	1	1
Echinodermata					
Asteroidea	Valvatida	Asterinidae	*Meridiastra mortenseni*	0	1
Asteroidea	Valvatida	Asterinidae	*Patiriella regularis*	1	1
Ophiuroidea	Ophiurida	Amphiuridae	*Amphipholis squamata*	1	1
Mollusca					
Bivalvia	Myoida	Hiatellidae	*Hiatella arctica*	0	1
Bivalvia	Mytiloida	Mytilidae	*Aulacomya atra maoriana*	0	1
Bivalvia	Mytiloida	Mytilidae	*Modiolarca impacta*	0	1
Bivalvia	Mytiloida	Mytilidae	*Perna canaliculus*	0	1

Major taxonomic group, Class	Order	Family	Genus and species	T1*	T2*
Bivalvia	Mytiloida	Mytilidae	*Xenostrobus pulex*	1	1
Bivalvia	Ostreoida	Ostreidae	*Ostrea chilensis*	1	1
Bivalvia	Veneroida	Lasaeidae	*Lasaea hinemoa*	1	1
Bivalvia	Veneroida	Veneridae	*Ruditapes largillierti*	0	1
Gastropoda	Basommatophora	Siphonariidae	*Siphonaria australis*	1	0
Gastropoda	Littorinimorpha	Calyptraeidae	*Sigapatella novaezelandiae*	1	1
Gastropoda	Littorinimorpha	Littorinidae	*Risellopsis varia*	1	1
Gastropoda	Neogastropoda	Muricidae	*Xymene plebeius*	1	1
Gastropoda	Nudibranchia	Chromodorididae	*Cadlina willani*	1	0
Gastropoda	Nudibranchia	Dendrodorididae	*Dendrodoris citrina*	0	1
Gastropoda	Nudibranchia	Dorididae	*Alloiodoris lanuginata*	1	0
Gastropoda	Nudibranchia	Dorididae	*Archidoris nanula*	1	0
Gastropoda	Nudibranchia	Dorididae	*Archidoris wellingtonensis*	0	1
Gastropoda	Nudibranchia	Dorididae	*Doriopsis flabellifera*	0	1
Gastropoda	Nudibranchia	Dorididae	*Paradoris leuca*	1	0
Gastropoda	Nudibranchia	Tritoniidae	*Tritonia flemingi*	0	1
Gastropoda	Nudibranchia	Zephyrinidae	*Janolus novozealandicus*	0	1
Gastropoda	Patellogastropoda	Lottiidae	*Notoacmea helmsi*	1	0
Gastropoda	Patellogastropoda	Lottiidae	*Notoacmea parviconoidea*	0	1
Gastropoda	Sacoglossa	Limapontiidae	*Ercolania felina*	1	0
Gastropoda	Systellomatophora	Onchidiidae	*Onchidella nigricans*	1	0
Gastropoda	Vetigastropoda	Trochidae	*Micrelenchus huttonii*	1	0
Polyplacophora	Acanthochitonina	Acanthochitonidae	*Acanthochitona zelandica*	1	0
Polyplacophora	Acanthochitonina	Acanthochitonidae	*Cryptoconchus porosus*	1	1
Polyplacophora	Ischnochitonina	Chitonidae	*Sypharochiton pelliserpentis*	1	0
Macroalgae					
Florideophyceae	Ceramiales	Ceramiaceae	*Anotrichium crinitum*	1	1
Florideophyceae	Ceramiales	Ceramiaceae	*Antithamnionella adnata*	0	1
Florideophyceae	Ceramiales	Ceramiaceae	*Ceramium apiculatum*	0	1
Florideophyceae	Ceramiales	Ceramiaceae	*Ceramium rubrum*	1	0
Florideophyceae	Ceramiales	Ceramiaceae	*Medeiothamnion lyallii*	0	1
Florideophyceae	Ceramiales	Delesseriaceae	*Acrosorium venulosum*	1	0
Florideophyceae	Ceramiales	Delesseriaceae	*Erythroglossum undulatissimum*	0	1
Florideophyceae	Ceramiales	Delesseriaceae	*Myriogramme denticulata*	1	1
Florideophyceae	Ceramiales	Delesseriaceae	*Phycodrys quercifolia*	1	1
Florideophyceae	Ceramiales	Delesseriaceae	*Schizoseris dichotoma*	0	1
Florideophyceae	Ceramiales	Rhodomelaceae	*Bostrychia harveyi*	1	0
Florideophyceae	Ceramiales	Rhodomelaceae	*Bostrychia moritziana*	1	0
Florideophyceae	Ceramiales	Rhodomelaceae	*Stictosiphonia hookeri*	1	0
Florideophyceae	Gigartinales	Phyllophoraceae	*Stenogramme interrupta*	1	0
Florideophyceae	Gigartinales	Sarcodiaceae	*Trematocarpus aciculare*	1	0
Florideophyceae	Plocamiales	Plocamiaceae	*Plocamium angustum*	1	0
Florideophyceae	Rhodymeniales	Lomentariaceae	*Lomentaria caespitosa*	1	0
Florideophyceae	Rhodymeniales	Rhodomeniaceae	*Rhodymenia foliifera*	1	0
Florideophyceae	Rhodymeniales	Rhodomeniaceae	*Rhodymenia novazelandica*	0	1
Phaeophyceae	Ectocarpales	Ectocarpaceae	*Ectocarpus siliculosus*	0	1
Phaeophyceae	Ectocarpales	Ectocarpaceae	*Hincksia mitchelliae*	0	1
Phaeophyceae	Laminariales	Lessoniaceae	*Lessonia variegata*	0	1
Ulvophyceae	Bryopsidales	Bryopsidaceae	*Bryopsis vestita*	1	1

Major taxonomic group, Class	Order	Family	Genus and species	T1*	T2*
Ulvophyceae	Bryopsidales	Codiaceae	*Codium fragile ssp. novae-zelandiae*	0	1
Ulvophyceae	Cladophorales	Cladophoraceae	*Cladophora crinalis*	1	0
Porifera					
Calcarea	Leucosolenida	Grantiidae	*Grantia ramulosa*	0	1
Calcarea	Leucosolenida	Sycettidae	*Sycon cf. ornatum*	0	1
Demospongiae	Dictyoceratida	Dysideidae	*Euryspongia cf. arenaria*	1	0
Demospongiae	Dictyoceratida	Irciniidae	*Ircinia akaroa*	0	1
Demospongiae	Haplosclerida	Chalinidae	*Haliclona cf. punctata*	1	1
Demospongiae	Haplosclerida	Chalinidae	*Haliclona glabra*	1	1
Demospongiae	Haplosclerida	Chalinidae	*Haliclona maxima*	0	1
Demospongiae	Poecilosclerida	Hymedesmiidae	*Phorbas cf. anchorata*	0	1
Demospongiae	Poecilosclerida	Hymedesmiidae	*Phorbas fulva*	1	1
Demospongiae	Poecilosclerida	Microcionidae	*Clathria cf. terraenovae*	0	1
Urochordata					
Ascidiacea	Aplousobranchia	Didemnidae	*Lissoclinum notti*	0	1
Ascidiacea	Aplousobranchia	Polyclinidae	*Aplidium adamsi*	1	1
Ascidiacea	Stolidobranchia	Botryllinae	*Botryllus stewartensis*	1	1
Ascidiacea	Stolidobranchia	Molgulidae	*Molgula amokurae*	1	0
Ascidiacea	Stolidobranchia	Molgulidae	*Molgula mortenseni*	1	1
Ascidiacea	Stolidobranchia	Pyuridae	*Pyura cancellata*	1	1
Ascidiacea	Stolidobranchia	Pyuridae	*Pyura carnea*	1	1
Ascidiacea	Stolidobranchia	Pyuridae	*Pyura lutea*	1	0
Ascidiacea	Stolidobranchia	Pyuridae	*Pyura pachydermatina*	1	1
Ascidiacea	Stolidobranchia	Pyuridae	*Pyura pulla*	0	1
Ascidiacea	Stolidobranchia	Styelidae	*Cnemidocarpa bicornuta*	1	1
Ascidiacea	Stolidobranchia	Styelidae	*Cnemidocarpa nisiotus*	1	1
Ascidiacea	Stolidobranchia	Styelidae	*Cnemidocarpa otagoensis*	0	1
Ascidiacea	Stolidobranchia	Styelidae	*Cnemidocarpa regalis*	1	0
Vertebrata					
Actinopterygii	Gadiformes	Moridae	*Pseudophycis bachus*	1	1
Actinopterygii	Mugiliformes	Mugilidae	*Aldrichetta forsteri*	0	1
Actinopterygii	Perciformes	Cheilodactylidae	*Nemadactylus macropterus*	1	0
Actinopterygii	Perciformes	Labridae	*Notolabrus celidotus*	1	1
Actinopterygii	Perciformes	Trypterigiidae	*Grahamina capito*	1	0
Actinopterygii	Perciformes	Trypterigiidae	*Grahamina gymnota*	1	0
Actinopterygii	Pleuronectiformes	Pleuronectidae	*Peltorhamphus latus*	1	0
Actinopterygii	Tetradontiformes	Monocanthidae	*Parika scaber*	0	1

* 1 = Present, 0 = Absent

Table 15: Cryptogenic marine species recorded from the Port of Lyttelton in the first (T1) and second (T2) surveys. Category 1 cryptogenic species (C1); Category 2 cryptogenic species (C2). Refer to "Definitions of species categories" for definitions.

Major taxonomic group, Class	Order	Family	Genus and species	Status	T 1*	T 2*
Annelida						
Polychaeta	Eunicida	Lumbrineridae	*Lumbrineris Lumbrineris-B-of-Orensanz*	C2	0	1
Polychaeta	Phyllodocida	Phyllodocidae	*Eulalia Eulalia-NIWA-2*	C2	1	1
Polychaeta	Phyllodocida	Phyllodocidae	*Mystides Mystides-B*	C2	1	1
Polychaeta	Phyllodocida	Phyllodocidae	*Pirakia Pirakia-A*	C2	0	1
Polychaeta	Phyllodocida	Syllidae	*Eusyllin-unknown Eusyllin-unknown-A*	C2	1	1
Polychaeta	Phyllodocida	Syllidae	*Eusyllis Eusyllis-B*	C2	1	1
Polychaeta	Phyllodocida	Syllidae	*Eusyllis Eusyllis-C*	C2	1	0
Polychaeta	Sabellida	Sabellidae	*Branchiomma Branchiomma-A*	C2	1	1
Polychaeta	Sabellida	Sabellidae	*Branchiomma curtum*	C1	1	1
Polychaeta	Sabellida	Sabellidae	*Potamilla Potamilla-A*	C2	1	0
Polychaeta	Sabellida	Sabellidae	*Sabellinae-unknown sabellinae-01*	C2	0	1
Polychaeta	Sabellida	Serpulidae	*Serpula Serpula-D*	C2	0	1
Polychaeta	Terebellida	Cirratulidae	*Cirratulus Cirratulus-A*	C2	1	1
Polychaeta	Terebellida	Terebellidae	*Lanassa Lanassa-A*	C2	0	1
Polychaeta	Terebellida	Terebellidae	*Terebella Terebella-B*	C2	1	1
Bryozoa						
Gymnolaemata	Cheilostomata	Scrupariidae	*Scruparia ambigua*	C1	0	1
Cnidaria						
Hydrozoa	Hydroida	Bougainvilliidae	*Bougainvillia muscus*	C1	0	1
Hydrozoa	Hydroida	Campanulariidae	*Clytia hemisphaerica*	C1	0	1
Hydrozoa	Hydroida	Campanulariidae	*Obelia dichotoma*	C1	1	1
Hydrozoa	Hydroida	Campanulinidae	*Phialella quadrata*	C1	0	1
Hydrozoa	Hydroida	Haleciidae	*Halecium delicatulum*	C1	1	1
Hydrozoa	Hydroida	Plumulariidae	*Plumularia setacea*	C1	1	1
Crustacea						
Malacostraca	Amphipoda	Amaryllidae	*Amaryllis sp. aff. A. kamata*	C2	0	1
Malacostraca	Amphipoda	Amaryllidae	*Amaryllis sp. aff. A. macrophthalma*	C2	1	1
Malacostraca	Amphipoda	Aoridae	*Aora sp. aff. A. typica*	C2	1	0
Malacostraca	Amphipoda	Aoridae	*Aora typica*	C1	1	1
Malacostraca	Amphipoda	Caprellidae	*Caprellidae gen. et sp. indet.*	C2	0	1
Malacostraca	Amphipoda	Caprellidae	*Pseudaeginella sp. indet.*	C2	0	1
Malacostraca	Amphipoda	Corophiidae	*Corophium sp. indet.*	C2	0	1
Malacostraca	Amphipoda	Corophiidae	*Meridiolembos sp. aff. acherontis*	C2	1	0
Malacostraca	Amphipoda	Corophiidae	*Monocorophium sp. aff. M. insidiosum*	C2	1	1
Malacostraca	Amphipoda	Dexaminidae	*Polycheria sp. aff. P. obtusa*	C2	1	0
Malacostraca	Amphipoda	Isaeidae	*Gammaropsis sp. 1*	C2	1	0
Malacostraca	Amphipoda	Ischyroceridae	*Ischyroceridae sp. A*	C2	0	1

Major taxonomic group, Class	Order	Family	Genus and species	Status	T 1*	T 2*
Malacostraca	Amphipoda	Leucothoidae	*Leucothoe sp. 1*	C2	1	1
Malacostraca	Amphipoda	Liljeborgiidae	*Liljeborgia sp.*	C2	1	0
Malacostraca	Amphipoda	Lysianassidae	*Acontiostoma n. sp.*	C2	0	1
Malacostraca	Amphipoda	Lysianassidae	*Parawaldeckia sp. aff. angusta*	C2	1	0
Malacostraca	Amphipoda	Lysianassidae	*Parawaldeckia sp. aff. P. stephenseni*	C2	0	1
Malacostraca	Amphipoda	Lysianassidae	*Parawaldeckia sp. D*	C2	0	1
Malacostraca	Amphipoda	Lysianassidae	*Stomacontion sp. aff. S. pungpunga*	C2	1	0
Malacostraca	Amphipoda	Stenothoidae	*Stenothoe ?miersii*	C1	0	1
Malacostraca	Amphipoda	Stenothoidae	*Stenothoe sp. aff. S. gallensis*	C1	1	0
Malacostraca	Amphipoda	Stenothoidae	*Stenothoe valida*	C1	0	1
Malacostraca	Brachyura	Portunidae	*Nectocarcinus sp. nov.* (identification revised; originally reported as *?Xanthidae sexlobata*	C2	1	0
Mollusca						
Bivalvia	Mytiloida	Mytilidae	*Mytilus galloprovincialis*	C1	0	1
Gastropoda	Nudibranchia	Polyceridae	*Polycera hedgpathi*	C1	0	1
Porifera						
Demospongiae	Dictyoceratida	Dysideidae	*Euryspongia new sp. 1*	C2	1	1
Demospongiae	Hadromerida	Suberitidae	*new g. new sp. 1*	C2	1	1
Demospongiae	Halichondrida	Halichondriidae	*Halichondria new sp. 2*	C2	0	1
Demospongiae	Halichondrida	Halichondriidae	*Halichondria panicea*	C1	1	1
Demospongiae	Haplosclerida	Chalinidae	*Adocia new sp. 2*	C2	0	1
Demospongiae	Haplosclerida	Chalinidae	*Adocia new sp. 3*	C2	1	0
Demospongiae	Haplosclerida	Chalinidae	*Haliclona new sp. 1*	C2	0	1
Demospongiae	Haplosclerida	Chalinidae	*Haliclona new sp. 4*	C2	0	1
Demospongiae	Haplosclerida	Chalinidae	*Haliclona new sp. 6*	C2	0	1
Demospongiae	Haplosclerida	Chalinidae	*Haliclona new sp. 8*	C2	1	0
Demospongiae	Haplosclerida	Chalinidae	*Haliclona new sp. 11*	C2	0	1
Demospongiae	Haplosclerida	Chalinidae	*Haliclona new sp. 13*	C2	0	1
Demospongiae	Haplosclerida	Chalinidae	*Haliclona new sp. 17*	C2	0	1
Demospongiae	Poecilosclerida	Hymedesmiidae	*Phorbas new sp. 2*	C2	0	1
Demospongiae	Poecilosclerida	Mycalidae	*Paraesperella new sp. 1 (macrosigma)*	C2	1	1
Urochordata						
Ascidiacea	Aplousobranchia	Didemnidae	*Didemnum* species group *(*includes *D.vexillum, D. incanum,* and other *Didemnum species)*	C1	1	1
Ascidiacea	Aplousobranchia	Didemnidae	*Diplosoma listerianum*	C1	0	1
Ascidiacea	Aplousobranchia	Polyclinidae	*Aplidium phortax*	C1	1	1
Ascidiacea	Phlebobranchia	Rhodosomatidae	*Corella eumyota*	C1	1	1
Ascidiacea	Stolidobranchia	Botryllinae	*Botrylliodes leachii*	C1	1	1
Ascidiacea	Stolidobranchia	Styelidae	*Asterocarpa cerea*	C1	1	1
Ascidiacea	Stolidobranchia	Styelidae	*Styela plicata*	C1	1	0

* 1 = Present, 0 = Absent

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

Table 16: Non-indigenous marine species recorded from the Port of Lyttelton during the first survey (T1) and second survey (T2). Likely vectors of introduction are largely derived from Cranfield et al. (1998), where H = Hull fouling and B = Ballast water transport. Novel NIS not listed in Cranfield et al. (1998) or previously encountered by taxonomic experts in New Zealand waters are marked as New Records (NR). For these species and others for which information is scarce, we provide dates of first detection rather than probable dates of introduction.

Major taxonomic group, Class	Order	Family	Genus and species	T1*	T2*	Probable means of introduction	Date of introduction or detection (d)
Annelida							
Polychaeta	Sabellida	Serpulidae	*Spirobranchus polytrema* ***(NR)***	0	1	H	Nov 2001[d]
Polychaeta	Spionida	Spionidae	*Polydora hoplura*	0	1	H	Unknown[1]
Bryozoa							
Gymnolaemata	Cheilostomata	Bugulidae	*Bugula flabellata*	1	1	H	Pre-1949
Gymnolaemata	Cheilostomata	Bugulidae	*Bugula neritina*	1	1	H	1949
Gymnolaemata	Cheilostomata	Candidae	*Tricellaria inopinata*	1	0	H	Pre-1964
Gymnolaemata	Cheilostomata	Cryptosulidae	*Cryptosula pallasiana*	1	1	H	1890s
Gymnolaemata	Cheilostomata	Electridae	*Conopeum seurati*	1	1	H	Pre-1963
Gymnolaemata	Cheilostomata	Watersiporidae	*Watersipora subtorquata*	1	1	H or B	Pre-1982
Cnidaria							
Anthozoa	Actiniaria	Haliplanellidae	*Haliplanella lineata*	1	?[2]	H	Mar 2002[d]
Hydrozoa	Hydroida	Plumulariidae	*Monotheca pulchella*	0	1	H	1928
Hydrozoa	Hydroida	Sertulariidae	*Symplectoscyphus subdichotomus*	0	1	H	1930
Crustacea							
Malacostraca	Amphipoda	Corophiidae	*Apocorophium acutum*	1	1	H	Pre-1921
Malacostraca	Amphipoda	Corophiidae	*Crassicorophium bonnellii* ***(NR)***	0	1	H	Nov 2004[d]
Malacostraca	Amphipoda	Corophiidae	*Monocorophium acherusicum*	1	1	H	Pre-1921
Malacostraca	Amphipoda	Corophiidae	*Monocorophium sextonae*	1	1	H	Pre-1921
Malacostraca	Amphipoda	Ischyroceridae	*Jassa slatteryi*	1	1	H	Unknown[1]

Major taxonomic group, Class	Order	Family	Genus and species	T1*	T2*	Probable means of introduction	Date of introduction or detection (d)
Malacostraca	Brachyura	Cancridae	*Cancer gibbosulus* ***(NR)***	1	0	H or B	Nov 2001[d]
Mollusca							
Bivalvia	Veneroida	Semelidae	*Theora lubrica*	1	1	B	1971
Macroalgae							
Florideophyceae	Ceramiales	Ceramiaceae	*Griffithsia crassiuscula*	1	1	H	Pre-1954
Florideophyceae	Ceramiales	Rhodomelaceae	*Polysiphonia brodiei*	1	1	H	Pre-1940
Florideophyceae	Ceramiales	Rhodomelaceae	*Polysiphonia senticulosa*	0	1	H or B	Pre-1993
Florideophyceae	Ceramiales	Rhodomelaceae	*Polysiphonia subtilissima*	1	0	H	Pre-1974
Phaeophyceae	Laminariales	Alariaceae	*Undaria pinnatifida*	1	1	H or B	Pre-1987
Porifera							
Demospongiae	Halisarcida	Halisarcidae	*Halisarca dujardini*	0	1	H or B	Pre-1973
Urochordata							
Ascidiacea	Aplousobranchia	Cionidae	*Ciona intestinalis*	1	1	H	Pre-1950
Ascidiacea	Phlebobranchia	Ascidiidae	*Ascidiella aspersa*	0	1	H	1900s
Ascidiacea	Stolidobranchia	Styelidae	*Styela clava* ***(NR)***	0	1	H	Nov 2004[d]

[*] 1 = Present, 0 = Absent
[1] Date of introduction currently unknown but species had been encountered in New Zealand prior to the present survey.
[2] Not determined at the time of reporting, as specimens of Anthozoa had not been identified.

Table 17: Species indeterminata recorded from the Port of Lyttelton in the first (T1) and second (T2) surveys. This group includes: (1) organisms that were damaged or juvenile and lacked crucial morphological characteristics, and (2) taxa for which there is not sufficient taxonomic or systematic information available to allow positive identification to species level.

Major taxonomic group, Class	Order	Family	Genus and species	T1*	T2*
Annelida					
Polychaeta	Phyllodocida	Nereididae	*Nereididae indet*	1	0
Polychaeta	Phyllodocida	Phyllodocidae	*Phyllodocidae Indet*	1	0
Polychaeta	Phyllodocida	Polynoidae	*Polynoidae indet*	1	0
Polychaeta	Phyllodocida	Sigalionidae	*Unknown sp_undet*	0	1
Polychaeta	Phyllodocida	Syllidae	*Syllidae Indet*	1	1
Polychaeta	Sabellida	Sabellidae	*Sabellidae Indet*	1	0
Polychaeta	Sabellida	Serpulidae	*Serpula Indet*	1	0
Polychaeta	Sabellida	Serpulidae	*Serpulidae Indet*	0	1
Polychaeta	Terebellida	Cirratulidae	*Cirratulidae Indet*	0	1
Polychaeta	Terebellida	Terebellidae	*Terebellidae Indet*	1	0
Bryozoa					
Gymnolaemata	Cheilostomata	Electridae	*Electra new sp.*	0	1
Gymnolaemata	Cheilostomata	Electridae	*Electra sp.*	1	0
Stenolaemata	Cyclostomata	Hastingsiidae	*Hastingsia sp.*	1	0
Chelicerata					
Pycnogonida			*Unidentified Pycnogonida*	0	1
Cnidaria					
Anthozoa	Actiniaria		*Acontiaria sp.*	1	0
Anthozoa	Actiniaria		*Actiniaria sp.*	1	0
Anthozoa	Actiniaria	Acontiophoridae	*Mimetridium sp.*	1	0
Anthozoa	Actiniaria	Diadumenidae	*Unidentified Diadumenidae*	1	0
Hydrozoa	Hydroida	Haleciidae	*Halecium ?beanii*	1	0
Crustacea					
Malacostraca	Amphipoda		*Unidentified Amphipoda*	0	1
Malacostraca	Amphipoda	Corophiidae	*Meridiolembos sp.*	1	0
Malacostraca	Amphipoda	Hyalidae	*Hyale sp.*	1	0
Malacostraca	Amphipoda	Isaeidae	*Gammaropsis indet sp.*	0	1
Malacostraca	Amphipoda	Ischyroceridae	*?Ventojassa sp.*	1	0
Malacostraca	Amphipoda	Ischyroceridae	*Ischyrocerus sp.*	1	0
Malacostraca	Amphipoda	Ischyroceridae	*Jassa sp.*	1	0
Malacostraca	Amphipoda	Lysianassidae	*?Lysianopsis sp.*	1	0
Malacostraca	Amphipoda	Lysianassidae	*?Parambasia sp. indet.*	0	1
Malacostraca	Amphipoda	Lysianassidae	*?Phoxostoma sp.*	1	0
Malacostraca	Amphipoda	Lysianassidae	*?Waldeckia sp.*	1	0
Malacostraca	Amphipoda	Podoceridae	*Podocerus sp.*	1	0
Malacostraca	Isopoda		*Isopoda sp.*	0	1
Malacostraca	Isopoda	Anthuridae	*Mesanthura ?affinis*	1	0
Malacostraca	Isopoda	Sphaeromatidae	*Pseudosphaeroma sp.*	1	0
Malacostraca	Mysidacea		*Unidentified Mysidacea*	0	1
Malacostraca	Tanaidacea		*Tanaidacea sp.*	0	1
Malacostraca	Tanaidacea	Tanaidae	*Zeuxoides sp.*	1	0
Malacostraca	Tanaidacea	Tanaidae	*Zeuxoides sp. 2*	1	0
Dinophyta					
Dinophyceae	Gymnodiniales	Polykrikaceae	*Pheopolykrikos sp.*	1	0
Dinophyceae	Peridinales	Peridiniaceae	*Protoperidinium sp.*	0	1
Macroalgae					
			Unidentified Phycophyta	1	1
Florideophyceae			*Unidentified Rhodophyceae*	1	0
Florideophyceae	Acrochaetiales	Acrochaetiaceae	*Audouinella sp.*	1	1

Major taxonomic group, Class	Order	Family	Genus and species	T1*	T2*
Florideophyceae	Ceramiales	Ceramiaceae	*Anotrichium?*	0	1
Florideophyceae	Ceramiales	Ceramiaceae	*Callithamnion sp.*	0	1
Florideophyceae	Ceramiales	Ceramiaceae	*Ceramium sp.*	0	1
Florideophyceae	Ceramiales	Ceramiaceae	*Griffithsia sp.*	0	1
Florideophyceae	Ceramiales	Delesseriaceae	*Unidentified Delesseriaceae*	1	1
Florideophyceae	Ceramiales	Delesseriaceae	*Erythroglossum sp.*	1	1
Florideophyceae	Ceramiales	Delesseriaceae	*Hymenena sp.*	1	1
Florideophyceae	Ceramiales	Delesseriaceae	*Schizoseris sp.*	1	0
Florideophyceae	Ceramiales	Rhodomelaceae	*Adamsiella sp.*	0	1
Florideophyceae	Ceramiales	Rhodomelaceae	*Polysiphonia sp.*	1	1
Florideophyceae	Plocamiales	Plocamiaceae	*Plocamium sp.*	0	1
Florideophyceae	Rhodymeniales	Lomentariaceae	*Lomentaria sp.*	0	1
Florideophyceae	Rhodymeniales	Rhodomeniaceae	*Rhodymenia sp.*	1	1
Florideophyceae	Stylonematales	Stylonemataceae	*Stylonema sp.*	0	1
Phaeophyceae	Ectocarpales	Acinetosporaceae	*Pylaiella sp.*	0	1
Phaeophyceae	Sphacelariales	Sphacelariaceae	*Sphacelaria sp.*	0	1
Ulvophyceae			Chlorophyceae sp.	0	1
Ulvophyceae	Bryopsidales	Bryopsidaceae	*Bryopsis sp.*	0	1
Ulvophyceae	Bryopsidales	Bryopsidaceae	*Derbesia sp.*	0	1
Ulvophyceae	Cladophorales	Cladophoraceae	*Cladophora sp.*	1	1
Ulvophyceae	Ulvales	Ulvaceae	*Enteromorpha sp.*	1	1
Ulvophyceae	Ulvales	Ulvaceae	*Ulva sp.*	1	1
Platyhelminthes					
Turbellaria	Polycladida		*Unidentified Polycladida*	1	0
Urochordata					
Ascidiacea			*Unidentified Ascideacea*	0	1
Ascidiacea	Aplousobranchia	Didemnidae	*Unidentified Didemnidae*	0	1
Ascidiacea	Stolidobranchia	Molgulidae	*Molgula sp.*	0	1
Vertebrata					
Actinopterygii	Perciformes	Tripterygiidae	*Tripterygiidae sp.*	0	1
Actinopterygii	Perciformes	Trypterigiidae	*Grahamina sp.*	1	0

* 1 = Present, 0 = Absent

Table 18: Non-indigenous marine organisms recorded from the Port of Lyttelton survey and the techniques used to capture each species. Species distributions throughout the port and in other ports and marinas around New Zealand are indicated.

Genus & species	Capture techniques in the Port of Lyttelton	Locations detected in the Port of Lyttelton		Detected in other locations surveyed in ZBS2000_04
		First survey	Second survey	
Annelida				
Polydora hoplura	Pile scrape		Cashin Quay 3 (See Figure 21)	Dunedin, Nelson, Picton, Tauranga, Timaru, Wellington, Whangarei
Spirobranchus polytrema	Pile scrape		Gladstone Pier, Oil Wharf (See Figure 22)	Dunedin, Napier, Picton, Timaru, Wellington,
Bryozoa				
Bugula flabellata	Benthic sled, Pile scrape,	Oil Wharf, Cashin Quay 3, Gladstone Pier, Wharf 2, Wharf 4 (See Figure 23)	Oil Wharf, Cashin Quay 3, Gladstone Pier, Wharf 3, Wharf 4, Wharf 5, Wharf 7 (See Figure 24)	Auckland, Bluff, Dunedin, Napier, Nelson, New Plymouth, Opua, Picton, Tauranga, Timaru, Wellington, Whangarei
Bugula neritina	Benthic grab, benthic sled, pile scrape, pile visual	Oil Wharf, Gladstone Pier, Wharf 2, Wharf 4 (See Figure 25)	Oil Wharf, Gladstone Pier, Wharf 3, Wharf 4, Wharf 7 (See Figure 26)	Auckland, Dunedin, Gisborne, Napier, Nelson, New Plymouth, Opua, Picton, Tauranga, Timaru, Whangarei
Conopeum seurati	Pile scrape	Cashin Quay 3 (See Figure 27)	Wharf 7 (See Figure 28)	Nelson, Whangarei
Cryptosula pallasiana	Pile scrape	Cashin Quay 3, Gladstone Pier, Wharf 2, Wharf 4 (See Figure 29)	Wharf 7 (See Figure 30)	Dunedin, Gisborne, Nelson, New Plymouth, Picton, Timaru, Wellington, Whangarei
Tricellaria inopinata	Benthic grab	Wharf 4		Gisborne, New Plymouth, Picton, Whangarei
Watersipora subtorquata	Benthic grab, pile scrape, pile visual	Cashin Quay 3, Gladstone Pier, Oil Wharf, Wharf 2, Wharf 4 (See Figure 31)	Cashin Quay 3, Gladstone Pier, Oil Wharf, Wharf 3, Wharf 4, Wharf 7 (See Figure 32)	Auckland, Bluff, Dunedin, Gisborne, Napier, Nelson, New Plymouth, Opua, Picton, Tauranga, Timaru, Wellington, Whangarei
Cnidaria				
Haliplanella lineata	Pile scrape	Wharf 4		
Monotheca pulchella	Pile scrape		Oil Wharf (See Figure 33)	New Plymouth, Tauranga, Timaru, Wellington
Symplectoscyphus subdichotomus	Benthic grab, pile scrape		Cashin Quay 3, Cashin Quay 4 (See Figure 34)	Timaru
Crustacea				
Apocorophium acutum	Pile scrape, pile visual	Gladstone Pier, Oil Wharf, Wharf 2, Wharf 4 (See Figure 35)	Cashin Quay 3, Gladstone Pier, Oil Wharf, Wharf 3, Wharf 7 (See Figure 36)	Auckland, Dunedin, Opua, Tauranga, Timaru
Cancer gibbosulus	Pile scrape	Cashin Quay 3		Timaru, Wellington
Crassicorophium bonnellii	Pile scrape		Cashin Quay 3 (See Figure 37)	

Genus & species	Capture techniques in the Port of Lyttelton	Locations detected in the Port of Lyttelton		Detected in other locations surveyed in ZBS2000_04
		First survey	Second survey	
Jassa slatteryi	Pile scrape	Cashin Quay 3 (See Figure 38)	Cashin Quay 3 (See Figure 39)	Timaru, Whangarei
Monocorophium acherusicum	Pile scrape	Cashin Quay 3, Galdstone Pier, Oil Wharf, Wharf 2, Wharf 4 (See Figure 40)	Cashin Quay 3, Galdstone Pier, Wharf 3, Wharf 4, Wharf 7 (See Figure 41)	Dunedin, Gisborne, Tauranga, Timaru, Wellington, Whangarei
Monocorophium sextonae	Pile scrape	Gladstone Pier, Oil Wharf (See Figure 42)	Cashin Quay 3 (See Figure 43)	New Plymouth
Mollusca				
Theora lubrica	Benthic sled, benthic grab	Wharf 2 (See Figure 44)	Cashin Quay 3, Cattle Jetty, Gladstone Pier, Oil Wharf, Recreational Fishing Jetty, Wharf 4, Wharf 5, Wharf 7 (See Figure 45)	Auckland, Gisborne, Napier, Nelson, New Plymouth, Opua, Picton, Wellington, Whangarei
Macroalgae				
Griffithsia crassiuscula	Benthic grab, benthic sled, pile scrape, pile visual	Gladstone Pier, Wharf 4 (See Figure 46)	Oil Wharf, Wharf 3 (See Figure 47)	Bluff, New Plymouth, Picton, Timaru, Wellington
Polysiphonia brodiei	Pile scrape	Gladstone Pier (See Figure 48)	Cashin Quay 3 (See Figure 49)	Bluff, Dunedin
Polysiphonia senticulosa	Pile scrape		Cashin Quay 3, Gladstone Pier, Wharf 3, Wharf 7 (See Figure 50)	
Polysiphonia subtilissima	Pile scrape	Wharf 4		Dunedin, Timaru
Undaria pinnatifida	Benthic sled, pile scrape, pile visual	Cashin Quay 3, Gladstone Pier, Oil Wharf, Wharf 2, Wharf 4 (See Figure 51)	Gladstone Pier, Wharf 3, Wharf 4, Wharf 7 (See Figure 52)	Dunedin, Gisborne, Napier, Nelson, New Plymouth, Picton, Timaru, Wellington,
Porifera				
Halisarca dujardini	Pile scrape		Cashin Quay 3 (See Figure 53)	Auckland, Bluff, Dunedin, New Plymouth, Picton, Wellington
Urochordata				
Ascidiella aspersa	Pile scrape		Gladstone Pier, Wharf 3 (See Figure 54)	Auckland, Gisborne, Napier
Ciona intestinalis	Benthic sled, Crab trap, Pile scrape, pile visual	Gladstone Pier, Oil Wharf, Wharf 2, Wharf 4 (See Figure 55)	Gladstone Pier, Oil Wharf, Wharf 3, Wharf 4, Wharf 5, Wharf 6, Wharf 7 (See Figure 56)	Napier, Nelson, Timaru
Styela clava	Pile scrape		Gladstone Pier (See Figure 57)	

Table 19: Summary statistics for taxon assemblages collected in the Port of Lyttelton using six different methods, and similarity indices comparing assemblages between the first and second survey. See "Definitions of species categories" for definitions of Native, C1 and C2 (cryptogenic category 1 and 2) and NIS (non-indigenous species) taxa.

	No. of samples in first survey	No. of samples in second survey	No. of taxa in first survey	No. of taxa in second survey	No. (%) of taxa shared between surveys	No. of taxa in first survey only	No. of taxa in second survey only	No. (%) of taxa in only one sample in first survey	No. (%) of taxa in only one sample in second survey	Chao Shared Esimated	Jaccard Classic	Sorensen Classic	Chao-Jaccard-Est Incidence-based	Chao-Sorensen-Est Incidence-based
Pile scrape quadrats														
Native	70	91	109	127	69 (41%)	40	58	35 (32%)	51 (40%)	103.112	0.413	0.585	0.768	0.807
C2	70	91	24	33	13 (30%)	11	20	7 (29%)	6 (18%)	14.525	0.295	0.456	0.484	0.618
NIS & C1	70	91	27	41	24 (55%)	3	17	5 (19%)	13 (32%)	30.026	0.545	0.706	0.93	0.958
Benthic sleds														
Native	10	20	38	19	12 (27%)	26	7	21 (55%)	9 (47%)	17.787	0.267	0.421	0.629	0.676
C2	10	20	2	2	1 (50%)	1	1	1 (50%)	2 (100%)	Not enough taxa encountered for meaningful analysis				
NIS & C1	10	20	11	7	7 (64%)	4	0	7 (64%)	1 (14%)	11.192	0.636	0.778	0.658	0.778
Benthic grabs														
Native	15	26	16	7	4 (21%)	12	3	10 (63%)	4 (57%)		See analysis for all taxa combined			
C2	15	26	2	1	0 (0%)	2	1	2 (100%)	1 (100%)	Not enough taxa encountered for meaningful analysis				
NIS & C1	15	26	5	2	0 (0%)	5	2	2 (40%)	2 (100%)	Not enough taxa encountered for meaningful analysis				
Native, C2, NIS & C1 taxa combined	15	26	23	10	4 (14%)	19	6	14 (61%)	7 (70%)	4.2	0.138	0.242	0.297	0.444
Crab traps														
Native	20	40	4	9	3 (30%)	1	6	1 (25%)	4 (44%)	See analysis for all taxa combined				
C2	20	40	0	1	0 (0%)	0	1	0 (0%)	1 (100%)	Not enough taxa encountered for meaningful analysis				
NIS & C1	20	40	0	3	0 (0%)	0	3	0 (0%)	3 (100%)	Not enough taxa encountered for meaningful analysis				
Native, C2, NIS & C1 taxa combined	20	40	4	13	3 (21%)	1	10	1 (25%)	8 (62%)	3	0.214	0.353	0.579	0.734
Fish traps														
Native	20	36	8	8	5 (45%)	3	3	2 (25%)	3 (38%)	5.707	0.455	0.625	0.783	0.869
C2	20	36	0	0	0 (0%)	0	0	0 (0%)	0 (0%)	No taxa encountered				
NIS & C1	20	36	0	0	0 (0%)	0	0	0 (0%)	0 (0%)	No taxa encountered				
Starfish traps														
Native	20	40	2	2	2 (100%)	0	0	0 (0%)	0 (0%)	Not enough taxa encountered for meaningful analysis				
C2	20	40	0	0	0 (0%)	0	0	0 (0%)	0 (0%)	No taxa encountered				
NIS & C1	20	40	0	0	0 (0%)	0	0	0 (0%)	0 (0%)	No taxa encountered				

Appendices

Appendix 1: Definitions of vessel types and geographical areas used in analyses of the LMIU shipping movements database

A. Groupings of countries into geographical areas. A country may be included in more than one geographical area category if different parts of that country are considered (by LMIU) to belong to different geographical areas (for example, Canada occurs in the NE Canada and Great Lakes area and in the West Coast North America area). Only countries that occur in the database are listed in the table below.

Geographical area	Countries/locations included
Africa Atlantic coast	Angola
	The Congo
	Nigeria
Antarctica (includes Southern Ocean)	Antarctica
	Australia (Macquarie Is)
Australia	Australia (general)
	Australia (VIC)
	Australia (QLD)
	Australia (NSW)
	Australia (TAS)
	Australia (WA)
	Australia (NT)
	Australia (SA)
Black Sea coast	Russian Federation
Caribbean Islands	Bahamas
	Cuba
	Jamaica
	Puerto Rico
Central America inc Mexico to Panama	Costa Rica
	El Salvador
	Guatemala
	Mexico
	Panama
North-west Pacific	People's Republic of China
	Republic of Korea
	Russian Federation
	Taiwan
	Vietnam
Eastern Mediterranean inc Cyprus, Turkey	Turkey
European Mediterranean coast	France
	Gibraltar
	Italy
	Malta
	Spain

Geographical area	Countries/locations included
Gulf of Mexico	United States of America
Gulf States	Iran
	Kuwait
	Saudi Arabia
	State of Qatar
	Sultanate of Oman
	United Arab Emirates
Central Indian Ocean	Bangladesh
	India
	Pakistan
	Sri Lanka
Japan	Japan
N.E. Canada and Great Lakes	Canada
New Zealand	New Zealand
North African coast	Algeria
	Arab Republic of Egypt
	Morocco
	Spain
	Tunisia
	Western Sahara
North European Atlantic coast	Belgium
	France
	Germany
	Netherlands
Pacific Islands	American Samoa
	Cook Islands
	Fiji
	French Polynesia
	Guam
	Independent State of Samoa
	Kiribati
	Marshall Islands
	New Caledonia
	Niue Island
	Norfolk Island
	Northern Marianas
	Papua New Guinea
	Pitcairn Islands
	Solomon Islands
	Tokelau Islands
	Tonga
	Tuvalu
	Vanuatu

Geographical area	Countries/locations included
	Wallis & Futuna
Red Sea coast inc up to the Persian Gulf	Arab Republic of Egypt
	Saudi Arabia
	Sudan
	Yemeni Republic
Scandinavia inc Baltic, Greenland, Iceland etc	Denmark
	Norway
	Poland
	Russian Federation
South & East African coasts	Heard & McDonald Islands
	Kenya
	Mauritius
	Mozambique
	Republic of Djibouti
	Republic of Namibia
	Reunion
	South Africa
South America Atlantic coast	Argentina
	Aruba
	Brazil
	Colombia
	Falkland Islands
	Netherlands Antilles
	Uruguay
	Venezuela
South America Pacific coast	Chile
	Ecuador
	Peru
Spain / Portugal inc Atlantic Islands	Canary Islands
	Portugal
	Spain
U.S, Atlantic coast including part of Canada	United States of America
United Kingdom inc Eire	United Kingdom
East Asian seas	Indonesia
	Malaysia
	Philippines
	Republic of Singapore
	Sultanate of Brunei
	Thailand
West coast North America inc USA, Canada & Alaska	Canada
	United States of America

B. Groupings of vessel sub-types according to LMIU definitions.

Vessel type definition in this report	General type as listed in LMIU database	Sub type code from LMIU database	Definition of sub type in LMIU database
Bulk/ cement carrier	B	BU	bulk
	B	CB	bulk/c.c.
	B	CE	cement
	B	OR	ore
	B	WC	wood-chip
Bulk/ oil carrier	C	BO	bulk/oil
	C	OO	ore/oil
Dredge	D	BD	bucket dredger
	D	CH	cutter suction hopper dredger
	D	CS	cutter suction dredger
	D	DR	dredger
	D	GD	grab dredger
	D	GH	grab hopper dredger
	D	HD	hopper dredger
	D	SD	suction dredger
	D	SH	suction hopper dredger
	D	SS	sand suction dredger
	D	TD	trailing suction dredger
	D	TS	trailing suction hopper dredger
Fishing	F	FC	fish carrier
	F	FF	fish factory
	F	FP	fishery protection
	F	FS	fishing
	F	TR	trawler
	F	WF	whale factory
	F	WH	whaler
General cargo	G	CT	cargo/training
	G	GC	general cargo
	G	PC	part c.c.
	G	RF	ref
LPG / LNG	L	FP	floating production
	L	FS	floating storage
	L	NG	Lng
	L	NP	Lng/Lpg
	L	PG	Lpg
Passenger/ vehicle/ livestock	M	LV	livestock
	M	PR	passenger
	M	VE	vehicle
Other (includes pontoons, barges, mining & supply ships, etc)	O	BA	barge
	O	BS	buoy ship/supply
	O	BY	buoy ship
	O	CL	cable
	O	CP	cable pontoon
	O	CS	crane ship
	O	CX	crane barge
	O	DE	depot ship
	O	DS	diving support
	O	ES	exhibition ship

Vessel type definition in this report	General type as listed in LMIU database	Sub type code from LMIU database	Definition of sub type in LMIU database
	O	FL	floating crane
	O	FY	ferry
	O	HB	hopper barge
	O	HF	hydrofoil
	O	HL	semi-sub HL vessel
	O	HS	hospital ship
	O	HT	semi-sub HL/tank
	O	IB	icebreaker
	O	IF	icebreaker/ferry
	O	IS	icebreaker/supply
	O	IT	icebreaker/tender
	O	LC	landing craft
	O	LT	lighthouse tender
	O	MN	mining ship
	O	MS	mission ship
	O	MT	maintenance
	O	OS	offshore safety
	O	PA	patrol ship
	O	PC	pollution control vessel
	O	PD	paddle
	O	PI	pilot ship
	O	PL	pipe layer
	O	PO	pontoon
	O	PP	pipe carrier
	O	RD	radio ship
	O	RN	ro/ro pontoon
	O	RP	repair ship
	O	RX	repair barge
	O	SB	storage barge
	O	SC	sludge carrier
	O	SP	semi-sub pontoon
	O	SS	storage ship
	O	SU	support
	O	SV	salvage
	O	SY	supply
	O	SZ	standby safety vessel
	O	TB	tank barge
	O	TC	tank cleaning ship
	O	TN	tender
	O	TR	training
	O	WA	waste ship
	O	WO	work ship
	O	YT	yacht
Passenger ro/ro	P	RR	passenger ro/ro
Research	R	HR	hydrographic research
	R	MR	meteorological research
	R	OR	oceanographic research
	R	RB	research/buoy ship
	R	RE	research
	R	RS	research/supply ship
	R	SR	seismographic research

Vessel type definition in this report	General type as listed in LMIU database	Sub type code from LMIU database	Definition of sub type in LMIU database
Tanker (including chemical/ oil / ashphalt etc)	T	AC	acid tanker
	T	AS	asphalt tanker
	T	BK	bunkering tanker
	T	CH	chem.tank
	T	CO	chemical/oil carrier
	T	CR	crude oil tanker
	T	EO	edible oil tanker
	T	FJ	fruit juice tanker
	T	FO	fish oil tanker
	T	FP	floating production
	T	FS	floating storage
	T	MO	molasses tanker
	T	NA	naval auxiliary
	T	PD	product tanker
	T	TA	non specific tanker
	T	WN	wine tank
	T	WT	water tanker
Container/ unitised carrier and ro/ro	U	BC	barge carrier/c.c.
	U	BG	barge carrier
	U	CC	c.c. container/unitised carrier
	U	CR	c.c.ref
	U	RC	ro/ro/c.c.
	U	RR	ro/ro
Tug	X	AA	anchor handling salvage tug
	X	AF	anchor handling firefighting tug/supply
	X	AG	anchor handling firefighting tug
	X	AH	anchor handling tug/supply
	X	AT	anchor handling tug
	X	CT	catamaran tug
	X	FF	firefighting tug
	X	FS	firefighting tug/supply
	X	FT	firefighting tractor tug
	X	PT	pusher tug
	X	ST	salvage tug
	X	TG	tug
	X	TI	tug/icebreaker
	X	TP	tug/pilot ship
	X	TR	tractor tug
	X	TS	tug/supply
	X	TT	tug/tender
	X	TX	tug/support

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

Site	Easting	Northing	Survey Method*	Number of sample units
Cashin Quay 1	2488323	5733142	CRBTP	2
Cashin Quay 1	2488386	5733140	CRBTP	2
Cashin Quay 1	2488413	5733145	FSHTP	4
Cashin Quay 1	2488323	5733142	SHRTP	2
Cashin Quay 1	2488386	5733140	SHRTP	2
Cashin Quay 1	2488323	5733142	STFTP	2
Cashin Quay 1	2488386	5733140	STFTP	2
Cashin Quay 2	2488050	5733086	CYST	2
Cashin Quay 3	2487965	5733023	BSLD	1
Cashin Quay 3	2488017	5733040	BSLD	1
Cashin Quay 3	2487873	5733074	PSC	16
Cashin Quay 4	2487600	5733022	BGRB	3
Cashin Quay 4	2487554	5733021	CRBTP	2
Cashin Quay 4	2487554	5733022	CRBTP	2
Cashin Quay 4	2487436	5733011	FSHTP	2
Cashin Quay 4	2487463	5733014	FSHTP	2
Cashin Quay 4	2487554	5733022	SHRTP	4
Cashin Quay 4	2487554	5733022	STFTP	4
Cattle Jetty	2486822	5733403	BSLD	1
Cattle Jetty	2486827	5733470	BSLD	1
Cattle Jetty	2486838	5733349	CRBTP	2
Cattle Jetty	2486840	5733349	CRBTP	2
Cattle Jetty	2486851	5733326	FSHTP	2
Cattle Jetty	2486853	5733329	FSHTP	2
Cattle Jetty	2486838	5733349	SHRTP	2
Cattle Jetty	2486840	5733349	SHRTP	2
Cattle Jetty	2486838	5733349	STFTP	2
Cattle Jetty	2486840	5733349	STFTP	2
Gladstone Pier	2487577	5733171	BGRB	3
Gladstone Pier	2487574	5733233	BSLD	1
Gladstone Pier	2487619	5733255	BSLD	1
Gladstone Pier	2487624	5733189	CRBTP	2
Gladstone Pier	2487658	5733215	CRBTP	2
Gladstone Pier	2487679	5733242	FSHTP	2
Gladstone Pier	2487693	5733258	FSHTP	2
Gladstone Pier	2487639	5733205	PSC	16
Gladstone Pier	2487624	5733189	SHRTP	2
Gladstone Pier	2487658	5733215	SHRTP	2
Gladstone Pier	2487624	5733189	STFTP	2
Gladstone Pier	2487658	5733215	STFTP	2
Lower Level Breastwork	2486930	5733651	CRBTP	2
Lower Level Breastwork	2486979	5733667	CRBTP	2
Lower Level Breastwork	2486910	5733550	CYST	2
Lower Level Breastwork	2486930	5733651	SHRTP	2
Lower Level Breastwork	2486979	5733667	SHRTP	2
Lower Level Breastwork	2486930	5733651	STFTP	2
Lower Level Breastwork	2486979	5733667	STFTP	2
Oil Wharf	2486952	5733274	BGRB	3
Oil Wharf	2487024	5733261	BSLD	1
Oil Wharf	2487027	5733232	BSLD	1
Oil Wharf	2486916	5733288	CRBTP	2
Oil Wharf	2487048	5733216	CRBTP	2
Oil Wharf	2486934	5733362	CYST	2
Oil Wharf	2486868	5733322	FSHTP	2
Oil Wharf	2486889	5733303	FSHTP	2
Oil Wharf	2487068	5733194	PSC	17
Oil Wharf	2486916	5733288	SHRTP	2
Oil Wharf	2487048	5733216	SHRTP	2
Oil Wharf	2486916	5733288	STFTP	2
Oil Wharf	2487048	5733216	STFTP	2
Recreational Fishing Jetty	2486842	5732984	BSLD	1
Recreational Fishing Jetty	2486918	5733013	BSLD	1

Recreational Fishing Jetty	2486970	5733031	CRBTP	2
Recreational Fishing Jetty	2486979	5733036	CRBTP	2
Recreational Fishing Jetty	2486931	5733022	FSHTP	2
Recreational Fishing Jetty	2486976	5733056	FSHTP	2
Recreational Fishing Jetty	2486970	5733031	SHRTP	2
Recreational Fishing Jetty	2486979	5733036	SHRTP	2
Recreational Fishing Jetty	2486970	5733031	STFTP	2
Recreational Fishing Jetty	2486979	5733036	STFTP	2
Slipway	2486841	5733424	BGRB	3
Wharf 1 Breastwork	2487614	5733400	CYST	2
Wharf 1 Breastwork	2487685	5733371	FSHTP	2
Wharf 1 Breastwork	2487692	5733334	FSHTP	2
Wharf 2	2487437	5733458	BGRB	3
Wharf 2	2487412	5733474	BSLD	1
Wharf 2	2487507	5733474	BSLD	1
Wharf 2	2487405	5733354	CRBTP	2
Wharf 2	2487432	5733381	CRBTP	2
Wharf 2	2487405	5733354	SHRTP	2
Wharf 2	2487432	5733381	SHRTP	2
Wharf 2	2487405	5733354	STFTP	2
Wharf 2	2487432	5733381	STFTP	2
Wharf 3	2487383	5733531	PSC	14
Wharf 4	2487229	5733497	BGRB	3
Wharf 4	2487273	5733459	BSLD	1
Wharf 4	2487286	5733477	BSLD	1
Wharf 4	2487247	5733496	CRBTP	2
Wharf 4	2487253	5733478	CRBTP	2
Wharf 4	2487330	5733519	CYST	2
Wharf 4	2487253	5733502	FSHTP	2
Wharf 4	2487265	5733514	FSHTP	2
Wharf 4	2487275	5733523	PSC	14
Wharf 4	2487247	5733496	SHRTP	2
Wharf 4	2487253	5733478	SHRTP	2
Wharf 4	2487247	5733496	STFTP	2
Wharf 4	2487253	5733478	STFTP	2
Wharf 5	2487237	5733544	BSLD	1
Wharf 5	2487241	5733547	BSLD	1
Wharf 6	2487172	5733620	BGRB	3
Wharf 6	2487172	5733606	BSLD	1
Wharf 6	2487190	5733584	BSLD	1
Wharf 7	2487082	5733491	BGRB	3
Wharf 7	2487046	5733573	BSLD	1
Wharf 7	2487050	5733578	BSLD	1
Wharf 7	2487066	5733663	CRBTP	2
Wharf 7	2487091	5733546	CRBTP	2
Wharf 7	2487030	5733489	FSHTP	2
Wharf 7	2487030	5733542	FSHTP	2
Wharf 7	2487042	5733494	PSC	17
Wharf 7	2487066	5733663	SHRTP	2
Wharf 7	2487091	5733546	SHRTP	2
Wharf 7	2487066	5733663	STFTP	2
Wharf 7	2487091	5733546	STFTP	2
Z Berth	2487290	5733093	BGRB	2

*Survey methods: PSC = pile scrape quadrats and diver observations on wharf pilings, BSLD = benthic sled, BGRB = benthic grab, CYST = dinoflagellate cyst core, CRBTP = crab trap, FSHTP = fish trap, STFTP = starfish trap, SHRTP = shrimp trap

Appendix 3: Specialists engaged to identify specimens obtained from the New Zealand port surveys

Major taxonomic group	Class	Specialist Survey 1 samples	Specialist Survey 2 samples	Institution
Annelida	Polychaeta	Geoff Read[1], Jeff Forman[1]	Geoff Read[1], Jeff Forman[1]	[1]NIWA Greta Point
Bryozoa	Gymnolaemata	Dennis Gordon[1]	Dennis Gordon[1]	[1]NIWA Greta Point
Chelicerata	Pycnogonida	David Staples[2]	David Staples[2]	[2]Melbourne Museum, Victoria, Australia
Cnidaria	Anthozoa	Adorian Ardelean[3]	No specialist available as yet	[3]West University of Timisoara, Timisoara, 1900, Romania
Cnidaria	Hydrozoa	Jan Watson[4]	Jan Watson[4]	[4]Hydrozoan Research Laboratory, Clifton Springs, Victoria, Australia
Crustacea	Amphipoda	Graham Fenwick[5]	Graham Fenwick[5]	[5]NIWA Christchurch
Crustacea	Cirripedia	Graham Fenwick[5], Isla Fitridge[5] John Buckeridge[6]	Isla Fitridge[5]	[5]NIWA Christchurch and [6]Auckland University of Technology
Crustacea	Decapoda	Colin McLay[7] Graham Fenwick[5], Nick Gust[5]	Colin McLay[7]	[7]University of Canterbury and [5]NIWA Christchurch
Crustacea	Isopoda	Niel Bruce[1]	Niel Bruce[1]	[1]NIWA Greta Point
Crustacea	Mysidacea	Fukuoka Kouki[8]	Niel Bruce[1]	[1]NIWA Greta Point and [8]National Science Museum, Tokyo
Echinodermata	Asteroidea	Don McKnight[1]	Niki Davey[9]	[1]NIWA Greta Point and [9]NIWA Nelson
Echinodermata	Echinoidea	Don McKnight[1]	Niki Davey[9]	[1]NIWA Greta Point and [9]NIWA Nelson
Echinodermata	Holothuroidea	Niki Davey[9]	Niki Davey[9]	[9]NIWA Nelson
Echinodermata	Ophiuroidea	Don McKnight[1], Helen Rottman[1]	Niki Davey[9]	[1]NIWA Greta Point and [9]NIWA Nelson
Echiura	Echiuroidea	Geoff Read[1]	Geoff Read[1]	[1]NIWA Greta Point
Mollusca	Bivalvia. Cephalopoda, Gastropoda, Polyplacophora	Bruce Marshall[10]	Bruce Marshall[10]	[10]Museum of NZ Te Papa Tongarewa
Nemertea	Anopla, Enopla	Geoff Read[1]	Geoff Read[1]	[1]NIWA Greta Point
Macroalgae	Phaeophyceae, Rhodophyceae, Ulvophyceae	Wendy Nelson[1], Kate Neill[1]	Wendy Nelson[1], Kate Neill[1]	[1]NIWA Greta Point
Platyhelminthes	Turbellaria	Sean Handley[9]	Sean Handley[9]	[9]NIWA Nelson
Porifera	Demospongiae, Calcarea	Michelle Kelly-Shanks[11]	Michelle Kelly-Shanks[11]	[11]NIWA Auckland
Priapula	Priapulidae	Geoff Read[1]	Geoff Read[1]	[1]NIWA Greta Point
Dinophyta	Dinophyceae	Hoe Chang[1], Rob Stewart[1]	Hoe Chang[1], Rob Stewart[1]	[1]NIWA Greta Point
Urochordata	Ascidiacea	Mike Page[e], Anna Bradley[e] Patricia Kott[12]	Mike Page[9], Anna Bradley[9]	[9]NIWA Nelson and [12]Queensland Museum
Vertebrata	Osteichthyes	Clive Roberts[10], Andrew Stewart[10]	Clive Roberts[10], Andrew Stewart[10]	[10]Museum of NZ Te Papa Tongarewa

Appendix 4: Generic descriptions of representative groups of the main marine phyla collected during sampling

Phylum Annelida

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

Phylum Arthropoda

The Arthropoda is 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 mm to many cm and superficially resemble spiders found on land.

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, 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 subantarctic 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 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 Dinophyta
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 Echinodermata
Echinoderms: This phylum contains a range of predominantly motile organisms – sea stars, brittle stars, sea urchins, sea cucumbers, sand dollars, feather stars and sea lilies. Echinoderms feed by filtering small food particles from the water column or by extracting food particles from sediment grains or rock surfaces.

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

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

Phylum Mollusca
Molluscs: The molluscs are a highly diverse group of marine animals characterised by the presence of an external or internal shell. This phyla includes the bivalves (organisms with hinged shells e.g. mussels, oysters, etc), gastropods (marine snails, e.g. winkles, limpets, topshells), chitons, sea slugs and sea hares, as well as the cephalopods (squid, cuttlefish and octopus).

Phylum Porifera
Sponges: Sponges are very simple colonial organisms that live attached to submerged natural and artificial surfaces including rocks, pilings, ropes and the shells or carapaces of other species. They vary greatly in colour and shape, and include sheet-like encrusting forms, branching forms and tubular forms. Sponge surfaces have thousands of small pores to through which water is drawn into the colony, where small food particles are filtered out before the water is again expelled through one or several other holes.

Appendix 5: Criteria for assigning non-indigenous status to species sampled from the Port of Lyttelton.

List of Chapman and Carlton's (1994) nine criteria (C1 – C9) for assigning non-indigenous species status that were met by the non-indigenous species sampled in the Port of Timaru. Criteria that apply to each species are indicated by (+). Cranfield et al's (1998) analysis was used for species previously known from New Zealand waters. For non-indigenous species that were first detected during the present study, criteria were assigned using advice from the taxonomists that identified them. Refer to footnote for a full description of C1 – C9.

Major taxonomic group and Species	C1	C2	C3	C4	C5	C6	C7	C8	C9
Annelida									
Spirobranchus polytrema	+		+		+			+	
Polydora hoplura			+		+	+	+	+	+
Bryozoa									
Bugula flabellata	+	+	+		+	+	+	+	+
Bugula neritina	+				+	+	+	+	+
Cryptosula pallasiana	+	+	+		+	+	+	+	+
Conopeum seurati	+		+	+	+	+	+	+	+
Watersipora subtorquata	+	+	+		+	+	+	+	+
Cnidaria									
Monotheca pulchella	+		+		+		+	+	
Symplectoscyphus subdichotomus	+		+		+	+	+	+	
Crustacea									
Apocorophium acutum			+			+		+	+
Monocorophium acherusicum			+		+	+		+	+
Monocorophium sextonae			+		+	+	+	+	+
Jassa slatteryi	+		+			+		+	+
Crassicorophium bonnellii	+		+		+	+	+	+	+
Mollusca									
Theora lubrica	+	+			+	+	+	+	+
Macroalgae									
Griffithsia crassiuscula	+	+				+		+	+
Polysiphonia brodiei	+	+	+		+	+	+	+	+
Polysiphonia senticulosa	+				+	+	+	+	
Undaria pinnatifida	+	+	+		+	+	+	+	+
Porifera									
Halisarca dujardini	+		+	+		+	+	+	+
Urochordata									
Ciona intestinalis	+		+		+	+	+	+	+
Ascidiella aspersa	+	+	+	+	+	+	+	+	+
Styela clava	+	+	+		+	+	+	+	+

Criterion 1: Has the species suddenly appeared locally where it has not been found before?
Criterion 2: Has the species spread subsequently?
Criterion 3: Is the species' distribution associated with human mechanisms of dispersal?
Criterion 4: Is the species associated with, or dependent on, other introduced species?
Criterion 5: Is the species prevalent in, or restricted to, new or artificial environments?
Criterion 6: Is the species' distribution restricted compared to natives?
Criterion 7: Does the species have a disjunct worldwide distribution?
Criterion 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?
Criterion 9: Is the species isolated from the genetically and morphologically most similar species elsewhere in the world?

Appendix 6a. Results from the pile scraping quadrats (replicates 1 to 4) and diver observations on pilings (replicates labelled "0").

Appendix 6a. Results from the diver collections and pile scrapings.

						Site code	Cashin Quay 3																Gladstone Pier																Oil Wharf																	Wharf 3														Wharf 4												Wharf 7																
						Pile replicate	1								2								1									2							1									2								1							2							1							2					1								2								
						Pile position	IN				OUT				IN				OUT				IN					OUT				IN			OUT				IN				OUT					IN				OUT				IN			OUT				IN			OUT				IN			OUT				IN	OUT				IN				OUT				IN				OUT				
phylum	class	order	family	genus	species	*class_code	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	0	1	2	3	4	1	2	3	4	1	2	3	1	2	3	4	1	2	3	4	0	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	1	2	3	4	1	2	3	1	2	3	4	1	2	3	1	2	3	4	1	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	0	1	2	3	4
Annelida	Polychaeta	Eunicida	Dorvilleidae	Dorvillea	australiensis	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annelida	Polychaeta	Eunicida	Dorvilleidae	Schistomeringos	loveni	N	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annelida	Polychaeta	Phyllodocida	Nereididae	Nereis	falcaria	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annelida	Polychaeta	Phyllodocida	Nereididae	Perinereis	amblyodonta	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Annelida	Polychaeta	Phyllodocida	Nereididae	Perinereis	camiguinoides	N	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Annelida	Polychaeta	Phyllodocida	Nereididae	Platynereis	Platynereis_australis_group	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annelida	Polychaeta	Phyllodocida	Phyllodocidae	Eulalia	Eulalia-NIWA-2	C2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annelida	Polychaeta	Phyllodocida	Phyllodocidae	Eulalia	microphylla	N	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annelida	Polychaeta	Phyllodocida	Phyllodocidae	Mystides	Mystides-B	C2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annelida	Polychaeta	Phyllodocida	Phyllodocidae	Pirakia	Pirakia-A	C2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Annelida	Polychaeta	Phyllodocida	Polynoidae	Harmothoe	macrolepidota	N	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	1	1	0	0	1	1	0
Annelida	Polychaeta	Phyllodocida	Polynoidae	Lepidastheniella	comma	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annelida	Polychaeta	Phyllodocida	Polynoidae	Lepidonotus	polychromus	N	0	0	1	0	0	0	1	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Annelida	Polychaeta	Phyllodocida	Polynoidae	Ophiodromus	angustifrons	N	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	1	1	1	0	1	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	1	0
Annelida	Polychaeta	Phyllodocida	Syllidae	Eusyllin-unknown	Eusyllin-unknown-A	C2	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annelida	Polychaeta	Phyllodocida	Syllidae	Eusyllis	Eusyllis-B	C2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annelida	Polychaeta	Phyllodocida	Syllidae	Haplosyllis	spongicola	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annelida	Polychaeta	Phyllodocida	Syllidae	Syllidae	Indet	SI	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annelida	Polychaeta	Sabellida	Sabellidae	Branchiomma	Branchiomma-A	C2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annelida	Polychaeta	Sabellida	Sabellidae	Branchiomma	curtum	C1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	0	0	1	1	1	0	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	1	1	1	1	0	1	1	1	0	0	1	1	0	1	1	1	0	0	1	1	1
Annelida	Polychaeta	Sabellida	Sabellidae	Demonax	aberrans	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0
Annelida	Polychaeta	Sabellida	Sabellidae	Megalomma	kaikourense	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annelida	Polychaeta	Sabellida	Sabellidae	Megalomma	suspiciens	N	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Annelida	Polychaeta	Sabellida	Sabellidae	Pseudopotamilla	laciniosa	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annelida	Polychaeta	Sabellida	Sabellidae	Sabellinae-unknown	sabellinae-01	C2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annelida	Polychaeta	Sabellida	Serpulidae	Serpula	Serpula-D	C2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Annelida	Polychaeta	Sabellida	Serpulidae	Serpulidae	Indet	SI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annelida	Polychaeta	Sabellida	Serpulidae	Spirobranchus	cariniferus	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annelida	Polychaeta	Sabellida	Serpulidae	Spirobranchus	polytrema	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annelida	Polychaeta	Scolecida	Opheliidae	Armandia	maculata	N	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annelida	Polychaeta	Spionida	Spionidae	Polydora	hoplura	A	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annelida	Polychaeta	Terebellida	Acrocirridae	Acrocirrus	trisectus	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annelida	Polychaeta	Terebellida	Cirratulidae	Cirratulidae	Indet	SI	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annelida	Polychaeta	Terebellida	Cirratulidae	Cirratulus	Cirratulus-A	C2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annelida	Polychaeta	Terebellida	Cirratulidae	Protocirrineris	nuchalis	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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Annelida	Polychaeta	Terebellida	Terebellidae	Lanassa	Lanassa-A	C2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annelida	Polychaeta	Terebellida	Terebellidae	Nicolea	armilla	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annelida	Polychaeta	Terebellida	Terebellidae	Streblosoma	toddae	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0
Annelida	Polychaeta	Terebellida	Terebellidae	Terebella	Terebella-B	C2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ectoprocta	Gymnolaemata	Cheilostomata	Bugulidae	Bugula	flabellata	A	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	1	1	0	0	1	1	0	0	1	1	1	0	1	1	1	0	1	1	0	0	1	1	0	1	1	0	0	1	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	1	0	0	0	0	1	1
Ectoprocta	Gymnolaemata	Cheilostomata	Bugulidae	Bugula	neritina	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	1	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1	0	1	1	0	0	0	0	1	0
Ectoprocta	Gymnolaemata	Cheilostomata	Calloporidae	Valdemunitella	valdemunita	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ectoprocta	Gymnolaemata	Cheilostomata	Candidae	Caberea	helicina	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Ectoprocta	Gymnolaemata	Cheilostomata	Candidae	Caberea	new sp. (cf. guntheri)	N	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ectoprocta	Gymnolaemata	Cheilostomata	Candidae	Caberea	zelandica	N	0	1	1	1	0	0	1	1	0	1	1	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	1	0	0	0	1	1	1	1	0	0	1	0	0	1	1	0	0	1	0	0	0	1	1	0	0	1	0	0	1	1	1	1	0	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0	1
Ectoprocta	Gymnolaemata	Cheilostomata	Candidae	Scrupocellaria	ornithorhyncus	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ectoprocta	Gymnolaemata	Cheilostomata	Cellariidae	Cellaria	immersa	N	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ectoprocta	Gymnolaemata	Cheilostomata	Celleporidae	Celleporina	proximalis	N	0	1	1	0	0	0	1	1	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ectoprocta	Gymnolaemata	Cheilostomata	Cryptosulidae	Cryptosula	pallasiana	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Ectoprocta	Gymnolaemata	Cheilostomata	Electridae	Conopeum	seurati	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Ectoprocta	Gymnolaemata	Cheilostomata	Electridae	Electra	new sp.	SI	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ectoprocta	Gymnolaemata	Cheilostomata	Hippothoidae	Celleporella	delta	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ectoprocta	Gymnolaemata	Cheilostomata	Microporellidae	Fenestrulina	thyreophora	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ectoprocta	Gymnolaemata	Cheilostomata	Romancheinidae	Escharoides	angela	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ectoprocta	Gymnolaemata	Cheilostomata	Scrupariidae	Scruparia	ambigua	C1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ectoprocta	Gymnolaemata	Cheilostomata	Watersiporidae	Watersipora	subtorquata	A	1	1	1	0	0	0	0	0	0	1	0	1	0	1	1	1	0	1	1	0	0	1	0	1	0	1	0	0	1	0	1	0	1	1	1	1	0	1	1	1	1	0	1	1	0	1	1	1	0	1	1	1	1	1	1	0	1	1	0	1	1	0	0	1	1	0	1	1	0	0	1	1	0	0	0	0	1	0	1	0	1	1	0	0	1	1	1	0	0	1	0	0
Ectoprocta	Stenolaemata	Cyclostomata	Crisiidae	Crisia	tenuis	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Cnidaria	Hydrozoa	Hydroida	Bougainvilliidae	Bougainvillia	muscus	C1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cnidaria	Hydrozoa	Hydroida	Campanulariidae	Clytia	hemisphaerica	C1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cnidaria	Hydrozoa	Hydroida	Campanulariidae	Obelia	dichotoma	C1	0	0	0	1	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	1	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Cnidaria	Hydrozoa	Hydroida	Campanulinidae	Phialella	quadrata	C1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cnidaria	Hydrozoa	Hydroida	Haleciidae	Halecium	beanii	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cnidaria	Hydrozoa	Hydroida	Haleciidae	Halecium	delicatulum	C1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cnidaria	Hydrozoa	Hydroida	Plumulariidae	Monotheca	pulchella	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cnidaria	Hydrozoa	Hydroida	Plumulariidae	Plumularia	setacea	C1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cnidaria	Hydrozoa	Hydroida	Sertulariidae	Sertularella	robusta	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cnidaria	Hydrozoa	Hydroida	Sertulariidae	Symplectoscyphus	subdichotomus	A	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arthropoda	Cirripedia	Thoracica	Balanidae	Austrominius	modestus	N	1	0	1	1	1	1	0	1	1	1	0	0	1	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	1	1	0	0	1	1	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	1	0	1	1	1	0	0	1	1	0	0	0	1	1	0	0
Arthropoda	Cirripedia	Thoracica	Balanidae	Notomegabalanus	decorus	N	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

*class_code: A = non-indigenous (highlighted by shading), C1 = cryptogenic category 1, C2 = cryptogenic category 2, N = native, SI = indeterminate species.

Appendix 6a. Results from the diver collections and pile scrapings.

						Site code	Cashin Quay 3				Gladstone Pier				Oil Wharf				Wharf 3				Wharf 4				Wharf 7			
						Pile replicate	1		2		1		2		1		2		1		2		1		2		1		2	
						Pile position	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT
phylum	class	order	family	genus	species	*class_code	1234	1234	1234	1234	01234	1234	123	1234	1234	01234	1234	1234	123	1234	123	1234	123	1234	1	1234	1234	1234	1234	01234
Arthropoda	Cirripedia	Thoracica	Chthamalidae	Chaemosipho	columna	N	0000	1000	0000	0000	00000	0000	000	0000	0000	00000	0000	0000	000	0000	000	0000	000	0000	0	0000	0000	0000	0000	00000
Arthropoda	Malacostraca	Amphipoda				SI	0100	0000	0000	0000	00000	0000	000	0000	0001	00010	0000	0000	001	0000	000	0100	000	0000	0	0000	0000	0000	0000	00000
Arthropoda	Malacostraca	Amphipoda	Amaryllidae	Amaryllis	sp. aff. A. kamata	C2	0000	0000	0010	0010	00000	0000	000	0000	0000	00000	0000	0000	000	0000	000	0000	000	0000	0	0000	0000	0000	0000	00000
Arthropoda	Malacostraca	Amphipoda	Amaryllidae	Amaryllis	sp. aff. A. macrophthalma	C2	0011	0000	0000	0000	00000	0000	000	0000	0000	00000	0000	0000	000	0000	000	0000	000	0000	0	1000	0000	0000	0000	00000
Arthropoda	Malacostraca	Amphipoda	Amphilochidae	Neocyproidea	otakensis	N	0000	0000	0000	0000	00000	0000	000	0000	0000	00000	0000	0000	000	0000	000	0000	000	0000	0	0000	0000	0000	0000	00100
Arthropoda	Malacostraca	Amphipoda	Aoridae	Aora	maculata	N	0000	0000	0000	0000	00000	0000	100	0000	0000	00000	0000	0000	000	0000	000	0000	000	0000	0	0000	0000	0000	0000	00000
Arthropoda	Malacostraca	Amphipoda	Aoridae	Aora	typica	C1	0000	0000	0000	0000	01000	1000	100	0100	0100	00100	0100	0000	000	0000	000	0000	000	0000	0	0000	0000	0000	0000	00100
Arthropoda	Malacostraca	Amphipoda	Aoridae	Haplocheira	barbimana	N	1011	1111	0011	0111	00000	0000	000	0000	0010	00100	0100	0111	010	0001	000	0010	001	1011	0	1001	0000	0000	0000	00000
Arthropoda	Malacostraca	Amphipoda	Caprellidae	Caprella	equilibra	N	0000	0000	0000	0010	00000	0000	000	0000	0000	00000	0000	0000	000	0000	000	0000	000	0000	0	0000	0000	0000	0000	00000
Arthropoda	Malacostraca	Amphipoda	Caprellidae	Pseudaeginella	campbellensis	N	0000	0000	0000	0000	00000	0000	000	0000	0000	00000	0000	0000	000	0000	000	0000	000	0001	0	0000	0000	0000	0000	00000
Arthropoda	Malacostraca	Amphipoda	Caprellidae	Pseudaeginella	sp. indet.	C2	0000	0000	0010	0011	00000	0000	000	0000	0000	00000	0000	0000	000	0000	000	0000	000	0000	0	0000	0000	0000	0000	00000
Arthropoda	Malacostraca	Amphipoda	Corophiidae	Apocorophium	acutum	A	0001	0001	0000	0010	01000	1100	101	0100	0000	00100	0000	0100	000	0000	100	0000	000	0000	0	0000	0000	0000	0000	00100
Arthropoda	Malacostraca	Amphipoda	Corophiidae	Corophium	sp. indet.	C2	0000	0000	0000	0010	00000	0000	000	0000	0000	00000	0000	0000	000	0000	000	0000	000	0000	0	0000	0000	0000	0000	00000
Arthropoda	Malacostraca	Amphipoda	Corophiidae	Crassicorophium	bonnellii	A	0000	0000	0000	0011	00000	0000	000	0000	0000	00000	0000	0000	000	0000	000	0000	000	0000	0	0000	0000	0000	0000	00000
Arthropoda	Malacostraca	Amphipoda	Corophiidae	Monocorophium	acherusicum	A	0000	0000	0010	0011	00000	0000	001	0000	0000	00000	0000	0000	000	0001	000	0010	000	0000	0	1000	0001	0001	0000	00000
Arthropoda	Malacostraca	Amphipoda	Corophiidae	Monocorophium	sextonae	A	0000	0000	0000	0010	00000	0000	000	0000	0000	00000	0000	0000	000	0000	000	0000	000	0000	0	0000	0000	0000	0000	00000
Arthropoda	Malacostraca	Amphipoda	Corophiidae	Monocorophium	sp. aff. M. insidiosum	C2	0000	0000	0000	0000	00000	1000	100	0000	0000	00000	0000	0000	000	0000	000	0000	000	0000	0	0000	0000	0000	0000	00000
Arthropoda	Malacostraca	Amphipoda	Cyproideidae	Peltopes	peninsulae	N	0000	0000	0000	0000	00000	0000	100	0000	0000	00000	0000	0000	000	0000	000	0000	000	0000	0	0000	0000	0000	0000	00000
Arthropoda	Malacostraca	Amphipoda	Dexaminidae	Paradexamine	pacifica	N	0000	0000	0000	0010	00000	0100	000	0000	0000	00000	0000	0000	000	0000	000	0000	000	0000	0	0000	0000	0000	0000	00000
Arthropoda	Malacostraca	Amphipoda	Dexaminidae	Polycheria	obtusa	N	0000	0100	0000	0010	00000	0000	000	0000	0000	00000	0000	0000	000	0000	000	0000	000	0000	0	0000	0000	0000	0000	00000
Arthropoda	Malacostraca	Amphipoda	Iphimediidae	Anisoiphimedia	haurakiensis	N	0000	0000	0000	0010	00000	0000	000	0000	0000	00000	0000	0000	000	0000	000	0000	000	0000	0	0000	0000	0000	0000	00000
Arthropoda	Malacostraca	Amphipoda	Isaeidae	Gammaropsis	dentifera	N	0000	0000	0010	0001	00000	0000	000	0000	0000	00000	0000	0000	000	0000	000	0000	000	0000	0	0000	0000	0000	0000	00000
Arthropoda	Malacostraca	Amphipoda	Isaeidae	Gammaropsis	indet sp.	SI	0000	0000	0000	0000	00000	0000	000	0000	0000	00000	0000	0000	000	0000	100	0000	000	0000	0	0000	0000	0000	0000	00000
Arthropoda	Malacostraca	Amphipoda	Isaeidae	Gammaropsis	longimana	N	0000	0000	0010	0010	00000	0000	000	0000	0000	00000	0000	0000	000	0000	000	0000	000	0000	0	0000	0000	0000	0000	00000
Arthropoda	Malacostraca	Amphipoda	Isaeidae	Gammaropsis	typica	N	0000	0000	0000	0010	00000	0000	000	0000	0000	00000	0000	0000	000	0000	000	0000	000	0000	0	0000	0000	0000	0000	00000
Arthropoda	Malacostraca	Amphipoda	Ischyroceridae	Ischyroceridae	sp. A	C2	0000	0000	0000	0010	00000	0000	000	0000	0000	00000	0000	0000	000	0000	000	0000	000	0000	0	0000	0000	0000	0000	00000
Arthropoda	Malacostraca	Amphipoda	Ischyroceridae	Ischyrocerus	longimanus	N	0000	0100	0000	0010	00000	1000	100	0000	0000	00000	0000	0000	000	0000	000	0000	000	0000	0	0000	0000	0000	0000	00000
Arthropoda	Malacostraca	Amphipoda	Ischyroceridae	Jassa	slatteryi	A	0000	0100	0010	0010	00000	0000	000	0000	0000	00000	0000	0000	000	0000	000	0000	000	0000	0	0000	0000	0000	0000	00000
Arthropoda	Malacostraca	Amphipoda	Ischyroceridae	Ventojassa	frequens	N	0000	0100	0100	0111	00000	0000	000	0000	0000	00000	0000	0000	000	0000	000	0000	000	0100	0	0000	0000	0000	0000	00000
Arthropoda	Malacostraca	Amphipoda	Leucothoidae	Leucothoe	sp. 1	C2	0011	0000	0011	0010	10000	0000	001	0000	0100	00000	0000	0010	110	0000	000	0000	000	0000	0	0001	0001	0000	0000	00000
Arthropoda	Malacostraca	Amphipoda	Leucothoidae	Leucothoe	trailli	N	0000	0000	0000	0000	00000	0000	000	0000	0000	00000	0100	0000	000	0000	000	0010	000	0001	0	0000	0000	0001	0000	00100
Arthropoda	Malacostraca	Amphipoda	Liljeborgiidae	Liljeborgia	akaroica	N	0001	0000	0010	0000	00000	0000	000	0000	0000	00000	0000	0000	000	0000	000	0000	000	0000	0	0000	0000	0000	0000	00000
Arthropoda	Malacostraca	Amphipoda	Lysianassidae	?Parambasia	sp. indet.	SI	0000	0000	0010	0010	00000	0000	000	0000	0000	00000	0000	0000	000	0000	000	0000	000	0000	0	0000	0000	0000	0000	00000
Arthropoda	Malacostraca	Amphipoda	Lysianassidae	Acontiostoma	n. sp.	C2	0010	0001	0110	0000	00000	0000	000	0000	0000	00000	0000	0000	010	0000	000	0010	000	0000	0	0000	0001	0000	0000	00000
Arthropoda	Malacostraca	Amphipoda	Lysianassidae	Parawaldeckia	sp. aff. P. stephenseni	C2	0001	0000	0000	0010	00000	0000	000	0000	0000	00000	0000	0100	000	0000	000	0010	000	1000	0	0000	0000	0001	0000	00000
Arthropoda	Malacostraca	Amphipoda	Lysianassidae	Parawaldeckia	sp. D	C2	0000	0000	0000	0000	00000	0000	000	0000	0000	00000	0000	0000	000	0000	000	0000	001	0000	0	0000	0000	0000	0000	00000
Arthropoda	Malacostraca	Amphipoda	Lysianassidae	Parawaldeckia	stephenseni	N	0000	0000	0000	0000	00000	0000	000	0000	0000	00000	0000	0000	000	0000	000	0000	000	0000	0	0000	0001	0000	0000	00000
Arthropoda	Malacostraca	Amphipoda	Lysianassidae	Parawaldeckia	vesca	N	0000	0000	0000	0011	00000	0000	000	0000	0000	00000	0000	0000	000	0000	000	0000	000	0000	0	0001	0000	0000	0000	00000
Arthropoda	Malacostraca	Amphipoda	Melitidae	Mallacoota	subcarinata	N	0011	0000	0000	0010	00000	0000	000	0000	0000	00000	0000	0000	000	0000	000	0000	000	0000	0	0000	0000	0000	0000	00000
Arthropoda	Malacostraca	Amphipoda	Podoceridae	Podocerus	cristatus	N	1000	0000	0000	0111	00000	0000	000	0000	0000	00000	0000	0100	000	0000	000	0000	000	0000	0	0000	0000	0000	0000	00000
Arthropoda	Malacostraca	Amphipoda	Podoceridae	Podocerus	karu	N	0000	0000	0010	0010	00000	0000	000	0000	0000	00000	0000	0000	000	0000	000	0000	000	0000	0	0000	0000	0000	0000	00000
Arthropoda	Malacostraca	Amphipoda	Podoceridae	Podocerus	manawatu	N	0000	0000	0000	0010	00000	0000	000	0000	0000	00000	0000	0000	000	0000	000	0000	000	0000	0	0000	0000	0000	0000	00000
Arthropoda	Malacostraca	Amphipoda	Podoceridae	Podocerus	wanganui	N	0000	0000	0000	0010	00000	0000	000	0000	0000	00000	0000	0000	000	0000	000	0000	000	0000	0	0000	0000	0000	0000	00000
Arthropoda	Malacostraca	Amphipoda	Stenothoidae	Stenothoe	?miersii	C1	0000	0000	0000	0010	00000	0000	000	0000	0000	00000	0000	0000	000	0000	000	0000	000	0000	0	0000	0000	0000	0000	00000
Arthropoda	Malacostraca	Amphipoda	Stenothoidae	Stenothoe	valida	C1	0000	0000	0100	0000	00000	0000	000	0000	0000	00000	0000	0000	000	0000	000	0000	000	0000	0	0000	0000	0000	0000	00000
Arthropoda	Malacostraca	Anomura	Porcellanidae	Petrolisthes	elongatus	N	0000	0000	0001	0000	00000	0000	000	0000	1000	00010	0000	0000	000	1000	000	0001	100	0000	1	0000	0000	0000	0000	00000
Arthropoda	Malacostraca	Anomura	Porcellanidae	Petrolisthes	novaezelandiae	N	0010	0000	0000	0000	00000	0000	000	0000	0000	00000	0000	0000	000	0000	000	0000	000	0000	0	0000	0010	0000	0000	00000
Arthropoda	Malacostraca	Brachyura	Cancridae	Metacarcinus	novaezelandiae	N	0000	0010	0000	0000	00000	0000	000	0000	0000	00000	0000	0000	010	0000	100	0000	000	0000	0	0000	0000	0000	0000	00000
Arthropoda	Malacostraca	Brachyura	Hymenosomatidae	Halicarcinus	varius	N	0000	0000	0000	0000	00001	0000	000	0101	0000	00000	0000	0000	001	0001	000	0000	000	0000	0	0000	0000	0000	0000	00000
Arthropoda	Malacostraca	Brachyura	Hymenosomatidae	Halicarcinus	whitei	N	0000	0010	0000	0000	00000	0100	000	0000	0000	00000	0000	0000	000	0000	000	0101	000	0001	0	0000	0000	0000	0000	00000
Arthropoda	Malacostraca	Brachyura	Majidae	Notomithrax	minor	N	0001	0000	0000	0010	00000	0000	000	0000	0000	00000	0000	0000	000	0000	000	0000	001	0000	0	0000	0000	0000	0000	00000
Arthropoda	Malacostraca	Caridea	Palemonidae	Periclimenes	yaldwyni	N	0000	0000	0000	0000	00000	0000	000	0000	0000	00000	0000	0000	010	0101	000	0011	000	0101	0	0010	0000	0000	0111	00010
Arthropoda	Malacostraca	Isopoda		Isopoda	sp.	SI	0000	0000	0000	0000	00000	0000	000	0000	0000	00000	0000	0000	000	0100	000	0000	000	0000	0	0000	0000	0000	0000	00000
Arthropoda	Malacostraca	Isopoda	Anthuridae	Mesanthura	affinis	N	0000	0000	0000	0000	00000	1000	000	0000	0100	00100	0000	0000	000	0000	000	0001	001	0000	0	0000	0000	0000	0011	00000
Arthropoda	Malacostraca	Isopoda	Pseudojaniridae	Schottea	sp.	N	0000	0000	0000	0000	00000	0000	000	0000	0100	00000	0000	0000	000	0000	000	0000	000	0000	0	0000	0000	0000	0000	00000
Arthropoda	Malacostraca	Isopoda	Sphaeromatidae	Cilicaea	caniculata	N	0000	0000	0110	0000	00000	0000	000	0100	0000	00000	0000	0000	010	0000	110	0000	000	0000	0	0001	0000	0000	0000	00000
Arthropoda	Malacostraca	Isopoda	Sphaeromatidae	Pseudosphaeroma	campbellensis	N	1000	0000	1000	1000	00000	0000	000	0000	0000	00000	0000	0000	000	0000	000	0000	000	1000	0	0000	1000	1000	1000	01000
Arthropoda	Malacostraca	Tanaidacea		Tanaidacea	sp.	SI	0000	1000	0100	0100	00000	0000	000	0000	0000	00000	0100	0000	010	0000	000	0000	000	0000	0	0000	0000	0000	0000	00000
Arthropoda	Pycnogonida					SI	0010	0000	0000	0000	00000	0000	000	0000	0000	00000	0000	0000	000	0000	000	0000	000	0000	0	0000	0000	0000	0000	00000
Arthropoda	Pycnogonida	Pantopoda	Ammotheidae	Achelia	assimilis	N	0000	0000	0000	0000	00000	0000	000	0000	0000	00000	0000	0000	000	0000	100	0000	000	0000	0	0000	0000	0000	0000	00000
Echinodermata	Asteroidea	Valvatida	Asterinidae	Meridiastra	mortenseni	N	0000	0000	0000	0000	00000	0000	000	0001	0000	00000	0000	0000	000	0000	000	0000	000	0000	0	0000	0000	0000	0000	00000
Echinodermata	Asteroidea	Valvatida	Asterinidae	Patiriella	regularis	N	0000	0000	0000	0000	00000	0000	000	0001	0000	00000	0000	0000	000	0000	000	0000	000	0000	0	0001	0000	0000	0000	00000
Echinodermata	Ophiuroidea	Ophiurida	Amphiuridae	Amphipholis	squamata	N	0001	0111	1000	0000	01100	1010	000	0100	0100	00100	0100	0000	110	1000	110	0010	000	0000	0	0000	0000	0000	0000	00010
Mollusca	Bivalvia	Myoida	Hiatellidae	Hiatella	arctica	N	0010	0001	1011	0011	00000	0000	100	0000	0000	00001	0000	0000	010	0000	010	0000	100	0000	0	0000	0000	0000	0000	00000
Mollusca	Bivalvia	Mytiloida	Mytilidae	Aulacomya	atra maoriana	N	0000	0000	0000	0000	00000	0000	100	0000	0000	00000	0000	0000	000	0000	000	0000	000	0000	0	0000	0000	0000	0000	00000
Mollusca	Bivalvia	Mytiloida	Mytilidae	Modiolarca	impacta	N	0000	0000	0000	0000	00000	0000	000	0000	0001	00000	0000	0000	000	0000	000	0000	000	0000	0	0000	0000	0000	0000	00000
Mollusca	Bivalvia	Mytiloida	Mytilidae	Mytilus	galloprovincialis	C1	0000	0000	0000	0000	00000	0000	000	0000	1000	00000	0000	0000	100	0000	000	0000	000	0000	0	0000	0100	0000	0000	00000
Mollusca	Bivalvia	Mytiloida	Mytilidae	Perna	canaliculus	N	0000	0000	0100	0000	00000	0000	000	0000	0000	00000	0000	0000	000	0000	000	0000	000	0000	0	0000	0000	0000	0000	00000
Mollusca	Bivalvia	Mytiloida	Mytilidae	Xenostrobus	pulex	N	1000	1100	1000	1111	01000	0000	100	0100	1100	01101	0100	1000	010	0000	000	0001	001	0000	0	0000	0100	1000	1010	01000
Mollusca	Bivalvia	Ostreoida	Ostreidae	Ostrea	chilensis	N	0000	0011	0000	0001	00000	0000	000	0000	0000	00000	0000	0000	000	0000	000	0000	000	0000	0	0000	0000	0000	0000	00000

*class_code: A = non-indigenous (highlighted by shading), C1 = cryptogenic category 1, C2 = cryptogenic category 2, N = native, SI = indeterminate species.

Appendix 6a. Results from the diver collections and pile scrapings.

						Site code	Cashin Quay 3																Gladstone Pier																Oil Wharf																	Wharf 3														Wharf 4												Wharf 7																
						Pile replicate								1								2									1							2									1								2							1							2							1					2								1									2
						Pile position				IN				OUT				IN				OUT					IN				OUT			IN				OUT				IN					OUT				IN				OUT			IN				OUT			IN				OUT			IN				OUT	IN				OUT				IN				OUT				IN					OUT
phylum	class	order	family	genus	species	*class_code	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	0	1	2	3	4	1	2	3	4	1	2	3	1	2	3	4	1	2	3	4	0	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	1	2	3	4	1	2	3	1	2	3	4	1	2	3	1	2	3	4	1	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	0	1	2	3	4
Mollusca	Bivalvia	Veneroida	Lasaeidae	Lasaea	hinemoa	N	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	1	0	1	0	0	1	0	0	0
Mollusca	Bivalvia	Veneroida	Veneridae	Ruditapes	largillierti	N	0	0	1	0	0	0	0	1	0	0	0	1	0	1	0	1	0	1	0	0	0	0	1	1	0	1	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mollusca	Gastropoda	Littorinimorpha	Calyptraeidae	Sigapatella	novaezelandiae	N	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mollusca	Gastropoda	Littorinimorpha	Littorinidae	Risellopsis	varia	N	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Mollusca	Gastropoda	Neogastropoda	Muricidae	Xymene	plebeius	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mollusca	Gastropoda	Nudibranchia	Dendrodorididae	Dendrodoris	citrina	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Mollusca	Gastropoda	Nudibranchia	Dorididae	Archidoris	wellingtonensis	N	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mollusca	Gastropoda	Nudibranchia	Dorididae	Doriopsis	flabellifera	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mollusca	Gastropoda	Nudibranchia	Polyceridae	Polycera	hedgpathi	C1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mollusca	Gastropoda	Nudibranchia	Zephyrinidae	Janolus	novozealandicus	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mollusca	Gastropoda	Patellogastropoda	Lottiidae	Notoacmea	parviconoidea	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Mollusca	Polyplacophora	Acanthochitonina	Acanthochitonidae	Cryptoconchus	porosus	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phycophyta						SI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhodophyta	Florideophyceae	Acrochaetiales	Acrochaetiaceae	Audouinella	sp.	SI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Rhodophyta	Florideophyceae	Ceramiales	Ceramiaceae	Antithamnionella	adnata	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhodophyta	Florideophyceae	Ceramiales	Ceramiaceae	Callithamnion	sp.	SI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhodophyta	Florideophyceae	Ceramiales	Ceramiaceae	Ceramium	apiculatum	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhodophyta	Florideophyceae	Ceramiales	Ceramiaceae	Ceramium	sp.	SI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhodophyta	Florideophyceae	Ceramiales	Ceramiaceae	Griffithsia	crassiuscula	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhodophyta	Florideophyceae	Ceramiales	Ceramiaceae	Griffithsia	sp.	SI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhodophyta	Florideophyceae	Ceramiales	Ceramiaceae	Medeiothamnion	lyallii	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhodophyta	Florideophyceae	Ceramiales	Delesseriaceae			SI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Rhodophyta	Florideophyceae	Ceramiales	Delesseriaceae	Erythroglossum	sp.	SI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Rhodophyta	Florideophyceae	Ceramiales	Delesseriaceae	Erythroglossum	undulatissimum	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhodophyta	Florideophyceae	Ceramiales	Delesseriaceae	Hymenena	sp.	SI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhodophyta	Florideophyceae	Ceramiales	Delesseriaceae	Myriogramme	denticulata	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhodophyta	Florideophyceae	Ceramiales	Delesseriaceae	Phycodrys	quercifolia	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhodophyta	Florideophyceae	Ceramiales	Delesseriaceae	Schizoseris	dichotoma	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhodophyta	Florideophyceae	Ceramiales	Rhodomelaceae	Polysiphonia	brodiei	A	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhodophyta	Florideophyceae	Ceramiales	Rhodomelaceae	Polysiphonia	senticulosa	A	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Rhodophyta	Florideophyceae	Ceramiales	Rhodomelaceae	Polysiphonia	sp.	SI	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Rhodophyta	Florideophyceae	Rhodymeniales	Lomentariaceae	Lomentaria	sp.	SI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhodophyta	Florideophyceae	Rhodymeniales	Rhodomeniaceae	Rhodymenia	novazelandica	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhodophyta	Florideophyceae	Rhodymeniales	Rhodomeniaceae	Rhodymenia	sp.	SI	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhodophyta	Florideophyceae	Stylonematales	Stylonemataceae	Stylonema	sp.	SI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Ochrophyta	Phaeophyceae	Ectocarpales	Acinetosporaceae	Pylaiella	sp.	SI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Ochrophyta	Phaeophyceae	Ectocarpales	Ectocarpaceae	Ectocarpus	siliculosus	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ochrophyta	Phaeophyceae	Ectocarpales	Ectocarpaceae	Hincksia	mitchelliae	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ochrophyta	Phaeophyceae	Laminariales	Alariaceae	Undaria	pinnatifida	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0
Ochrophyta	Phaeophyceae	Laminariales	Lessoniaceae	Lessonia	variegata	N	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ochrophyta	Phaeophyceae	Sphacelariales	Sphacelariaceae	Sphacelaria	sp.	SI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Chlorophyta	Ulvophyceae					SI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chlorophyta	Ulvophyceae	Bryopsidales	Bryopsidaceae	Bryopsis	sp.	SI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chlorophyta	Ulvophyceae	Bryopsidales	Bryopsidaceae	Bryopsis	vestita	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Chlorophyta	Ulvophyceae	Bryopsidales	Bryopsidaceae	Derbesia	sp.	SI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chlorophyta	Ulvophyceae	Bryopsidales	Codiaceae	Codium	fragile ssp. novae-zelandiae	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Chlorophyta	Ulvophyceae	Cladophorales	Cladophoraceae	Cladophora	sp.	SI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Chlorophyta	Ulvophyceae	Ulvales	Ulvaceae	Enteromorpha	sp.	SI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chlorophyta	Ulvophyceae	Ulvales	Ulvaceae	Ulva	sp.	SI	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0
Porifera	Calcarea	Leucosolenida	Grantiidae	Grantia	ramulosa	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Porifera	Calcarea	Leucosolenida	Sycettidae	Sycon	cf. ornatum	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Porifera	Demospongiae	Dictyoceratida	Dysideidae	Euryspongia	new sp. 1	C2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Porifera	Demospongiae	Dictyoceratida	Irciniidae	Ircinia	akaroa	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Porifera	Demospongiae	Hadromerida	Suberitidae	new g.	new sp. 1	C2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Porifera	Demospongiae	Halichondrida	Halichondriidae	Halichondria	new sp. 2	C2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Porifera	Demospongiae	Halichondrida	Halichondriidae	Halichondria	panicea	C1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Porifera	Demospongiae	Halisarcida	Halisarcidae	Halisarca	dujardini	A	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Porifera	Demospongiae	Haplosclerida	Chalinidae	Adocia	new sp. 2	C2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Porifera	Demospongiae	Haplosclerida	Chalinidae	Haliclona	cf. punctata	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Porifera	Demospongiae	Haplosclerida	Chalinidae	Haliclona	glabra	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Porifera	Demospongiae	Haplosclerida	Chalinidae	Haliclona	maxima	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Porifera	Demospongiae	Haplosclerida	Chalinidae	Haliclona	new sp. 1	C2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Porifera	Demospongiae	Haplosclerida	Chalinidae	Haliclona	new sp. 11	C2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Porifera	Demospongiae	Haplosclerida	Chalinidae	Haliclona	new sp. 13	C2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Porifera	Demospongiae	Haplosclerida	Chalinidae	Haliclona	new sp. 17	C2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Porifera	Demospongiae	Haplosclerida	Chalinidae	Haliclona	new sp. 4	C2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Porifera	Demospongiae	Haplosclerida	Chalinidae	Haliclona	new sp. 6	C2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Porifera	Demospongiae	Poecilosclerida	Hymedesmiidae	Phorbas	cf. anchorata	N	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Porifera	Demospongiae	Poecilosclerida	Hymedesmiidae	Phorbas	fulva	N	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Porifera	Demospongiae	Poecilosclerida	Hymedesmiidae	Phorbas	new sp. 2	C2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

*class_code: A = non-indigenous (highlighted by shading), C1 = cryptogenic category 1, C2 = cryptogenic category 2, N = native, SI = indeterminate species.

Appendix 6a. Results from the diver collections and pile scrapings.

						Site code	Cashin Quay 3															
						Pile replicate	1								2							
						Pile position	IN				OUT				IN				OUT			
phylum	**class**	**order**	**family**	**genus**	**species**	***class_code**	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Porifera	Demospongiae	Poecilosclerida	Microcionidae	Clathria	cf. terraenovae	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Porifera	Demospongiae	Poecilosclerida	Mycalidae	Paraesperella	new sp. 1 (macrosigma)	C2	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0
Chordata	Ascidiacea					SI	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Chordata	Ascidiacea	Aplousobranchia	Cionidae	Ciona	intestinalis	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chordata	Ascidiacea	Aplousobranchia	Didemnidae			SI	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0
Chordata	Ascidiacea	Aplousobranchia	Didemnidae	Didemnum	sp.	C1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Chordata	Ascidiacea	Aplousobranchia	Didemnidae	Diplosoma	listerianum	C1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chordata	Ascidiacea	Aplousobranchia	Didemnidae	Lissoclinum	notti	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chordata	Ascidiacea	Aplousobranchia	Polyclinidae	Aplidium	adamsi	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chordata	Ascidiacea	Aplousobranchia	Polyclinidae	Aplidium	phortax	C1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Chordata	Ascidiacea	Phlebobranchia	Ascidiidae	Ascidiella	aspersa	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chordata	Ascidiacea	Phlebobranchia	Rhodosomatidae	Corella	eumyota	C1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Chordata	Ascidiacea	Stolidobranchia	Botryllinae	Botrylliodes	leachii	C1	0	1	0	0	0	0	1	0	0	0	0	0	0	1	0	0
Chordata	Ascidiacea	Stolidobranchia	Botryllinae	Botryllus	stewartensis	N	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Chordata	Ascidiacea	Stolidobranchia	Molgulidae	Molgula	mortenseni	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chordata	Ascidiacea	Stolidobranchia	Molgulidae	Molgula	sp.	SI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chordata	Ascidiacea	Stolidobranchia	Pyuridae	Pyura	cancellata	N	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Chordata	Ascidiacea	Stolidobranchia	Pyuridae	Pyura	carnea	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chordata	Ascidiacea	Stolidobranchia	Pyuridae	Pyura	pachydermatina	N	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Chordata	Ascidiacea	Stolidobranchia	Pyuridae	Pyura	pulla	N	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Chordata	Ascidiacea	Stolidobranchia	Styelidae	Asterocarpa	cerea	C1	0	0	1	0	0	0	0	1	0	0	0	0	0	1	1	1
Chordata	Ascidiacea	Stolidobranchia	Styelidae	Cnemidocarpa	bicornuta	N	0	1	1	1	0	0	1	0	0	0	1	1	0	0	1	1
Chordata	Ascidiacea	Stolidobranchia	Styelidae	Cnemidocarpa	nisiotus	N	0	0	1	0	0	0	0	0	0	0	1	1	0	0	1	0
Chordata	Ascidiacea	Stolidobranchia	Styelidae	Cnemidocarpa	otagoensis	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Chordata	Ascidiacea	Stolidobranchia	Styelidae	Styela	clava	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

			Gladstone Pier															
			1									2						
			IN					OUT				IN			OUT			
family	**genus**	**species**	0	1	2	3	4	1	2	3	4	1	2	3	1	2	3	4
Microcionidae	Clathria	cf. terraenovae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mycalidae	Paraesperella	new sp. 1 (macrosigma)	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
			0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0
Cionidae	Ciona	intestinalis	0	0	1	1	0	0	1	1	1	0	1	1	0	0	1	0
Didemnidae			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Didemnidae	Didemnum	sp.	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0
Didemnidae	Diplosoma	listerianum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Didemnidae	Lissoclinum	notti	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polyclinidae	Aplidium	adamsi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polyclinidae	Aplidium	phortax	0	0	0	0	1	1	0	1	1	0	0	0	0	0	0	0
Ascidiidae	Ascidiella	aspersa	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0
Rhodosomatidae	Corella	eumyota	0	0	1	1	1	1	1	1	0	0	1	0	0	1	1	1
Botryllinae	Botrylliodes	leachii	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0
Botryllinae	Botryllus	stewartensis	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
Molgulidae	Molgula	mortenseni	0	0	1	0	1	1	1	0	0	0	1	0	0	0	0	0
Molgulidae	Molgula	sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pyuridae	Pyura	cancellata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pyuridae	Pyura	carnea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pyuridae	Pyura	pachydermatina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pyuridae	Pyura	pulla	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Styelidae	Asterocarpa	cerea	0	0	1	1	1	1	1	1	1	0	1	1	0	1	1	1
Styelidae	Cnemidocarpa	bicornuta	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Styelidae	Cnemidocarpa	nisiotus	0	0	0	1	0	0	1	0	0	0	1	1	0	0	0	0
Styelidae	Cnemidocarpa	otagoensis	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Styelidae	Styela	clava	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0

			Oil Wharf																
			1									2							
			IN				OUT					IN				OUT			
family	**genus**	**species**	1	2	3	4	0	1	2	3	4	1	2	3	4	1	2	3	4
Microcionidae	Clathria	cf. terraenovae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Mycalidae	Paraesperella	new sp. 1 (macrosigma)	0	1	1	0	0	0	0	0	1	0	0	0	0	0	1	1	1
			0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0
Cionidae	Ciona	intestinalis	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1
Didemnidae			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Didemnidae	Didemnum	sp.	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Didemnidae	Diplosoma	listerianum	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Didemnidae	Lissoclinum	notti	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polyclinidae	Aplidium	adamsi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polyclinidae	Aplidium	phortax	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ascidiidae	Ascidiella	aspersa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhodosomatidae	Corella	eumyota	0	0	0	1	0	0	1	1	0	0	1	1	1	0	0	0	0
Botryllinae	Botrylliodes	leachii	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0
Botryllinae	Botryllus	stewartensis	0	0	1	1	0	0	0	0	1	0	0	1	0	0	0	0	0
Molgulidae	Molgula	mortenseni	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Molgulidae	Molgula	sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pyuridae	Pyura	cancellata	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Pyuridae	Pyura	carnea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pyuridae	Pyura	pachydermatina	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0
Pyuridae	Pyura	pulla	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Styelidae	Asterocarpa	cerea	0	1	1	1	0	0	1	1	1	0	1	1	1	0	1	0	1
Styelidae	Cnemidocarpa	bicornuta	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Styelidae	Cnemidocarpa	nisiotus	0	1	0	1	0	0	0	1	1	0	1	1	0	0	0	0	0
Styelidae	Cnemidocarpa	otagoensis	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Styelidae	Styela	clava	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

			Wharf 3													
			1							2						
			IN			OUT				IN			OUT			
family	**genus**	**species**	1	2	3	1	2	3	4	1	2	3	1	2	3	4
Microcionidae	Clathria	cf. terraenovae	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mycalidae	Paraesperella	new sp. 1 (macrosigma)	0	1	1	0	1	0	0	0	1	1	0	0	1	0
			0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cionidae	Ciona	intestinalis	0	0	1	0	1	1	1	0	1	1	0	1	1	1
Didemnidae			0	0	0	0	0	0	0	0	0	0	0	0	0	0
Didemnidae	Didemnum	sp.	0	1	0	0	0	0	0	0	1	0	0	0	0	0
Didemnidae	Diplosoma	listerianum	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Didemnidae	Lissoclinum	notti	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polyclinidae	Aplidium	adamsi	1	0	0	0	0	0	0	0	0	0	0	1	0	0
Polyclinidae	Aplidium	phortax	0	0	0	0	1	0	1	1	0	0	0	0	0	0
Ascidiidae	Ascidiella	aspersa	0	0	0	0	0	0	0	0	0	1	0	1	0	0
Rhodosomatidae	Corella	eumyota	0	1	1	1	1	0	1	1	0	0	0	1	0	0
Botryllinae	Botrylliodes	leachii	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Botryllinae	Botryllus	stewartensis	0	0	1	0	0	1	1	0	0	0	0	0	0	1
Molgulidae	Molgula	mortenseni	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Molgulidae	Molgula	sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pyuridae	Pyura	cancellata	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Pyuridae	Pyura	carnea	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pyuridae	Pyura	pachydermatina	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Pyuridae	Pyura	pulla	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Styelidae	Asterocarpa	cerea	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Styelidae	Cnemidocarpa	bicornuta	0	0	0	0	1	0	0	1	0	0	0	0	0	0
Styelidae	Cnemidocarpa	nisiotus	0	1	1	0	0	0	0	0	1	0	0	0	0	0
Styelidae	Cnemidocarpa	otagoensis	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Styelidae	Styela	clava	0	0	0	0	0	0	0	0	0	0	0	0	0	0

			Wharf 4												
			1							2					
			IN			OUT				IN		OUT			
family	**genus**	**species**	1	2	3	1	2	3	4	1	3	1	2	3	4
Microcionidae	Clathria	cf. terraenovae	0	0	0	0	0	0	0	0		0	0	0	0
Mycalidae	Paraesperella	new sp. 1 (macrosigma)	0	1	0	0	1	1	0	0		0	0	0	0
			0	0	0	0	0	0	0	0		0	0	0	0
Cionidae	Ciona	intestinalis	0	0	0	0	0	1	1	0		1	0	1	1
Didemnidae			0	0	0	0	0	0	0	0		0	0	0	0
Didemnidae	Didemnum	sp.	0	0	0	0	0	0	0	0		0	0	0	1
Didemnidae	Diplosoma	listerianum	0	0	0	0	0	0	0	0		0	0	0	0
Didemnidae	Lissoclinum	notti	0	0	0	0	0	0	1	0		0	0	0	0
Polyclinidae	Aplidium	adamsi	1	1	0	0	0	0	1	0		0	0	1	0
Polyclinidae	Aplidium	phortax	0	0	0	0	1	1	0	0		1	1	0	0
Ascidiidae	Ascidiella	aspersa	0	0	0	0	0	0	0	0		0	0	0	0
Rhodosomatidae	Corella	eumyota	1	1	0	0	0	1	1	1		0	0	1	0
Botryllinae	Botrylliodes	leachii	0	0	0	0	0	0	0	1		0	0	0	0
Botryllinae	Botryllus	stewartensis	0	0	0	0	0	0	0	0		0	0	0	0
Molgulidae	Molgula	mortenseni	0	0	0	0	0	0	0	0		0	0	0	0
Molgulidae	Molgula	sp.	0	0	0	0	0	0	0	0		0	0	0	0
Pyuridae	Pyura	cancellata	0	0	0	0	0	0	0	0		0	0	0	0
Pyuridae	Pyura	carnea	0	0	0	0	0	0	0	1		0	0	0	0
Pyuridae	Pyura	pachydermatina	0	0	0	0	0	0	0	1		1	0	0	0
Pyuridae	Pyura	pulla	0	0	0	0	0	0	0	0		0	0	0	0
Styelidae	Asterocarpa	cerea	1	1	0	0	1	1	1	1		1	1	1	1
Styelidae	Cnemidocarpa	bicornuta	0	1	0	0	0	0	0	0		0	0	1	0
Styelidae	Cnemidocarpa	nisiotus	0	0	0	0	0	0	1	1		1	0	0	1
Styelidae	Cnemidocarpa	otagoensis	0	0	0	0	0	0	0	0		0	0	0	1
Styelidae	Styela	clava	0	0	0	0	0	0	0	0		0	0	0	0

			Wharf 7																
			1								2								
			IN				OUT				IN				OUT				
family	**genus**	**species**	1	2	3	4	1	2	3	4	1	2	3	4	0	1	2	3	4
Microcionidae	Clathria	cf. terraenovae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mycalidae	Paraesperella	new sp. 1 (macrosigma)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
			0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Cionidae	Ciona	intestinalis	0	0	1	1	0	1	1	1	0	0	1	1	0	0	1	1	1
Didemnidae			0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Didemnidae	Didemnum	sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Didemnidae	Diplosoma	listerianum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Didemnidae	Lissoclinum	notti	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polyclinidae	Aplidium	adamsi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polyclinidae	Aplidium	phortax	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ascidiidae	Ascidiella	aspersa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhodosomatidae	Corella	eumyota	0	0	1	1	0	0	1	1	0	1	1	1	0	0	1	1	1
Botryllinae	Botrylliodes	leachii	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Botryllinae	Botryllus	stewartensis	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0
Molgulidae	Molgula	mortenseni	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Molgulidae	Molgula	sp.	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Pyuridae	Pyura	cancellata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pyuridae	Pyura	carnea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pyuridae	Pyura	pachydermatina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pyuridae	Pyura	pulla	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Styelidae	Asterocarpa	cerea	0	1	1	1	0	1	1	1	0	0	1	1	0	0	1	1	1
Styelidae	Cnemidocarpa	bicornuta	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0
Styelidae	Cnemidocarpa	nisiotus	0	0	0	1	0	1	1	0	0	1	1	0	0	0	1	0	0
Styelidae	Cnemidocarpa	otagoensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Styelidae	Styela	clava	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

*class_code: A = non-indigenous (highlighted by shading), C1 = cryptogenic category 1, C2 = cryptogenic category 2, N = native, SI = indeterminate species.

Appendix 6b. Results from the benthic grab samples.

Appendix 6b. Results from the benthic grab samples.

						Site Code	Cashin Quay 4			Gladstone Pier			Oil Wharf			Slipway			Wharf 2			Wharf 4			Wharf 6			Wharf 7			Z Berth	
phylum	**class**	**order**	**family**	**genus**	**species**	***class_code**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**
Annelida	Polychaeta	Eunicida	Lumbrineridae	Lumbrineris	Lumbrineris-B-of-Orensanz	C2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Annelida	Polychaeta	Phyllodocida	Nephtyidae	Aglaophamus	verrilli	N	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Annelida	Polychaeta	Phyllodocida	Sigalionidae	Labiosthenolepis	laevis	N	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Annelida	Polychaeta	Scolecida	Orbiniidae	Phylo	novazealandiae	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Annelida	Polychaeta	Spionida	Spionidae	Scolecolepides	benhami	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Cnidaria	Hydrozoa	Hydroida	Sertulariidae	Symplectoscyphus	subdichotomus	A	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arthropoda	Malacostraca	Brachyura	Ocypodidae	Macrophthalmus	hirtipes	N	0	0	1	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0
Arthropoda	Malacostraca	Ogyrididae	Ogyrididae	Ogyrides	delli	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Echinodermata	Asteroidea	Valvatida	Asterinidae	Meridiastra	mortenseni	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Mollusca	Bivalvia	Veneroida	Semelidae	Theora	lubrica	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0

*class_code: A = non-indigenous (highlighted by shading), C1 = cryptogenic category 1, C2 = cryptogenic category 2, N = native, SI = indeterminate species.

Appendix 6c. Results from the benthic sled samples.

Appendix 6c. Results from the benthic sled samples.

						Site code	Cashin Quay 3		Cattle Jetty		Gladstone Pier		Oil Wharf		Recreational Fishing Jetty		Wharf 2		Wharf 4		Wharf 5		Wharf 6		Wharf 7	
phylum	**class**	**order**	**family**	**genus**	**species**	***class_code**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
Annelida	Polychaeta	Phyllodocida	Nephtyidae	Aglaophamus	verrilli	N	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0
Annelida	Polychaeta	Phyllodocida	Phyllodocidae	Pirakia	Pirakia-A	C2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Annelida	Polychaeta	Phyllodocida	Polynoidae	Harmothoe	macrolepidota	N	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0
Annelida	Polychaeta	Phyllodocida	Polynoidae	Ophiodromus	angustifrons	N	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Annelida	Polychaeta	Phyllodocida	Sigalionidae	Labiosthenolepis	laevis	N	0	0	1	0	0	1	0	0	0	0	1	1	1	0	0	0	1	0	0	0
Annelida	Polychaeta	Phyllodocida	Sigalionidae	Unknown	sp_undet	SI	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annelida	Polychaeta	Sabellida	Sabellidae	Branchiomma	curtum	C1	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	1	0	0	0
Annelida	Polychaeta	Terebellida	Trichobranchidae	Terebellides	narribri	N	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Ectoprocta	Gymnolaemata	Cheilostomata	Bugulidae	Bugula	flabellata	A	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0
Ectoprocta	Gymnolaemata	Cheilostomata	Candidae	Caberea	zelandica	N	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0
Cnidaria	Hydrozoa	Hydroida	Campanulariidae	Obelia	dichotoma	C1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arthropoda	Malacostraca	Amphipoda	Phoxocephalidae	Torridoharpinia	hurleyi	N	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Arthropoda	Malacostraca	Brachyura	Hymenosomatidae	Halicarcinus	whitei	N	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Arthropoda	Malacostraca	Brachyura	Ocypodidae	Macrophthalmus	hirtipes	N	1	0	0	0	0	1	1	0	0	0	1	1	0	1	0	0	1	0	0	0
Arthropoda	Malacostraca	Caridea	Crangonidae	Pontophilus	australis	N	0	1	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Arthropoda	Malacostraca	Mysidacea		Mysidacea	sp.	SI	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Arthropoda	Malacostraca	Ogyrididae	Ogyrididae	Ogyrides	delli	N	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Echinodermata	Asteroidea	Valvatida	Asterinidae	Patiriella	regularis	N	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Mollusca	Bivalvia	Veneroida	Semelidae	Theora	lubrica	A	0	1	1	0	0	1	1	0	1	0	0	0	1	1	1	1	0	0	0	0
Mollusca	Gastropoda	Neogastropoda	Muricidae	Xymene	plebeius	N	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	1	0	0
Mollusca	Gastropoda	Nudibranchia	Tritoniidae	Tritonia	flemingi	N	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mollusca	Gastropoda	Nudibranchia	Zephyrinidae	Janolus	novozealandicus	N	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Algae (Unidentified)						SI	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhodophyta	Florideophyceae	Ceramiales	Ceramiaceae	Anotrichium	crinitum	N	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Rhodophyta	Florideophyceae	Ceramiales	Ceramiaceae	Anotrichium?		SI	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Rhodophyta	Florideophyceae	Ceramiales	Ceramiaceae	Ceramium	apiculatum	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Rhodophyta	Florideophyceae	Ceramiales	Ceramiaceae	Ceramium	sp.	SI	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0
Rhodophyta	Florideophyceae	Ceramiales	Delesseriaceae			SI	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Rhodophyta	Florideophyceae	Ceramiales	Delesseriaceae	Myriogramme	denticulata	N	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Rhodophyta	Florideophyceae	Ceramiales	Rhodomelaceae	Adamsiella	sp.	SI	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhodophyta	Florideophyceae	Ceramiales	Rhodomelaceae	Polysiphonia	sp.	SI	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Rhodophyta	Florideophyceae	Plocamiales	Plocamiaceae	Plocamium	sp.	SI	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ulvophyta	Ulvophyceae	Cladophorales	Cladophoraceae	Cladophora	sp.	SI	0	0	0	1	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Ulvophyta	Ulvophyceae	Ulvales	Ulvaceae	Enteromorpha	sp.	SI	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Porifera	Demospongiae	Poecilosclerida	Mycalidae	Paraesperella	new sp. 1 (macrosigma)	C2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Chordata	Ascidiacea	Aplousobranchia	Cionidae	Ciona	intestinalis	A	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	1	0
Chordata	Ascidiacea	Phlebobranchia	Rhodosomatidae	Corella	eumyota	C1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	1	0
Chordata	Ascidiacea	Stolidobranchia	Styelidae	Asterocarpa	cerea	C1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0
Chordata	Ascidiacea	Stolidobranchia	Styelidae	Cnemidocarpa	nisiotus	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0

*class_code: A = non-indigenous (highlighted by shading), C1 = cryptogenic category 1, C2 = cryptogenic category 2, N = native, SI = indeterminate species.

Appendix 6d. Results from the dinoflagellate cyst core samples.

Appendix 6d. Results from the dinoflagellate cyst samples.

						Site code	Cashin Quay 2		Lower Level Breastwork		Oil Wharf		Wharf 1 Breastwork		Wharf 4	
phylum	**class**	**order**	**family**	**genus**	**species**	***class_code**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
Dinoflagellata	Dinophyceae	Peridinales	Peridiniaceae	Protoperidinium	conicum	N	0	0	0	0	0	0	0	0	1	0
Dinoflagellata	Dinophyceae	Peridinales	Peridiniaceae	Protoperidinium	oblongum	N	0	0	0	1	0	0	0	0	0	0
Dinoflagellata	Dinophyceae	Peridinales	Peridiniaceae	Protoperidinium	sp.	SI	0	0	0	1	1	0	1	0	1	1
Dinoflagellata	Dinophyceae	Peridinales	Peridiniaceae	Scrippsiella	trochoidea	N	0	0	0	0	1	0	1	0	1	1

*class_code: A = non-indigenous (highlighted by shading), C1 = cryptogenic category 1, C2 = cryptogenic category 2, N = native, SI = indeterminate species.

Appendix 6e. Results from the fish trap samples.

Appendix 6e. Results from the fish trap samples.

						Site code	Cashin Quay 1				Cashin Quay 4				Cattle Jetty				Gladstone Pier				Oil Wharf				Recreational Fishing Jetty				Wharf 1 Breastwork				Wharf 4				Wharf 7			
						Trap line	**1**		**2**		**1**		**2**		**1**		**2**		**1**		**2**		**1**		**2**		**1**		**2**		**1**		**2**		**1**		**2**		**1**		**2**	
phylum	**class**	**order**	**family**	**genus**	**species**	***class_code**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
Chordata	Chondrichthyes	Squaliformes	Squalidae	Squalus	acanthias	N	1	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	1	1	1	0	1	1	1
Arthropoda	Malacostraca	Brachyura	Cancridae	Metacarcinus	novaezelandiae	N	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	0	1	0	1	0	0	1	0	0	0	0	0	1	1	0	1	0	0	0	0
Arthropoda	Malacostraca	Brachyura	Portunidae	Ovalipes	catharus	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Echinodermata	Asteroidea	Valvatida	Asterinidae	Patiriella	regularis	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Vertebrata	Actinopterygii	Gadiformes	Moridae	Pseudophycis	bachus	N	1	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vertebrata	Actinopterygii	Mugiliformes	Mugilidae	Aldrichetta	forsteri	N	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0
Vertebrata	Actinopterygii	Perciformes	Labridae	Notolabrus	celidotus	N	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	1	0	1	1	1	1	1	1	0	1	1	1
Vertebrata	Actinopterygii	Perciformes	Tripterygiidae	Tripterygiidae	sp.	SI	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0
Vertebrata	Actinopterygii	Tetradontiformes	Monocanthidae	Parika	scaber	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0

*class_code: A = non-indigenous (highlighted by shading), C1 = cryptogenic category 1, C2 = cryptogenic category 2, N = native, SI = indeterminate species.

Appendix 6f. Results from the crab trap samples.

Appendix 6f. Results from the crab trap samples.

						Site code	Cashin Quay 1				Cashin Quay 4				Cattle Jetty				Gladstone Pier				Lower Level Breastwork			
						Trap line	1		2		1		2		1		2		1		2		1		2	
phylum	class	order	family	genus	species	*class_code	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Chordata	Chondrichthyes	Squaliformes	Squalidae	Squalus	acanthias	N	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Arthropoda	Malacostraca	Amphipoda	Caprellidae	Caprellidae	gen. et sp. indet.	C2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arthropoda	Malacostraca	Brachyura	Cancridae	Metacarcinus	novaezelandiae	N	1	1	1	1	1	1	1	0	1	0	0	1	1	1	1	1	0	0	0	1
Arthropoda	Malacostraca	Brachyura	Portunidae	Ovalipes	catharus	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arthropoda	Malacostraca	Palinura	Palinuridae	Jasus	edwardsi	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Echinodermata	Asteroidea	Valvatida	Asterinidae	Meridiastra	mortenseni	N	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Echinodermata	Asteroidea	Valvatida	Asterinidae	Patiriella	regularis	N	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	1
Chordata	Ascidiacea	Aplousobranchia	Cionidae	Ciona	intestinalis	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chordata	Ascidiacea	Phlebobranchia	Rhodosomatidae	Corella	eumyota	C1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chordata	Ascidiacea	Stolidobranchia	Styelidae	Asterocarpa	cerea	C1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chordata	Ascidiacea	Stolidobranchia	Styelidae	Cnemidocarpa	bicornuta	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vertebrata	Actinopterygii	Gadiformes	Moridae	Pseudophycis	bachus	N	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vertebrata	Actinopterygii	Perciformes	Labridae	Notolabrus	celidotus	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vertebrata	Actinopterygii	Perciformes	Tripterygiidae	Tripterygiidae	sp.	SI	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1

		Oil Wharf				Recreational Fishing Jetty				Wharf 2				Wharf 4				Wharf 7		
		1		2		1		2		1		2		1		2		1		2
genus	species	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1
Squalus	acanthias	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Caprellidae	gen. et sp. indet.	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Metacarcinus	novaezelandiae	1	1	1	0	0	1	0	0	1	1	1	1	1	1	1	1	0	1	1
Ovalipes	catharus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Jasus	edwardsi	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Meridiastra	mortenseni	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Patiriella	regularis	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0
Ciona	intestinalis	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Corella	eumyota	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Asterocarpa	cerea	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Cnemidocarpa	bicornuta	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Pseudophycis	bachus	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	1	0
Notolabrus	celidotus	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0
Tripterygiidae	sp.	0	1	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0

*class_code: A = non-indigenous (highlighted by shading), C1 = cryptogenic category 1, C2 = cryptogenic category 2, N = native, SI = indeterminate species.

Appendix 6f. Results from the crab trap samples.

						Site code	
						Trap line	
phylum	**class**	**order**	**family**	**genus**	**species**	***class_code**	**2**
Chordata	Chondrichthyes	Squaliformes	Squalidae	Squalus	acanthias	N	0
Arthropoda	Malacostraca	Amphipoda	Caprellidae	Caprellidae	gen. et sp. indet.	C2	0
Arthropoda	Malacostraca	Brachyura	Cancridae	Metacarcinus	novaezelandiae	N	0
Arthropoda	Malacostraca	Brachyura	Portunidae	Ovalipes	catharus	N	0
Arthropoda	Malacostraca	Palinura	Palinuridae	Jasus	edwardsi	N	0
Echinodermata	Asteroidea	Valvatida	Asterinidae	Meridiastra	mortenseni	N	0
Echinodermata	Asteroidea	Valvatida	Asterinidae	Patiriella	regularis	N	0
Chordata	Ascidiacea	Aplousobranchia	Cionidae	Ciona	intestinalis	A	0
Chordata	Ascidiacea	Phlebobranchia	Rhodosomatidae	Corella	eumyota	C1	0
Chordata	Ascidiacea	Stolidobranchia	Styelidae	Asterocarpa	cerea	C1	0
Chordata	Ascidiacea	Stolidobranchia	Styelidae	Cnemidocarpa	bicornuta	N	0
Vertebrata	Actinopterygii	Gadiformes	Moridae	Pseudophycis	bachus	N	0
Vertebrata	Actinopterygii	Perciformes	Labridae	Notolabrus	celidotus	N	0
Vertebrata	Actinopterygii	Perciformes	Tripterygiidae	Tripterygiidae	sp.	SI	0

*class_code: A = non-indigenous (highlighted by shading), C1 = cryptogenic category 1, C2 = cryptogenic category 2, N = native, SI = indeterminate species.

Appendix 6g. Results from the starfish trap samples.

Appendix 6g. Results from the starfish trap samples.

						Site code	Cashin Quay 1				Cashin Quay 4				Cattle Jetty				Gladstone Pier				Lower Level Breastwork				Oil Wharf				Recreational Fishing Jetty				Wharf 2				Wharf 4				Wharf 7			
						Trap line	1		2		1		2		1		2		1		2		1		2		1		2		1		2		1		2		1		2		1		2	
phylum	**class**	**order**	**family**	**genus**	**species**	***class_code**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
Arthropoda	Malacostraca	Brachyura	Cancridae	Metacarcinus	novaezelandiae	N	0	1	1	1	0	1	1	0	1	1	0	1	1	1	0	1	1	1	0	1	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	0	0	1	0	1
Echinodermata	Asteroidea	Valvatida	Asterinidae	Patiriella	regularis	N	0	1	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0

*class_code: A = non-indigenous (highlighted by shading), C1 = cryptogenic category 1, C2 = cryptogenic category 2, N = native, SI = indeterminate species.

Appendix 6h. Results from the shrimp trap samples.

Appendix 6h. Results from the shrimp trap samples.

						Site code	Cashin Quay 1				Cashin Quay 4				Cattle Jetty				Gladstone Pier				Lower Level Breastwork				Oil Wharf				Recreational Fishing Jetty				Wharf 2				Wharf 4				Wharf 7			
						Trap line	**1**		**2**		**1**		**2**		**1**		**2**		**1**		**2**		**1**		**2**		**1**		**2**		**1**		**2**		**1**		**2**		**1**		**2**		**1**		**2**	
phylum	**class**	**order**	**family**	**genus**	**species**	***class_code**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
Arthropoda	Malacostraca	Amphipoda				SI	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arthropoda	Malacostraca	Brachyura	Grapsidae	Helice	crassa	N	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arthropoda	Malacostraca	Brachyura	Ocypodidae	Macrophthalmus	hirtipes	N	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arthropoda	Malacostraca	Isopoda		Isopoda	sp.	SI	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Arthropoda	Malacostraca	Isopoda	Cirolanidae	Eurylana	arcuata	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arthropoda	Malacostraca	Isopoda	Cirolanidae	Natatolana	rossi	N	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0

*class_code: A = non-indigenous (highlighted by shading), C1 = cryptogenic category 1, C2 = cryptogenic category 2, N = native, SI = indeterminate species.

Addendum

Recent revision by one of the authors (G.F.) of the status of amphipods identified in this survey has lead to a change in status of one that was classed as species indeterminata in this report. *Meridiolembos* sp. appears to be different to the other species in this genus, but as the genus is endemic to New Zealand, it can be safely regarded as a native species that is a new record for New Zealand. This taxon was recorded from the first baseline survey of the Port of Lyttelton but not in the re-survey.

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