NIWA

Taihoro Nukurangi

Criteria for identifying and selecting high value locations and locations at risk of invasion by exotic marine organisms in New Zealand

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Final Research Report

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Executive Summary

The objectives of this project were:

- to develop criteria for selecting high value locations (e.g. in terms of their ecology and production) and locations that are at risk of invasion by exotic marine organisms, and
- to make recommendations on the location and priority of sites to be included in an ongoing surveillance regime (using the criteria from objective 1).

In this report, I review a range of published and unpublished information to develop the criteria. These included:

- existing published information and data on the ecological, economic, social and cultural values of New Zealand's marine environments,
- relevant international, national and regional policy and legislation,
- existing data and international scientific literature on the patterns of distribution and spread of non-indigenous marine species, and
- preliminary consultation with relevant industry sectors and experts.

The report summarises the results of this review in separate sections that outline the major values associated with New Zealand's coastal environments, the ways in which NIS can affect these values, criteria for identifying high value sites and sites under high risk of incursion, and sites of importance identified in existing policy and legislation. Based on the findings, general recommendations are presented for the design of a comprehensive surveillance network that includes:

(1) Intensive, scientific surveys of high risk ports of entry;
(2) Regular, rapid assessment of a broad range of habitat types within harbours and estuaries surrounding high risk ports of entry; and
(3) Targeted surveillance of high-value locations for known unwanted species.

To achieve broad geographic, ecological and temporal coverage, NIWA believes that the most effective and sustainable form of surveillance monitoring will be one that engages and uses the skills and resources of a range of government, special-interest, industry and community groups. This will be most appropriate for the latter two categories of sites, which benefit most from broad geographic coverage and stakeholder involvement.

NIWA recommends that ZBS2000/01 consist of three components:

(1) development and trialing of techniques for rapid inventory of NIS species in a range of habitats within, or adjacent to sheltered harbours and estuaries that contain major, high risk ports identified in project ZBS 2000/04, and

(2) broader consultation with sectoral groups, using the criteria outlined in this document, to identify and select sites of value to each group,

(3) development and implementation of surveillance kits tailored to the needs of each sectoral group that has interests in protecting high value sites from incursions.

Eight major harbours and estuaries were identified as being at particular risk of incursion by NIS. These locations should be considered in the final selection of high risk locations for surveillance.

(1) Waitemata Harbour
(2) Tauranga Harbour
(3) Whangarei Harbour
(4) Lyttelton Harbour
(5) Wellington Harbour
(6) Bluff Harbour
(7) Otago Harbour
(8) Nelson Harbour

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1 Introduction

1.1 Designing Surveillance Programmes for Non-indigenous Species (NIS)

Surveillance is an integral part of pest control. In general terms, it is a specialised form of monitoring that is intended to detect critical events during the introduction and spread of unwanted species. Experience shows that successful eradication and control programmes for unwanted species depend upon early detection of populations, while they are still relatively small and isolated (Moody and Mack 1988, Culver and Kuris 2000, Field 1999). The accelerating global spread of non-indigenous species (NIS) in marine environments and growing recognition of their impacts on native ecosystems have highlighted the need for comprehensive surveillance programmes to detect unwanted species before they endanger native marine environments (Ruiz et al. 1997, 2000). The design of such programmes is not a trivial issue since, at an early stage of establishment, populations of NIS are likely to be sparse, aggregated, and to contain a large proportion of immature individuals, making them easy to miss using conventional sampling designs. There is currently limited international experience in developing generalised surveillance networks for marine NIS. Some initial steps have been taken in Australia and elsewhere to implement baseline surveys of major ports (e.g. Hewitt et al. 2001), but guidance is lacking on survey design for broader-scale surveillance programmes and, in particular, on where and how surveillance efforts should most appropriately be focused.

1.2 Purpose of surveillance for NIS

The overall objectives of surveillance depend upon the stage of pest management that it is intended to inform. In general, management of unwanted species is targeted at three stages in the process of invasion:

- **Pre-border controls** - measures taken to prevent unwanted organisms reaching the country (e.g. restrictions on pathways of species transfer);

- **Border controls** - measures taken to prevent unwanted organisms reaching native ecosystems (e.g. quarantine), and

- **Post-border controls** - activities used to manage the impacts of species that have escaped into native environments (e.g. eradication, maintenance control).

Surveillance activities can be applied to assist each stage of management to:

- detect the arrival of an NIS by a known pathway;
- detect incursions of NIS into native environments;
- detect changes in the distribution and prevalence of established NIS outside their current range;
- support the protection of significant natural, cultural or production values by detecting incursions of pest species into valued environments (or products); or
- detect changes caused by non-native species in the quality of the environment or in specific products that may affect human health.

Other, related functions can include:

(i) to support the development of pest management strategies;

(ii) to fulfil international treaty obligations, including the prompt reporting of incursion events that might put New Zealand's commitment to the treaties at risk; and

(iii) to facilitate trade in New Zealand products by being able to credibly certify the sanitary (or other) requirements that markets have for them

Locations chosen for surveillance depend upon which of these functions the programme is intended to achieve. For example, to detect new incursions of NIS, surveillance is most effectively targeted at the major pathways and sites by which species enter the country (e.g. international ports of entry for goods and people). Sampling to detect the spread of established NIS, however, is best done at the periphery of the existing range of the unwanted species, in habitats under immediate risk of invasion. Other factors, such as the degree of public concern, the likely consequences of establishment by an NIS, the relative cost of surveillance, jurisdictional responsibility, and the feasibility of control also guide the choice of suitable locations.

1.3 Surveillance for NIS in New Zealand's coastal waters.

MFish has proposed a surveillance network for marine NIS in New Zealand that consists of three types of sampling locations:

Ports of Entry – where NIS are likely to be introduced and establish founding populations;

High Risk / Sentinel Sites – natural habitats that are at greatest risk of initial establishment by NIS. (Typically, natural environments within the dispersal distance of the site of introduction or founder populations); and

High Value Sites – where the impacts of NIS are likely to be greatest if they become established.

The objective of this project is to develop a rationale for selecting locations in the latter two categories of sampling sites: high risk / sentinel sites (hereafter referred to as "high risk sites") and high value sites. Criteria for selecting Ports of Entry to be sampled are being developed in a separate project (ZBS2000/04). In this report, preliminary recommendations are made for two types of criteria that can be used to decide upon appropriate locations for surveillance. The first ("identification criteria"), describe considerations for identifying sentinel sites and high risk sites. The second set of criteria provide guiding principles ("selection criteria") for selecting a final set of sites from those that are initially identified.

2 Methods

A range of published and unpublished information was reviewed to develop the criteria. These included:

- Existing published information and data on the ecological, economic, social and cultural values of New Zealand's marine environments,
- Relevant international, national and regional policy and legislation,
- Existing data and international scientific literature on the patterns of distribution and spread of non-indigenous marine species, and
- Preliminary consultation with relevant industry sectors and experts.

Information obtained from these sources is summarised below in separate sections that describe the range of values that are associated with New Zealand's coastal environments (Section 3), and how these values may be affected by NIS (Section 4). Established criteria for identifying valued components of marine environments were combined with policy goals in relevant international, national and regional policy and legislation to develop criteria for identifying high value marine sites in New Zealand (Section 5.2). Section 5.3 describes a range of marine and coastal sites within New Zealand that have been identified by policy and legislation as having special significance to sectors of the community. Guiding principles for selecting sites for surveillance ("selection criteria") are presented in Section 5.4. Existing data and international literature on the patterns of distribution and spread of non-indigenous marine species were used to develop separate criteria for identifying sites that are at high risk of establishment by NIS (Section 6). Lastly, general recommendations are made for the development of project ZBS2000/01 to ensure a comprehensive surveillance network that incorporates the roles and responsibilities of different groups (Section 7).

3 Values associated with New Zealand's Marine Environments

3.1 Generic values of New Zealand's marine environments

The coastal and marine ecosystems of New Zealand are an important source of the nation's social and economic wealth. Ecosystem services associated with the marine environments of New Zealand's Exclusive Economic Zone (EEZ) have been valued at more than $183 billion per year. This reflects both the direct and indirect economic value attributed to the functions that ocean ecosystems fulfil and the large area of ocean that is under New Zealand's care (Patterson & Cole 1997). The benefits that we gain from marine resources are not simply monetary (Box 1). Although direct uses of native marine flora and fauna contribute substantially to the national economy, the economic value of these assets is not easily separated from the variety of indirect recreational, social and cultural benefits that they provide to society (PCE 2000a). For example, the widespread perception of New Zealand environments as "clean, green, and natural" is a powerful image that is used to brand and promote New Zealand's tourism and seafood products nationally and internationally. Maintaining the value of

this brand requires safeguarding the ecological, social and commercial values that have helped construct it.

Box 1. Uses and values of the marine environment*

1. Direct Use Values: Consumptive Uses

- Commercial, industrial market goods (fish, shellfish, crayfish, bioprospecting, oil, gas and minerals, etc
- Traditional or customary uses (fish, shellfish, crayfish, kina, seaweed etc)
- Recreational benefits (fish, shellfish, crayfish etc).

2. Direct Use Values: Non Consumptive Uses

- Recreation (charter cruises, wildlife photography, diving, swimming, sailing, catch and return fishing)
- Science and education (marine studies of various kinds)
- Transport (domestic and international shipping).

3. Indirect Use Values

- Climate control (moderation of weather, generation of sea breezes etc
- Oxygen/carbon dioxide exchange; contribution to water cycle;
- Absorption and dispersal of land-based pollution
- Habitat and protection of biodiversity and species (potential sources of medicines, source of future aquaculture).

4. Option and Existence Values

- People may value the option to use a particular resource aspect of the ocean in the future. They may value the option to retain it in its natural state. Although difficult to measure, these different values should be recognised in assessing the contributions of the ocean to human welfare.
- People may value the ocean purely for its existence without any intention to directly use the resource in the future. This includes intrinsic natural value.

* Source: Office of the Parliamentary Commissioner for the Environment (2000a)

3.2 Direct Economic Worth

An indication of the direct economic worth of key marine industry sectors is provided in Table 1.

Table 1 Estimated production value from major New Zealand industries based on extraction or servicing the marine sector (source PCE 2000a)

Industry	Production Value (NZ$)
Oil and Gas (1997)	$1,395 million
Wild fishing (1998)	$1,050 million
Boat building industry (1998)	$375 million
Marine farming – aquaculture (1998)	$170 million
Total	**$2,990 million**

Tourism and recreation are also major beneficiaries of New Zealand's natural coastal environments. Overall tourism expenditure (domestic and international) within New Zealand is estimated at around $11.5 billion dollars per annum and it contributes around 16% of New Zealand's export earnings. It is difficult to determine what proportion of this revenue is associated with marine and coastal environments since it is not possible to distinguish many marine-tourism operations from other sectors of the industry. Nevertheless, natural environments, including coastal and marine environments, are fundamental to the New Zealand market brand. Collectively, nature tourism, adventure tourism and attraction/activity-based tourism comprise around 34% of the industry. Wildlife-viewing is a growing segment of the industry and is based largely around icon species of marine mammals (whales, dolphins & seals), and seabirds (e.g. penguin, albatross, gannets). Specific coastal landscapes such as Cape Reinga, the Bay of Islands, Ninety-Mile Beach, Abel Tasman National Park, Kaikoura, and Milford Sound are heavily promoted features of New Zealand tourism and are among the most visited destinations.

Domestic tourism and recreation are also heavily dependent on coastal environments. Around one in every three New Zealanders goes marine fishing or collecting each year, and our harbours and beaches are enjoyed by a much larger proportion of the population for sightseeing, wild-life viewing, swimming, sunbathing, sailing, surfing and diving (PCE 2000a).

3.3 The Value of Indigenous Biodiversity

New Zealand's coastal ecosystems also contribute disproportionately to global marine biodiversity, given the relatively small size of our land mass. New Zealand is the world's most isolated large archipelago (Towns and Ballantine 1993). This geological isolation from continental coasts has meant that New Zealand marine ecosystems contain a comparatively large proportion of endemic species. Estimates suggest that up to 80% of New Zealand's indigenous biodiversity occurs in the sea. Long ocean distances between New Zealand and the closest similar shoreline (Australia) mean that few coastal species are transported to New Zealand by ocean currents. As a result, there are major differences between marine biological communities in New Zealand and elsewhere (Green 2000). High levels of endemism are known amongst macroalgae (~35% of recorded species), sponges (55%), bryozoans (45%), fishes (20%) and seabirds (30%) (Towns and Ballantine 1993). New Zealand also has an extraordinarily large proportion of the world's species of penguin (75%), albatross, petrel, shearwater and prion (54%) and marine mammal fauna.
The large number of endemic species in New Zealand's coastal waters makes our indigenous marine biodiversity of considerable international significance. However, island faunas that contain a large proportion of endemic species are also particularly vulnerable to incursions by, and the effects of NIS from continental regions (MacArthur and Wilson 1967).

3.4 Value to Tangata Whenua

Maori have especially strong spiritual and cultural connections with the sea. Utilisation of, and kaitiakitanga (guardianship) over marine resources are fundamental to traditional and contemporary Maori culture. Seafood is an important source of mana at hui, celebrations and other events. Gathering and use of seafood are important

mana at hui, celebrations and other events. Gathering and use of seafood are important to the identity and community links of hapu and whanau (PCE 2000a). In addition, many marine species have inherent value as taonga (treasures). Their significance is much greater than their value as food, but incorporates the wider social, spiritual and cultural relationship of iwi, hapu and whanau (PCE 2000a). Coastal landscapes also have great significance to Maori. A large number of wahi tapu on the coasts and islands mark burial grounds, battle sites, landing places of ancestral voyages and other places of significance.

Maori have developed complex management systems around the utilisation of marine resources and protection of significant sites. The value of these resources and locations, and protocol for their management are traditionally associated with particular iwi, hapu or whanau (PCE 2000a).

4 Modes of impact of NIS on identified values

Prioritising valued sites for surveillance requires balancing the interests of different sectors of society. The choice of sites will depend upon the relative magnitude of threat that particular species or groups of species pose to different site values. This will vary according to the species and values under question. The complexity of marine ecosystems and the novelty of interactions of each invader with its new environment mean that it is difficult to predict the course and outcome of any invasion in advance. As Williamson and Fitter (1996) put it, "each pest is a pest for its own reasons", meaning that identifying a "pest" species requires considering the environmental, social and economic effects it has as well as the ecological processes that allow it to become abundant. A surveillance regime intended to protect sites of high value should, therefore, reflect:

(a) the range of natural, economic, social and cultural values that are to be protected,
(b) the species identified as posing the greatest risk to these values, and
(c) the likelihood that they will become established.

In general, the effects of NIS on valued components of marine ecosystems are most often manifested through the impacts that they have on the distribution, abundance and quality of native species (Ruesink et al. 1995, Ruiz et al. 1999). These vary greatly according to the particular species involved, but can include:

- direct competition, predation or herbivory on native species;
- modification of native habitat;
- parasitism on native species;
- pathogenicity; or
- genetic hybridization (Ruiz et al. 1999)

Because not all uses of the marine environment are equally dependent on the natural integrity of native ecosystems, they are not equally vulnerable to the effects of NIS. New Zealand's indigenous marine biological assets are especially important to:

- Industries based on native or established species and their quality (e.g., wild fisheries and aquaculture),
- The tourism industry, which relies on the provision of natural experiences through the integrity of unique biological landscapes, and the lack of threatening species,
- The recreational and aesthetic values of landscapes, plants, and wildlife which are important to the majority of New Zealanders
- The cultural, spiritual, and other values of tangata whenua
  (adapted from PCE 2000b)

NIS can, however, also have significant direct impacts on uses of the marine environment that are not as dependent on native biological resources. For example, invasive marine fouling species, such as the black-striped mussel, *Mytilopsis sallei* (Field 1999), can clog water-cooling intakes and reduce the fuel efficiency of ocean-going vessels. Other species have direct consequences for human health and recreation. For example, the Australian Quarantine and Immigration Service (AQIS) has compiled a list of 148 pathogens that could arrive in ballast water that includes cholera bacteria. In 1991 ships from south Asia are thought to have discharged ballast water containing cholera bacteria into Peruvian Ports. The resulting epidemic killed thousands of people (PCE 2000b). Other species, such as the stinging jellyfish, *Chrysaora quinquecirrha*, are a lesser threat to human health, but can significantly curtail recreational use of coastal environments (Lafferty and Kuris 1996).

4.1 Effects on the values of tangata whenua

All species in an ecosystem have cultural value to Maori in terms of the connecting forces of mauri, whakapapa, mana, and tapu. This can mean that, as with other sectors of New Zealand society, value is placed upon some NIS for the utilitarian or cultural benefits that they provide. Nevertheless, incursions by NIS can have physical effects on valued native plants and animals, and can also adversely affect tangata whenua associations or connections with landscapes and locations, intrinsic value of biodiversity and spiritual interests in the protection of natural resources and taonga (PCE 2000b).

5 High Value Sites

5.1 Sources of criteria for identifying sites of high value

Guidelines for identifying the significant conservation, economic and social values of sites have been developed independently for a wide range of different purposes, including environmental impact assessment, selection of sites for conservation reserves, and environmental planning. Many of these guidelines can readily be adapted to identify valued sites that may be threatened by NIS. For example, Table 2 presents criteria established by the US National Research Council (1986) for identifying valued ecosystem components in environmental assessments. Ruesink

et al. (1995) have proposed using these criteria in assessments of biosecurity risk to identify valued ecosystem components that are at risk from new or recent incursions.

A range of other, similar criteria and guidelines are present within existing legislation and policy in New Zealand. Policy goals provide a useful starting point for identifying valued components of New Zealand's marine ecosystems since they incorporate values that have already undergone a process of formal evaluation and acceptance by society and/or government. In most cases, this formal recognition is supported by obligations to protect and enhance the specified values. A selection of this material and its relevance to the management of marine environments and biosecurity risks in New Zealand is reviewed in Annex 1. Emphasis was given to sections of the documents that specifically identify marine values and environments that may be threatened by incursions of NIS.

Table 2: Suggested criteria for identifying valued ecosystem components (from Ruesink et al. 1995)

Legal requirements	Air and water quality standards Public Health Rare, threatened, endangered species Protected areas or habitats
Aesthetic values	Landscape appeal Attractive communities Species at higher trophic levels Clean air and water
Economic concerns	Species or habitats of recreational or commercial interests Ecosystem components (watersheds, erosion control, nutrient cycling, and soil salinity)
Environmental values and concerns	Ecosystem rarity or uniqueness Sensitivity of species or ecosystems to stress Ecosystem naturalness Genetic resources Ecosystem services (nutrient cycling, erosion control, pollution cleansing, and oxygen production) Recovery potential of ecosystems Keystone species

Based on this review a proposed list of criteria for identifying marine sites of high value is presented in the following section. Because of the repeated emphasis on particular types of goals in existing policy and legislation, priority was given to:

- New Zealand's international commitments and obligations,
- endemic biodiversity,
- industries that rely on the natural integrity and quality of marine environments, and which contribute significantly to the national economy (e.g. fisheries, aquaculture and tourism), and
- values of tangata whenua.

5.2 Proposed criteria for identifying sites of high value for surveillance[1]

5.2.1 Importance of site recognised internationally, nationally or regionally

Has the area been identified, or does it have the potential to be identified, as a site of international, national or regional importance by:

(a) Listing as a World or National Heritage site;
(b) Declaration as a marine reserve, wildlife sanctuary, marine mammal sanctuary, or other protected environment;
(c) Declaration as a marine park;
(d) An international, national or regional conservation agreement;
(e) Listing as an area of "significant conservation value" in a regional coastal plan.

5.2.2 Uniqueness

Does the area:

(a) support populations of rare, vulnerable or endangered species or subspecies of plant or animal; or
(b) contain a specific type of habitat or community that is rare, vulnerable or endangered; or
(c) have unusually high biodiversity; or
(d) contain a large concentration of endemic species; or
(e) contribute to the maintenance of important ecological processes

5.2.3 Naturalness

To what extent has the area been protected from, or has not been subject to, or is at risk from:

(a) anthropogenic disturbances (e.g. exploitation, pollution); or
(b) non-indigenous species

5.2.4 Economic value

5.2.4.1 Fisheries and aquaculture

Does the area support:

(a) Habitat of particular national or regional significance for fisheries management; or
(b) Nationally significant production of native marine species or any valued introduced species of particular significance to wild fisheries or aquaculture.

[1] (adapted from criteria described in Cromarty and Scott 1996, ANZECC 1999, DoC 1992 and values identified in relevant legislation and policy)

5.2.4.2 Tourism

Does the area support:

(a) Outstanding natural features, landscapes or habitat that are significant attractions for international or national tourists; or
(b) Large concentrations of native species of particular national or regional significance for tourism.

5.2.5 Social value

Does the area have existing or potential value to the international, national or regional communities because of its heritage, cultural, traditional aesthetic, educational, recreational, or economic values.

5.2.6 Value to tangata whenua

Does the area:

(a) Support large concentrations of taonga or other species of particular significance to the culture and traditions of Maori; or
(b) Have special customary significance to iwi or hapu either:
- As a source of food; or
- For spiritual or cultural reasons.

5.3 Sites of High Values Identified in Existing Policy, Legislation, and Literature

5.3.1 Protected Marine Species

A limited number of marine species are specifically protected by law under the *Marine Mammals Protection Act 1978* and the *Wildlife Protection Act 1953*. These include all marine mammals, most seabirds and a small number of other species (spotted black groper, marine reptiles, black and red corals). Important locations for spotted black groper include the Kermadec Islands, Poor Knights Islands and Three Kings Islands. Black and red corals are particularly abundant in Fiordland and in deep waters surrounding the northern offshore islands (e.g. Poor Knights, Three Kings).

5.3.2 Protected Marine Areas of International Significance

5.3.2.1 World Heritage Sites

New Zealand currently has three sites listed on the World Heritage List. Two of these – Te Wahipounamu (South-West New Zealand World Heritage Area), and New Zealand Subantarctic Islands – contain significant coastal environments.

Te Wahipounamu was added to the World Heritage List in 1990 for its natural values. It covers a 450 km long stretch of the south-western coast of the South Island and extends 40 to 90 km inland. Although the seaward boundary of the World Heritage Area is taken to be the mean high water mark, some areas included within the

nomination are significant protected estuarine and coastal marine environments (e.g. *Saltwater Lagoon Scenic Reserve* (43°06'S, 170°21'E), *Okarito Lagoon Wildlife Management Reserve* (43°11'S, 170°13'E), *Waitutu Conservation Area* (intertidal rock platforms)). The fjords, rocky coasts and cliffs of Fiorldland were also highlighted in the nomination as being of significant conservation value. The United Nations World Heritage Committee also noted that, although the marine waters of the Fiords were not specifically included in the World Heritage Area, they were an integral part of Fiordland National Park. The Committee actively supported moves to extend the boundaries of the park to include adjacent coastal environments, but as yet this has not occurred.

New Zealand's Subantarctic Islands were inscribed on the World Heritage List in 1998. The nominated area covers the entire land and sea (to 12 nm) area surrounding the Snares Islands (48°02'S, 166°35'E), Bounty Islands (47°45'S, 179°03'E), Antipodes Islands (49°41'S, 178°48'E), Auckland Islands (50°45'S, 166°05'E) and Campbell Islands (48°02'S, 166°35'E). Conservation values of the islands are associated predominantly with the large and diverse population of seabirds, that includes several endemic species of penguin, albatross and cormorant. The islands are also significant for the diversity and numbers of endemic landbirds and flora, the large breeding populations of the rare New Zealand sealion, and the low level of human disturbance. A marine mammal sanctuary around the Auckland Islands excludes all fishing activities (see below). Marine diversity and endemism in the waters of the Subantarctic Islands are not particularly high, in comparison to mainland areas of New Zealand, but there are several notable endemic species, including the large Auckland Islands Spider Crab, *Jacquinotia edwardsii*, and new species of seaweeds in the genera *Durvillaea* and *Lessonia*. Inclusion of the marine environment in the World Heritage Listing recognised the importance of the surrounding marine resources to the land fauna, in particular to the seabirds and marine mammals.

5.3.2.2 Ramsar Wetlands

Five wetlands in New Zealand have been registered under the Ramsar Convention, an intergovernmental treaty on the protection and wise management of wetlands of international importance. A further 108 sites potentially meet the Ramsar criteria (Cromarty and Scott 1996). Three of the five Ramsar listed sites contain coastal or marine environments (Fig. 1). These are:

- *Firth of Thames* (Waikato) – marine habitats include shallow estuarine mudflats, shellbanks, seagrass meadows, mangrove forest, salt marsh and swamp;
- *Farewell Spit* (Tasman District) – marine habitats include intertidal sand and mudflats, seagrass meadows, salt marsh, sand spit and dunes; and
- *Waituna Lagoon* (Southland) – marine habitats include gravel beaches, brackish water lagoon, intertidal mudflats;

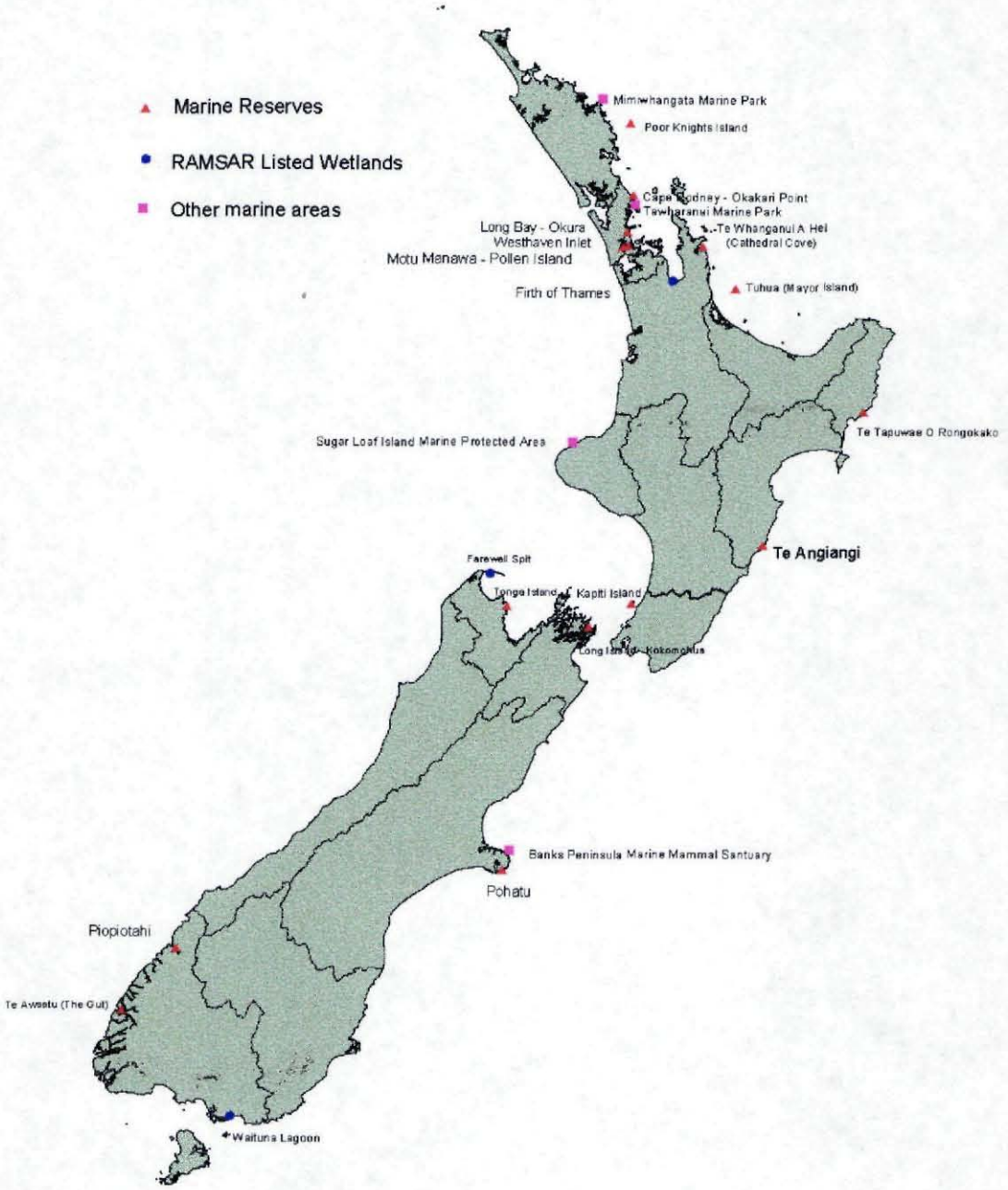

Figure 1. Location of protected coastal marine environments in New Zealand.

5.3.3 Protected Marine Areas of National Significance

5.3.3.1 Marine reserves

There are currently 16 marine reserves in New Zealand (Fig. 1). Marine reserves contain the highest level of protection for natural marine areas. All species and habitats within the reserves are protected because of particular features of habitat, biodiversity, or scientific value. Marine mammal sanctuaries

Two marine mammal sanctuaries have been established in New Zealand's waters. The Auckland Islands Marine Mammal Sanctuary was put into place in 1993 to protect Hooker's Sealions and southern right whales. All fishing is excluded up to 12 nautical miles from the islands. The Banks Peninsula Marine Mammal Sanctuary includes bans on set nets to protect the endemic Hector's dolphin.

5.3.4 Protected Marine Areas of Regional Significance

5.3.4.1 Marine Parks

Marine parks provide for a range of different extractive and non-consumptive uses and incorporate a range of levels and instruments of protection. There are currently 4 marine parks in New Zealand.

Tawharanui Marine Park (northern Hauraki Gulf)
Mimiwhangata Marine Park (Northland)
Sugar Loaf Islands Marine Protected Area (Taranaki)
Hauraki Gulf Marine Park

5.3.5 Protected environments of significance for fisheries management

5.3.5.1 Fisheries closures

General provisions in the Fisheries Act also allow the Minister to close specific areas to fishing, where necessary, to protect stocks and/or important fisheries habitat.

5.3.5.2 Taiapure

Part IX of the Fisheries Act provides for the establishment of taiapure; areas of estuarine or littoral coastal waters that have customarily been of special significance to iwi, or hapu either:

(a) as a source of food; or
(b) for spiritual or cultural reasons.

5.3.5.3 Mataitai

Customary Fishing Regulations established under the *Fisheries Settlement Act 1992* also provide special management conditions for areas of significance for customary, non-commercial fishing (*mataitai* reserves). These areas are identified traditional

fishing grounds from which commercial fishing is excluded, and where tangata whenu may manage all non-commercial fishing.

A geographic database of the locations of existing closures to fishing (C-FAB; Commercial Fishing Area Boundaries), including all taiapure and mataitai, has been compiled by Seabed Mapping International consultants, but this was not available for inclusion at the time that this report was prepared.

5.3.6 Valued Fishery Stocks and their locations

The ten most important fisheries species, based upon their export value, are listed in Table 3. Indications of important habitat and locations for these stocks are also presented. Most at threat from NIS are likely to be relatively sedentary (i.e. site-attached) fisheries stocks that inhabit shallow coastal waters. This includes farmed Greenshell™ mussels and salmon, wild stocks of rock lobster, abalone and other shell-fisheries. Long-line mussel culture already experiences fouling problems from at least two introduced species (the Japanese kelp, *Undaria pinnatifida*, and the tunicate, *Ciona intestinalis*) and has had to develop specific policy to manage the impacts of blooms of introduced toxic dinoflagellates on spat and adult mussel quality. The large number of shellfish predators and pathogens that has been reported world-wide as introduced marine pests suggests that this industry is particularly vulnerable to new incursions (Ruiz et al. 1997, 1999, 2000; Burkholder 1998, Hallegraeff 1998, Hewitt et al. 1999, Reise et al. 2000).

Table 3 (a): New Zealand's top-ten fisheries exports, based on total export value

Common name	Species name	Export value† ($NZ millions)	Habitat	Important stocks
Hoki	*Macruronus novaezealandiae*	311	Mid-water fishery, at depths of around 300 – 600 metres	West Coast, South Island Cook Strait Chatham Rise
Greenshell™ mussel	*Perna canaliculus*	169	Farmed on long-lines in sheltered coastal embayments, Native habitat = rocky shorelines	Marlborough Sounds Coromandel Peninsula Tasman / Golden Bays Big Glory Bay (Stewart Island)
Rock lobster	*Jasus edwardsii*	129	Rocky reefs in depths ranging from 5 to 275 metres	Important areas include Fiordland, Chatham Islands, Kaikoura, and East Cape
Orange Roughy	*Hoplostethus atlanticus*	84	Deep sea fishery at depths of 750 to 1200m.	Chatham Rise Southern West Coast, South Island Challenger Plateau
Ling	*Geypterus blacodes*	78	Bottom dweller, living at depths of 300-700 metres	Southern South Island Campbell Rise

Common name	Species name	Export value† ($NZ millions)	Habitat	Important stocks
Paua	*Haliotis iris*	66	Coastal rocky reefs, at depths between 1 and 15 metres.	South Island Chatham Islands Stewart Island Southern North Island
Squid	*Nototodarus sloanii,* *N. gouldi*	42	Surface depths to 500 metres in coastal shelf waters	South Island Campbell Islands Auckland Islands
Snapper	*Pagrus auratus*	37	Warmer coastal waters in depths of 10-100 metres. Predominantly a bottom feeder	Northern North Island Bay of Plenty
Hake	*Merluccius australis*	34	Mid-water fishery, at depths of 200-800 metres	West Coast, South Island Chatham Islands Southern South Island
Pacific King Salmon	*Oncorhynchus tshawytscha*	29	Farmed in cages in sheltered bays and river mouths	Marlborough Sounds Canterbury Stewart Island

† based on the year 2000

Table 3 (b): Other significant coastal shell-fisheries in New Zealand

Common name	Species name	Export value $NZ FOB	Important stocks
Scallops	*Pecten novaezelandiae*	10.4†	Tasman Bay Golden Bay Marlborough Sounds Northland
Pacific Oysters	*Crassostrea gigas*	45*	Bay of Islands Whangaroa Harbour Mahurangi Harbour Coromandel Peninsula
Dredge oysters	*Tiostrea lutaria*	Not specified	Foveaux Strait Tasman Bay Golden Bay

* Source MFish, †Source SEAFIC

5.3.7 Sites of Value to the Tourism Industry

Specific landscape icons such as Cape Reinga, the Bay of Islands, Ninety-Mile Beach, Cape Kidnappers, the Marlborough Sounds, Abel Tasman National Park, Kaikoura, and Fiordland National Parks are important destinations for international and domestic tourists. However, sites most at risk are those where the attractions and/or activities themselves are nature-based, and therefore, at risk from an incursion by NIS. The most significant of these destinations are important for viewing marine wildlife, and include Kaikoura Peninsula, Okarito Lagoon, Bay of Islands, Cape Kidnappers, Banks Peninsula, Otago Peninsula, Oamaru and the Catlins Coast.

5.3.8 Sites of Value to Tangata Whenua

A large number of wahi tapu exist on the coasts, islands and in the many harbours around New Zealand. Wahi tapu include battle sites and burial places, and tauranga waka, the landing-places of the ancestral voyagers (PCE 2000a). Important marine sites of national significance include Cape Reinga and Spirits Bay. The values placed on these environments and taonga are determined at a hapu and whanau level and are often specific to that hapu or whanau. Because of this, local environmental knowledge held by Maori is necessary to identify locations and values that may be threatened by incursions of unwanted organisms (PCE 2000b).

5.3.9 Sites of High Endemic Biodiversity

The large area of New Zealand's EEZ means that only a small proportion (~ 5×10^{-5} %) of marine seafloor habitats has been explored (Nelson and Gordon 1997). As a result, there are relatively few syntheses of patterns in the distribution of marine groups within New Zealand's waters that allow the identification of specific sites of high biodiversity and endemism. Despite this, many areas of high endemic biodiversity are known. Based on analysis of the distributions of large brown algae, Nelson (1994) highlighted the distinctive marine floras of several of New Zealand's offshore islands. The Kermadec Islands, in particular, are unique in the archipelago and have affinities with the marine floras of warmer waters of South Africa and the eastern Pacific. Many species on the Kermadecs do not occur elsewhere in New Zealand (Nelson 1994). The largest numbers of island endemic species of large brown algae, however, were recorded in the Three Kings and Chatham Island groups. The long geological isolation of these islands from mainland New Zealand is also reflected in high levels of endemism across a wide range of plant and animal groups (Estcourt 1966, Willan 1978, Brook and Laurenson 1992, McKnight 1993, Towns and Ballantine 1993). Offshore islands on the northeastern coast of New Zealand (e.g. Poor Knights) also contain diverse marine assemblages. Because of the occasional intrusion of the East Australian current, these islands contain a mixture of cool-temperate and subtropical species from warm waters of the Indo-Pacific region (Grange 1986).

On the main islands, Spirits Bay, Fiordland, and Kaikoura Peninsula are known to support particularly rich marine assemblages. An assessment survey in 1996 discovered a large diversity of rare and unusual species in Spirit's Bay, many of which were suspected to be new to science. This included 218 species of sponge, 170 bryozoans, corals, gorgonians, sea squirts, hydroids, crustaceans, and a barnacle whose nearest relative is thought to have become extinct 300 million years ago (PCE 2000a). Rock-wall assemblages in Fiordland are dominated by unusually diverse invertebrate assemblages that include brachiopods, serpulid polychaetes, antipatharian and gorgonian corals (Grange et al. 1981, Smith 2001). A common species of black coral, *Antipathes fiordensis*, is endemic to the fiords (Grange 1990). The subtropical convergence zone of southern and northern water masses and deep Kaikoura trench make the Kaikoura Peninsula a particularly rich marine environment for a variety of marine flora, fauna and wildlife.

Deep sea environments that have just begun to be explored also have particularly high biodiversity. New Zealand's seamounts are habitat for nearly 200 fish species, many of which are of commercial importance (e.g. hoki, orange roughy, oreo, eels, dogfish, sharks, rays, skates, squid, octopus) and at least 169 species of macro-invertebrates (i.e. corals, crustaceans, barnacles, crinoids, sea eggs, starfish, brittle stars, including 18 species of black corals, 18 species of gorgonian "fan/bamboo corals", and 37 species of true corals).

5.4 Principles to be considered in the selection of high value sites for surveillance ("Selection criteria")

Selection of sites for surveillance must optimise use of available resources so that efforts are targeted at locations where they are likely to achieve the greatest results. This requires (at least) an initial qualitative risk assessment for each site identified using the criteria in Section 5.2. In this section, I outline factors that should be considered when selecting high-value locations for surveillance.

5.4.1 Risk of incursion

Surveillance programmes are most effectively targeted at areas where there is a reasonable risk of incursion (e.g. areas near major international ports). Priority should be given to areas that are potentially at greatest risk. Some identified areas of high conservation value, such as deep sea mounts, appear unlikely to be under immediate risk of invasion because of their distance from major ports introduction. Generic risk factors associated with the introduction and spread of NIS are described in Section 6.1.

5.4.2 Consequences of incursion by NIS for identified values

A useful concept for prioritising the choice of locations included in a surveillance programme is the **expected cost** of an identified unwanted species becoming established in a valued-environment (NZIER 2000). This is defined as the product of the probability of an incursion occurring and the relative magnitude of its cost (or impacts). Highest priority for surveillance should be given to those sites that have the greatest expected cost.

At this stage, both the probability of an incursion and the relative magnitude of impacts on the values outlined above are difficult to quantify. In most cases, this will require individual risk assessment for species identified as a particular risk to each sectoral group. For example, the cost to fishing and aquaculture in New Zealand of the arrival of the northern Pacific Seastar has recently been estimated at around $200 million per year in lost revenue and $10 million per year in control efforts (Mountford 1998). Qualitative risk assessments are possible for a range of identified unwanted species that have previously invaded coastal environments overseas and caused substantial impacts, and which are capable of becoming established in New Zealand (Ruesink et al. 1995). This process is best carried out in consultation with potentially affected stakeholders.

5.4.3 Practicality/feasibility of surveillance

The isolation and difficulty of access to some identified areas of high conservation value (e.g. Antarctic territories, deep sea mounts and offshore islands) makes them extremely costly to sample. In many cases, these difficulties are compounded by incomplete knowledge of the range of native species present, making identification of incursions by non-indigenous species problematic. In most instances, isolated sites where surveillance is impractical will also have a relatively low risk of incursion by NIS.

5.4.4 Likely success of a management response

Because surveillance programmes serve as a trigger for managing the impacts of NIS, they are of limited utility at locations where control is impractical or where it is unlikely to be effective.

5.4.5 Comprehensiveness

Because of the uncertainty in predicting which NIS will become established in New Zealand environments and subsequently cause problems (Mack et al. 2000), the surveillance network should seek to incorporate a broad range of habitat types and communities that are at risk of invasion.

5.4.6 Shared responsibility

Responsibility for managing biosecurity risks in New Zealand is most appropriately shared among central and local government agencies, industry, tangata whenua, research organisations, non-government organisations, and the general public (PCE 2000b). This includes responsibility for surveillance. In a recent report, the Office of the Parliamentary Commissioner for the Environment stressed the need to explore opportunities for improving co-ordination of monitoring, surveillance and information-sharing between central government, local government and the public and private sectors (PCE 2000b). Shared responsibility and action is also one of four key goals in the government's recently released Biodiversity Strategy. Goal 1 of the strategy seeks to:

"Enhance community and individual understanding about biodiversity, and inform, motivate, and support widespread and co-ordinated action to conserve and sustainably use biodiversity."

Five government agencies – the Ministry of Fisheries, the Ministry of Agriculture and Forestry, the Ministry of Health, the Ministry for the Environment, and the Department of Conservation – have responsibility for biosecurity in New Zealand. In addition, the Biosecurity Act (s13) gives regional councils the responsibilities for surveillance of pests and unwanted organisms in their regions. Co-operation between these agencies is needed to ensure that surveillance effort is not duplicated and to develop synergies with established monitoring programmes in high value areas (e.g. in protected marine environments). For example, the Department of Conservation is developing standardised monitoring programmes for the marine reserve network and the Ministry of Health has an on-going Biotoxin monitoring programme in co-

operation with the shellfish industry. Proposed surveillance of high value sites by MFish should build upon existing monitoring programmes, where they exist, to achieve better interagency co-operation and efficient use of funds.

5.4.7 Resource Criteria

5.4.7.1 Feasibility

Although some deep ocean areas have been identified as areas of unique endemism and biodiversity (e.g. seamounts) their isolation and/or depth makes them extremely costly to sample. This is also compounded by incomplete knowledge of the range of native species present, making identification of incursions by non-indigenous species difficult. Choice of individual sites or habitats should not detract from the need for comprehensiveness and broad geographic coverage in a surveillance network (see sampling criteria in Section 6.1.2) by consuming a disproportionate amount of the available funds.

5.4.7.2 Complementarity with ZBS2000/04

Complementarity of site selection with MFish project ZBS2000/04 will create greater efficiencies in training, field and laboratory costs. There is considerable potential to increase the consistency and quality of information retrieved and lower the costs involved if these two projects are integrated effectively. Therefore, it is important that site selection complement the high-risk points of entry that are selected for surveillance.

6 High Risk / Sentinel Sites

6.1 Criteria for Identifying high risk / sentinel locations

The purpose of including sentinel locations in a surveillance network is to provide an early indication of the potential spread of an unwanted species into natural or valued environments. The chosen locations should, therefore, have the following characteristics:

- have a high probability of being among the first sites colonised by the unwanted species,
- provide an early indication of the habitat requirements and impacts of the species,
- be amenable to rapid and effective incursion control.

Despite growing research efforts on the characteristics of successful invaders and their impacts, many aspects of biological invasions remain unpredictable (Ruiz et al. 1997; 2000; Cranfield et al. 1998; Mack et al. 2000; Kolar and Lodge 20001). In particular, it is difficult to predict with any accuracy which species will invade, where and when they will establish, and what the ecological or economic consequences are likely to be, since existing studies show considerable geographic variation in each of these aspects, even for the same species (Carlton 1996; Grosholz and Ruiz 1996; Ruiz et al. 1997; 1999; 2000; Mack et al. 2000). This uncertainty makes it difficult to identify high risk locations precisely, but some general risk profiles have emerged from existing

literature that are useful for prioritising sites for surveillance. These are outlined below. Selection of sites for inclusion in the surveillance network should also consider the principles for selection outlined in the previous section.

6.1.1 Proposed criteria for identifying high risk / sentinel sites for surveillance

6.1.1.1 Proximity to ports of entry

The likelihood that a particular location will receive immigrants is influenced by its proximity to the point of introduction and by the frequency, speed, and mode of dispersal of the immigrants themselves (Mack et al. 2000). The most common contemporary means of introduction of NIS in marine environments is by ship-borne transport in ballast water or on the hulls of vessels. Most new incursions, therefore, appear to be associated with major international seaports (Ruiz et al. 1997, 2000, Cranfield et al. 1998). Coastal spread of NIS from these points of initial introduction occurs in three ways:

- by transport of adults or juvenile stages by human vectors to other coastal environments (e.g. by coastal shipping or movement of aquaculture species and/or equipment; Lavoie et al. 1999; Floerl and Inglis 2000);
- by advective dispersal of planktonic larvae; and
- by passive or active redistribution of mobile adults (Wilhelmsen 1999).

Recorded rates of spread by the latter two mechanisms vary widely among different species and geographic areas (Grosholz 1996; Grosholz and Ruiz 1996; Armonies 2001). Estimated average range expansion for marine NIS has varied between 12 to 125 $km.yr^{-1}$ for different species (mean = 51 $km.yr^{-1}$, Grosholz 1996), but there is considerable interannual variation associated with variability in reproductive success, ocean currents and the invasibility of native communities (Grosholz 1996; Armonies 2001). For benthic species, the probability of range expansion by natural means increases with the size and rate of growth of the founder population so that, within the first few years following establishment, surveillance is best targeted at sites clustered close to points of introduction (i.e. major international ports), within the median range of recorded range expansion. Targeting of locations for sampling can be enhanced by supporting information on patterns of water movement in the vicinity of high risk ports (e.g., hydrodynamic models; Stanton 1997).

6.1.1.2 Sheltered bays and estuarine environments

World-wide, most marine invasions have been reported in sheltered bay and estuarine environments (Ruiz et al. 1997; 2000; Cranfield et al. 1998; Reise et al. 1999). This includes a broad range of taxonomic and trophic groups that have occupied a diverse range of habitats within these sheltered environments. Comparatively few invasions have been reported from rocky and sandy shorelines of outer coasts (Ruiz et al. 1997). In New Zealand, almost all of the currently recognised NIS are confined to harbours or embayments (Cranfield et al. 1998). All of the adventive algae (except *Undaria pinnatifida*), all of the barnacles and most of the fouling Bryozoa are confined to ports or anchorages. Most of the sponges and ascidians also appear tightly restricted to specific harbour habitats and 15 (out of 24) of the recently introduced molluscs occur solely in harbours (Cranfield et al. 1998). These observations suggest that sheltered

bays and estuaries are the marine environments most at risk from future incursions. However, there are considerable biases in the distribution of the existing sampling effort for marine NIS. Few comparative analyses have been done anywhere in the world of the prevalence of NIS on mainland and island areas, among coastal environments, or among different habitats, so this conclusion should be considered preliminary.

The large incidence of invasions in estuarine and harbour environments probably reflects the location of international ports and anchorages and also the similarity in environmental conditions between the source of immigrants and recipient ports. Ballast water is usually taken from, and discharged into bays and estuaries. Species whose larvae or adults are able to tolerate estuarine conditions are, therefore, most likely to colonise ship ballast and hulls and, subsequently, to survive in the discharge environment. Moreover, restricted water circulation within the confines of sheltered ports and harbours can effectively entrain populations within these areas (Floerl and Inglis 2001; Cranfield et al. 1998). Recent reviews show that many of the species introduced into US waters are euryhaline, with broad salinity tolerances (Ruiz et al. 2000). Most invasions, however, have been reported from high salinity zones (18–35 ppt) of estuaries, rather than from the freshwater reaches (Ruiz et al. 2000).

Many of New Zealand's major ports and points of entry for international vessels are located within semi-enclosed embayments or estuaries (Table 4). Nine ports are located in natural deep water harbours or embayments that provide sheltered waters for berthage and which have a range of surrounding habitats that may be colonised by NIS (Table 4). Others are situated in the mouths of small river estuaries (e.g., Gisborne, Nelson, Westport), or have been constructed on exposed shorelines, with protection from artificial breakwalls (e.g., Timaru, Taranaki). Ports in large sheltered embayments and estuaries that have restricted exchange of water with open coast environments are likely to have a wide range of habitats available and, because of the limited dilution of arriving propagules, may be at greatest risk of incursion (Ruiz et al. 2000, Floerl & Inglis in review).

Table 4: General descriptions of the location of New Zealand's major ports and their surrounding environment

	Physical location				
Port	**Large natural embayment or harbour**	**River mouth / estuary**	**Open coast**	**Offshore terminal**	**Description**
Opua	✓ (Waikare Inlet, Bay of Islands)				Small domestic shipping wharf and marina
Whangarei	✓ (Whangarei Harbour)				Separate terminals at Marsden Pt, Portland, Port Whangarei and Whangarei Basin Marina

Port	Physical location				Description
	Large natural embayment or harbour	River mouth / estuary	Open coast	Offshore terminal	
Auckland	✓ (Waitemata Harbour)				Multiple terminals located in central Auckland. Two marinas are associated with the port (Viaduct Basin and Westhaven Marina) and a number of other large marinas are distributed in the Auckland region, notably Gulf Harbour Marina (Whangaparoa)
Tauranga	✓ (Tauranga Harbour)				25 berths and associated cargo terminals situated at the entrance to Tauranga Harbour. Associated boat marina
Gisborne		✓			Situated at the entrance to the Turanganui River
Taharoa				✓	Terminal for mineral sands located off the Kawhia coast
New Plymouth			✓		Constructed harbour. Artificial breakwalls enclose the port and a popular beach.
Napier			✓		Constructed harbour surrounded by artificial breakwalls. Adjacent to Ahuriri Estuary.
Wellington	✓ (Port Nicholson)				Main port located in central Wellington. Separate oil terminals at Burnham and Seaview.
Nelson		✓			Dredged harbour contained between Boulder Bank and the mainland, bounded to the SW by Haulashore Island and on the NE by the mudflats of Nelson Haven
Picton	✓ (Queen Charlotte Sound)				Small, domestic terminal located at the head of Queen Charlotte Sound. Separate forestry terminal in Port Shakespeare. Boat marinas in Picton and Waikawa.
Westport		✓			Small port located within the Buller River mouth

Port	Physical location				Description
	Large natural embayment or harbour	River mouth / estuary	Open coast	Offshore terminal	
Christchurch	✓ (Lyttelton Harbour)				Multiple terminals centrally located in Lyttelton Harbour, enclosed by an artificial breakwall.
Timaru			✓		Constructed harbour surrounded by artificial breakwalls.
Dunedin	✓				Separate terminals located throughout the harbour at Port Chalmers, George Street, Beach Street, Dunedin City and Ravensbourne
Milford	✓ (Milford Sound)				Small port at the head of Milford Sound, predominantly servicing tourist vessels
Invercargill	✓ (Bluff Harbour)				Multiple terminals situated 2 miles inside Bluff Harbour

6.1.1.3 Recent history of incursions

The recent history of incursions by NIS may also be a useful guide to the locations of future introductions, since patterns of invasion by different species often appear to be spatially correlated (Ruesink et al. 1995). Internationally, particular locations can be identified as "hot-spots" for repeat introductions of variety of NIS, across a broad range of taxonomic and functional groups. For example, San Francisco Bay on the US West Coast, Chesapeake Bay on the East Coast, and Pearl Harbour in Hawaii are known to have particularly large concentrations of NIS that appear to reflect the recent history of international shipping into the USA (Cohen and Carlton 1998; Coles et al. 1999; Ruiz et al. 1999; 2000). In Australia, Port Philip Bay in Victoria and the Derwent River Estuary in Tasmania are hot-spots for NIS (Hewitt et al. 1999). Focal points in the distribution of NIS in New Zealand include the Hauraki Gulf, and Lyttelton and Wellington Harbours (Figs 2 & 3). Some of the centres of distribution of NIS represent historical introductions, associated with whaling, sealing and trading patterns in the late 18^{th} and early 19^{th} centuries (Nelson 1993). Sheltered anchorages in the Marlborough Sounds, Port Adventure, Port Pegasus, Fiordland and Akaroa that contain unusually large numbers of NIS were once important centres of trade and industry, but are mostly no longer at high risk of new incursions.

Waitemata Harbour and, in particular, Orakei Basin, an enclosed tidal basin within Waitemata Harbour, have been the site of establishment for many NIS, including a number of the most recent arrivals (Dromgoole and Foster 1983; Hayward et al. 1997; Willan 1987; Cranfield et al. 1998; Willis et al. 1999). Provided that there are no major changes in the patterns of international shipping to associated ports (Carlton 1996), these areas should be considered of particularly high risk for future incursions.

Again, it is important to stress that these patterns are indicative only, since there have been large biases in these data associated with the relative distribution of past sampling effort and taxonomic expertise for NIS (Ruiz et al. 2000).

6.1.1.4 Disturbance

Physical disturbances provide spatial and temporal refuges for locally rare species by reducing competition with, or predation by established populations. Such refuges, or "invasion windows", often allow NIS to gain a foothold (Carlton 1996). Episodic and chronic disturbances are thought to facilitate invasion, although there is as yet little quantitative evidence of this for marine environments. Ruiz et al. (1999) suggested that more than half of the 54 NIS of plants and fishes in Chesapeake Bay appear to have established followed some form of anthropogenic disturbance. Similarly, Nicols et al. (1990) attributed the spectacularly rapid colonisation of San Francisco Bay by the Asian clam *Potamocorbula amurensis* to depression of the native biota by preceding floods. Where new habitats become available (e.g. new port or marina facilities) or where some form of existing disturbance means that a full complement of native species is not present, there may be opportunity for NIS to establish (Lonsdale 1999).

6.1.2 Sampling and survey design criteria

6.1.2.1 Comprehensiveness

Because of the uncertainty in predicting which NIS will become established in New Zealand environments and subsequently cause problems (Mack et al. 2000), the surveillance network should seek to incorporate a broad range of habitat types and communities that are under immediate risk of invasion.

6.1.2.2 Geographic coverage

The likelihood of detecting an incursion is a function of the number of sites included within the surveillance network. Because of the uncertainty in predicting where any new incursions will occur, the greatest chance of detection will be provided by a surveillance network that includes a large number of sites, across the range of high risk locations throughout the country.

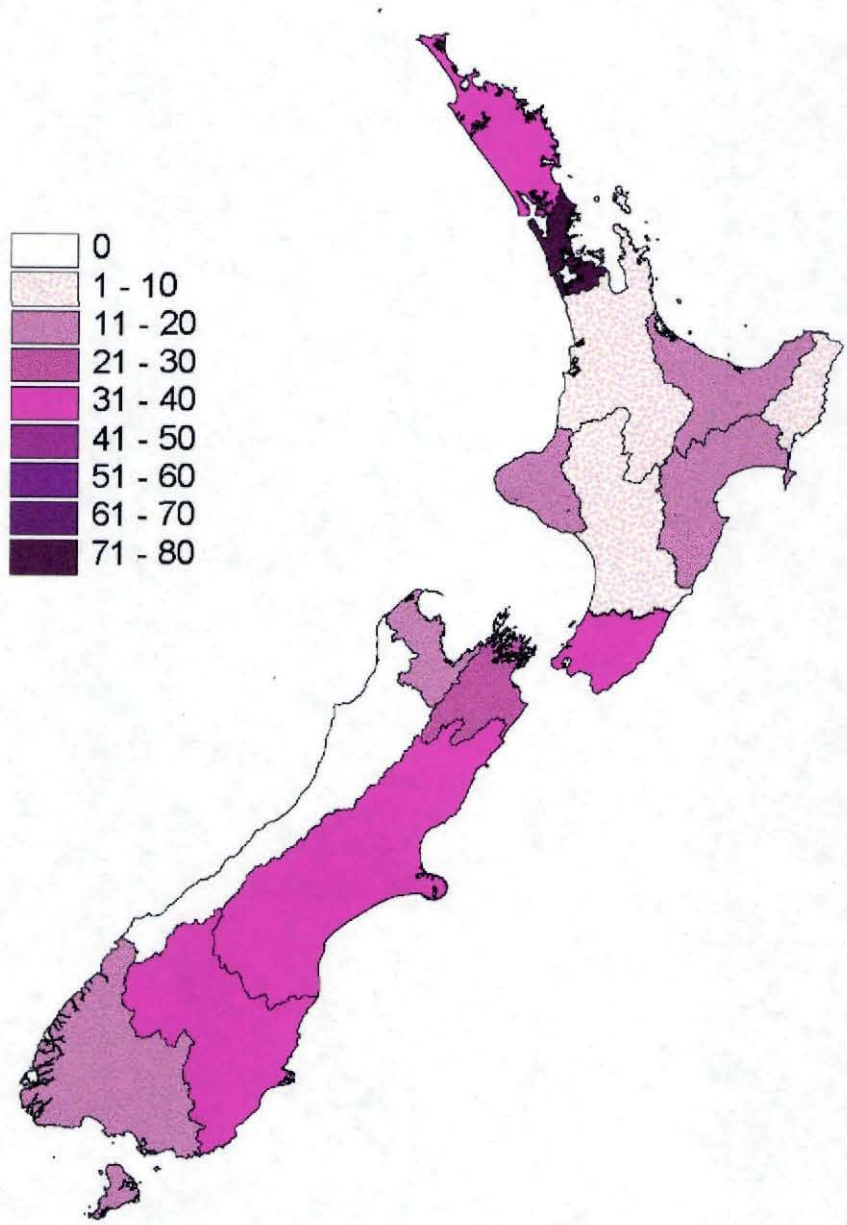

Figure 2. The regional distribution of known NIS in New Zealand. Shading indicates the relative number of NIS in each regional centre (data from Cranfield et al. 1998).

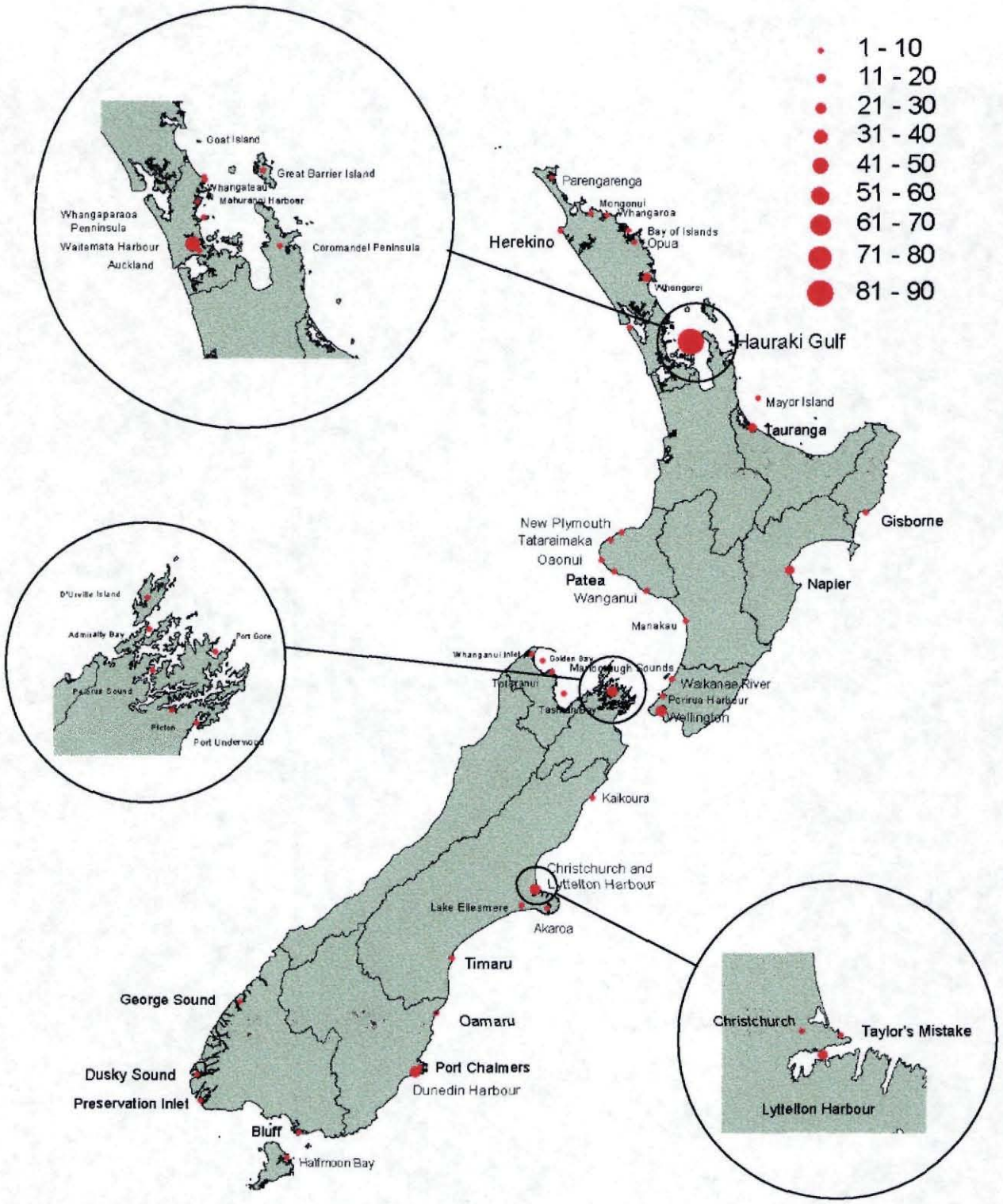

Figure 3. Centres of the distribution of known marine NIS in New Zealand (from Cranfield et al. 1998). The size of the symbols indicates the relative number of NIS recorded from each location.

7 Recommendations for the design of the surveillance network

To maximise the chances of detection, surveillance should be focussed on areas where incursions are most likely to occur, and any sampling programmes should be sufficiently powerful to detect them. Given the difficulty of detecting comparatively small establishing populations, it is important that sufficient effort is directed toward particularly high risk locations and that the study is able to state confidently that a particular species is not present, if it is not detected in the survey (Kovalak et al. 1986, Green & Young 1993). Broad-scale, long-term, scientific surveillance, is very resource intensive and can usually only be targeted at a handful of strategic locations. The proposed surveillance network of major ports (under ZBS2000/04), sentinel locations and valued sites contains an implicit hierarchy of sampling effort. New incursions are likely to occur first in major ports or locations associated with the main transport pathways for NIS, secondarily in surrounding natural habitats and, subsequently, in other valued coastal environments as the population spreads from its point of introduction. To enable detection at the earliest possible stage, greatest effort should be focused on the first two types of locations. A "watching brief" is more appropriate for high-value sites that are located well away from major ports, where the risks of any initial incursion are generally smaller, but where the costs of an incursion are likely to be high.

Since the costs (economic or otherwise) of an incursion will be specific to the pest and the valued ecosystem components that it affects, there is also an implied difference in the type of sampling that should be applied to each type of site. At ports of entry, the purpose of surveillance should be to detect **any** new incursions, since the taxonomic identity of any new invaders and their likely impact on the environment are unknown. Because ports are reasonably confined areas, surveys should sample intensively the habitats within the general port environment. It is more difficult to anticipate where any establishments will occur outside the immediate confines of the port. In surrounding harbours or estuaries that are at risk of incursion, therefore, surveillance should attempt to cover as broad a range of habitats and locations as possible. This requires the development of rapid assessment techniques for NIS and may necessitate restricting the search field to a more limited number of species that have been identified as unwanted or likely to reach New Zealand (see MFish project ZBS2000/05). The search field for unwanted species can be narrowed even further for surveys of high value sites, since it should be possible to identify a subset of species or types of species that pose a particular threat to the identified values of the location (i.e. not all potential NIS will pose a threat to the site's values).

NIWA envisages a three-pronged approach to surveillance:

(1) Intensive, scientific surveys of high risk ports of entry;
(2) Regular, rapid assessment of a broad range of habitat types within harbours and estuaries surrounding high risk ports of entry; and
(3) Targeted surveillance of high-value locations for known unwanted species.

To achieve broad geographic, ecological and temporal coverage, NIWA believes that the most effective and sustainable form of surveillance monitoring will be one that engages and uses the skills and resources of a range of special-interest industry and

community groups. This will be most appropriate for the latter two categories of sites which benefit most from broad geographic coverage and stakeholder involvement.

There are already successful examples of this approach to monitoring within New Zealand and overseas. For example, in the USA, SeaGrant projects have sought to increase public awareness of marine pests by producing a range of information and identification packs for key target species, such as the round goby, *Neogobius melanostomus*, and Zebra mussel, *Dreissena polymorpha*. Volunteer programmes for surveillance and control of NIS have been initiated in several US states and a broad-scale monitoring programme has begun in the 25 US National Estuarine Research Reserves. In Australia, the Great Barrier Reef Marine Park Authority has enlisted the help of a network of tourism operators to monitor and control outbreaks of the crown-of-thorns starfish (*Acanthaster plancii*).

Co-operative development of surveillance networks has a number of direct and indirect benefits for managing the impacts of NIS. Engaging the broader public in surveillance and control:

- allows agencies to identify more accurately the sites that are valued by particular groups and the concerns that they have for them,
- increases general awareness of the threat posed by NIS to valued environments and resources,
- increases individual responsibility for reducing the risk of spread, and
- increases general vigilance for unwanted species (Green 2000, PCE 2000b).

With few exceptions, members of the public have initially detected most new incursions of NIS in a range of countries world-wide. Taking advantage of this resource can build considerable capacity for surveillance and be a cost-effective way of broadening geographic coverage. This would complement and extend the efforts that MFish has already made in increasing public awareness of specific unwanted species.

Several successful models already exist for co-operative monitoring and surveillance within New Zealand. For example, the marine farming industry actively participates in the NZ Ministry of Health's marine biotoxin programme by collecting water and tissue samples for analysis of dinoflagellate toxicity. A similar approach has been recommended for control of the invasive Japanese kelp, *Undaria pinnafitida* (Sinner et al. 2000). Local stakeholder groups (e.g. iwi, marine farmers, dive clubs, fishers, etc) were identified as playing a potentially important role in managing the spread and impacts of the alga in areas of local significance that the groups have an interest in protecting. For example, marine farmers in Golden Bay have already established an *Undaria* surveillance and control programme at important spat catching sites.

Maori also have a significant interest in monitoring, surveillance and management of threats to marine and coastal resources that are of particular significance to iwi, hapu or whanau (PCE 2000b). A useful example of the development of monitoring tools for Maori is the Stream Health Monitoring and Assessment Kit (SHMAK). NIWA is currently working on a joint training programme with 18 runanga of Ngai Tahu to implement stream health monitoring at a range of sites throughout the South Island.

The kits include information on:

- How to plan and establish monitoring sites,
- Data sheets for recording results,
- Instructions on how to monitor a stream,
- Pictures and identification guides, and
- Scoring systems for data analysis.

Similar systems could be tailored to the biosecurity concerns of Maori and other stakeholders for the marine environment.

NIWA recommends that ZBS2000/01 consist of three components:

(1) development and trialing of techniques for rapid inventory of NIS in a range of habitats within high risk environments (i.e. sheltered harbours and estuaries which contain major, high risk ports),
(2) broader consultation with sectoral groups, using the criteria outlined in this document, to identify and select sites of value to each group,
(3) development and implementation of surveillance kits tailored to the needs of each sectoral group that has interests in protecting high value sites from incursions.

To be successful, development of, and reporting from these components should be co-ordinated nationally.

7.1 Recommendations for surveillance of high risk sites

Preliminary risk profiles have been developed for New Zealand's major international ports based on patterns of shipping and ballast discharge (Inglis 2001). Marine environments that are at greatest risk of incursion by NIS will be habitats within sheltered harbours or estuaries that surround these high risk points of entry. On the basis of these profiles and criteria outlined in this document, the following harbours are recommended for surveillance. In relative order of risk, they are:

(1) Waitemata Harbour
(2) Tauranga Harbour
(3) Whangarei Harbour
(4) Lyttelton Harbour
(5) Wellington Harbour
(6) Bluff Harbour
(7) Otago Harbour
(8) Nelson Harbour

Prioritisation of the harbours was based on the relative volume of international vessel movements and ballasting at the ports (Inglis 2001), upon the extent and relative enclosure of surrounding harbour environments, and the recent history of incursions by NIS (this report).

8 References

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9 Annex 1

9.1 Goals and values identified in relevant legislation and policy

9.1.1 International conventions and guidelines

9.1.1.1 Convention on Biological Diversity

New Zealand is a party to the Convention on Biological Diversity. Under the convention, governments are required to conserve and sustainably use biodiversity and to develop national strategies for achieving this. Obligations of the signatories include:

- Identifying and monitoring the important components of biological diversity that need to be conserved and used sustainably.
- Establishing protected areas to conserve biological diversity while promoting environmentally sound development around these areas.
- Rehabilitating and restoring degraded ecosystems and promoting the recovery of threatened species in collaboration with local residents.
- Respecting, preserving and maintaining traditional knowledge of the sustainable use of biological diversity with the involvement of indigenous peoples and local communities.
- Preventing the introduction of, controlling, and eradicating alien species that could threaten ecosystems, habitats or species.
- Promoting public participation, particularly when it comes to assessing the environmental impacts of development projects that threaten biological diversity.
- Educating people and raising awareness about the importance of biological diversity and the need to conserve it, and
- Reporting on how the country is meeting its biodiversity goals.

The government has recently developed a National Biodiversity Strategy and Action Plan to fulfil these obligations (see below). Alien species are specifically recognised in the plan as a major threat to New Zealand's indigenous biodiversity.

9.1.1.2 United Nations Convention of the Law of the Sea (UNCLOS)

UNCLOS describes customary international law of the sea and identifies the rights and responsibilities of sovereign nations over the oceans and seafloor that surround their coasts. Part XII of the convention describes the obligations that nations have to protect and preserve the marine environment within their Exclusive Economic Zone. In particular, it gives each nation powers to take measures to "protect and preserve rare or fragile ecosystems, as well as the habitat of depleted, threatened or endangered species and other forms of marine life". Coastal nations are required to monitor and evaluate the risks or effects of coastal pollution (including "alien" species) on the marine environment.

9.1.1.3 World Heritage Convention

New Zealand is a signatory to the World Heritage Convention. This agreement provides a means of identifying sites that have sufficient *'outstanding universal cultural or natural value'* to merit their recognition as significant parts of global World Heritage. In signing the Convention, New Zealand pledged to identify and protect such sites, together with others that represent our own national heritage. New Zealand currently has three sites listed on the World Heritage List, two of which contain significant coastal environments: Te Wahipounamu (South-West New Zealand World Heritage Area), and New Zealand Subantarctic Islands.

Obligations for monitoring under the World Heritage Convention
In 1998, the World Heritage Committee recommended periodic reporting by member nations on the condition and status of the values of listed sites. Included in these provisions are the requirements for monitoring the World Heritage values of the sites and potential threats to these values (UNESCO World Heritage Centre 1998). NIS may pose a significant threat to sites whose recognised values relate specifically to natural ecosystems. Both Te Wahipounamu and New Zealand's Subantarctic Islands fall into this category.

9.1.1.4 Ramsar Convention

The Ramsar Convention is an intergovernmental treaty on the protection and wise management of wetlands of international importance. Article 2 of the convention specifies a range of criteria that are to be used to identify wetlands of international importance. As it was originally developed to protect wetlands of significance to waterfowl the criteria for identifying Ramsar sites are heavily weighted toward sites that are important bird habitat. New Zealand currently has five Ramsar listed wetlands, but a further 108 sites potentially meet the Ramsar criteria (Cromarty and Scott 1996).

Obligations for monitoring under the Ramsar Convention

As a signatory to the Ramsar Convention, the New Zealand government is required to promote the significance of the listed wetlands, and to monitor and advise the Ramsar Secretariat of any changes to their ecological character. Some terrestrial and aquatic NIS already pose threats to marginal habitats within the three Ramsar sites that contain coastal or marine habitats, but it is unclear what threats might exist from marine NIS.

9.1.1.5 Convention on the Conservation of Migratory Species of Wild Animals

As a signatory to this convention, New Zealand has agreed to extend protection and conservation to endangered migratory species, their habitats and migration routes. The convention specifies two lists of species to which it applies. In New Zealand waters, these include marine turtles, humpback and blue whales, dusky dolphins, spectacle porpoise and a range of threatened albatross, mollymawks, terns and other sea birds.

9.1.1.6 IUCN Invasive Species Specialist Group

Guidelines produced by the IUCN's Invasive Species Specialist Group (2000) recommend protecting "islands and other centres of endemism with particularly vulnerable native biodiversity". In particular, the guidelines recommend control measures be targeted at:

- islands with a high percentage of endemics in the flora and fauna;
- isolated areas which are centres of endemism and/or have high levels of biodiversity or threatened endemics;
- sites where a new invasion has occurred and is not yet entrenched.

The IUCN guidelines have a particular focus on terrestrial environments and the relative value of the marine flora and fauna of offshore islands has been less well-defined. In New Zealand (and elsewhere), the terrestrial flora and fauna of offshore islands has significant conservation value, partly because of their isolation from centres of human population and existing pests (Green 2000). The relative proportion of marine biota shared between New Zealand's coastal environments and offshore islands is related to the distance of the islands from the mainland, with generally the more unique island assemblages being located further from the mainland (Towns and Ballantine 1993).

9.1.1.7 ANZECC Guidelines

The Australia-New Zealand Environment Conservation Council (ANZECC) Task Force on Marine Protected Areas developed criteria for identifying and selecting marine areas of environmental significance (ANZECC 1998). These criteria are based on international guidelines for selecting marine protected areas (Kelleher and Kenchington 1992) and have biodiversity and natural environmental values as their principal focus.

9.1.2 National policy and legislation

The task of maintaining the natural resources that support the economic, social and environmental values of New Zealand's marine environments is divided among several different agencies. MFish manages fisheries under the *Fisheries Act 1996* and is responsible for surveillance and emergency response to the entry of new exotic marine species. The Department of Conservation (DoC) has responsibility for protected species (*Wildlife Act 1953*, *Marine Mammals Act 1978*), the conservation of biodiversity *Conservation Act* 1987) and protected marine environments (*Marine Reserves Act 1971*). Utilisation of coastal resources (excluding fisheries) is managed jointly by DoC and regional councils under the *Resource Management Act 1991* (PCE 2000a). The legislation and policy that governs decisions made by these authorities contains specific statements of the purpose of the legislation and the values that the agency is mandated to protect.

9.1.2.1 New Zealand Biodiversity Strategy

New Zealand has recently developed a National Biodiversity Strategy and Action Plan to fulfil its obligations under the International Convention on Biodiversity (Anon. 2000). The strategy has four main goals:

- to enhance community and individual understanding about biodiversity, and inform, motivate and support widespread and coordinated action to conserve and sustainably use biodiversity;
- to actively protect iwi and hapu interests in indigenous biodiversity, and build and strengthen partnerships between government agencies and iwi and hapu in conserving and sustainably using indigenous biodiversity;
- to maintain and restore a full range of remaining natural habitats and ecosystems to a healthy functioning state, enhance critically scarce habitats, and sustain the more modified ecosystems in production and urban environments and do what else is necessary to maintain and restore viable populations of all indigenous species and subspecies across their natural range and maintain their genetic diversity;
- to maintain the genetic resources of introduced species that are important for economic, biological and cultural reasons by conserving their genetic diversity.

The Strategy outlines seven objectives for marine biodiversity, three of which are of particular relevance to biosecurity and the identification of high value sites:

> Objective 3.5: Develop an integrated system to identify biosecurity risks to marine biodiversity from exotic organisms and establish appropriate management responses to prevent and reduce these risks and to minimise their impacts.
>
> Objective 3.6: Protect a full range of natural marine habitats and ecosystems to effectively conserve marine biodiversity, using a range of appropriate mechanisms, including legal protection.
>
> Objective 3.7: Protect and enhance populations of marine and coastal species threatened with extinction, and prevent additional species and ecological communities from becoming threatened.

9.1.2.2 Biosecurity Review by the Office of the Parliamentary Commissioner for the Environment

The Parliamentary Commissioner for the Environment recently undertook a review of the biosecurity risks to New Zealand and their management (PCE 2000b). Importantly, the review identified a number of principles that should be considered for efficient and effective management of future threats:

(1) The concept of shared responsibility for managing biosecurity risks, and public participation in monitoring and surveillance.

(2) The appropriate focus of biosecurity should be on high risk pathways by which exotic organisms arrive in New Zealand.

(3) The need to increase New Zealand's resources and capabilities in marine biosecurity to deal effectively with the risks associated with marine invasive species.

(4) That all biosecurity agencies should contribute to the co-ordination and targeting of biosecurity monitoring and surveillance, and exchange of information.

9.1.2.3 Biosecurity Act 1993

The *Biosecurity Act 1993* regulates the management and control of "unwanted" organisms in New Zealand. Section V of the Act describes the situations in which the Minister may propose national pest management strategies for identified pest species. Pest management strategies may be developed for species that are capable of causing "serious adverse or unintended effects" on one or more of the following:

- Economic well-being;
- The viability of rare or endangered species of organisms, the survival and distribution of indigenous plants or animals, or the sustainability of natural and developed ecosystems, ecological processes, and biological diversity;
- Soil resources or water quality;
- Human health or enjoyment of the recreational value of the natural environment;
- The relationship of Maori and their culture and traditions with their ancestral lands, waters, sites, wahi tapu, and taonga.

The Minister may propose a National Pest Management Strategy (NPMS) only if there is potential for the organism to:

- have or be likely to have a significant effect on economic well-being
- have aroused widespread public concern or interest; or
- be unlikely to be eradicated or effectively managed without significant use of Crown resources; or
- affect or be likely to affect any structure, feature, place or area of national significance; or
- affect or be likely to affect more than one region; or
- affect or be likely to affect or are relevant to New Zealand's international obligations.

Each department with responsibilities for biosecurity (MAF, DoC, MFish and MoH) has developed a policy statement that sets out criteria for identifying "unwanted organisms" under the Biosecurity Act. These statements detail identified threats to values which the department has responsibility for safeguarding. Criteria prepared by DoC and MFish identify "unwanted species" as those capable or potentially capable of:

a. forming self-sustaining populations in New Zealand, taking into account the ease of eradication; and

b. displacing or reducing the abundance of any native marine species or any valued introduced marine species for which the MFish or DoC is responsible; or

c. causing the alteration or deterioration of natural habitats; or

d. causing adverse effects to New Zealand's indigenous biological diversity; or

e. causing disease, being parasitic, or becoming a vector for animal or plant disease affecting indigenous marine species or valued introduced marine species for which the MFish or DoC is responsible.

9.1.2.3.1 NPMS for marine pests

A draft NPMS has recently been proposed for the Japanese kelp, *Undaria pinnatifida* (Sinner et al. 2000). Since *Undaria* is already well-established in New Zealand and eradication appears unlikely, the strategy recommended a control programme based around protecting coastal marine areas of national significance. Four criteria were suggested for identifying sites with high ecological and natural values. These are:

That the site is:

I. remote and largely pristine; or
II. protected from exploitation; or
III. contains unique species or habitats; or
IV. Contains species or habitats that are broadly representative of coastal marine ecosystems around New Zealand.

Based on these criteria, six types of locations have been recommended for targeted control:

- Fiordland National Park; (Criterion I)
- Abel Tasman National Park; (Criterion III: natural character of the coastline)
- Stewart Island; (Criterion I)
- Sub-Antarctic Islands; (Criterion I)
- Chatham Islands (Criterion I); and
- Existing marine reserves and marine parks (Criterion II).

9.1.2.4 The Marine Reserves Act 1971

The *Marine Reserves Act 1971* provides for the establishment of marine reserves for the purpose of "preserving them in their natural state as the habitat of marine life for scientific study". The focus of the Act has been on marine areas that contain "underwater scenery, natural features, or marine life of such distinctive quality, or so typical or beautiful or unique, that their continued presence is in the national interest". The Act is currently under review to update its overall purpose to reflect the government's obligations to biodiversity protection and the Treaty of Waitangi (DoC 2000).

9.1.2.5 Fisheries Act 1996

The main purpose of the *Fisheries Act 1996* is to "provide for the utilisation of fisheries resources while ensuring sustainability". This includes managing the current and potential production of fisheries in New Zealand and their impact on the habitats

that support them. The Act establishes environmental principles to guide the utilisation of fisheries resources. These include the "maintenance of biological diversity" and the "protection of habitat of particular significance for fisheries management". Provisions within the Act allow for the protection of specific areas that are important for local and customary fisheries (taiapure), traditional fishing (mataitai) and for the protection of specific stocks or their habitat.

9.1.2.6 Resource Management Act 1991

The Resource Management Act 1991 (RMA) requires regional authorities to develop regional coastal plans as a basis for use of coastal and marine resources (other than fisheries). Coastal plans are required to identify areas that have "significant conservation value". Guidance for the selection of such areas and a list of generic criteria to aid their identification are provided in the New Zealand Coastal Policy Statement (DoC 1992). These are outlined in Box 1.

Section 6 of the RMA specifies "matters of national importance" that are to be provided for in resource management decisions. These include:

- The preservation of the natural character of the coastal environment and wetlands;
- The protection of outstanding natural features and landscapes;
- The protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna; and
- The relationship of Maori and their culture and traditions with their ancestoral lands, water, sites, wahi tapu, and other taonga.

9.1.2.7 Conservation Act 1987

The *Conservation Act* provides for the protection and management of natural areas in the national estate. It allows for the establishment of six types of specially protected area (SPA) and defines the purpose of each type:

- Conservation Parks
- Wilderness Areas
- Ecological Areas
- Sanctuary Areas
- Watercourse Areas
- Marginal Strips

Each of these areas has a different purpose and level of protection, but collectively they provide for the "preservation and protection of natural and historic resources for the purpose of maintaining their intrinsic values, providing for their appreciation and recreational enjoyment by the public and safeguarding the options for future generations".

Box 1. Criteria for identifying areas of significant conservation value in regional coastal plans.

Maori cultural values

- Areas of local, regional, or national significance identified by the tangata whenua in accordance with tikanga Maori, including wahi tapu, urupa, tauranga waka and mahinga mataitai.

Protected areas

- Where there are protected areas below Mean High Water Springs
- Any gazetted or notified marine reserve, marine mammal sanctuary, marine park or other marine protected area, including adequate buffer areas, or any proposal which is under current investigation.
- Where there are protected areas above Mean High Water Springs
- Where there are protected areas above mean high water springs, consideration may be given to whether the adjoining area below mean high water springs should be identified as an area of significant conservation value.

Wetlands, Estuaries & Coastal lagoons

- Any wetland, estuary, or coastal lagoon in the coastal marine area which is of national or international importance, including those:
- (a) necessary to act as buffer zones;
- (b) that are important spawning grounds or nurseries for marine and freshwater species;
- (c) where related catchments, marginal land and tidal flats have been minimally modified;
- (d) strategically situated to act as stepping stones for migratory species along coastal tracts.

Areas of importance for Marine Mammals and Birds

- Areas including or near any:
- (a) marine mammal breeding or haul out site;
- (b) habitats of endangered, vulnerable, rare or threatened bird species;
- (c) important roost sites, or feeding areas of wading birds.

Ecosystems, flora and fauna habitats

- Any area that contains regionally, nationally, or internationally significant or threatened ecosystem or plant or animal species.

Scenic Sites

- Any part of the coastal marine area that forms a land or seascape of national or international importance.

Historic Places

- Historic places of national or outstanding significance (including archaeological sites adjoining mean high water springs), especially places where values relate to the seabed as well as to the land.

Coastal landforms and associated processes

- Representative examples of nationally significant or outstanding coastal landforms and their associated sediment transport systems and sources including:
- (a) submerged landforms (e.g. fiords, drowned river valleys, banks, reefs, moraines, and drowned shorelines);
- (b) erosional landforms including those that have been carved out of the land by the sea (e.g. shore platforms and submarine canyons);
- (c) geologically rare or unusual features of very high quality.