APPENDIX 17

EFFECTS ON MAHINGA KAI

REPORT

Lyttelton Port of Christchurch

Lyttelton Harbour / Whakaraupō: a Mahinga kai and a Working Port

Report prepared for:

Lyttelton Port of Christchurch

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Distribution:

Lyttelton Port of Christchurch	1 PDF
Tonkin & Taylor Ltd (FILE)	1 copy

November 2014

Job No: 53312.006

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Executive summary

In June 2014, the Minister for the Canterbury Earthquake Recovery directed Lyttelton Port Company (LPC) and Environment Canterbury (ECan) to develop a Lyttelton Port Recovery Plan. LPC is required to provide ECan with an initial information package, from which a preliminary draft Recovery Plan can be developed.

The Recovery Plan includes the proposed reclamation of up to 37 ha of seabed at Te Awaparahi Bay, immediately east of the existing Port. There is therefore a need to characterise the mahinga kai species and values associated with Te Awaparahi Bay, and in the wider Lyttelton Harbour.

This report provides information specifically on kaimoana, which, as part of the information package, complements other reports on Cultural Impact Assessment (Jolly 2014), and Assessment of Marine Ecological Effects (Sneddon 2014).

- More specifically, this report provides;
- A list of kaimoana species that are recognised as locally-important by mana whenua;
- A summary of key biological characteristics of each the species;
- A list of the species that are currently known to be present in the proposed Te Awaparahi Bay reclamation area;
- Approaches that could be used to monitor the status of mahinga kai resources, and therefore the success of any offset activities;
- A review of potential activities to offset the impacts of the reclamation on current and future kaimoana resources.

A total of thirty-eight different kaimoana species were identified as important to Whakaraupō/Lyttelton Harbour. This included 14 types of shellfish, an octopus, a sea tulip, a seaweed, and twenty-one species of finfish.

In historical surveys of Te Awaparahi Bay, five of the non-finfish species were found to be present. These were the green-lipped mussel (*Perna canaliculus*), the blue mussel (*Mytilus edulis*), two pūpū species, *Lunella smaragdus* (Cat's-eye) and *Diloma aethiops* (the scorched monodont), and the sea squirt *Pyura pachydermatina*. In subsequent discussion with Tangata Tiaki, it was raised that other species, including paua, kina, and oysters, might also be present in Te Awaparahi Bay. To allow confirmation, further surveys, that include Tangata Tiaki, are suggested. These surveys, and future surveys (for example, after reclamation) could utilise innovative Maori-culture based techniques, such as the Marine Cultural Health Index (MCHI).

For finfish there appear to be no surveys specifically on Te Awaparahi Bay. Because finfish are mobile, and so can move to different areas of the harbour, it is difficult to determine the impact that the proposed reclamation, or wider activities, might have on them.

There are a number of potential methods to enhance kaimoana, as part of a process of offsetting the impacts of the proposed reclamation activity. Potential methods, outlined in more detail herein, include:

1. Mara Mātaitai (kaimoana gardens) with reseeding new areas of chosen kaimoana species, with tuaki (cockles) being a good example candidate;
2. Supporting future aquaculture development;
3. Engineering new port structures (such as seawalls) in a manner that creates new habitat space for desired kaimoana species.

Consideration also needs to be given to the utilisation or relocation of existing kaimoana in areas that may be displaced as part of the reclamation process.

1. Background

In June 2014, the Minister for the Canterbury Earthquake Recovery directed Lyttelton Port Company (LPC) and Environment Canterbury to develop a Lyttelton Port Plan (Lyttelton Port Company, 2014). The plan will enable the rebuild and recovery of the port, following the earthquake sequence of 2010-11.

The Port Lyttelton Plan sets out LPC's 30 year vision for the repair, rebuild, enhancement and reconfiguration of the port. A large number of construction projects are required as part of the vision, and these are expected to occur over a period of approximately 12-15 years. These construction projects will enable the port to continue to reconfigure to meet the growing freight demands for the next 30 years as well as providing community access to the waterfront.

Planning ahead to 2044, there will be a gradual shift of port activities to the east. This includes the proposed reclamation of up to 37 ha, in Te Awaparahi Bay, immediately to the east of existing port structures.

1.1 Lyttelton Port Company and Te Hapū o Ngāti Wheke (Rāpaki rūnanga)

LPC and Rāpaki rūnanga have had a long-term and enduring relationship. There is joint commitment to work together, to enable future generations to realise the benefits that would accrue from the protection of Whakaraupō, and its ability to provide for cultural, social, and economic well-being. This commitment has been formalised in the following statement, signed by both the Chair of Te Hapū o Ngāti Wheke, and the Chief Executive of the Port of Lyttelton:

> *"Whakaraupō is of immense cultural significance to Ngāi Tahu. Tangata Whenua associations with Whakaraupō extend over many centuries, and include three major streams of Māori – Waitaha, Ngāti Mamoe and in later generations, Ngāi Tahu. The rich resources of the harbour brought Māori to settle in this area, and today the harbour remains highly valued for mahinga kai. The mana moana (traditional authority) of Rāpaki Ngāi Tahu over this special place is inherited from the ancestors.*
>
> *Just as the harbour drew Ngāi Tahu to settle in this place, its attractiveness as a port was recognised by 1849, with the first four ships of immigrants to the Canterbury settlement following shortly thereafter. Whakaraupō is now the largest deep water port in the South Island, providing significant economic benefit for the community and the region.*
>
> *Lyttelton Port Company (LPC) and Te Hapū o Ngāti Wheke share a long term interest in the future of Whakaraupō. We place a high level of importance on working together to fulfil our common responsibility as custodians and kaitiaki of the harbour.*
>
> *LPC is committed to strengthening the partnership that already exists between us, and to enable future generations to realise the benefits of this partnership through the protection of Whakaraupō and its ability to provide for cultural, social and economic well-being.*
>
> *LPC is entering a critical phase of port recovery and development. The Port Lyttelton Plan sets out the long term plans for the rebuild and expansion of the port. Our ability to work together to promote and protect the unique value of Whakaraupō as both a mahinga kai and a working port is critical to the success of these endeavours."*

A critical part of this commitment, captured in the final sentence above, is the joint aspiration that Whakaraupō can be <u>both</u> a mahinga kai <u>and</u> a working port. This is the central focus of this report.

1.2 Context of this report

An information package will be presented to Environment Canterbury relating to the Port's earthquake recovery plans for the preparation of a preliminary draft Lyttelton Port Recovery Plan, further consultation, and a hearing.

As part of this information package, the objectives of this report are:

1. To list, and where possible, characterise, the shellfish kaimoana associated with the reclamation area, and the finfish kaimoana of Whakaraupō/Lyttelton Harbour;
2. To recommend future kaimoana monitoring activities;
3. To outline suggested measures to mitigate for the displacement of kaimoana, should the proposed reclamation activity proceed.

This report has been prepared alongside other technical reports to assess the potential effects of the Port's vision as contained in the Port Lyttelton Plan. Of particular relevance is the Cultural Impact Assessment report (Jolly 2014) which gives the wider context Ngāi Tahu response to the Port Lyttelton Plan, and the wider planning framework. Also of close relevance is the Assessment of Marine Ecological Effects report (Sneddon 2014) which details wider ecological effects beyond kaimoana. This report complements the above two reports by providing additional information on kaimoana.

2. Kaimoana species

Whakaraupō has a rich history of Ngāi Tahu land use and occupancy, and a strong mahinga kai tradition. Kaimoana provided an abundant and reliable supply of food for tāngata whenua and their visitors. As stated in the Mahaanui Iwi Management Plan (2013), the restoration of kaimoana values to Whakaraupō is a key principle for the kaitiaki Rūnanga in this catchment.

This section describes the species of kaimoana that have been highlighted as important to local Maori. Unless otherwise noted, each of the species below has been identified in the Te Hapū o Ngāti Wheke (Rapaki) application for a mātaitai reserve (Te Hapū o Ngāti Wheke, 2014, originally lodged in 2011, but was on hold following the Canterbury earthquakes), or specifically highlighted by Tangata Tiaki. A mātaitai reserve is an identified traditional fishing ground in fisheries waters established for the purpose of customary food gathering. The mātaitai application illustrates the long-term vision of Ngāti Wheke for Whakaraupō, and reflects the importance of the harbour as a mahinga kai. A central principle is supporting mahinga kai abundance and diversity at levels that can sustain customary use, for now, and for future generations (Jolly, 2014). The Port Lyttelton Recovery Plan supports this principle, as evidenced in the joint commitment with Ngāti Wheke, that Whakaraupō can be both a mahinga kai and a working port. Actions that result in a net increase of mahinga kai (such as those outlined in Section 5 below) also support the Ngāti Wheke long-term vision embodied in the mātaitai application.

A total of thirty-eight different species of marine organism were identified as locally-important (Tables 1 & 2). This included 14 types of shellfish, an octopus, a sea tulip, a seaweed, and twenty-one species of finfish.

Table 1: List of Mahinga Kai Species (non-finfish) associated with Lyttelton Harbour

Maori name	English or common name	Species name
Paua	Abalone	*Haliotis iris*
Kina	Sea urchin	*Evechinus chloroticus*
Kutai	Blue mussel	*Mytilus edulis*
	Green lipped mussel	*Perna canaliculus*
Koura	Spiny crayfish	*Jasus edwardsii*
Tio	Oyster	*Ostrea lutaria*
	Rock oyster	*Saccostrea commercialis*
Tipa	Scallop	*Pecten novaezelandiae*
Tuaki	Cockle	*Austrovenus Stutchburyi*
Pipi	Pipi	*Paphies australis*
Pūpū (or boo boos)	Cat's eye	*Lunella smaragdus*
	Scorched monodont	*Diloma aethiops*
	Mudflat snail	*Amphibola crenata*
Tuatua	Tuatua	*Paphies subtriangulata*
Wheke	Octopus	*Pinnoctopus cordiformis* and other species
Kāeo	Sea tulip	*Pyura pachydermatina*
Karengo	Seaweed	*Porphyra, Pyropia, and Clymene species*

Table 2: List of Mahinga Kai finfish Species associated with Lyttelton Harbour

Maori name	English or common name	Species name
Moki	Blue moki	*Latridopsis ciliaris*
Marari	Butter fish	*Odax pullus*
Pioki	Rig	*Mustelus lenticulatus*
Hoka	Red cod	*Pseudophycis bachus*
Hapuku	Groper	*Polyprion oxygeneios*
Whairepo	Stingray	*Sasyatis brevicaudatus*
Pakaurua*	Skate	*Dipturus nasutus*
Patiki	Sand flounder	*Rhombosolea plebeia*
	Yellow belly flounder	*Rhombosolea leporina*
Patiki rori	Lemon sole	*Pelotretis flavilatus*
Patiki mohoao	Black Flounder	*Rhombosolea tapirinia*
	Whiting	*Micromesistius australis*
Aua*	Yellow-eyed mullet (herring)	*Aldrichetta forsteri*

Maori name	English or common name	Species name
Marare*	Butterfish (greenbone)	*Odax pullus*
Koiro	Conger eel	*Conger verreauxi*
Maka*	Barracouta	*Thyrsites atun*
Moamoa*	Stargazer	*Genyagnus monopterygius*
Whitebait	Inanga	*Galaxias maculatus* and other species
Makohuarau*	Spiny dogfish	*Squalus acanthias*
Hāmana	Quinnat salmon	*Oncorhynchus tshawytscha*
Manaia*	Sea horse	*Hippocampus abdominalis*

*According to Strickland (1990)

2.1 Shellfish – summary of biological characteristics

Paua – Abalone (*Haliotis iris*)

Paua are slow movers, generally found in the sublittoral zone along rocky coastlines. They are often found in clusters and feed on brown and red algae that are attached to solid substrates, and grow up into the water column (Morton & Miller 1973).

Paua are found in the outer Lyttelton Harbour and were noted to occur at relatively high densities in the low intertidal zone along the northern shoreline in 2009 (Oliver Floerl pers. comm.) and specifically in the vicinity of Livingstone Bay (Ross Sneddon pers. comm.), see Figure 1. Livingstone Bay is on the northern side of Lyttelton Harbour, about 2.5 km to the east of Te Awaparahi Bay. The only access to the site is by boat but even this is limited due to the frequent surge conditions. Hence one of the reasons for high densities of adult paua is probably that the site experiences little harvesting pressure.

Figure 1. Paua in shallow low-tidal pools, Livingstone Bay, December 2013. Also note individual specimens of pūpū. Photo courtesy of Ross Sneddon

Kina – Sea urchin (*Evechinus chloroticus*)

Kina prefer to live on rocky substrate immediately below the low water mark where they are often found in high densities. They are found nestled in cracks and crevices, and feed on coralline and other more delicate algae (Morton & Miller 1973).

While kina haven't been reported in recent surveys of Lyttelton Harbour, Tangata Tiaki report that they are present.

Kutai – Mussels (Green-lipped mussel *Perna canaliculus*, Blue mussel, *Mytilus edulis*)

Mussels are sedentary bivalves found in the intertidal zones along rocky coastlines. They are found in clusters and filter feed on algae in the water column (Morton & Miller 1973). Blue mussels and green-lipped mussels are both currently found within the Lyttelton Harbour, albeit with a patchy distribution (Sneddon & Bailey 2010).

The blue mussel has been used since 2004, as a sentinel species in Lyttelton Harbour, for monitoring contaminant bioaccumulation (Sneddon 2013).

Koura – Crayfish (*Jasus edwardsii*)

Koura prefer to live in deeper waters but have been known to be found in more shallow areas. They are found in thick seaweed areas or in caves/crevices in the submarine rock surface. Koura generally venture out at night to feed on small fish, seaweeds, urchins, crabs, and barnacles (Morton & Miller 1973).

A specimen of *Jasus edwardsii* was trapped at the Port of Lyttelton in a biosecurity study in 2004 (Inglis et al. 2008, Page 98).

Tio – Oysters (*Ostrea lutaria*)

The oyster is a species of marine bivalve mollusc that lives on the sand or mud well below the low tide mark. Oysters are filter feeders, feeding on algae that is suspended in the water column (Morton & Miller 1973).

Tipa – Scallop (*Pecten novaezelandiae*)

Scallops, similar to oysters, live at the low tide mark and below and are often found in beds. Scallops are filter feeders, feeding on algae that is suspended in the water column (Morton & Miller 1973).

Tuaki – Cockle (*Austrovenus Stutchburyi*)

Cockles are bivalve filter feeders, feeding on phytoplankton in the water column. They live in sandy and/or muddy habitats immediately below the surface, burying themselves into the sediment using their "tongue" like foot appendage (Morton & Miller 1973).

In a recent survey by Woods et al. (2013), cockles were sampled from 5 different bays within Lyttelton Harbour. Edible-sized cockles were only present at Governors Bay, Rapaki and Purau. Of the combined total, about 56% of individuals were juveniles, 40% were reproductive adults, 4% were recruits and 1% were edible-sized cockles. The densities and biomass were low compared to those from Childrens Bay in Akaroa Harbour and from a site in the Avon-Heathcote Estuary. Bolton-Ritchie (2013) also noted that cockle density and biomass in Whakaraupō is generally lower than in other parts of Banks Peninsula and Canterbury.

Pipi – (*Paphies australis*)

Pipi prefer sandy habitats, burrowing 2-3 cm into the sediment and filter feeding phytoplankton out of the water column. Adult pipi are generally found at the low tide mark and deeper, while juveniles are found further towards the shore (Morton & Miller 1973).

In a 2013 survey, a pipi bed was found in the bay immediately west of the jetty at Rapaki, and in Purau Bay (Woods et al. 2013).

Pūpū – topshell snail species (*Diloma aethiops*)

Pūpū are also colloquially referred to as "boo boos".

Topshell snails graze on the open surface in the barnacle and oyster zones, feeding on organic particles found in cracks and crevices. Topshell snails also feed on other shellfish where algae has formed on the outside of their shells (see Figure 1, a pūpū is grazing on the surface of the upper-most paua). They move freely around pools on open rock surfaces (Morton & Miller 1973).

Pūpū – cat's eye (*Lunella smaragdus*)

Cat's eyes are found on the rocky shore within the inter-tidal zones. Similar to topshell snails, cat's eyes feed on algae and other organic material on the surfaces of the rocky shore (Morton & Miller 1973).

Mudflat snail (*Amphibola crenata*)

Mudflat snails are primarily found in soft muds with the highest densities of individuals towards the high tide mark. The snails bury themselves during high tide and feed during low tide consuming organic material found on the surface of mud (Morton & Miller 1973).

This species is present in the Head of the Bay, Charteris Bay, and Governor's Bay (Hart et al. 2008) but doesn't appear to have been specifically surveyed in other parts of the Harbour.

2.2 Finfish - summary of biological characteristics

Moki (*Latridopsis ciliaris*)

Found on the sea/coastal floors to depths of 100 m. Historically abundant in the Harbour and caught by spear fishing. Diet includes small benthic animals including polychaete, crustaceans, molluscs and echinoderms. This species is currently present, it is targeted or caught incidentally by recreational fishers (Sneddon, 2014).

Marari – Butterfish (*Odax pullus*)

Butterfish are dull green to bronze in colour and can grow up to 50-60 cm long. They are generally found in shallow inshore waters where kelp and other seaweed is abundant, which is the main component for which they feed on (Morton & Miller 1973).

This species is common in Lyttelton Harbour, and is targeted or caught incidentally by recreational fishers (Sneddon, 2014).

Pioki – Rig (*Mustelus lenticulatus*)

Traditionally caught in the centre of the harbour.

Small coastal shark species, in particular juvenile school shark (*Galeorhinus galeus*) and rig (*Mustelus lenticulatus*) are known to use Lyttelton Harbour as a nursery ground, although few data exist to quantify the importance of the harbour (Francis et al., 2011).

Hoka – Red cod (*Pseudophycis bachus*)

Traditionally caught in the centre of the harbour. Found mainly on sea floor along muddy/sandy substrates. Diet includes small fish, cephalopods, crabs and other crustaceans. This species is present, it is targeted or caught incidentally by recreational fishers (Sneddon, 2014).

Hapuku – Groper (*Polyprion oxygeneios*)

Move between deep (mainly winter) and shallow waters (mainly summer) and live on rocky reefs, pinnacles, sea bed and any areas with cracks, crevices and caves. Traditionally caught in the centre of the harbour. Diet includes invertebrates and small fish such as red and blue cod, terakihi, hoki and squid.

2.3 Seaweed

Karengo (*Porphyra, Pyropia, and Clymene* species)

Karengo is the name used for a range of edible seaweeds that belong to the *Porphyra*, *Pyropia* and *Clymene* genera (O'Connell-Milne & Hepburn, 2014). *Porphyra* includes nori, the Japanese seaweed used to wrap sushi. There are around 35 known karengo species, and *Porphyra columbina* is the most well-known. Karengo is harvested from Lyttelton Harbour. Abundance is seasonal, with highest biomass typically occurring during spring.

3. Mahinga kai species present within the proposed reclamation area

3.1 Intertidal and seabed species

The intertidal area and subtidal seabed at Te Awaparahi Bay has been sampled periodically over the past 14 years (Figure 2), documented in Sneddon & Barter (2009), Sneddon & Dunmore (2014), and Sneddon (2014). While none of these surveys were specifically designed to sample kaimoana species, they do provide useful relevant information. It appears there have been no other such surveys in the bay.

In terms of the kaimoana species listed in Table 1 above, surveys in 2008 and 2013 of the intertidal area at Battery Point showed four species. There were two mussel representatives, the green-lipped mussel (*Perna canaliculus*) and the blue mussel (*Mytilus edulis*). There were also two pūpū species, *Lunella smaragdus* (Cat's-eye) and *Diloma aethiops* (scorched monodont). Each of these four species is illustrated in Figure 3.

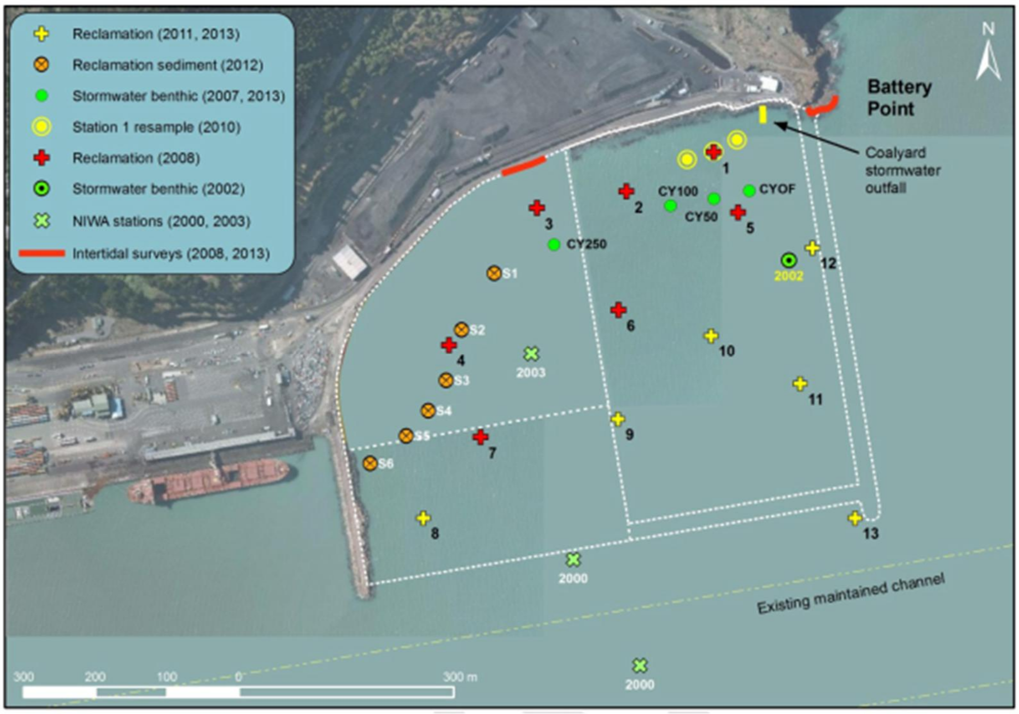

Figure 2. Intertidal and benthic sampling locations (and years) at Te Awaparahi Bay. From Sneddon (2014).

Figure 3. Intertidal kaimoana species present at Te Awaparahi Bay. From left: green-shell mussel, blue mussel, cat's-eye, and scorched monodont (these latter two are pūpū species).

In the subtidal area, only one species was found in surveys, the sea squirt *Pyura pachydermatina* (see Figure 4).

Figure 4. Sea squirt Pyura pachydermatina*, the subtidal kaimoana species found in Te Awaparahi Bay.*

While these five species were identified in the surveys, in subsequent discussions, Tangata Tiaki suggested that other species, including paua, kina, and oysters, may also be within the proposed reclamation area.

Notwithstanding future monitoring done by Tangata Tiaki, the kaimoana species known to be present within Te Awaparahi Bay are at Battery Point. The eastern boundary of the proposed reclamation area will encroach upon the western edge of the Battery Point platform, and will therefore cause a loss of the kaimoana species that are currently present. I therefore recommend that the western edge of the Battery Point platform is excluded from future reclamation plans. The manner of exclusion could take some form of “step in” to the west, but consideration will need to be made to ensure that the shape doesn’t create local hydrodynamics (such as a refocus of wave and tidal energy, or an increase in sediment deposition) that are detrimental to kaimoana.

3.2 Finfish species

For finfish there appear to be no surveys specifically on Te Awaparahi Bay. Because finfish are mobile, and so can move to different areas of the harbour, it is difficult to survey these species, or to determine the impact that the proposed reclamation might have on them (Knox, 1988).

3.3 Wider Harbour considerations: The Lyttelton Port Plan and mahinga kai

Marine ecological effects from the activities proposed in the Lyttelton Port Plan are likely to occur over limited spatial areas, with the key exception being the potential changed hydrodynamic effects of the reclamation Sneddon (2014). In a generalised sense, wave energy in Lyttelton Harbour occurs on a spectrum from high energy conditions at the mouth of the Harbour, to low energy conditions at the mud flats in the upper harbour. Mahinga kai species naturally establish in the areas to which they are adapted. Paua, for example, occur in the higher-energy areas near the harbour mouth, while mudflat snails (one type of pūpū) occur in the low-energy conditions of the upper harbour.

Hydrodynamic modelling suggests that activities proposed in the Recovery Plan may result in an increase in wave energy in outer harbour sites east of Battery Point, and a decrease in energy in the central harbour (e.g. decreased wave energy at Stoddart Point, Diamond Harbour). Such changes in wave energy conditions could subsequently result in small, but potentially discernible changes in the distribution of non-finfish mahinga kai species, with new higher-energy sites being more suitable for species such as paua, and lower-energy sites being more suitable for species such as pūpū.

4. Monitoring

Within the context of this report, monitoring refers to activities aimed at measuring the presence and abundance (number and/or biomass) of kaimoana species. There are two different situations where monitoring will be important. Firstly, in determining the baseline situation for any particular kaimoana species (hereafter referred to as baseline monitoring), and secondly, for determining any changes in kaimoana presence and abundance after new management regimes (such as reclamation, or kaimoana reseeding) have been implemented (hereafter referred to maintenance monitoring).

4.1 Baseline monitoring

As the existing species presence data presented in Section 3 was obtained through surveys that weren't specifically designed for monitoring kaimoana, it is recommended that intertidal and subtidal kaimoana surveys are undertaken within the proposed reclamation area, including at Battery Point. These surveys should include local Tangata Tiaki representatives, to ensure that:

- Locally-recognised species are identified;
- Local searching methods are included;
- The results of the survey have local trust and support.

This approach is consistent with the Cultural Impact Assessment report (Jolly, 2014):

> "Ngāi Tahu identified a number of concerns with the marine ecology assessment as it relates to the direct loss of mahinga kai at the reclamation site. Importantly, mahinga kai species were not an explicit part of the assessment methodology. Further, sub tidal reefs of particular value for mahinga kai were not adequately surveyed. As a result, there is some disconnect between the mahinga kai value that Ngāi Tahu assign to the area, and the results of the survey. In response, Ngāi Tahu have indicated that further work is required to understand what mahinga kai species are present at the proposed reclamation site. A key message is that Ngāi Tahu and LPC must jointly agree to the methodology for this work."

4.2 Maintenance monitoring

Maintenance monitoring will come into play after there has been a change in the management regime, such as if the proposed reclamation is approved. Maintenance monitoring will also be important for determining the success of new management options, such as enhancing habitats to make them more suitable for mahinga kai species (expanded further in Section 5, below), or reseeding of kaimoana beds.

4.2.1 The Marine Cultural Health Index (MCHI) monitoring toolkit

Ngāi Tahu have been working on the development of a Marine Cultural Health Index (MCHI) monitoring toolkit for a number of years, as part of the State of the Takiwā programme. One intention of MCHI is to allow Ngāi Tahu representatives to assess the health of their kaimoana harvest resources, and to therefore give a voice to community members to collectively manage their resources, using traditional and local knowledge. It will also enable Ngāi Tahu to establish restoration targets and sustainable mahinga kai (the practice of customary food-gathering) harvest strategies within coastal protection areas. The toolkit incorporates a range of environmental indicators, based on local and traditional knowledge.

Schweikert et al (2013) contains the most complete and up-to-date MCHI toolkit documentation.

The adoption of MCHI is directly consistent with the Mahaanui Iwi Management Plan (2013):

> "TAN4.3 - To support the continued development and use of the Marine Cultural Health Index as a tāngata whenua values-based monitoring scheme for estuaries and coastal environment that is part of the Te Rūnanga o Ngāi Tahu's State of the Takiwā Programme."

At least theoretically, MCHI could be used to undertake both the baseline, and the maintenance monitoring. However, as MCHI is a work in progress, it will be important for Ngāi Tahu and LPC to jointly agree on the actual monitoring methodology that is adopted. This would be directly consistent with the Mahaanui Iwi Management Plan (2013) policy WH2.1:

> "To continue to maintain a good working relationship between tāngata whenua and the LPC to address cultural issues and achieve positive cultural, environmental and economic outcomes."

5. Enhancement of mahinga kai species– obtaining a net gain in kaimoana

In the event that the proposed reclamation activity is consented following the Recovery Plan process, there is considerable scope to explore methods to promote the enhancement of mahinga kai habitat, and theoretically cause a net increase in mahinga kai biomass. This section is a review of approaches that could be used to enhance mahinga kai abundance.

5.1 Mara mātaitai (kaimoana gardens)

Mara mātaitai are seafood gardens, and the seeding of shellfish beds is a feature of this type of husbandry (Williams 2012). Garven et al. (1997) reports that, historically "Shellfish beds were seeded with superior strains taken and transplanted from other areas, and established beds were both enhanced and depleted by biological methods".

"Karengo (*Porphyra columbina*), an edible seaweed, only grows on certain types of rocks, none of which occur naturally south of the Clutha River mouth, yet I have been shown karengo on a large cluster of uniformly sized boulders in a small bay south of the Mataura. As the sea current along the coast is south to north, both the boulders and the alga could only have been brought in by human agency. This suggestion is supported by the uniform size of the boulders: each is about as large as a strong man could carry to and from a canoe" (Williams 2012).

The development of mara mātaitai is one approach that could be used to cause a net increase in mahinga kai. A specific example, which has already been used to a limited degree in Whakaraupō, is the reseeding of cockles into new areas, outlined in more detail in the next section.

5.1.1 Tuaki (Cockle) reseeding: an example project in progress

Discussion with Tangata Tiaki / Kaitiaki at Rapaki highlighted existing efforts to experimentally reseed beds of tuaki in isolated areas of Lyttelton Harbour. There was also specific mention of significant potential to expand these efforts, with an area to the south of Otamahua (Quail Island) highlighted. Woods et al. (2013) suggested that Rapaki could be a suitable site for cockle transplantation, and that this would potentially aid the recovery of this valued resource and help to re-establish customary gathering beds (Figure 5).

Figure 5. People from Te Hapū of Ngāti Wheke (Rapaki) and University of Canterbury undertaking experimental seeding of cockles (Photo by Graham Fenwick, from Francis et al. 2011).

Other species that have been highlighted as of interest for enhancement are scallops, dredge oysters, pipi, toheroa, paua, rock lobster, snapper and salmon (Booth & Cox 2003). While not all of these species will be relevant to Lyttelton Harbour, this list gives an indication of the general NZ interest in this area of endeavour.

5.2 Aquaculture

Various Ngāi Tahu entities have existing interests in commercial aquaculture activities. Te Runanga o Koukourarata, for example, have interests in green-shell mussel aquaculture in the bay at Koukourarata. While aquaculture isn't directly enhancing wild kaimoana populations, it nevertheless offers a significant opportunity to enhance seafood availability. One approach, therefore, to creating a net increase in kaimoana, would be to support the further development of aquaculture activities.

5.3 Ecological engineering concept

There is a developing body of scientific literature around the ecological engineering of shorelines to improve their value as habitat. A particularly exciting area of research is around how infrastructure, such as seawalls, can be built to meet engineering requirements, and also increase its value as habitat – termed ecological engineering (Chapman and Underwood 2011). This line of research fits neatly into LPC and Te Hapū o Ngāti Wheke aspirations to work together, to protect the value of Lyttelton Harbour as both a Mahinga Kai and a working port.

During the planning of seawall construction, there are three inherent characteristics that can significantly influence habitat availability: substrate slope, substrate type, and substrate complexity. In simple terms, gentler slope angles mean that a larger surface area of habitat is available than would be for a steep slope. Steeper parts of rocky shores also often support fewer species than do flatter parts of the habitat (Lewis 1964).

Substrate type is also very important. Particular species will have preferences for certain surface types. By way of example, if the aim for the construction of the seawall around the proposed reclamation area was to enhance paua populations, then one approach might be to emulate the substrates in neighbouring bays where good populations of paua are currently present (such as at Livingstone Bay, see Figure 1). This approach has been successfully used to increase the numbers of the edible limpet *Patella candei* in Portugal (Martins et al. 2010).

There are many potential ways to increase the complexity of seawalls, which in turn increases the availability of habitat types. A simple method is to add small cavities (such as crevices, drill holes, or pits) into existing walls (see Figure 6). Such cavities would be suitable habitat for smaller mahinga kai species such as boo boos (e.g. *Lunella smaragdus*).

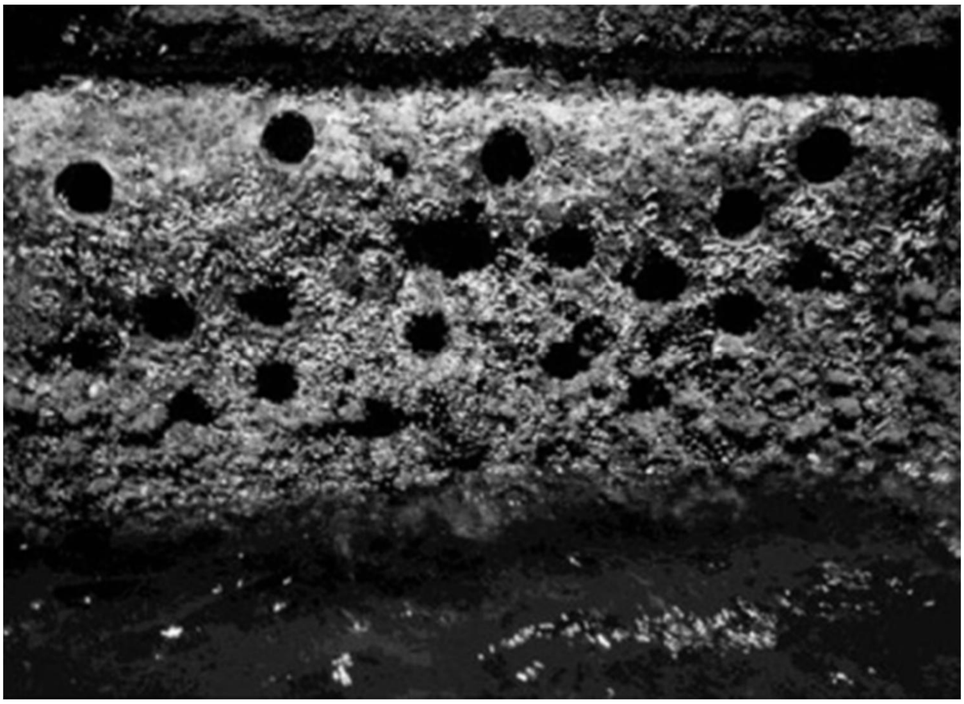

Figure 6. Drill holes, each about 50 mm in diameter, added to a sandstone seawall, to increase available habitat for snails such as Lunella smaragdus*, (from Chapman & Underwood 2011).*

Another approach to increasing habitat complexity is to add structure that will result in rock pools being formed. This could be through the use of pot-type structures on more vertical walls (Figure 7), or through the creation of small embayments within the seawall structure (Figure 8). Such embayments might, for example, enhance populations of paua.

Figure 7. "Flower pots" to mimic rock-pools, added to a seawall, in North Sydney (from Chapman & Underwood 2011).

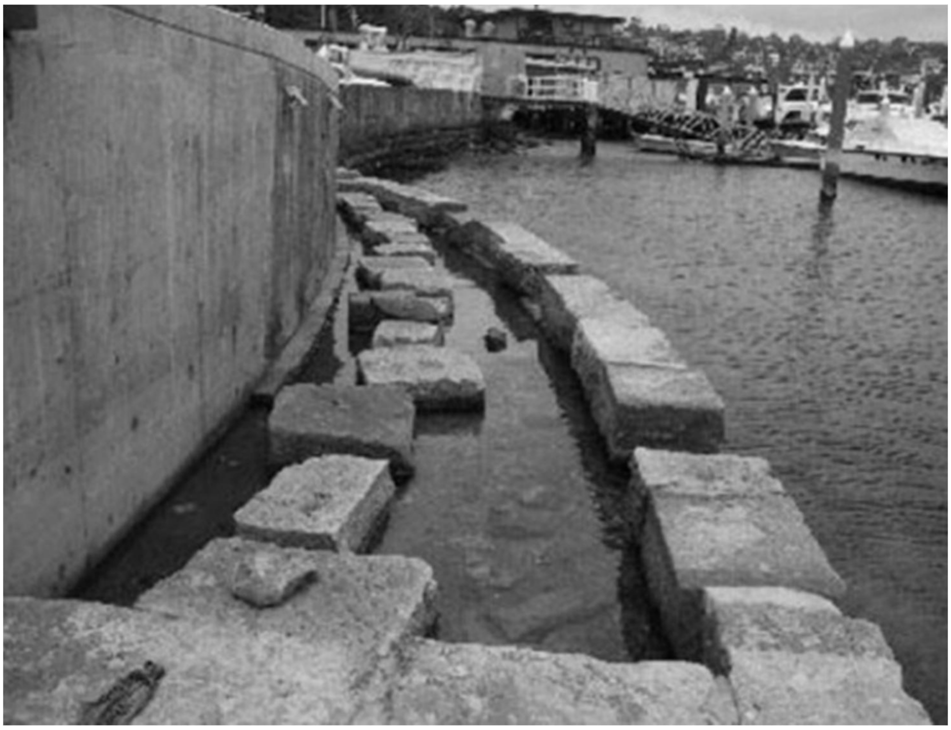

Figure 8. Small embayments added to a seawall, to create rock-pools (from Chapman & Underwood 2011).

5.4 Ecological engineering suitable for Lyttelton Port

It is important to note that the structures illustrated in Figures 6-8 above are given simply as examples of the concept of ecological engineering, and may not be directly suitable to the

Lyttelton Port situation. The existing seawall structure that occupies almost all of the shoreline at Te Awaparahi Bay consists of riprap laid out in a revetment (Figure 9). If the same kind of design is adopted for planned new seawall structures, habitat enhancement could be achieved through the inclusion of 'Bioblock' type structures within the riprap matrix (Figure 10). Such structures provide additional suitable habitats, such as rock-pool type environments, sheltered shelves and pockets which provide a stable habitat within the seawall structure, to increase biodiversity (www.seacams.ac.uk/case-study/9/).

There is considerable scope for enhancing mahinga kai habitat in this manner, LPC are progressing investigations in this direction.

Figure 9. The existing riprap reclamation seawall structure at Te Awaparahi Bay (from LPC 2009).

Figure 10. Experimental 'Bioblock' incorporated into a riprap seawall in Colwyn Bay, North Wales. The Bioblock is designed to provide additional habitats within the seawall, to increase biodiversity. Photo from www.seacams.ac.uk/case-study/9/.

6. Conclusions and recommendations

- Lyttelton Port Company and Rāpaki Rūnanga have a shared aspiration for Whakaraupō/Lyttelton Harbour to be both a mahinga kai and a working port;
- A total of thirty-eight different kaimoana species were identified as important in Whakaraupō/Lyttelton Harbour, including 14 types of shellfish, an octopus, a sea tulip, a seaweed, and twenty-one species of finfish;
- In surveys of Te Awaparahi Bay undertaken in 2008 and 2013, five of the non-finfish species were found to be present at Battery Point (the Eastern-most end of Te Awaparahi Bay). These were the green-lipped mussel, the blue mussel, two pūpū species (the Cat's-eye and the scorched monodont) and a sea squirt.

Recommendation 1: As Battery Point has documented value as kaimoana habitat, it would be advisable to exclude this area from the reclamation space.

- In subsequent discussion with Tangata Tiaki, it was raised that other species, including paua, kina, and oysters, might also be present at Battery Point, and so would also be retained if the Battery Point area were excluded from the reclamation space;
- There are a number of potential methods to enhance kaimoana, as part of a process of off-setting the impacts of the proposed reclamation activity, including:
  - Mara Mātaitai (kaimoana gardens, with reseeding of chosen kaimoana species);
  - Supporting future aquaculture development;
  - Engineering new port structures (such as seawalls) in a manner that creates new habitat space for desired kaimoana species.

Recommendation 2: A Kaimoana Management Plan be prepared, in agreement with Te Hapū o Ngāti Wheke and Te Rūnanga o Koukourārata, which includes but is not limited to:

  - Details of methods to monitor the health of kaimoana in the vicinity of the reclamation, including surveys using Matauranga Maori-based techniques, such as the Marine Cultural Health Index (MCHI);
  - Assessment of whether the reclamation seawalls can be designed in a manner that creates new habitat space for desired kaimoana species;
  - Methods to enhance kaimoana such as the establishment of kaimoana gardens, or reseeding of chosen kaimoana species;
  - Consideration of the practicalities of utilisation or relocation of kaimoana if reclamation is approved in a manner that could result in kaimoana loss.

- For finfish there appear to be no surveys specifically on Te Awaparahi Bay. Because finfish are mobile, and can move to different areas of the harbour, it is difficult to survey these species, or to determine the impact that the proposed reclamation might have on them.

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8. Applicability

This report has been prepared for the benefit of Lyttelton Port of Christchurch with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement.

Tonkin & Taylor Ltd

Environmental and Engineering Consultants

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Appendix A: Glossary of terms

- kaimoana - seafood
- Kaitiaki - guardian or steward natural resources
- Kaitiakitanga - the process of guardianship or stewardship of natural resources
- mahinga kai - food and other resources, and the areas from which they are gathered
- mana whenua - the right (and responsibility) to make decisions about the resources of a particular area
- Manawhenua - those who exercise mana whenua
- Rūnanga - Hapū council or assembly
- Takiwā - district or region
- Tangata Tiaki - individuals or groups who can authorise customary fishing within their rohe moana, in accordance with tikanga Maori.
- Whakaraupō - Lyttelton Harbour