Final Research Report

Ministry of Fisheries Research

Project ZBS 2000/03

Objectives 1 and 2

1. **Date:** **20 July 2001**
2. **Contractor:** **Kingett Mitchell & Associates Ltd.**
3. **Project Title:** **Alternative Biosecurity Management Tools for Vector Threats - Technical Guidelines for Acceptable Hull Cleaning Facilities**
4. **Project Code:** **ZBS 2000/03**
5. **Principal Investigator:** **Dan McClary**
6. **Duration of Project:** **01 March 2001 to 31 July 2001**
7. **Executive Summary:**

1. It is estimated that in New Zealand about 30,000 vessels per annum are removed from the sea and cleaned in facilities other than tidal grids or by beaching. Over half this number are present in the Auckland area.

2. Capture of particulates arising from hull cleaning is considered to be an important means of reducing the risk of establishment of exotic or cryptogenic marine species in the different regions of New Zealand

3. Capture of particulates above an average size threshold of 60 μm diameter is considered to offer an acceptable level of security from marine pest species being introduced from hull cleaning. The 60 μm diameter average size is referred to as the particle standard.

4. Captured particulates will require disposal to a facility capable of receiving potentially bio-hazardous wastes.

5. Hull cleaning facilities capable of meeting the proposed particle standard and that dispose of the captured particulates to an appropriate facility may be considered 'Approved Facilities.'

6. Of the cleaning facilities that presently operate, it is estimated that about 64 either comply or are capable of being upgraded so that they would comply with the proposed minimum containment and disposal standards. To date upgrading has been driven by the need for compliance with Resource Consents and has been focused on containment of heavy metals from anti-fouling and hull painting.

7. An estimate of the total cost to upgrade those facilities that could be upgraded but that presently do not comply with the proposed minimum containment requirements is $4.8M.

8. The survey showed that of 37 facilities or services visited and inspected, 8 would currently meet the proposed minimum containment standards.

9. Of the remainder, 10 have in place containment and settling tank equipment, and could comply by the addition of a sand filter on the liquid effluent discharge.

10. The balance of facilities visited will require major civil works and purchase of equipment if they are to comply. For some, a re-location is required.

11. The survey indicates that there are presently sufficient hull cleaning facilities that comply or that could be upgraded, and their geographical distribution is adequate to satisfy the current demand without the need for new facilities to be built.

12. Disposal of solid waste is usually by waste collection contractors who truck the material as a sludge or slurry to approved landfills. The survey indicated that for the whole of New Zealand this represents about 400 cubic metres of solid material per annum.

13. A period of three years from the date of the introduction of the changes to the Resource Management Act is considered sufficient time to allow existing facilities to upgrade their hull cleaning containment and disposal equipment and processes.

8. Objectives

8.1 Overall Objectives for ZBS 2000/03:

1. To develop technical guidelines for the collection and disposal of the solid matter from vessel hull cleaning.

8.2 Specific Objectives:

1. To develop technical guidelines to be used in designing and upgrading hull cleaning facilities used to collect and dispose of the solid matter removed from yachts, launch and fishing vessel hulls.
2. To produce a checklist of requirements to be used by authorities when they assess hull cleaning facilities and processes used for yachts, launches, cargo ships and fishing vessels.

9. Methods

9.1 Introduction

Biosecurity is a significant issue for New Zealand as an island nation that is reliant on primary industry. New Zealand's geographic isolation has afforded the country protection from a number of adverse biological influences, and its ecosystems have evolved in isolation from the rest of the world, in the absence of many predators, competitors and diseases. This isolation produced a unique flora and fauna, but one that is inherently vulnerable to introduced biota. Although terrestrial invasion biology has had a long history of study in New Zealand, studies of marine adventives have only really been of note within the last few decades. A Royal Society of New Zealand symposium held in 1995 (Ballast Water: A Marine Cocktail on the Move) was one of the first broad-scale examinations of the issue in New Zealand waters. Hayward (1997) recorded at least 66 non-native species within Auckland's Waitemata Harbour. Some of the introductions were likely to have been introduced as a result of hull scrapings, the cleaning/removal of flora and fauna from vessel hulls while in a port. This is considered a possible introduction vector for the bryozoan *Watersipora arcuata*, which was first noted in New Zealand in 1957.

The problem is not restricted to New Zealand alone. The spread of the European zebra mussel (*Dreissena polymorpha*) through inland waterways in North America is one of the better known examples. In another example of the problem, smooth shelled blue mussels, *Mytilus galloprovincialis*, were introduced to Hawai'i (Oahu Harbour) on the hull of a naval vessel from mainland North America in June 1998 (Gardner, pers. comm. to D. McClary). Spawning activity, likely induced by temperature shock of these temperate water epibionts, was noted within 2 hours of arrival. Normally, cool-water larvae released into tropical waters would die of thermal stress, but in this instance they were pumped into the ballast tanks of another nearby naval vessel, which was leaving the port at the time. The ballast water in this vessel, a submarine, cooled rapidly, and in September 1998, during routine maintenance, small mussels were collected from the ballast tanks. This pathway of introduction was confirmed through population genetic analyses (Apte et al 2000).

This example, in which a translocation event was mediated by both hull fouling and ballast water, illustrates the difficulty in managing exotic species in busy shipping ports and harbours. A coordinated strategy, which addresses both the ballast-water and hull fouling communities, is required.

An example of such a coordinated strategy was prepared by the state of Victoria in Australia (Anon. 1999). The key details of this policy pertaining to hull fouling organisms including:

- Hull fouling to be minimised through hull maintenance procedures.
- The underwater sections of vessels greater than 200 t must not be cleaned in Victoria marine waters except in accordance with a specific code of practice.
- Waste cleaned from vessels less than 200 t must be disposed to an approved landfill.
- Maintenance facilities must provide for containment and disposal of biological waste.

It is significant to note that vessels smaller than 200 t gross weight are not considered in the Victorian programme. As shown by the outbreak of black striped mussels in Darwin harbour (Bax 1999), these small vessels can play, however, a significant role as vectors for introduced marine species.

To address the general issue of vessel-based pollution, Environment Australia has prepared a Marine Wastes Reception Facilities Programme (MWRF). This covers a number of different types of marine waste, including oily wastes, sewage, garbage, noxious liquid substances, and slipway wastes (for example, antifoulants). While not specifically targeted at marine pest species, arisings from hull cleaning could potentially be treated in these facilities.

The MWRF Program includes stages which:

1. Identify facilities required at ports, marinas and boat harbours.
2. Funds demonstration projects to install "best practice" waste reception facilities.
3. Funds a second round of additional demonstration projects in priority areas not yet fully covered by the Program.
4. Promotes building or upgrading facilities during the demonstration projects stage.

The Australian government may fund up to 50 per cent of the construction costs for proposed marine waste reception facilities. Demonstration projects illustrate the benefits of environmental "best practice" and how effective waste reception can be easily achieved.

Existing programmes dealing with hull cleaning are thus generally not oriented towards biosecurity, but rather towards minimising pollution in the coastal marine area.

Worldwide, programmes dealing with marine adventive species are focussed upon dealing with those carried in ballast waters. Mention of the problems associated with hull fouling appear in documents produced through a variety of international organisations (International Maritime Organisation, Convention on Biological Diversity, International Union for the Conservation of Nature). A proposed international regulation on ballast water is aimed at addressing the environmental damage caused by the introduction of unwanted aquatic organisms in ballast water. Few (if any) specific programmes are designed to reduce the effects of translocation of nuisance species by hull fouling.

Consistent with one of the guiding principles of the Convention on Biological Diversity, the present study focuses on preventing the introduction of exotic marine species by intercepting those organisms present on vessel hulls.

9.2 Specific Methods: Objective 1

Three main approaches were used to develop a database that was used to provide the information required to achieve this objective:

- Analysis of existing guidelines (national/international).
- Broad consultation with the industry and consultation with relevant regulatory authorities.
- Inspection of a range of existing hull cleaning facilities and practices.

The analysis of existing guidelines assisted in identifying the adequacy of the present regulatory framework and best international practices. It also assisted in the later assessment of the implications to the industry of the adoption of new standards, guidelines and practices

Consultation involved conducting with a nation-wide representative sample of industry participants (e.g., Ports of Lyttelton Engineering Services Ltd.; Port Marlborough New Zealand Ltd.; Port of Tauranga Ltd.; Ports of Auckland Ltd.; NorthPort Engineering Ltd.). Telephone contacts were followed up with face-to-face interviews at 37 locations around New Zealand (see Table 9.1; Fig. 9.1). This approach has the added value of inviting participation, as well as informing the industry of impending legislation that may affect on their business. Consultation also occurred with regulatory authorities and other interested parties. This included, for example, Ministry of Fisheries (who are currently developing a set of hull cleaning regulations), Regional Councils (with responsibility for enforcement of the RMA), and other biosecurity researchers. In addition, preliminary discussion with the dive industry lead us to consultation with two diver services companies developing (potentially) biologically secure in-water cleaning systems.

A review of the available hull cleaning and material-interception technologies was conducted. This served to document and assess equipment availability, levels of particle size that can be realistically captured with existing technology both in New Zealand and internationally.

The system of high-pressure water blasting (pressures of up to 20,000psi) often used for hull cleaning presents containment problems as a result of wide dispersion of the arisings (the biological and physical materials removed from a vessel's hull during cleaning) unless adequate screening and bunding of the area is provided.

Table 9.1: Locations of site visits conducted in 2001

Site No.	Name	Type	Location	Region
1	Westhaven Marina	marina	Auckland	Auckland
2	Babcocks/RNZN Dockyard	drydock & boatyard	North Shore	Auckland
3	Westpark Marina	marina & boatyard	Waitakere	Auckland
4	Gulf Harbour Marina	marina & boatyard	Whangaparaoa	Auckland
5	Floating Dock Services	floating dock	Auckland	Auckland
6	Orams Marine	slipway & boatyard	Auckland	Auckland
7	Diver Services Ltd	underwater cleaning	Auckland	Auckland
8	Ashby Boatbuilder	boatyard	Opua	Bay of Islands
9	Sealift	floating dock	Opua	Bay of Islands
10	Russell Marine	slipway rails	Russell	Bay of Islands
11	Riverside Drive	marina & boatyard	Whangarei	Northland
12	Whangarei Crusing	boatclub	Whangarei	Northland
13	Dockland 5	boatyard	Whangarei	Northland
14	Refit NZ Ltd	ship repair slip	Tauranga	Bay of Plenty
15	Tauranga Marina Soc	marina & hardstand	Tauranga	Bay of Plenty
16	Hutcheson Boatbuild	boatbuilders	Tauranga	Bay of Plenty
17	Tauranga Bridge Mar.	marina & hardstand	Mt Manganui	Bay of Plenty
18	South Port NZ Ltd	syncrolift/hardstand	Bluff	Southland
19	Ocean Beach Slip	boat repairs	Bluff	Southland
20	Christchurch Yacht	club	Sumner	Canterbury
21	Stark Bros Ltd	ship repair slip	Lyttelton	Canterbury
22	Lyttelton Port Co.	ship repair	Lyttelton	Canterbury
23	Banks Penninsula	cruising club	Lyttelton	Canterbury
24	Miller & Tunnage	boat builder	Port Chambers	Otago
25	Otago Yacht Club Inc	boat club	Dunedin	Otago
26	Otago Harbour Rec.	boat Club	Dunedin	Otago
27	Charter Boats Ltd	boat builder	Napier	Hawke Bay
28	Napier Sailing club	boat Club	Napier	Hawke Bay
29	Ports of Napier Ltd	port company	Napier	Hawke Bay
30	Nelson City Council	port owner	Nelson	Nelson
31	Dickson Marine Ltd	boat repairs	Nelson	Nelson
32	Nelson Ship Repair	ship maintenance	Nelson	Nelson
33	NZ Diving & Salavage	underwater clean	Wellington	Wellington
34	Seaview Marina	marina & hardstand	Wellington	Wellington
35	Chaffers Marine Ltd	marina	Wellington	Wellington
36	Evans Bay Y&MB	boat club	Wellington	Wellington
37	Mana Marina Trust	marina & hardstand	Kapiti Coast	Wellington

KINGETT MITCHELL & ASSOCIATES LTD.
ENVIRONMENTAL CONSULTANTS

TITLE:

LOCATIONS OF SITE INSPECTIONS
(NUMBERS REFER TO SITES LISTED IN TABLE 9.1)

DATE: JULY 2001

PROJECT NO: 240400

CLIENT: MINISTRY OF FISHERIES

FIGURE NO: 9.1

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Initial pilot visits in the Auckland region were conducted to gauge the quality and extent of the information available. A questionnaire was then designed for use by the data gathering team on the remainder of face-to-face visits which occurred across the country (see Appendix 1 for the survey form used). Data gathered included such information as:

- Estimates of the number/instances of overseas and domestic vessels are cleaned in New Zealand waters.
- Existing containment and disposal methods.
- Effectiveness of handling the arisings from hull cleaning.
- Current levels of compliance with RMA.
- Industry expectations, willingness and capability to meet future regulations.

Following initial consultation, a number of hull cleaning facilities representative of the range of practices in New Zealand was identified and visited. Overall, a wide geographical spread of sites was required. This is particularly relevant for vessels that transit regularly between regions even within New Zealand, but may be slipped for cleaning in other locations.

The objective of the visits was to establish the current benchmark for New Zealand trade practices and to set a new minimum standard for containment of arisings, separation of liquid and solid wastes, disposal of solid wastes and render harmless liquid wastes for discharge or return to the sea. The visits also provided information on the design of existing facilities and possible design changes that could be implemented to upgrade them.

There may be a need for facilities to be able to demonstrate that they have the capability to contain even in adverse weather. This would involve screening and separation of all bunded water, testing, and sampling if the need arises, and a managed and documented method of solids disposal in an authorised landfill. As very few facilities currently have the capability of filtration and separation, an option to be considered would include pooling resources so those individual hull cleaners need only provide waste storage tanks.

The results of the review carried out in Objective 1 was used as the basis for developing a draft set of requirements and an analysis of how these requirements will address the key biosecurity issues.

An analysis of limited set of representative invasive species was conducted in order to identify the specific level of containment required. The interim target-species list developed would be further evaluated through consultation with Ministry of Fisheries and other stakeholders, including other biosecurity researchers.

Draft minimum design standards for hull cleaning facilities and processes have been prepared, including;

- Where and when such operations may be performed.
- Specific equipment required (e.g., filtration systems for diver cleaning).
- Safeguards that are required to be put in place.
- Recommendations of a minimum, practicable particle size to be contained.
- Proposed containment methods, and design upgrades that are able to meet the minimum requirement.
- Identification of acceptable solids disposal methods that are both practical and enforceable.

A set of guidelines for hull cleaning facilities was also developed as a method of formalising the design standards noted above. This included a series of sample technical schematics demonstrating the technologies that can be used to achieve a 'bio-secure' cleaning facility.

Finally, a checklist to be used by the assessors of hull cleaning facilities was prepared. The checklist was a logical outcome of the findings from the above studies, and was directly linked to the technical guidelines.

10. Results

10.1 Relevant retention sizes required to minimise risk of biological invasion

Hewitt & Martin (1996) recognised 79 different hull fouling exotic taxa that were either at risk of introduction or were already present in Australian waters. This list has been used as a starting point for the preparation of a similar list for New Zealand. In addition, the interim trigger list of introduced marine pests produced by an Australian government taskforce (The Joint Standing Committee on Conservation/ Standing Committee on Fisheries and Aquaculture National Taskforce on the Prevention and Management of Marine Pests) was examined, as were the lists of species prepared by the Australian ballast water management advisory council, and the Environment and Natural Resources Committee of the state of Victoria. At least 38 of the species on these lists are already present in New Zealand waters (Morton & Miller 1968; Powell 1982; Cranfield et al 1998; Kingett Mitchell 2001).

Given approximately similar patterns of trade and vessel movement for Australia and New Zealand, the provisional hull fouling target (PHFT) species list reported here consists of 43 species that could be considered first-order risks of introduction to New Zealand and other to other bio-regions within New Zealand by hull fouling. A taxonomic analysis, with potential origins of the PHFT species, is presented in Table 10.1.

Three invasive species already present in New Zealand, the laminarian alga *Undaria pinnatifida*, the bivalve *Musculista senhousia*, and the polychaete *Chaetopterus* sp. are included in this list, as they are not present around the entire coastline of New Zealand and may undergo range expansion through domestic ship movements. *Chaetopterus* sp. is considered to be cryptogenic, as the geographic origin of the species is as yet unconfirmed (Tricklebank et al 2001).

Determining an appropriate and relevant size threshold, below which there is minimal biodiversity risk, is problematic. Key life history characteristics to consider include adult size, the size of spores, gametes, or resting stages, and capacity for asexual reproduction. The ability to survive the mechanically disruptive processes that will occur as part of hull cleaning would also require evaluation.

Unfortunately, our knowledge of such life-history information for marine organisms is far from complete. Thus the information found in Table 10.1 is to be considered to provide an interim assessment, which will require continual upgrading, particularly as new 'risk' organisms are added to the PHFT species list.

In summary, the key 'risk' species present on the PHFT list to date includes 4 marine algae, 12 molluscs, 14 arthropods, 4 ascidians, 3 polychaetes and 6 other species (including hydrozoans, bryozoans, and echinoderms). The number and potential risk of these organisms being introduced and establishing in New Zealand via hull fouling

Table 10.1: Provisional hull fouling target species list (PHFT) of marine species that may be introduced to New Zealand waters or regions.

Phylum/ Division	Group	Species	Origin	Relevant Sizes	Comments
Chlorophyta	Chlorophyceae	*Caulerpa taxifolia* [1]	pan-tropics, NSW	3-5 cm in size in shallow, 40-60 cm in deeper waters	sexual reproduction uncommon; habit a dense mass of bright green, small, strap-like leaves called ramuli; each ramulus measures 100-200 mm long and 5 mm wide; warm water species which has become cool water tolerant (aquarium strain); capable of vegetative spread, through fragmentation, aquarium strain apparently only male; fragments smaller than 1 mm in size are unlikely to survive (Schaffelke, pers. comm.)
		Caulerpa filiformis	South Africa, NSW	Thalli to 180 mm	found at low-tide levels along the edges of rock platforms and in gutters, on medium- to high-energy shores, down to 40 metres; viable fragment size considered similar to *C. taxifolia* at 1 mm
Phaeophyta	Phaeophyceae	*Sargassum muticum* [1]	SE Asia	Frond > 1 m; 1-3 cm discoidal holdfast can regenerate fronds	haplobiontic species; spores may be transported in ballast water, on ships' hulls and by rafting or floating of entire plants or detached fragments (Critchley et al. 1990); rapid growth rate (Hales & Fletcher 1989) and high fecundity (Norton & Deysher 1989); receptacles androgynous with self-fertilisation; ideal conditions for growth are 25°C and 34 ppt salinity, although this species will grow at temperatures from 10 to 30°C and salinities from 6.8 to 34ppt; holdfast not considered strong enough to remain attached to a moving vessel (Deysher 1982); (japweed, wireweed, strangleweed).
		Undaria pinnatifida [1,2]	NZ, SE Asia	10 µm propagule; 1-3 m mature alga	annual species reaching maximum size late spring-early summer, dies back as spores released in late summer, can release up to 100 million spores that can settle in only a few days; spores and other sizes less than 120 µm in size considered unlikely to survive hull cleaning practices (Stuart pers. comm.).
Cnidaria	Hydrozoa	*Cordylophora lacustris*	Europe		to salinity of 3 psu This species is generally considered to be native to the Caspian and Black Seas, but has been found worldwide including a variety of low salinity sites from British Columbia to California (Carlton, 1979). Brackish water hydroid; = *C. caspia*
		Sarsia tubulosa	Europe	15 mm	colonial hydroid, widely spread; mature colonies erect; = *Syncoryne minabilis*
Ectoprocta	Cheilostomata	*Conopeum tenuissimum*	NE Atlantic	0.53 x 0.25 mm	Lacy Crust Bryozoan Colonies of C. tenuissimum form white crusts on seagrasses, shells, and other substrata. Zooids are oval in shape and measure 0.53 X 0.25 mm, has a distal-proximal budding pattern; lophophore averages 0.475 mm in diameter and bears an average of 12 tentacles; grows to reproductive size in less than 1 month; no ovicells present; reproduction occurs in both spring and fall (peak; Winston 1982); fertilization and early development planktonic.
		C. tubigerum	Europe		Nodding Head kamptozoan; little additional information found
Entoprocta	Barentsiidae	*Barentsia benedeni*	N Europe		entoproct; little additional information found
Mollusca	Bivalvia	*Teredo navalis*	Europe	10-15 mm length; 10 mm diameter; burrows 10-15 cm long	shipworm; planktonic free swimming larvae enter pilings and logs through minute pinholes during Oct.-Dec (Canada); wood may become completely honeycombed before the infestation is noticed.
		Musculista senhousia [1,3]	NZ, SE Asia	10-30 mm	Asian Date Mussel, often found in dense aggregations up to 3000/m2, grow rapidly reaching adult size in only 9 months, thought to live no longer than 2 years; fertilization and early development planktonic, latter period up to 55 days long.
		Mytilopsis leucophaeata	North America	1-2 cm shell length	Dreissenid fouling mussel; estuarine, found in salinities as low as 5 ppt; dioecious, broadcast spawning with planktotrophic development
	Gastropoda	*Corambe pacifica*	Japan	Up to 15 mm	may be found from Canada to Mexico; usually only found on the prostrate bryozoan *Membranipora membranacea* (which is present in New Zealand).
		Doridella steinbergae	NE Pacific		may be found in Canada to Mexico; usually only found on the prostrate bryozoan *Membranipora membranacea* .
		Godiva quadricolor	South Africa		may live for up to one year, during which time they feed on corals, sea anemones or the spawn of other opisthobranchs; internal fertilisation with benthic development; development may be entirely benthic (lecithotrophy) or planktonic (oligotrophy) dependant upon environmental condiitons.
		Haliotis sanguinea	South Africa		little additional information found
		Illyanessa obsoleta	NW Atlantic	165 µm eggs	benthic egg capsules, spring/summer
		Polycera capensis	South Africa, Australia	7 cm	introduced into Australia from South Africa.
		Rapana venosa	NW Pacific, NW Atlantic; NZ?	adult to 18 cm shell length	predatory muricid; single record noted (Powell 1979) of a suspected introduction west of Cape Maria van Deimen; = *R. thomasina*
		Sakuraeolis enosimensis	Japan		having a longitudinal, opaque white line on dorsal surface of oral tentacles; cerata tipped with white, cores yellow-orange to reddish-brown, occasionally green
		Tenellia adspersa	Japan	3.6 mm at maturity, up to 8 mm	Lagoon Sea Slug; can rapidly devour hydroid colonies, exhausting its own food supply; breeds every year over an extended period; subannual lifecycle with a generation time as short as 20 days when reared at 20°C and 30 ppt on the hydroid *Cordylophora lacustris* ; the animals may spawn 3 to 5 times a day with 25 to 50 eggs per spawn (Chester, 1996); period from spawning to hatching approximately 4-5 days; the method of development (planktonic or benthic) varies with the environmental conditions.
Annelida	Polychaeta	*Boccardia proboscidea*	N Pacific	100-150 µm eggs	broods planktonic or demersal larvae, late spring early summer, high intertidal; can assist in consolidation of fine substrates; frequently found boring into bivalve shells; transfer of infected aquaculture oysters an indirect vector; poecilogenous; = *Polydora proboscidea* .
		Chaetopterus sp.	Cryptogenic[3]	150 µm (check) eggs; 5-10 cm adults (body only; tube larger)	currently undergoing dramatic range expansion in north-eastern New Zealand; possesses extensive regenerative powers; laboratory studies have indicated that a complete segment # 13 (approximately 5 mm long) is capable of regenerating an entire organism (Eckberg & Hill 1996).
		Sabella spallanzanii [1]	Mediterranean, Europe, Australia	< 200 µm egg; 40 cm x 12 cm adult	1-30 m depth, broadcaster, wide variety of substrates
Arthropoda	Amphipoda	*Caprella acanthogaster*	Japan		caprellids attach to fouling epibiota including algae, hydrozoans and bryozoans, making them probable candidates for translocation on the hulls of ships; endemic to the northern Pacific, it has also been found in scallop aquaculture farms in Tasmania
	Cirripedia	*Megabalanus tintinnabulum*	?	1-3 cm	red and white striped acorn barnacle
		Notomegabalanus algicola	South Africa		little additional information found
	Decapoda	*Palaemon macrodactylus*	SE Asia	Females to 73 mm tl, Males 64 mm tl	peak hatching during summer months when larvae subject to the least amount of downstream transport by freshwater
		Rhithropanopeus harisii	NW Atlantic		methoprene affects early development (Costlow, J.D. 1977); little additional information found
	Isopoda	*Cirolana harfordi*	NE Pacific	20 mm	Marine Pillbug; free-living predators or carnivorous scavengers; little additional information found
		Ligia oceanica	N Atlantic	30 mm	Bilgebug, Sea Slater; grey-green with pale markings, may change colour to blend in with their surroundings; high intertidal, all around the British Isles, in sea-weed and under stones.
		Limnoria lignorum	N Pacific, N Atlantic	5-6 mm	Gribble; feeds gregariously on marine pilings, concentrated at the low tide level; grey body consisting of 14 clearly defined segments; burrows about 12 mm into wood.
		Paracerceis sculpta	NE Pacific, Australia		broods eggs and young; males in three different morphs; associations with other fouling sessile invertebrate organisms make it susceptible to translocation.
		Paradella dianae	NE Pacific		introduced to Australia; little additional information found
		Sphaeroma serratum	NE Atlantic	1 cm	offspring produced throughout the summer; these overwinter, reproduce and then die; females reproduce when they are one year old and have only one gestation during the short period of reproduction. Some of them can have a second laying the year after; number of offspring positively correlated with female size.
		S. walkeri	N Indian		introduced to Australia; little additional information found
		Synidotea laevidorsalis	E Asia	18-22 mm	May have been introduced into Australia; little additional information found
	Mysidacea	*Neomysis japonica*	Japan		significant member of the brackish-water hyperbenthic community in native range
	Tanaidacea	*Tanais dulongi*	Europe		brood offspring; possibly established in South Australia (unconfirmed).
Echinodermata	Asteroidea	*Asterias amerensis* [1]	Australia, Japan	40-50 cm	Prefers water temperatures between 7 and 10°C, but has adapted to warmer waters (up to 22°C) in Australia and other countries; in Australia spawning occurs during winter (July to October ;Byrne et al 1997) at temperatures of 10 to 12°C; fertilisation and development is external, 90 day planktonic period; newly recruited juveniles may be found on ships hulls but adults unlikely to remain on external vessel surfaces; adults have been found in seachests.
Urochordata	Ascidea	*Botrylloides violacea*	NW Pacific	*50-400 mm colonies*	Broods offspring; large colonial ascidian, forms globular colonies; smaller colonies are spherical, larger ones squat, with a small basal attachment; test transparent, with a greenish tinge when out of water; zooids large with white markings; typically a deep water form with a preference for clear offshore water, quite common in Scottish west coast waters inshore in the Oban/Mull area; usually on rock ledges or stable boulders in current-swept areas. 20-200 m depth; sexual reproduction during the summer, colonies degenerate in late summer/autumn to a hard globular resting bud; growth begins again in January; = *Diazona violacea* .
		Molgula manhattensis	N Atlantic	2 cm diameter individuals	solitary ascidian; common inhabitant of shallow water on the coast of most of Europe and Britain (Norway to Portugal) and on the Atlantic and Gulf coasts of the United States from Maine to Texas; large irregular eggs; fertilization and development external.
		Styela clava	NW Pacific	< 7 cm	introduced to Australia (Port Phillip Bay, Sydney Harbour); solitary ascidian with a roughened test generally growing a short stalk less than 7 cm long; test normally reddish brown; settlement occurs in late spring to early summer.

NOTE: [1]listed on Australian Joint SSC/SCFA interim trigger list of introduced marine pests; [2]already present in South Island, lower North Island waters; [3]already present in northern North Island waters will continue to be refined, as more life history information becomes available in the future.

10.2 Number of vessels cleaned

The survey of hull cleaning facilities included questions on the numbers and origin of vessels cleaned. Most facilities keep records and were able to give accurate numbers. Slipway and travelift operators could also make good estimates of the numbers of vessels that were from overseas, or had been overseas since last slipping. Operators were also asked about the numbers of vessels from other New Zealand regions, or that were known to have travelled to other New Zealand regions since last cleaned.

Results of the survey are reported in Table 10.2. The study revealed that 89% of vessels cleaned were local, and had not ventured outside their own region since the last cleaning. This group are primarily small private pleasure boats and yachts. Just over 7% of the boats cleaned were from other New Zealand regions, or have travelled to other regions. Examples include Wellington boats that summer in the Marlborough Sounds, and fishing boats that work out of Bluff but are maintained in Lyttelton. Less than 4% of vessels had been in foreign waters since last cleaning. These were mainly ocean-going ships.

For each region, the total number of vessels cleaned was estimated by extrapolation from the survey results. Staff from the Department of Conservation (DoC) were able in some instances to provide some check data. For example, the *Undaria* Management Team based in Invercargill monitor some 400 vessels in Otago/Southland/Stewart Island. In Northland, DoC have identified 11 harbours where slipways, haul out facilities or grids are used.

No visits were made to the west coast of New Zealand, so an estimate of 200 vessels has been included to cover this region.

Our estimate of 30,000 vessels cleaned per annum does not include trailer boats or those vessels cleaned on tidal grids, careening bays or by beaching them at high tide. This method of hull cleaning is not considered to comply with the proposed

Table 10.2: Results of site visits conducted in 2001

				Max dimensions		Origin of vessels since last cleaned				Estimated volume of arisings		Disposal methods used				
Sample No.	Details	Number of berths	Lifting method	Weight	Length	Local	NZ	Overseas	#/annum	per vessel (m3)	per annum (m3)	separation method	screen size	Liquid disposal	Solid Disposal	Consent Type
1	Westhaven Marina Marina Auckland	1800	13 yacht 10 launch tidal grids	25t	12m	770	0	0	770	0.003	2.4	settle	nil	sea	sea	under review
2	Babcocks Dockyard /RNZNDockyard North Shore City	50	Drydock Syncrolift	14,000t 200t	160m 30m	1 14	8 8	21 8	30 30	0.8 0.004	24 0.12	floc/sand filter	1 micron	wwtp	landfill	Coastal Permit
3	Westpark Marina Marina & boatyard Hobsonville	600	travelift	35t	18m	1950	0	50	2000	0.003	6	settle	20mm	sea	landfill	Resource
4	Gulf Harbour Marina Marina & boatyard Whangaparaoa	1200	travelift	100t	30m	3030	10	80	3120	0.001	3.12	grating	10mm	sea	landfill	Resource
5	Floating Dock Services. Auckland	1	floating dock	20t	15m	2183	5	2	2190	0.001	2.19	no	no	sea	sea	under review
6	Orams Marine Slipway & boatyard Auckland	25	drystack 2xtravelift 2xslipway	200boats 50t,60t 200t 600t		1885	100	15	2000	0.0025	4.8	sand/peat	no	sea	landfill	Resource
7	Diver Services Ltd Underwater clean Auckland region			all	all	0 178	0 2	10 20	10 200	0.05	0.5	filter	60 micron	sea	landfill (inc. bag)	Cert. Of Comp.
8	Ashby Boatbuilder Boatyard Opua, BOI	10	travelift slipway	35t 35t	40m 40m	390	90	120	600	0.01	3	settle	20mm	sea	landfill	Resource
9	Sealift Submersible Opua, BOI	1	floating dock	25t	15m	360	30	10	400	0.001	0.4	settle sand filter	60-150 micron	recirc to waterblast	landfill	Coastal Permit
10	Russell Marine Slipway rails Russell BOI	2	slipway	150t	24m	14	6	20	40	0.004	1.2	settle	3mm	recirc to waterblast	landfill	Resource
11	Riverside Drive Marina & boatyard Whangarei	25 (10 live on)	travelift	40t	20m	170	30	100	300	0.002	0.6	settle	no	sea	landfill	Resource
12	Whangarei Crusing Club. Boatclub Whangarei.	100	3 tidal grids	20t	15m	71	4	0	75	0.004	0.3	no	no	sea	sea	Resource
13	Dockland 5 Boatyard Whangarei	60 hardstand	travelift	60t	30m	64	22	130	216	0.04	8.2	settle weirs	no	sea	landfill	Resource
14	Refit NZ Ltd Ship repair slip Tauranga	12	slipway	600t	65m	0	45	5	50	3	15.0	sand bund	no	sea	landfill	RC under review
15	Tauranga Marina Soc Marina & hardstand Tauranga	750	travelift 3 grids	35t	20m	1792	200	8	2000	0.005	1.0	settle sand filter	<100ppm	sea	landfill	Resource
16	Hutcheson Boatbuild Boatbuilders Tauranga	20	slipway	90t	25m	25	25	0	50	0.004	0.2	sand bund	no	sea	landfill	no
17	Tauranga Bridge Mar. Marina & hardstand Mt Manganui	530	travelift	35t	20m	468	72	60	600	0.009	5.4	sep pit sand filter	no	sea	landfill	Resource
18	South Port NZ Ltd Syncrolift/hardstand Bluff	12	syncrolift	1050t	45m	144	16	0	160	0.01	1.6	no	no	sea	sea	RC under review
19	Ocean Beach Slip Boat repairs Bluff	4	slipway 1 grid	30t	18m	46	2	0	48	0.004	0.2	no	no	sea	sea	RC under review
20	Christchurch Yacht Club Sumner	?	3 slipways	20t	15m	?	?	?	?	?	?	no	no	sea	sea	?
21	Stark Bros Ltd Ship repair slip Lyttelton	1	slipway	30t	20m	30	5	0	35	0.075	2.6	no	no	sea	sea	Existing use right
22	Lyttelton Port Co. Ship repair Lyttelton	1 or 2	dry dock patent slip	6000t 130t	120m 30m	0 15	36 15	4 0	40 30	0.46 inc above	32.0 inc above	settle floc	no	sea	landfill lime stab.	Existing use right
23	Banks Penninsula Cruising club Lyttelton	40+	ramp hardstand	20t	10m	?	?	?	?	?	?	no	no	sea	sea	?
24	Miller & Tunnage Boat builder Port Chambers	4	4 slips 1 covered	100t	30m	23	23	4	50	0.005	0.3	no	no	sea	sea	no
25	Otago Yacht Club Inc Boat club Dunedin	135	slipway hardstand	12t	12m	56	2	2	60	0.001	0.1	no	no	sea	sea	no
26	Otago Harbour Rec. Boat Club Dunedin		ramp	20t	10m	?	?	?	?	?	?	no	no	sea	sea	no
27	Charter Boats Ltd Boat builder Napier	3	3 slips 1 covered	100t 10t	30m 12m	26	14	0	40	0.005	0.2	sump	no	wwtp pumped	wwtp	Resource
28	Napier Sailing club Boat Club Napier	450	3 slips ramps	20t	12m	?	?	?	?	?	?	no	no	sea	sea	Resource
29	Ports of Napier Ltd Port Company Napier	3	divers	tugs		?	?	?	?	?	?	no	no	sea	sea	no
30	Nelson City Council Port owner Nelson	453 55 o/s !55non local	1 grid	10t	9m	?	?	?	?	?	?	no	no	sea	sea	no
31	Dickson Marine Ltd Boat repairs Nelson	20	travelift	50t	25m	226	12	12	250	0.003	0.8	settle O&G	no	sea	landfill	Resource
32	Nelson Ship Repair Ship maintenance Nelson	10	slipway slipway	1800t 100t	65m 30m	21 143	3 66	6 11	30 220	0.2 0.02	6.0 4.4	no	no	sea	sea	Rc under review
33	NZ Diving & Salavage Underwater clean Wellington			all	all	0	15	5	20	0.15	3.0	filter	120micron	sea	landfill	Coastal permit
34	Seaview Marina Marina & hardstand Wellington	365	travelift	35t	18m	636	112	2	750	0.005	3.8	settle O&G	no	wwtp pumped	landfill	Resource
36	Chaffers Marine Ltd Marina Wellington	185	fixed hoist	40t	18m	1800	200	0	2000	0.004	8.0	settle	no	wwtp pumped	landfill	Resource
37	Evans Bay Y&MB Boat club Wellington	80	slipway	18t	14m	74	74	2	150	0.005	0.8	no	no	sea	sea	no
35	Mana Marina Trust Marina & hardstand Kapiti Coast	340	travelift	30t	20m	40	160	0	200	0.005	1.0	settle	no	sea	landfill	Resource
Totals		**6911**		**14,000 t max**	**160 m max**	**16645**	**1412**	**707**	**18764**	**0.15 m^3 average**	**4.33 m^3 average**					

regulations. It is recommended that this method of hull cleaning be banned except where

a) it is under the control of a responsible boat club or marina operator, the vessel owners are local members of the club or marina, and

b) the vessel has not been out of the region since its last clean, and

c) the vessel is not fouled by hard or calcareous growths or conspicuous macroalgae

This concession is recommended in recognition of the large majority of pleasure boat owners who would otherwise be penalised if they were required to use an approved facility. The majority of these local boat owners are not considered to pose a significant bio-security risk. For example, many competitive sailors clean the hulls of their vessels as frequently as fortnightly during the summer months. The costs (generally length dependent) to lift a small vessel out of the water for hull cleaning at travelifts or floating docks are typically between $60 and $150 per boat. This is considered to impose an un-necessary burden on the majority of trailer-boat owners.

11. Discussion

11.1 Relevant Particle Sizes

11.1.1 Propagules

The smallest structures that are generally capable of producing an entire organism are generally the gametes or spores. For most marine invertebrates, these can range from approximately 25 μm to in excess of 2000 μm diameter. The vast majority of described species, however, possess gametes that fall in the range of 70 μm to 200 μm diameter. Gamete/spore sizes for the identified 'risk' species range from 10 μm (for spores of *Undaria pinnatifida*) to upwards of 700 μm for some solitary ascidians (e.g., *Styela clava, Molgula manhattensis*).

Many of these early life history phases, however, will not survive if physically removed from the adult. Marine invertebrate eggs, for example, are often held in meiotic arrest while in the adult gonad. Simple removal from the gonad is occasionally, but not normally, sufficient to break meiotic arrest, activating the egg for fertilisation. Gamete stripping has been used successfully in a variety of aquacultural applications. These organisms, however, are usually artificially conditioned to be at an advanced state of maturity prior to utilisation. Inactive eggs will not (apart from a few parthenogenetic species) undergo further development to form an adult of the species. Several species (notably ascidians) also require additional egg coatings (follicle cells or similar) for successful fertilisation to occur, thus the effective size for this purposes of this exercise may be much larger than the theoretical minimum egg size.

Given the generally physically sensitive nature of gametes and spores, it is considered unlikely that most would survive the mechanical disruption of hull cleaning (by scraping or high pressure water blasting). More advanced stages, however, may be sufficiently hardy to withstand such treatment. Recent discussions with a leading expert on the life history of *Undaria pinnatifida* (Dr. M. Stuart, pers. comm.) support this contention. Dr. Stuart considers that *Undaria* spores (10 μm in size) would be unlikely to survive typical hull cleaning practices, although later stages (in excess of 100 μm in size) might survive such mechanical abrasion.

The mechanism of reproduction for each of the 'risk' species must also be considered. The risk of establishment after any introduction is reduced for species that have separate sexes (dioecious) or, if both sexes are present within the same individual (monoecious), are self-incompatible, when compared to self-fertile hermaphrodites.

11.1.2 Vegetative or Regenerative Capacity

Several of the PHFT species that are noted in Table 10.1 have the ability to spread through vegetative or other non-sexual means. Many marine algae are capable of vegetative reproduction, and are capable of re-growing an entire plant from a small fragment. This includes the invasive seaweeds of the genus *Caulerpa.*

While there are already several species of *Caulerpa* in New Zealand (Adams 1995), *C. taxifolia*, and C. *filiformis* are considered major threat species. Although native to warm waters off Queensland Australia, a cool-water tolerant strain escaped from a commercial aquarium in the Mediterranean in the early 1980s (Creese et al 2001). This aquarium strain of *C. taxifolia* has since spread, and although a cool water tolerant strain of *C. taxifolia* was found in New South Wales in 2000, its precise origin is unclear (Schaffelke et al 2001). Based upon her experience and unpublished data accumulated while working with this species, Schaffelke (pers. comm.), a phycologist with the Centre for Research on Introduced Marine Pests, has indicated that fragments of *C. taxifolia* smaller than 1 mm would be unlikely to be able to regenerate an entire plant.

Such capacity for regenerative or vegetative spread is not restricted to the marine algae. Some hydrozoans, for instance, are well known to be able to form offspring by vegetative budding from a stalk, sometimes as small as 500 μm in size (Strathmann 1987). A large number of marine invertebrates possess quite extensive regenerative capabilities. Members of several phyla, including the Echinodermata (e.g., sea stars; Hyman 1955), Annelida (e.g., polychaete worms; Strathmann 1987), and Cnidaria (e.g., hydroids, sea anemones; Hyman 1955) have this ability. The minimum size that is required to regenerate an entire individual is generally species-specific.

Colonial bryozoans can potentially regenerate an entire colony from a single zooid. The zooid for the lacy crust bryozoan, *Conopeum tenuissimum*, for instance, is 530 x 250 μm in size. Thus escape of a particle as small as this from a hull cleaning facility could potentially result in successful colonisation by *C. tenuissimum* if it was able to survive abrasive cleaning processes.

As another example, the parchment worm *Chaetopterus* has already spread widely throughout northeastern New Zealand (Tricklebank et al 2001), and it's presence has been associated with reduced benthic diversity in at least one location (Kingett Mitchell 2001; McClary et al 2001;). This cryptogenic species has an extensive regenerative capacity, being able to regenerate a complete individual from a single fragment. Eckberg & Hill (1996) found that an entire adult worm could be grown in the laboratory from a single, complete piece of segment 13 (which is approximately 3 to 5 mm long in an adult *Chaetopterus*).

11.1.3 Other Life History Characteristics

Several of the PHFT species listed in Table 10.2 are usually only found in association with other (un-named) species. Such associations are quite common within the living world. The nudibranchs *Corambe pacifica* and *Doridella steinbergae* are normally only found upon the cheilostome bryozoan *Membranipora membranacea* (McFarland 1966). Thus if the host species is not already present or is unable to colonise the invaded area, these species are unlikely to pose a significant biosecurity risk. As *M.*

membranacea is already present in New Zealand, these species may find an appropriate host upon which to survive.

11.1.4 Summary – particle sizes

The above evaluation presumes that no other treatment of the arisings from hull cleaning is to occur. Should arisings be further treated through chemical neutralisation or other means, the effective minimum size of filtration required may be increased. The black striped mussel, *Mytilopsis sallei*, for example, was eliminated from Darwin harbour in 1999 by treatment of the area and all boats therein with solutions of sodium hypochlorite and copper sulfate (Bax 1999). Use of biocides in this manner may be considered appropriate should the risk of successful colonisation by an invasive species be considered extremely high. This type of treatment is not without side effects, however. Nearly all of the biota in the marinas at Darwin harbour was destroyed, although recolonisation is in progress (Bax, pers. comm.)

This assessment is based upon a combination of cellular disruption through mechanical abrasion of a vessel hull to remove epibionts, along with a degree of particle retention to remove hardy or otherwise durable life history stages. We have not considered the use of treatment chemicals, as environmental damage could result should residual biocides (e.g., sodium hypochlorite, copper sulfate) be released.

The smallest particle size identified as part of this assessment (based upon the provisional hull fouling target species list; see Table 10.1) is approximately 100 μm in average diameter. This is the size of relatively robust early life history stages of the macroalga *Undaria pinnatifida.* In addition, the majority of marine invertebrates possess gametes of size greater than about 70 μm diameter. Although these life history stages are unlikely to survive hull cleaning, it is deemed prudent to consider this with respect to an appropriate particle size

Overall, it is considered, when taking a precautionary approach, that simple retention of any biological material larger than approximately 60 µm diameter should provide reasonable safety from the identified biosecurity ‘risk’ species (see Fig. 11.1). This provides for greater than a 10% 'margin of error' with respect to the gametes of marine invertebrates, and is 30% smaller than the minimum 'at risk' size for *Undaria*. Should further treatment using sand and gravel filters be utilised (resulting in additional abrasion), it is possible that a larger effective particle size could be deployed. Alternatively, the size threshold could be maintained with added security. Further treatment with biocides could raise this threshold further, but the potential cost savings must be weighed against any resultant potential for environmental damage.

It must be cautioned that this recommendation on particle size is based upon a desktop assessment of a restricted list of species considered to pose a biosecurity risk to New Zealand marine environments. We strongly recommend that the results of this study be subject to empirical testing (e.g., examination of filtrates from a model system) in order to verify the efficacy of this standard. Such testing could take the form of simple inoculation and tracking of biological material (from locally abundant species, to negate any biosecurity risk) through a standard-design filtration device.

> The majority of biological materials smaller than approximately 60 µm average diameter are considered unlikely to survive the hull cleaning process. Retention of materials above this size is thus considered to provide an acceptable level of biosecurity. 60 µm is thus referred to as the ***particle standard***

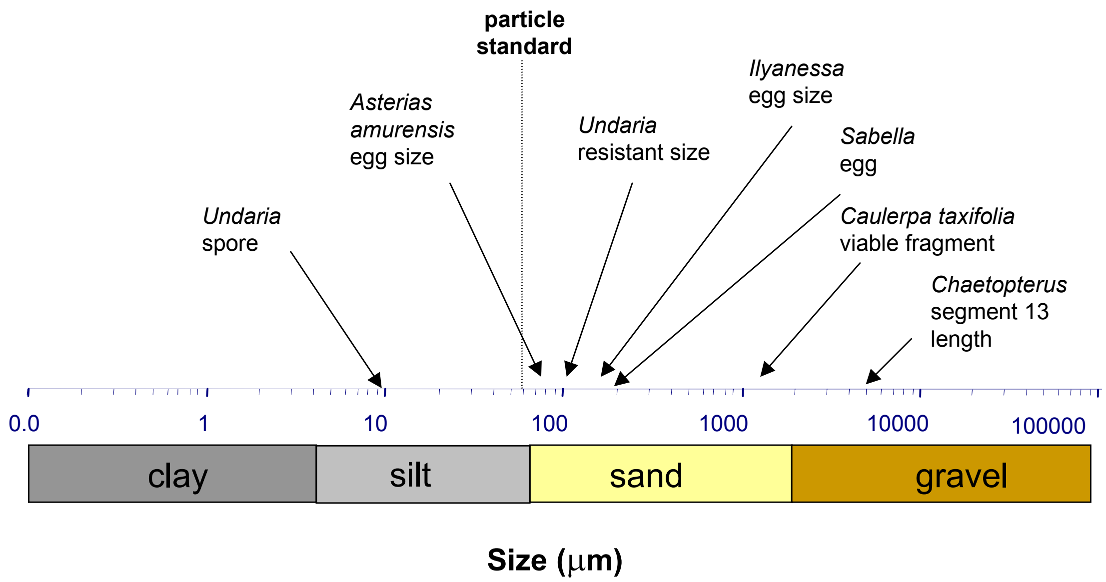

Fig. 11.1: Information on particle sizes relevant to the proposed particle standard.

11.2 Compliance Costs

In order to estimate the cost to the industry of upgrading so that facilities can meet the proposed bio-security standards and be considered '*Approved Facilities*', it has been necessary subdivide the information into a number of groups. A facility was assigned to a particular group for analysis based upon its overall capacity (the maximum size of vessel that could be cleaned), and each group was considered separately. The full analysis by category of facility is presented in Table 11.1.

11.2.1 Facilities capable of cleaning vessels of over 2000 tonnes displacement.

At present there are two facilities in New Zealand capable of cleaning vessels of over 2000 t displacement. These are the dry docks in Lyttelton and Devonport. Of these, Devonport has spent $1.5M installing a new wastewater separation and treatment plant in the last two years. It is capable of meeting the requirements of the proposed guidelines. Liquid waste is discharged to the sanitary sewer system (not to the sea), and solid waste is transferred to an approved landfill. While there remain some operational problems to be resolved, the process at this facility can readily meet the 60 μm particle standard, and in fact is capable of reducing the particle size to 1 μm and 1.5 NTU turbidity.

Lyttelton has installed a small trial plant that pumps liquid and suspended solids from the dry dock floor to a three stage settling tank where some manual treatment is carried out by addition of alum for pH correction and *Magnafloc* for solids separation. Floating solids are then scraped off before the liquid is returned to the dock floor and thence to sea. Collected solids are lime stabilised using a front-end loader before disposal at a landfill. This plant was installed mainly to contain anti-foul and paint overspray and inorganic oxides from metal hulls and fittings.

For the Lyttleton facility to meet the requirements of the proposed bio-security guidelines, permanent collection, settling and separation plant is required, and somewhat limited space converted for final filtration plant if the liquid is to be returned to the sea. It is estimated that the cost to upgrade this facility could be $0.75M provided a new building is not required, filtration levels are not required below the 60 μm particle standard, and the existing solid waste disposal methods are acceptable to the Local Authority.

Table 11.1: Estimates of Compliance Costs for Hull Cleaning Facilities

	Survey vessels cleaned/yr	Estimated proportion of total	Estimated vessels cleaned /yr	Cleaning Facilities complying (estimated) or capable of upgrade to compliance				Estimated cost (**NZ$000**) to bring facilities to acceptable condition for compliance			
REGION				over 2000t	200t to 2000t	60t to 200t	up to 60tonnes	over 2000t	200t to 2000t	60t to 200t	up to 60 tonnes
Northland	1325	50	2700	0	0	3	8	0	0	90	400
Auckland	10656	60	17760	1	2	5	15	0	0	150	750
B.O.P.	2700	80	3400	0	1	0	3	0	400	0	150
Hawke Bay	40	50	80	0	0	1	2	0	0	30	100
Wellington	3120	90	3500	0	0	0	6	0	0	0	300
Nelson/Marlborough	500	50	1000	0	1	1	2	0	400	30	100
Canterbury	105	50	210	1	0	1	3	750	0	0	150
Otago/Southland	318	85	375	0	1	1	2	0	400	200	100
West Coast NI/SI	0	0	200	0	0	2	2	0	0	200	100
TOTALS	**18764**	**57.2**	**29225**	**2**	**5**	**14**	**43**	**750**	**1200**	**700**	**2150**

Grand Totals **Vessels cleaned 30,000** **Cleaning facilities 64** **Cost to upgrade NZ$ 4.8M**

11.2.2 Facilities capable of cleaning vessels between 200 and 2000 tonnes.

The survey has identified five existing facilities capable of slipping and cleaning vessels in this displacement range. Two are in Auckland, and one each in Tauranga, Nelson and Bluff. The two in Auckland are both operated by Orams Marine Ltd in the Westhaven basin, and are conventional slipways. Both have recently been modified to include collection trenches across the slipways above the high tide line, pumps to settling tanks, and a final sand/peat-polishing filter on the liquid effluent before discharge to sea. While the results of water samples are still to be reported, Auckland Regional Council is confidant that filtration levels to below 50 μm particle size and 18-21 mg/l total dissolved solids will be achieved (Shaver, pers. comm).

In Tauranga an older, established ship repair yard, Refit New Zealand Ltd, operates a slipway alongside the Tauranga/Mt Manganui toll bridge. Containment of hull cleaning material is by building a sand bund or wall across the base of the slip after a ship is hauled up. Before the vessel is returned to the water, the sand is removed and disposed. The owners are under notice that future widening of the bridge may force them to relocate the slip in the next 2-5 years, and when this happens they intend to invest in a 1000 t travelift. While it is technically possible to upgrade the facility, it is unlikely that the existing slip can be economically modified to comply with the proposed guidelines for the short period that it is to remain.

Nelson Ship Repair Group operate a large slip in the centre of the port area. Vessels are mainly slipped for hull cleaning, anti-fouling and maintenance. While minimal containment presently exists, the owners are in the process of purchasing a large sand filter (ex- Centennial pool, Christchurch) for the purposes of upgrading. Capture, pumping, settlement and disposal plant and systems will be required.

The Bluff syncrolift operated by South Port Ltd, is the only large ship cleaning facility south of Lyttelton. Vessels are lifted vertically out of the water, and when supported on a cradle, can be towed to a cleaning area. At present the arisings are not contained, and liquids flow back to sea. To comply, sealing, capture, pumping, settlement and filtration are required. A further restriction on the use of the syncrolift is that some vessels, such as the Port Company tugs, cannot be moved off the syncrolift, and so are cleaned *in-situ*, allowing the arisings to be washed back into the sea. These vessels would need to be refitted or docked elsewhere unless special cradles are built for them to be moved off the syncrolift.

We estimate that each of the facilities at Tauranga, Nelson, and Bluff would need to spend about $400,000 to meet the containment requirements of the proposed guidelines.

11.2.3 Facilities capable of cleaning vessels between 60 and 200 tonnes.

The survey indicates that there are about 14 facilities in this category. Most are conventional boat building or repair yards with an uncovered slipway at the waters edge. Exceptions are a syncrolift at Devonport, and a 100 t travel lift at Gulf Harbour Marina. Some have attempted to comply with Resource Consent conditions by installing some form of containment bund or trench, pumping of waste to a settlement tank, and then allowing the liquid to return to the sea via an overflow. Solids are periodically removed by vacuum loading tanker by suction from the sumps and tanks.

This group range from being compliant with the proposed regulations, to requiring major upgrading or relocation in order to comply. Those that will never comply in their present location include Miller & Tunnage boat builders of Dunedin where their slips are regularly under water at high tide. They can not move further inland because they are located directly against the main road. Similarly, Hutcheson Boat builders in Tauranga are limited by their site.

Estimates of the cost to upgrade the 14 facilities range from zero to $250,000 with a mean of $50,000 considered realistic.

11.2.4 Facilities capable of cleaning vessels up to 60 tonnes displacement.

This group covers the remainder of the facilities (approximately 43 nationwide) that could be bought up to an acceptable condition for compliance. Those in the North Island are typically marinas operating a travelift where the boat is lifted and transported to a sealed area for hull cleaning. Containment is good, and all effluent usually passes through a screen to an oil and grit arrester pit before settling in a tank or being passed directly to local authority wastewater treatment plants. Other marinas have installed sand filters. A review of existing sand filter technology and proprietary systems available, confirms that the use of a properly designed and maintained sand filter will meet the requirements for solids collection of hull cleaning discharges. Typical small sand filter systems suitable for most marinas and slipways could be purchased and installed for under $15,000.00.

Oil and grit interceptor units of 3000 litre capacity can be purchased and installed for under $5,000.00.

In the South Island the smaller numbers of boats, particularly pleasure craft has meant that the demand for marinas and associated hull cleaning facilities is much less. Nelson was the only South Island port visited where a travelift is in service. Its owners, Dickson Marine (Nelson) Ltd. report about 250 lifts per annum compared with 2000 lifts per annum each at Chaffers in Wellington, West Park Marina in Hobsonville, or Tauranga Marina society Inc.

Compliance costs for older style slipways could therefore be greater per vessel in the South Island despite the fewer number of vessels cleaned. It is estimated that at least $2.15M will be required to be spent to bring all 43 facilities into a compliance

> Four categories of vessels were considered as part of an evaluation of likely costs to industry of achieving compliance with the proposed particle standard. Estimated compliance costs (required to upgrade facilities to meet the proposed particle standard) for each region varied with the number and type of facilities present. Regional estimates ranged from $130,000 (Hawke Bay region) to $900,000 (Auckland and Canterbury regions). Total, countrywide upgrade costs are on order of $4,800,000.

state.

11.2.5 Solids disposal

The survey has revealed that containment of solid waste from hull cleaning is generally happening, with 18 of the 35 sites visited being capable of capturing and holding solids as sediment in settling tanks. These tanks are typically concrete and are installed below ground to collect wastewater from the wash down area as well as storm water run-off from hardstand areas. Where available land is limited, above ground tanks made from polyethylene have been used effectively with effluent from sumps pumped to them.

In either situation, an industrial waste cartage contractor typically performs removal from the site of solid waste. Vacuum loading as a sludge or slurry is currently carried out and there is no need to modify or change this method of solids disposal in most instances.

The survey attempted to determine the total quantity of solid waste material captured at present. This was complicated by anecdotal reports of occasional hull cleaning jobs that generated several 200 l drums of waste. The Devonport dry dock averages about 400 to 1600 l per ship of pressed solid cake. Lyttelton processes about 800 l per ship without pressing. However, the average small boat that is regularly cleaned and used is unlikely to produce more than a few hundred ml of organic solid material. It is estimated that the two dry docks account for about 56 cubic metres per annum of solid waste. An estimate of the total solid waste load from all facilities on an annual basis is 400 cubic metres or about 140 t.

All licensed industrial waste collectors are required to identify and treat if necessary, any hazardous substances. From a bio-security perspective, and provided the solid waste is not dumped in its raw state within a coastal zone, there is no need to change the present collection methods.

However, individual hull cleaning facilities may wish to consider installing additional treatment plant, to reduce their waste disposal costs. On site pH adjustment and flocculation dosing could significantly reduce the effluent disposal volumes.

Where a sand filter is added to the facility, there will be an additional solid waste disposal cost to replace and dump the top layers of the sand that have captured the sediments. This contaminated sand is disposed of in the same way as for the sediments recovered from settling tanks.

The impact on disposal costs could be to double the present charges after a sand filter is installed.

11.3 Guidelines and Compliance Verification

The implementation of any new industrial standard can be facilitated through production of a set of guidelines. Such guidelines would ideally provide specific instructions on the type of facility/plant required to meet an approved standard. Provision of a set of technical requirements illustrating the key features of the standard as part of the guidelines would provide industry with models on which to tailor specific solutions.

Based upon the survey of hull cleaning facilities and services conducted during the first half of 2001, we have prepared a Set of guidelines for the industry (Appendix 3).

As an aid to regulatory authorities, we have also produced an assessment checklist against which hull cleaning facilities can be evaluated (Appendix 4).

12. Publications:

No publications have been prepared at this stage of the work

13. Data Storage:

The data collected in this project have been checked using Kingett Mitchell's protocols for research data quality management. The data will be provided to the Ministry of Fisheries in electronic form for storage and archiving on the Ministry of Fisheries' database.

14. Appendices:

Appendix 1: Survey form used during site visits.

Appendix 2: Samples of information collected during site visits.

Appendix 3: Guidelines for hull cleaning facilities.

Appendix 4: Model checklist for assessors of cleaning

Appendix 5: Building Industry Authority (BIA) Approved Document G14

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