PROPOSAL FOR HOROWHENUA SURF ZONE SHELLFISH STUDY

Manaaki Taha Moana

MTM Report No. 20

Proposal for Horowhenua Surf Zone Shellfish Study

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1. INTRODUCTION

1.1 BACKGROUND AND CONTEXT

The research proposed in this report is part of the research programme, “Enhancing Coastal Ecosystems for Iwi: Manaaki Taha Moana” (MAUX0907), funded by the Ministry for Business, Innovation and Employment. Manaaki Taha Moana (MTM) is a six-year programme, running from October 2009 to September 2015, with research being conducted primarily in two areas: Tauranga moana and the Horowhenua coast (from the Hokio Stream to Waitohu Stream). This programme builds upon Massey University’s previous research with Ngāti Raukawa in the lower north island: 'Ecosystem Services Benefits in Terrestrial Ecosystems for iwi' (MAUX0502).

Professor Murray Patterson, of Massey’s School of People Environment and Planning is the Science Leader of MTM. A number of different organisations are contracted to deliver the research: Manaaki Te Awanui Trust in the Tauranga moana case study; Te Reo a Taiao Ngāti Raukawa Environmental Resource Unit (Taiao Raukawa) and Dr Huhana Smith in the Horowhenua coast case study; WakaDigital Ltd; Cawthron Institute; and Massey University. The research team does its best to engage extensively with local communities and end users through a variety of means. The MTM programme website is: http://www.mtm.ac.nz and readers are encouraged to visit our website to read more about this research programme.

The central research question of MTM is: “how can we best enhance and restore the value and resilience of coastal ecosystems and their services, so that this makes a positive contribution to iwi identity, survival and welfare in the case study regions?” Thus, our research aims to restore and enhance coastal ecosystems and their services of importance to iwi/hapū, through a better knowledge of these ecosystems and the degradation processes that affect them. Action Plans are being produced for improving coastal ecosystems in each rohe. Mechanisms will also be put in place to facilitate uptake amongst other iwi throughout NZ. The key features of this research are that it is: cross-cultural; interdisciplinary; applied/problem solving; technologically innovative; and integrates the ecological, environmental, cultural and social factors associated with coastal restoration.

The first phase of MTM was a ‘Stocktake’ of the published research and knowledge of coastal ecosystems and their services in the two case study regions. This phase resulted in a number of publications and coastal resource management tools. Collectively, these components helped inform the research team and tangata whenua in the selection case studies for more in-depth study and tool development in the current stage of MTM. A number of projects have been undertaken, or are continuing (see: http://www.mtm.ac.nz/index.php/knowledge-centre/publications; http://www.mtm.ac.nz/index.php/toolkits).

This purpose of this proposal is to outline the research that we wish to undertake in the Horowhenua case study surf zone.

2. RATIONALE

Tangata whenua are concerned about the decline of toheroa (*Paphies ventricosa*), tohemanga (*Oxyperas elongata*) and other surf clam species (*e.g.* tuatua, pipi) along the Horowhenua coastline. Kaitiaki, customary fisheries representatives and kaumātua have expressed concern about the safety of eating shellfish harvested along the Horowhenua coastline, since poor water quality and faecal contamination were evident in a recent report on water quality in Waiwiri Stream (Allen *et al.* 2012).

Tangata whenua have considerable local knowledge about both historical and current populations of surf zone shellfish on the Horowhenua beaches. For the study proposed here, they will play a key role in identifying sampling sites, the placement of transects and the hands-on sampling work to investigate factors affecting the population and health of shellfish from Hokio to Ōtaki.

A recent report produced by a Ngāti Raukawa Māori environmental consultancy commented on the severe decline in shellfish populations, particularly "the total absence of Tohemanga[1]… (in areas) … once revered as a place of abundance for the large delicacy. It is now devoid of Tohemanga, which is an alarming finding" (Moore and Royal 2012: 18).

A recent study by National Institute of Water and Atmospheric Research (NIWA;Williams *et al.* 2013a) has identified a number of factors that could help to explain the decline of toheroa, including land use change and associated changes to the freshwater flows coming onto the beaches, food availability, climate and weather, sand smothering/sediment instability, damage caused by vehicle traffic, predation, harvesting, toxic algal blooms and disease. At the same time, a literature review by Cawthron (Heasman *et al.* 2012) identified many of these same potential factors, plus the possibility that ghost shrimp (*Biffarius filholi*) are predating or otherwise displacing toheroa and other shellfish or may be correlated with other changes that are causing shellfish decline.

Moore and Royal (2012) also note the presence of "a mega-worm bed", which is likely a ghost shrimp colony. Ghost shrimp modify the habitat by changing sediment quality through burrowing and irrigation activities. It is difficult to separate cause and effect to determine whether ghost shrimp are excluding shellfish by modifying the habitat, or if

[1] The terms tohemanga and toheroa are often used interchangeably by tangata whenua on the Horowhenua coast. It appears in this case that Moore and Royal were referring to toheroa (*Paphies ventricosa*).

the decline in shellfish has allowed ghost shrimp to colonise new areas. In addition, although there is very limited direct evidence, a number of anecdotal reports suggest that ghost shrimp predate upon toheroa. Williamson (1967-1970) reported that ghost shrimp density and distribution increased dramatically in the same period that O'Shea (1986) reported a decline in toheroa density and distribution along Wellington west coast beaches. O'Shea (1986) also noticed that on Orepuki Beach, the highest levels of toheroa recruitment occurred where ghost shrimp were absent, or present at a very low density.

Toheroa appear to be associated with freshwater seepage and beds are often located close to freshwater streams, near seepage from brackish lagoons behind adjacent sand dunes or where the water table lies close to the surface (Williams *et al.* 2013a, b; Heasman *et al.* 2012). Groundwater flow supplies nutrients to benthic diatoms, an important food source for toheroa, and increases the area able to be inhabited without desiccation. In addition, a lowering of the water table has the potential to affect erosion of beach sediments and alter temperature and salinity regimes that might be important cues for spawning, or directly affect the ability of toheroa and other shellfish to survive (Heasman *et al.* 2012). Williams *et al.* (2013a) explored the effect of land use change on toheroa populations by comparing modern and historic land use adjacent to Dargaville and Ninety Mile beaches, which historically supported two of the largest populations of toheroa in New Zealand. Lower numbers of toheroa were encountered at Ninety Mile beach, which is expected to have altered hydrology due to an increase in forestation and has shown a greater decrease in the number of watercourses annotated on topographical maps over time. Land use changes adjacent to the beach therefore have the potential to alter the amount and/or quality of the freshwater seepage and will be investigated within this survey.

Tohemanga (*Oxyperas elongata*) is reported by Willan *et al.* (2010) to be a subtidal species, *i.e.* occurs from the low tide mark down to at least 80 m, whereas toheroa (*Paphies ventricosa*) is intertidal, *i.e.* occurs in wetted areas exposed at low tide. Of a similar size to toheroa (80-100+mm), its habitat is described as “buried in clean sand, off open beaches” and it is said to occur “throughout New Zealand, including Stewart Island and the Chatham Islands” (Willan *et al.* 2010, p 510). Less is known about populations of tohemanga and the factors affecting them, and because it is subtidal it is much more difficult than toheroa to study.

Together with local kaitiaki, we propose an intensive survey of Horowhenua surf zone habitat to investigate one of these factors: changes in land use and freshwater flows. As secondary objectives, we would explore habitat changes associated with increase in ghost shrimp and investigate the prevalence of faecal contamination of shellfish. The study will target the intertidal zone and the shellfish found therein, but will also document tohemanga that are encountered during sampling.

3. METHODS

3.1. Site selection

The proposed study would involve a detailed one-off habitat survey (16 sites). Sampling would target sites near the mouths of local rivers (for example, Hokio, Waiwiri, Ohau, Waikawa, Waiorongomai , Waitohu) as well as sites away from this influence, and sites with varying degrees of land use change in the nearby dunes and adjacent areas (Table 1). Site selection would also take into account the location of current and historic shellfish beds and incorporate some areas colonized by ghost shrimp. Tangata whenua would identify 16 sites that fit the criteria shown in Table

3.2. Land use change

To determine the influence of land use practices on freshwater flows and toheroa/shellfish populations, we would map the historical and current land use of the catchments/inland coastal zones adjacent to the study area, as done in Northland by Williams *et al.* (2013a). For each shellfish sampling site, aerial photographs would be used to generate a variable (*e.g.* distance from freshwater seeps and streams, or proportion of catchment in pine trees) that we would include in our statistical models to assess the influence of land use on shellfish populations.

Table 1. Sampling site design. Ghost shrimp (GS) colonies will be targeted at some of the sites that historically had, or never had, shellfish populations.

Site	Freshwater influence	Land use change	Shellfish Populations
1	High	High	Current
2	High	High	Current
3	High	High	Historic + GS
4	High	High	Never
5	High	None/low	Current
6	High	None/low	Current
7	High	None/low	Historic
8	High	None/low	Never + GS
9	Low	High	Current
10	Low	High	Current
11	Low	High	Historic + GS
12	Low	High	Never
13	Low	None/low	Current
14	Low	None/low	Current
15	Low	None/low	Historic
16	Low	None/low	Never + GS

Ideally we would have access to historical photographs to quantify land use change over time, which would be interesting to compare with evidence from kaumātua concerning changes in shellfish populations over time, *i.e.* whether population declines are greatest where pine trees have been planted or other land use changes has occurred. This land use information would be useful in helping to determine initial site selection.

3.3. Sampling methods at each site

At each site, two downshore transects would run perpendicular to the shoreline (edge of dunes to low water) with six levels of the shore measured (Figure 1). The precise placement of transects will be guided by local kaitiaki to target a line that is most likely to yield significant numbers of shellfish. For each site, we will document mātauranga and other local knowledge about the site, including about land use change and changes in the relative abundance of shellfish at the site over recent decades.

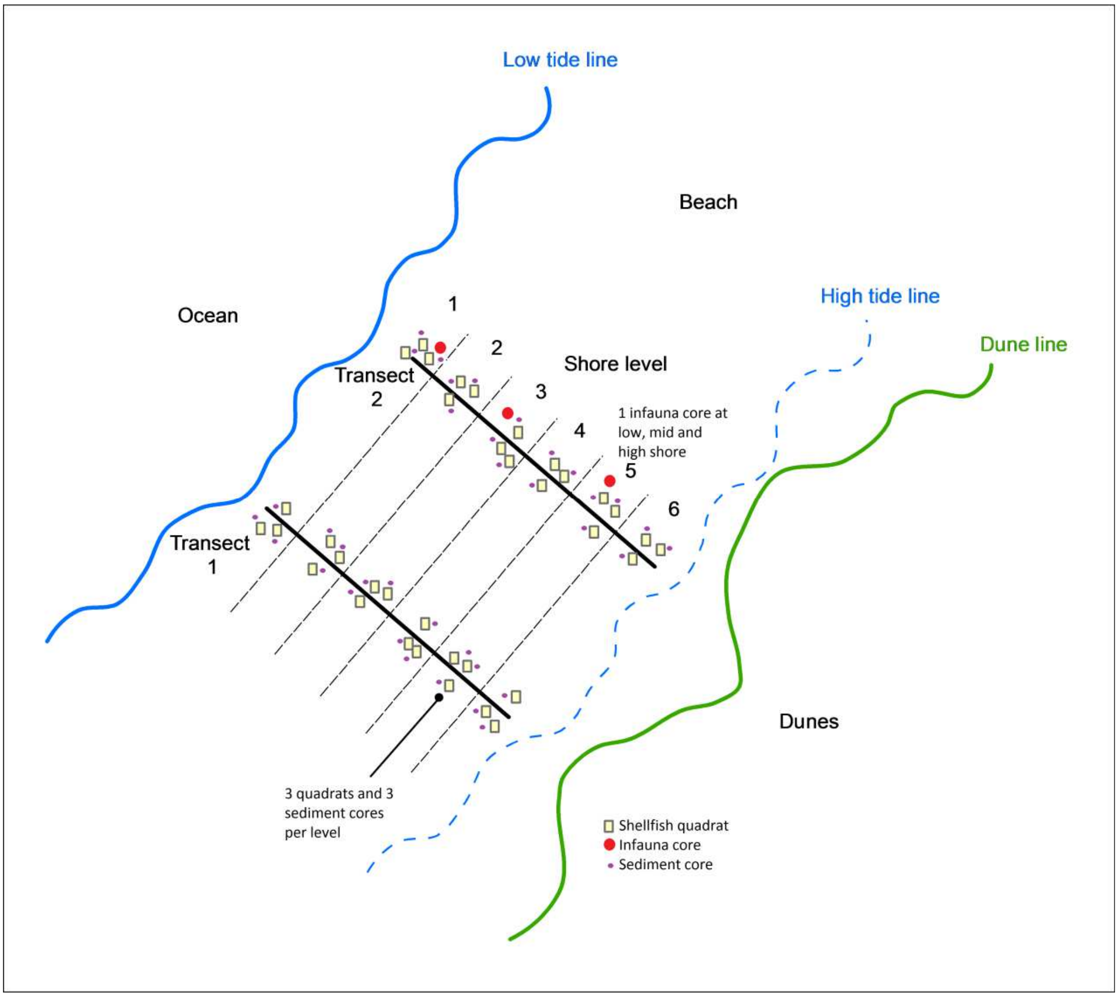

Figure 1. A diagrammatic representation of a sampling regime for surf clam populations

At each shoreline level, three replicate 0.5 m^2 quadrats dug to 30 cm would be sampled, similar to methods employed in other toheroa/shellfish surveys (*e.g.* Beentjes 2010a, b; Futter & Moller 2009; Akroyd *et al.* 2008; Carbines & Breen 1999). The excavated sand would be spread out onto a tarpaulin (see Beentjes 2010a, b) and searched for toheroa, tohemanga, tuatua (*Paphies subtriangulata*), pipi (*Paphies australis*) and any other species of importance to the local tangata whenua. The size frequency of these species would then be recorded and the shellfish returned to the substrate.

This method of counting is much quicker than sieving, though it has the potential to miss the smaller size classes. In order to obtain information about juveniles, one infauna core (130 mm diameter x 100 mm deep) would be collected from low, mid and high tide shore levels along one transect at each site (Figure 1). Each core would be gently sieved through a 0.5 mm mesh and juvenile toheroa, tohemanga, tuatua, pipi collected and preserved with ethanol (diluted to ~ 70% with seawater). When at the small juvenile stage, these four species are difficult to distinguish and, as this information would add little to our study, no attempt will be made to identify the juveniles to species level. However, the size frequency of these juvenile shellfish would be recorded. Ghost shrimp would also be collected and counted to obtain information on species distribution and abundances.

A sub-sample of adult shellfish would be taken to Cawthron to measure concentrations of faecal indicator bacteria (FIB). We could also consider measuring a condition index (ratio of shellfish flesh to volume) as a further indicator of the health of shellfish populations, as poor condition can explain low reproductive success.

Sediment cores (20 mm diameter x 20 mm deep) would be collected adjacent to each of the quadrats used to sample shellfish (Figure 1). For each shoreline level, the replicates from both transects (six in total) would be combined in a single sample and the sediment would be analysed for a variety of sediment characteristics: grain-size, organic matter, total nitrogen, chlorophyll-α. Other data that may be collected at each site includes photographs of the beach slope along the line of the transect, land use directly above the transect, the height of the beach surface above the water table in each quadrat, salinity, water temperature, penetrability of the sediment and dissolved oxygen levels.

If possible, the surveys will be timed to coincide with spring low tides (sampling two hours either side of low tide) to allow the maximum possible extent of the intertidal beach to be surveyed. The number of sampling days needed, however, will mean that the tidal range will likely vary during the sampling period. We recommend sampling at spring tides in December or January when there are extended daylight hours.

We will then use statistical analysis to determine what factors are correlated with variation in shellfish abundances, to test in particular for significant correlations with land use and freshwater regimes, and with ghost shrimp populations.

If more funding were available, we would add quarterly sampling of a limited number of parameters to capture the dynamic nature of this coastline. We could also consider measuring a condition index (ratio of shellfish flesh to volume) as a further indicator of the health of shellfish populations, as poor condition can explain low reproductive success. These could also be done as a second phase to the proposed study.

4. KEY STEPS

1. Interview local kaitiaki to identify sites for sampling and other factors to consider in sampling methodology, and obtain information on land use change and other mātauranga about the sites
2. Finalise survey design for habitat survey
3. Map land-use change adjacent to the study sites
4. Test habitat survey design and train survey team
5. Conduct habitat survey
6. Process samples
7. Analyse data using statistical methods
8. Present results to tangata whenua
9. Write reports and journal articles

5. BUDGET

The budget for this project assumes that tangata whenua will be doing most of the sampling effort, guided by MTM personnel. In addition to designing the study, processing the samples, analyzing the data and writing the report, Cawthron (3 people) will fly up for two days to establish the sampling protocol and train the local sampling team. We have allowed for 36 tangata whenua, for three 5-hours days each, at $100 per 5-hour day for the sampling, plus another day for 12 tangata whenua (two team leaders for each whanau group of six) to participate in a workshop and training prior to the main sampling.

The cost of the project is estimated at $129,970 (gst excl). The breakdown is as follows:

	Cost estimate
Cawthron labour	$ 55,010.00
Taiao Raukawa	6,750.00
Hapu members	25,800.00
Sample processing	34,960.00
Consumables & Equipment	7,450.00
Total cost	129,970.00

The above budget is an outline of the total costs to undertake this project. The Manaaki Taha Moana programme will contribute $55,010, which covers the cost of Cawthron labour. We are seeking co-funding for the additional $74,960 for the remaining components of the budget.

Budget notes:

Sampling at each site involves the digging of 36 quadrats (two transects each with six levels, and three quadrats per level) and the shellfish sorted by size and counted. We estimate that a team of two people can do a quadrat in 15 minutes, a team of six can do 12 quadrats per hour, and therefore the team can do the shellfish surveying at one site in three hours. Allow an extra hour for setup, core sampling and pack up, and it will be about four hours per site. Given the need to be at each site at low tide, and the need to travel between sites, it will probably take three days for a team to sample its three sites.

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