NIWA

Taihoro Nukurangi

Design of baseline surveys for exotic marine organisms

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Report Title: Design of baseline surveys for exotic marine organisms

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7. **Executive Summary:**

Objective 3 of this project involves the design of baseline surveys. Since developing criteria for selecting ports (Objective 1), and making recommendations on the location and priority of sites (Objective 2), we have concentrated on details of the sampling design and survey methodology. Initial liaison with port companies in both North and South Islands has been successful, and an ongoing dialogue has been established. Port companies have generally been forthcoming with information and have promised logistical support for the planned baseline surveys. To maintain consistency with surveillance efforts overseas we have adopted survey protocols developed by the CSIRO: Centre for Research on Introduced Marine Pests (CRIMP). Some refinement to the CRIMP survey protocols were necessary to make them suitable for New Zealand conditions. A workshop was held at which leading New Zealand marine scientists with expertise in a wide range of marine vertebrate, invertebrate and plant groups reviewed the proposed sampling protocols and made recommendations based on their experience of New Zealand conditions. Accordingly a number of methodological details of the Australian CRIMP survey protocols have been altered to ensure these generic recommendations can be implemented in New Zealand Port environments.

This report outlines how baseline port surveys have been designed in accordance with objective 3 of ZBS2000/04.

8. Objective 3:

To design baseline surveys for selected locations identified in Objective 2.

9. Purpose of Baseline Port Surveys

Before significant attempts can be made to control the introduction and spread of non-indigenous species (NIS) in New Zealand's marine environment, we need to establish the current diversity and distribution of species introduced by shipping. Accordingly baseline port surveys are designed to provide an inventory of indigenous and non-indigenous species in New Zealand ports as well as to identify cryptogenic species (i.e. those species of uncertain status that could be endemic or introduced and may become major pests in the future). A standardised set of survey methods will be used to provide a consistent basis on which to assess the introduced species status of individual ports. Surveys designed to identify all non-indigenous species in a port will inevitably be subject to scientific, logistic and cost constraints that will limit their taxonomic, spatial and temporal scope. Recognition of these constraints led us to concentrate surveys on a group of substrata and locations within ports (such as pier piles and wharves) where invasive species are most likely to be found.

10. Survey Design and Methodology

In accordance with the original tender requirements, design of port survey sampling and methodology has been based on protocols developed by CSIRO's Centre for Research on Introduced Marine Pests (CRIMP). These protocols were originally developed in 1996 for implementing baseline surveys of marine pests in Australian ports and were revised by CRIMP in 2001. CRIMP protocols aim to provide a consistent approach to surveys across a wide variety of Australian port habitats varying from southern ocean environments to ports in tropical latitudes. The CRIMP protocols are somewhat generic and require modifications to local conditions. Details on the CRIMP survey protocols can be viewed online at: www.marine.csiro.au/CRIMP/. We restrict our discussion here to proposed modifications to the protocols which we feel will augment their approach while ensuring suitability to New Zealand port conditions.

11. Recommendations from the Port Survey Design Workshop

A group of New Zealand marine biologists reviewed the CRIMP protocols at a workshop held in Wellington on the 17th of September 2001. The aim of the workshop was to assess the feasibility of CRIMP protocols for conducting Port Baseline Surveys in this country and to refine techniques for sampling, labelling and preservation. A number of recommendations ensued from this workshop which are summarised in Table 1 and described in detail in the subsequent text. Proposed modifications will ensure cost effective and efficient collection of baseline invasive species data for New Zealand ports.

Table 1. Summary of recommended modifications to CRIMP Survey Protocols

	CRIMP Protocol	Recommended Modification
1	Equivalent search effort for invasive species at each port irrespective of risk profiles.	Vary search effort among ports on the basis of risk profiles. For instance intensify searches in areas likely to receive fouling organisms at ports with a high risk of hull fouling (as identified in the second ZBS2000/04 progress report).
2	Pile scrapings for fouling assemblages.	Increase replication from 3 to 4 quadrats per pile and sample pairs of piles in light and shade areas at each berth.
3	Sample fish using seine nets and poisoning.	Collect fish using 'opera house' traps.
4	Sample planktonic organisms without temporal replication.	Do not sample planktonic organisms without temporal replication.
5	Diver collection of benthic samples over soft sediment habitats.	Sample benthos from soft sediment habitats using vessel deployed grab samplers (e.g. Smith McIntyre grabs) and sled tows.
6	Indiscriminate sampling for dinoflagellate cysts over soft sediments.	Targeted sampling for dinoflagellate cysts over high depositional sites in soft sediment to increase the probability of cyst detection.
7	No settlement plate studies recommended.	Deploy settlement plates at a subset of ports.
8	Extensive use of pre-fixing methods for preservation of samples.	Simplification of sample preservation techniques and elimination of most pre-fixing techniques. Some taxon- specific modifications to preservation, for instance polychaetes to be preserved in formalin rather than alcohol.

11.1 Variation to sampling effort among ports on the basis of risk assessments

Sampling emphasis at each of the ports will be varied on the basis of identified risk profiles for introduced species. For instance ports identified as having higher risk of hull fouling organisms than ballast water introduced species will have areas such as pier piles more intensively searched. While a consistent minimum search effort will be applied across all ports, additional emphasises to sampling will be made in appropriate habitats within high risk ports. This approach will improve the efficiency of searches nation-wide and ensure a more cost effective utilisation of resources.

Furthermore we recommend that resources initially proposed for non-indigenous species (NIS) surveys of Westport are better redirected to more comprehensive surveys of ports with higher risk profiles. The port of Westport is very weakly saline with a predominantly fresh water fauna and a recent NIWA survey at this location revealed a conspicuous lack of marine fouling organisms. Coupled with little international shipping traffic and ballast discharge, the risk profile of Westport for invasive marine organisms appears particularly low. Consequently workshop attendees felt that resources would be better utilised at sites characterised by high volumes of ballast water discharge and/or significant international shipping traffic likely to introduce NIS to New Zealand.

11.2 Augmentation of pile scraping techniques for fouling assemblages

The CRIMP protocols suggest sampling 3 replicate 0.10m^2 quadrats on each of 3 piles per berth and multiple berths per port. This level of sampling is considered minimal and would benefit from more replication at the level of individual piles to adequately

represent the vertical zonation in fouling assemblages with depth. We intend to sample 4 replicate 0.10m^2 quadrats on each of 4 piles per berth. Furthermore to allow for variation in composition of assemblages with differing light exposure (a common observation for pile fouling communities) sampling would benefit from selecting piles that represent exposed and sheltered light regimes beneath wharves and piers. Accordingly we propose to structure pile sampling more formally than that proposed by CRIMP, and sample quadrats on 2 light and 2 dark piles from each berth.

11.3 Modifications to fish sampling protocols

CRIMP suggest sampling ports for non-indigenous fish species using beach seine nets and poison stations. These techniques are impractical here for a number of reasons. First, most New Zealand ports do not have suitable beaches on which seine nets could be hauled. Secondly rotenone or similar fish poisons are also poorly suited to use in the typically low-visibility, turbid waters of New Zealand ports. We anticipate that the use of fish poisons would result in poor capture rates despite high fish mortality due to problems associated with divers being unable to see the poisoned fishes. Fish poisons can also represent a health risk to workers handling them. Furthermore we feel that obtaining permission to use fish toxins within ports and adverse public reactions from dead or dying fish would cause significant problems.

The majority of invasive marine fishes known to be introduced via ballast water transport world wide are smaller bodied and creviculous in nature, i.e, they occupy crevices and holes for shelter. As such, capture techniques should concentrate on smaller species such as gobies, blennies and triplefins found around piles and rocky reef structures and not the larger more mobile fishes that occupy more diverse habitats and will occasionally enter ports. The latter are unlikely to remain within port environments and would be more effectively sampled within the surrounding harbour environments. Sampling this larger, mobile component of the fish fauna is logistically difficult and unlikely to represent a cost effective approach to the port inventories. Accordingly we propose to concentrate on the smaller, habitat- associated fishes.

As a workable alternative the fish experts at the workshop recommended the deployment of baited 'opera house' fish traps which have been extensively trialed by NIWA in the North Island and found to be suited to capturing invasive fish species in a variety of habitats. These collapsible traps are suitable for capturing creviculous species of gobies, blennies and triple fins likely to dominate the invasive fishes found in port environments. While additional trapping or netting techniques could also augment this approach, advice from NIWA's marine fish experts suggests that fish diversity is likely to be low within ports and any larger invasive fish species are more likely to be found in adjacent habitats than within port limits. A recent comparison of 4 trapping designs for capturing fish in Australian ports recommended 'opera house' traps as the most appropriate trapping technique. Short soak times for these traps also mean they can be re-set in a variety of habitats and locations within a single day, thus providing more comprehensive surveys than poisoning and seine nets.

11.4 Removal of plankton net samples without temporal replication

Phytoplankton and zooplankton communities are extremely variable in both space and time. Extreme variability is likely to exist in plankton community composition, species richness, relative abundance and trophic structure within the port and through the year and changes in composition occur rapidly within a matter of hours to days. As such, plankton tows and drop net deployments taken at one point in time (as proposed by CRIMP) provides an inadequate characterisation of this component of the marine flora and fauna of ports. The workshop participants felt that this effort was unjustified and unlikely to prove a useful means of surveillance of invasive marine planktonic organisms. Since very little confidence could be attached to findings from sampling limited to a single week of the year, we suggest that resources would be better diverted to more rigorous sampling methods that target other components of the biota such as pile scrapings, benthic trawls or trapping.

To characterise the temporal and spatial variability in planktonic organisms at each of the ports and detect invasive species would require a considerable increase in sampling frequency and effort. However this is beyond the scope of the current program and would necessitate a substantially increased cost. There are also significant difficulties in the identification of many planktonic organisms, so that the expense of this sampling is currently impractical. While limited planktonic sampling could certainly be carried out as suggested by CRIMP, the limitations of such an approach are so significant that the sampling would not be worthwhile.

While we propose to eliminate plankton net samples from port surveys, sediment core samples will be taken to detect dinoflagellate cysts since such samples can provide a historical record of phytoplankton species that may have been introduced.

11.5 Substitute diver sampling of open sediment benthos with vessel deployed grab samples and sledge tows

A number of techniques exist to successfully sample benthic infauna from soft sediment habitats. Vessel deployed grab sampling using a Smith-McIntyre grab and benthic sled tows are widely adopted practical alternatives to diver collected cores (as noted by CRIMP). Advice from NIWA's national diving safety officer and staff with practical experience diving in busy port environments, suggests it is unsafe to dive over soft sediments in open sections of ports. Boating traffic, poor visibility underwater and navigational problems for divers over relatively featureless substrata represent significant hazards to workers and explain our decision to employ grab sampling and epibenthic sled tows as alternatives.

11.6 Dinoflagellate cyst diver searches to be limited to sites of high probability

Dinoflagellate cysts are not deposited evenly across open areas of sediment within port environments, rather they are only reliably detected in depositional environments characterised by depressions in fine sediments. Accordingly cost efficient searches for these cysts using diver operated coring techniques to capture cysts in the surface layers of sediment are best achieved by initially identifying local gyres and high sedimentation locations. We propose to initially identify such locations from existing bathymetry data for ports and local knowledge of sedimentation regimes to improve

our probability of detecting these cysts. Such an approach minimises the expenses of unnecessary sampling across broad areas of cyst-free seafloor, and reduces safety concerns associated with deploying divers in potentially high shipping traffic areas.

11.7 Settlement plates to be trialed in a subset of ports

The baseline surveys provide a single 'snap-shot' of the marine organisms present in the ports and do not account for seasonal changes in the abundance of some species. Use of settlement plates is proposed to provide some temporal measure of changes in the abundance of fouling species. Accordingly we propose to deploy settlement plates in a subset of ports characterised by high risk from fouling organisms. We propose to adopt methods comparable with similar fouling plate studies of invasive species being undertaken by CRIMP and the Smithsonian Environmental Research Center (SERC). Equivalent methods will ensure that settlement results from ports in this country are comparable with other international studies of invasive species recruitment.

11.8 Alterations to methods for fixation and preservation of some groups

Expert advice from leading taxonomists in this country suggested that many of the CRIMP fixative and preservation techniques were unnecessarily complex and would be difficult and time consuming to implement in the field. In particular, the taxonomists felt that many of the pre-fixing methodologies were unnecessary and could be avoided without detriment to sample quality or subsequent specimen identification. Some taxon-specific suggestions from researchers with extensive experience in particular groups were also made. For instance:

- Sponges should be preserved in 70% ethanol rather than formalin.
- Preservation of polychaetes in formalin is critical for their successful identification since they degrade in alcohol. The recommendation to remove worms from tubes is not necessary and will avoid the risk that worm & tube could be mismatched.
- Oligochaete worms should be preserved in 70% alcohol rather than in formalin.
- Macroalgae will be treated in three ways:
    1. Fresh pressed on herbarium paper – only where there is sufficient time to handle material directly after collection (or within 24 hours if the material is refrigerated quickly after collection).
    2. Preserved in 3–5% formalin/seawater, before identification or pressing.
    3. Sub-samples of preserved material dried in silica gel. This is for molecular sequence analysis – all silica gel samples will be vouched by a preserved sample.

11.9 Sampling Limits

Port surveys will provide inventories of native, non-indigenous and cryptogenic species from the ports listed in previous progress reports. However, as noted earlier in this report we recommend that Westport not be surveyed. The spatial extent of sampling will include the wharves, piers, breakwaters and associated structures in commercial port areas and open sediment areas within commercial sectors of the ports, while not extending to harbour limits. Sampling at most ports will extend over a period of approximately a week. The need to extensively sample 17 ports for diverse taxa to establish baselines precludes significant temporal replication in sampling which may prevent identification of some invasive species simply because they are not

present at the time of sampling. However by scheduling port surveys through the summer months we have maximised the chances of detecting seasonally abundant marine plants that may be absent or difficult to detect at other times of year.

12. Conclusion

Baseline port surveys will be conducted at 17 ports around the North and South Islands over the next 2 years. Inventories of native, non-native and cryptic species will be established using CRIMP survey protocols modified for New Zealand conditions as described in this report. Survey emphasis will be placed on structures at highest risk of incursion within ports. The first port survey will be conducted in Wellington in mid November and will provide the initial opportunity to assess the extent of New Zealand ports' invasion by introduced marine organisms.