# Waipū Estuary SEA assessment 2021

Patuharakeke
TE IWI TRUST BOARD

Northland
REGIONAL COUNCIL
Te Kaunihera ā rohe o Te Taitokerau

## Authors/Contributors:

Nick Bamford
Ari Carrington
Loren Carr
Katrina Hansen
Richard Griffiths
Zoee Hoy
Steve Johnson
Taryn Shirkey
Xzavier Watson

## For any information regarding this report please contact:

Richard Griffiths

richardg@nrc.govt.nz

Northland Regional Council
Private Bag 9021
Whangārei Mail Centre
Whangārei 0148

**Phone:** 09 470 1200
**Freephone:** 0800 002 004
**Fax:** 09 470 1202
**Email:** info@nrc.govt.nz

Taryn Shirkey
taryn@patuharakeke.maori.nz

Patuharakeke Te Iwi Trust Board
PO Box 557, Whangārei

Takahiwai Marae
229 Takahiwai Rd
Takahiwai

Photo credit, front cover: Photoblique, Biospatial Ltd.

# Contents

# Tables



# Figures

# Introduction

In the Proposed Regional Plan (PRP) for Northland (Northland Regional Council 2019), Waipū Estuary has been identified as a significant ecological area (SEA) on account of its "*sequences of shallow channels and tidal sand flats, both of which are significant and highly-productive habitats. The sand tidal habitats are home to valuable benthic invertebrate communities and also have extensive seagrass beds*" (Kerr, 2016).

Between January and April 2021, Northland Regional Council (Council) and the Patuharakeke Trust Board (PTB) conducted an ecological survey and a cultural health assessment of Waipū Estuary to provide baseline data so that in the future we can assess whether the policies and rules in the PRP have been effective at maintaining the ecological values identified for this SEA. Specifically, the survey should in the future help us to assess the effectiveness of Policy D.2.18 (managing adverse effects on indigenous biodiversity).

The assessment also addresses council's responsibilities under the Resource Management Act (RMA 1991) in relation to sustainable management principles set out in Part II Section 5, and directives to monitor the state of the environment as set out in Part IV Section 35(1) & 2 (a) & (b), and contributes to achieving the following Policies and Objectives in the New Zealand Coastal Policy statement (Department of Conservation 2010) and the Regional Policy Statement (RPS) for Northland (Northland Regional Council 2016):

- Objective 1 (To safeguard the integrity, form, functioning and resilience of the coastal environment and sustain its ecosystems) and Policy 11 (To protect indigenous biological diversity in the coastal environment) in the New Zealand Coastal Policy Statement (NZCPS 2010);
- Objective 3 in the New Zealand Coastal Policy Statement 2010 "to take account of the principles of the Treaty of Waitangi, recognise the role of tangata whenua involvement in management of the coastal environment";
- Objective 3.4 in the RPS (Indigenous ecosystems and biodiversity);
- Objective 3.12 in the RPS "*Tangata whenua role is recognised and provided for in decision-making over natural and physical; resources*";
- Policy 8.1.1 in the RPS "*provide opportunities for tangata whenua to participate in the review, development, implementation and monitoring of plans and resource consent processes...";*
- Policy 8.1.3 in the RPS "*provide opportunities for the use and incorporation of Mātauranga Māori into decision-making, management, implementation, and monitoring of natural and physical resources under the Resource Management Act 1991*";
- Policy 8.1.4 in the RPS *"…Māori concepts, values and practices will be clarified through consultation with Tangata whenua to develop common understandings of their meanings and to develop methodologies for their implementation*";
- Policy 8.1.8 in the RPS "*The regional council will support tangata whenua if they choose to develop and implement a regional Mātauranga Māori-based environmental monitoring framework by: (a) Providing information and advice during the development of the monitoring framework; (b) Providing training to assist tangata whenua to promote and implement the monitoring framework on an ongoing basis; and (c) Incorporating the results and recommendations of tangata whenua monitoring in council's monitoring reports*".

The ecological assessment included a survey of the substrate, flora and epifauna, shellfish and avifauna (birds). An eDNA sample was also collected, and shellfish flesh was analysed for metal contamination. Results and interpretation of council's routine water quality sampling in the estuary are also presented. The cultural assessment was completed using a Takutai Health Analysis, which assesses tohu such as whanaungatanga, whakapapa, and mauri.

# Waipū Estuary

The Waipū Estuary is a drowned river valley system located on the east coast of the Northland peninsula (Figure 1). The estuary comprises a river section that flows in a south easterly direction to the coast before turning sharply in an easterly direction into Bream Bay, a large coastal embayment. To the south and partly separated from the river section, by a rock groyne, is a shallow lagoon protected by a narrow sand spit. The lagoon extends approximately 4 km in a south easterly direction, parallel to the shoreline, towards the small settlement of Waipū Cove.


**Figure 1.** Waipū Estuary location.

# Cultural Importance

The general Waipū area is historically a very important mahinga mātaitai (fishing/gathering site) where a vast range of kaimoana (marine species) were, and still are, harvested including an array of finfish species including: Kanae (mullet, *Mugil cephalus*); Kahawai (*Arripis trutta*); Araara (trevally, *Pseudocaranx georgianus*); Tāmure (snapper, *Chrysophrys auratus*); Ihe (piper, *Hyporhamphus ihi*), Kātaha (yellow-eye mullet, *Aldrichetta forsteri*); and Pātiki (yellow belly sand flounder, *Rhombosolea plebeia*). Additionally, shellfish including: Kōura (crayfish, *Jasus edwardsii*); Kina (sea urchin, *Evechinus chloroticus*) Kūtai (mussels, *Perna canaliculus*); Tuatua (*Paphies subtriangulata*), Pūpū (cat's eye, *Turbo smaragdus*); Karehu (mud-flat snail, *Amphibola crenata*); Kōkota (pipi, *Paphies australis*); Hū ai (cockle, *Austrovenus stutchburyi*); Kūtai (mussel, *Perna canaliculus*); and Tio (rock oyster, *Saccostrea glomerata*) are sourced from this area.

Waipū was once a rich, abundant customary harvesting area for seasonal and regular collecting of resources for kai (food), materials for tools and equipment, and for collecting specific items for cultural practices. Patuharakeke continue to carry out their duties as kaitiaki of Te Rerenga Parāoa, Te Ākau/Bream Bay and the wider rohe moana.

The foredunes of the area were formerly a significant source of Pīngao (*Ficinia spiralis*) which was used to weave nets specifically used to catch small fish such as Ihe. Former Kuaka (Godwit, *Limosa lapponica*) customary harvesting areas are located in and around the intertidal area of Waipū Estuary. These practices and customary fisheries management measures are continued in contemporary times through kaitiakitanga (stewardship/guardianship). As kaitiaki, Patuharakeke are responsible for both the mātauranga (intergenerational/traditional knowledge) and the tikanga (custom/practice) of kaitiakitanga in relation to resources. This relationship is a responsibility rather than a right – a duty Patuharakeke are bound by both culture and tradition to maintain. This area of takutai moana (coastal area) is immensely significant for gathering and harvesting kaimoana (and other taonga species) used historically and to this day by Patuharakeke as mana moana.

# History

Waipū Cove is known to Patuharakeke as Pariwaka and is a culturally significant part of Patuharakeke's wider cultural landscape and seascape. This locale contains a number of heritage sites, such as the headland pā site adjacent to Te wahapū o Waipū - The Waipū estuary. The estuary and the main Waipū river provided important transportation routes leading to many pā along the inland ranges, such as the Pāritū pā. These trade and transport networks served a major social and political function in maintaining the linkages from one hapū to the next.

Spiritual and whakapapa connections to Te Taiao are of importance to Patuharakeke uri, one connection being to *Te Kahuitara* (the goddess of sea birds such as - Tara, Kuaka and Torea). The knowledge and taonga tuku iho handed down through the many generations through pūrākau are acknowledged through our whakapapa connections to the life within the estuary today. Many different pūrākau of Patuharakeke are instilled in special events like 'naming ceremonies', such as the name of one of Patuharakeke's significant wahine ancestors - Te Kahuitara, the eldest daughter of the late Wiki Te Pirihi, a Prominent chief of Patuharakeke in his time. This gives higher significance and importance to the areas that manu, ika and invertebrates (hātaretare/tuaiwi-kore) inhabit.

# Catchment

The Waipū Estuary receives freshwater flow from the Waipū River, which drains a catchment of approximately 223.4 $km^2$. Analysis of land use in the catchment, based on New Zealand Land Cover Database LCDB v5.0 (New Zealand Land Cover Database, 2020), indicated that 52% of the catchment was covered by high producing exotic grassland for pasture and that indigenous forest and manuka kanuka scrub covered 30%, and exotic forest covered 14% of the catchment (Figure 2 & Appendix 1).

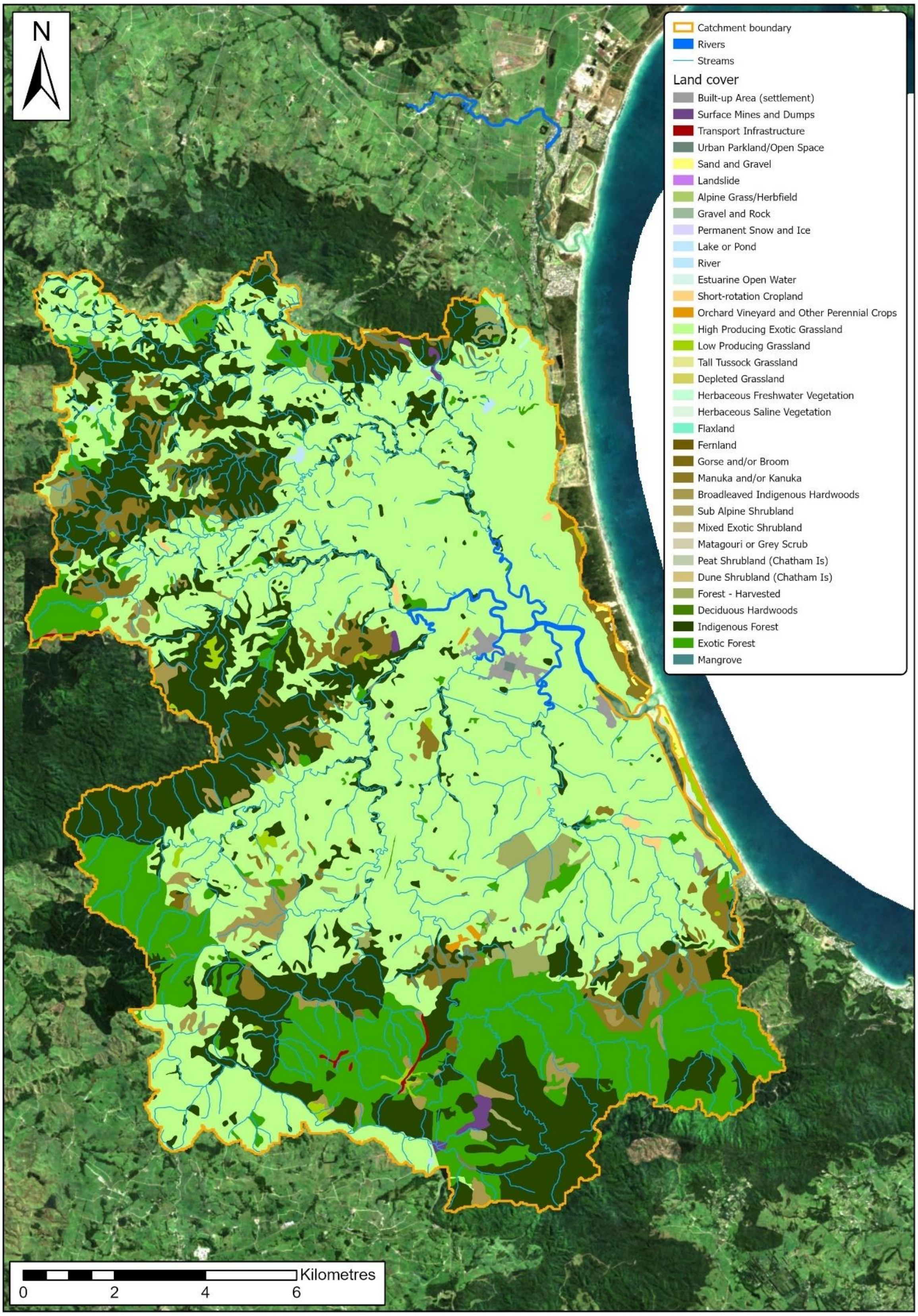



**Figure 2.** Distribution of major land use classes in the Waipū Estuary catchment, from the New Zealand Land Cover Database v5.0 (2020).

## Consented activities

There are 83 active consents in the catchment and a further eight permitted farm dairy effluent (Figure 3). Twelve permits relate to water takes, 16 are for land use permits including five stormwater permits, 23 are permits to discharge sewage to land and 22 are for consented farm dairy effluent discharges. Of the 23 permits to discharge sewage to land, 17 of these are for domestic sewage, one relates to a discharge of wastewater from public toilets and another for a dairy factory discharge. The stormwater permits include two stormwater discharges from quarries, one industrial site, two residential developments and one associated with the development of a cycleway.

The Waipū township and the smaller communities of Waipū Cove and Langs Beach are served by a reticulated sewerage system. The collected wastewater is treated at a wastewater treatment plant located just outside of the catchment boundary on coastal dunes to the northeast of Waipū. The treated effluent is disposed into the ground, inside the treatment plant property.

## Coastal consents

Within the estuary there are only three consented activities or structures. The most significant of these is a rock groyne (Figures 4 and 5) near the mouth of the estuary. The other consents are for a stormwater discharge from a residential subdivision into the Waipū River and for a rock revetment and stormwater outlet at Hamon Road (Figure 6).

**Rock groyne**

The mouth of the Waipū River has historically moved north and south along the shoreline between its current location and further south along the barrier sand spit towards Waipū Cove. Major floods would punch through the dunes to give a more direct outlet from the river channel to the coast while in intervening years sand would build up on the dunes and the outlet would move further south. On occasions a second outlet to the coast also opened.

At some time prior to 1900, a channel was cut through the dunes to the sea and a wooden groyne constructed to stabilise the river mouth at its current general location. This was primarily for navigation purposes and for the protection of farmland adjacent to the old river channel. This wooden groyne deteriorated over time and the river mouth migrated to a more southerly position. In 1957, the mouth of the Waipū River was again cut through at its current position. The wooden structure was dismantled at this time and a 300m rock structure was built to replace it (Figures 4 and 5). This structure was approved at its current extent by the Northland Harbour Board (NHB) in 1967 and the NHB maintained the groyne until the organisation was dissolved in 1989. The primary purpose of the groyne is to constrain the river mouth to its current location, providing better access for small vessels and erosion protection. The groyne is likely to have restricted water flow and exchange between the river channel and the southern lagoon area of the estuary and may have restricted flushing of the lagoon.

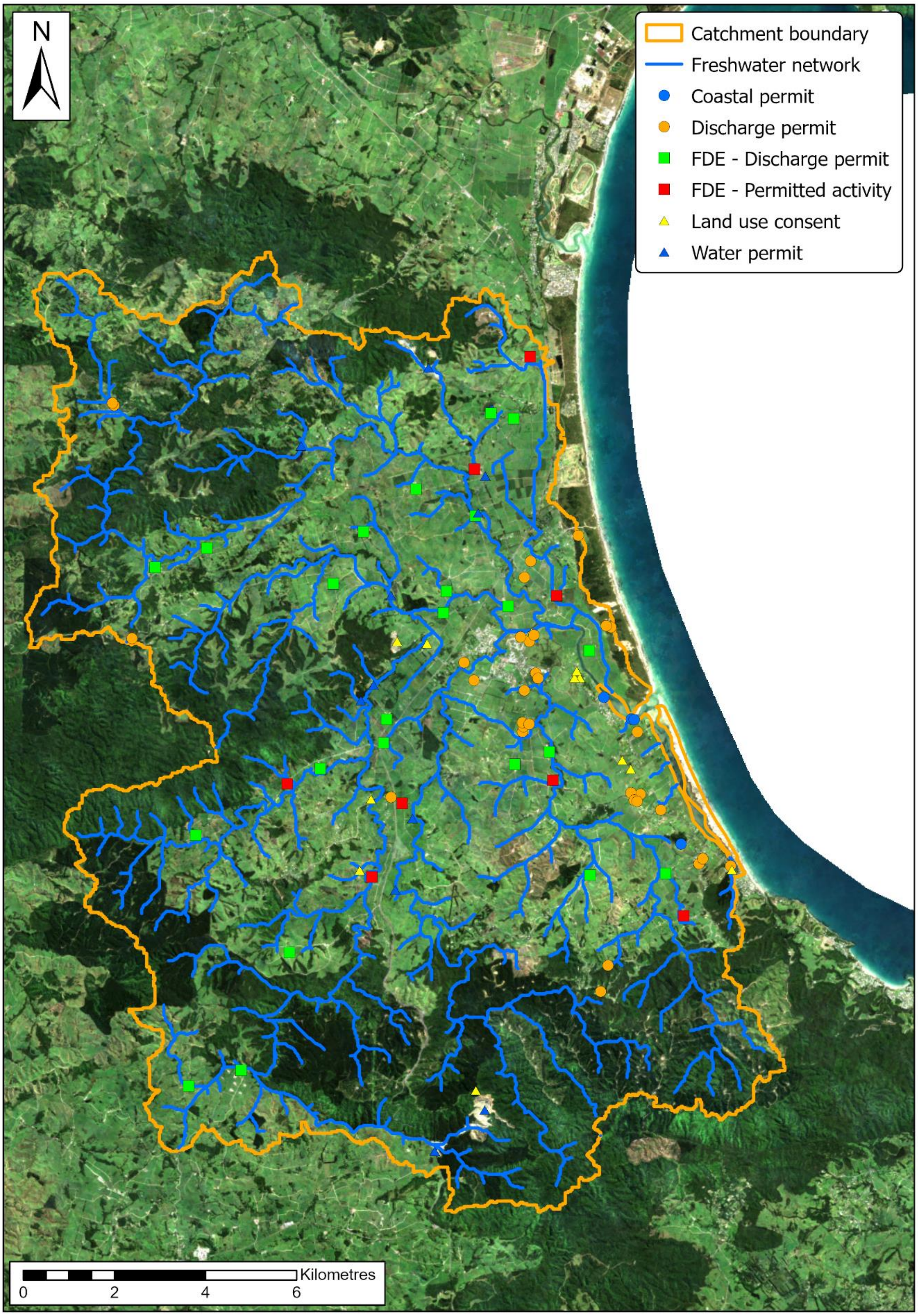



**Figure 3.** Consented activities and permitted farm dairy effluent activity in the Waipū Estuary catchment (NRC internal database extracted August 2021).

**Figure 4.** The rock groyne at the entrance to the Waipū Estuary.

**Figure 5.** The rock groyne photographed from the Lagoon area of the Waipū Estuary.


**Figure 6.** Stormwater box culvert and rock revetment in the river section of Waipū Estuary.

## Nuisance algae

**Waipū Cove**

During recent years there have been several events where large quantities of macroalgae have been deposited along the beach at Bream Bay, with the most significant events occurring at Waipū Cove. This deposition has resulted in a number of negative impacts including curtailing access to the beach and water for recreation, and producing unpleasant odours (Nelson, 2018).

In 2018, Wendy Nelson (NIWA) was commissioned by council to undertake a review of existing information about algae at Waipū Cove and assemble baseline data on the composition of macroalgae. The findings of this NIWA report indicate that the majority of the specimens collected between 2010 and 2018 were red algae including *Spyridia filamentosa*, and several species of *Plocamium,* which are considered native to the region (Nelson, 2018). Both species are able to grow in submerged accumulations in the water column and are understood to contribute the majority of the biomass. Relatively few species of green algae were recorded, and the brown algae species were all typical of rocky reefs in north-eastern North Island areas (Nelson, 2018).

Cawthron Institute are set on pursuing this further in coming years, something that Patuharakeke Taiao unit will endeavour to remain involved in, assisting with insights into how this may be approached from a cultural health/Te Ao Māori perspective.

**Waipū Estuary**

In March 2021, after the lagoon area of Waipū estuary had been surveyed for this study, Council received numerous complaints about dead fish, discoloured water and an unpleasant odour in the lagoon area of the Waipū Estuary. During the initial visits, council staff and Patuharakeke kaitiaki observed a large quantity of dead and decaying red macroalgae in the upper southern area of the lagoon and recorded very low dissolved oxygen concentrations. It appears that red macroalgae had been washed into the lagoon from Bream Bay and then become trapped in the upper portion of the lagoon, where there is more limited circulation and exchange of water with the open coast. Initially conditions were probably favourable for the red macroalgae to continue to grow but once the algae started to die, microbial decomposition of the algae would have consumed oxygen. This decomposition appears to have been the cause of a decrease in the dissolved oxygen levels that then caused mortality to other marine plants and animals.

Staff continued to visit the estuary throughout March and April 2021, and it appeared that the estuary slowly recovered without any intervention. Dissolved oxygen levels returned to normal levels, the black colouration of the water and the strong odour caused by anoxic conditions dissipated. It is likely that a combination of tidal flushing and surface aeration helped by moderate winds, helped to re-oxygenate the water. This is the first time that large quantities of nuisance algae have been reported in Waipū Estuary and it is still unclear what climatic or hydrodynamic factors contributed to this event.

# Methods

## Cultural health assessment

A Cultural Health Indicator (CHI) framework was used throughout this monitoring project. Patuharakeke Rohe Moana Committee developed a coastal cultural health framework in 2010, adapted from cultural health indicator frameworks of the time (Tipa & Tierney, 2006; Chetham & Shortland, 2013). The key aims of using this methodology include:

- To enable and promote the contemporary expression of kaitiakitanga and effective customary fisheries management by tangata whenua;
- To provide mana whenua with an assessment of the condition and trend of the environmental health of selected significant ecological areas; and
- To determine whether cultural values are being enhanced or diminished.

Cultural health assessments were completed using this Takutai Health Analysis which assesses tohu such as whanaungatanga, whakapapa, and mauri. The assessment involves providing kaitiaki with survey methods and tools to conduct scientific surveys independently, to complement tikanga Māori and further expressions of kaitiakitanga. Recently, Patuharakeke Taiao unit updated the takutai health analysis to incorporate new tohu, such as the 'kaimoana quality' taste test. For Patuharakeke it is important to continue adapting and evolving meaningful methods of measuring the health and mauri of these culturally significant sites.


This method uses a ranking system of 1 to 5 covering a spectrum from takutai-mate (poor health) to takutai-ora (great health). Each tohu is given a score, which is decided on through a consensus process, eventually reaching a score of mauri for that site. During field work, kaitaiao are encouraged to be aware and conscious of their surroundings while surveying, take notes, and think about their experience in reference to the tohu listed in Table 1.

It is important to create and facilitate an inclusive space for open communication for each tohu at each location, to allow a collective agreement to be achieved. Through kōrero and wānanga by the group who undertook the habitat assessment survey, a consensus is agreed upon, and this is the score that is captured. Additional comments and notes are made throughout this process to add robustness and depth to the observations, and to facilitate comparisons when the assessment and scores are revisited in coming years.

**Table 1.** Patuharakeke Takutai Health Analysis (Coastal Cultural Health Index).

| **Ngā Tohu** (indicators) | **Takutai-mate or Takutai-kino** (unhealthy, sick or polluted) | **Takutai-maori** (average coastline/ shoreline) | | | **Takutai-ora** (healthy coastline/shoreline) |
|---|---|---|---|---|---|
| **SCORES** | | | | | |
| **Catchment**<br>What does the land look like next to the Takutai? | 1. Land very changed (roads, houses, industry, no plants, trees or wetlands) | 2 | 3 | 4 | 5. Still natural, lots of bush or trees other coastal plants |
| **Takutai**<br>What does the sand/shore look like? | 1. Covered by mud/sand/slime, litter | 2 | 3 | 4 | 5. Clean sand, shells |
| **Wai tai**<br>What is the water quality like? | 1. Looks polluted (e.g. foams oils, slime, dirty colour) | 2 | 3 | 4 | 5. Clean, clear water no apparent pollution |
| **Mahinga Mātaitai**<br>Number of kaimoana | 1. No kaimoana or dead and dying | 2 | 3 | 4 | 5. Large number of kaimoana |
| **Whanaungatanga**<br>What are the size classes of the population? | 1. No adults or no babies (only one size class represented) | 2 | 3 | 4 | 5. Adults, juveniles/babies (various size ranges, well represented) |
| **Whakapapa**<br>Number of other species in the mataitai area. Te Ao Maori worldview all species whakapapa to one another | 1. Very limited number of other species seen | 2 | 3 | 4 | 5. A range of other species present and in good numbers |
| **Kaimoana**<br>Taste Test, quality of kaimoana for consumption | 1. Looks and smells yuck, you wouldn't want to eat it | 2 | 3 | 4 | 5. Kai reka! Delicious! |
| **Mauri**<br>Overall health of this site | 1. Takutai-mate or takutai-kino | 2 | 3 | 4 | 5. Takutai-ora |

# Ecological assessment

## Sampling sites

Sampling sites for quadrat and core sampling was initially predetermined by placing transects 100m apart with sites located 100m along each transect. However, it was not possible to access all sites due to access across channels and additional sampling sites were placed in the river section of the estuary. In total, core samples were collected from 70 locations (Figure 7). Quadrat surveys were only undertaken at 63 of these sites as it was not possible to sample quadrats at seven sites because of the water depth. A further 10 sites were underwater when the quadrat surveys were undertaken, which may have impacted the ability of the sampler to accurately count all species (Figure 8). Bird surveys were undertaken at six locations within the lagoon area of the estuary and at two locations within the river channel area (Figure 9) and an environmental DNA (eDNA) sample was collected from the river channel. Shellfish samples were collected from two sites within the river section of the estuary for analysis of metal contamination in the shellfish flesh (Figure 9).

## Substrate

At each sampling site the substrate was classified into one of nine categories (Table 2). These categories were developed from the sediment categories in the Estuary Monitoring Protocol (Robertson *et al*., 2002) and an intertidal habitat survey of Waikato estuaries conducted by Needham *et al.* (2013).

**Table 2.** Substrate categories.

| Substrate categories | Description |
|---|---|
| Very soft mud | The surface appears brown with a black anaerobic layer below. When walking on the substrate you will sink greater than 5cm. |
| Soft mud | The surface appears brown with a black anaerobic layer below. When walking on the substrate you will sink 2-5cm. |
| Firm mud/sand | A mixture of mud and sand, the surface appears brown with a black anaerobic layer below. When walking on the substrate you will sink 0-2cm. |
| Firm sand | Firm sand flats may be mud-like in appearance but are granular when rubbed between the fingers, and solid enough to support an adult's weight without sinking more than 1-2cm. Firm sand may have a thin layer of silt on the surface making identification from a distance impossible. |
| Mobile sand | The substrate is clearly recognised by the granular beach sand appearance and the often rippled surface layer. Mobile sand is continually being moved by strong tidal currents and often forms bars and beaches. When walking on the substrate you will sink less than 1cm. |
| Soft sand | Substrate containing greater than 99% sand. When walking on the substrate you will sink greater than 2cm. |
| Very soft sand | Substrate containing greater than 99% sand. When walking on the substrate you will sink greater than 5cm. |
| Gravelfield | Sediment characterised by unconsolidated gravel (2-20mm diameter). Visually observed to cover ~70-100% of sediment surface to the extent that very little (or none) of the underlying sediment is visible. |
| Shell hash | The substrate is dominated by shells. |


**Figure 7.** Location of shellfish core sites.


**Figure 8.** Location of quadrat sites.

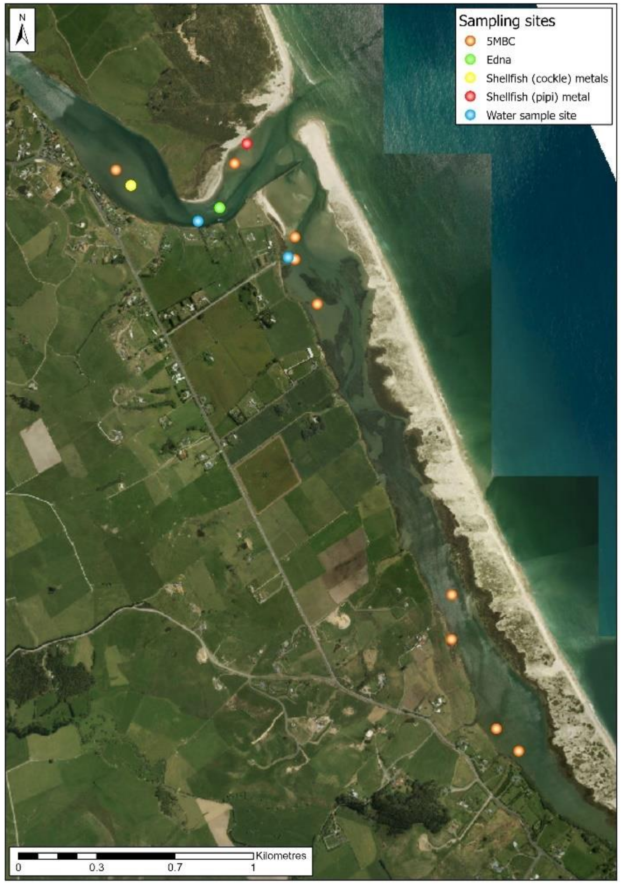



**Figure 9.** Sediment, water, eDNA and bird survey.

## Quadrat survey

Epifauna and flora was surveyed by placing a $0.25m^2$ quadrat on the substrate and identifying all animals and flora within the quadrat. In addition, any crustacean burrows within the quadrat were recorded. Ten sites were underwater at the time of sampling, which may have impacted the ability of the sampler to accurately count all species (Figure 8).

## Shellfish core sampling

Shellfish were sampled by collecting two circular core samples (with a 150mm diameter) pushed into the substrate to a depth of 150mm, at each sampling site (Figure 7). The contents from the two cores were aggregated and passed through a 5mm aperture sieve. All hū ai/cockles (*Austrovenus stutchburyi*), hanikura/wedge shell (*Macamona liliana*) and kōkota/pipi (*Paphies australis*) retained on the sieve were identified and counted. A photograph was also taken of all the individuals at each site, using a specially adapted 20L bucket, which had a hole drilled through the lid and an indent to match the sampler's phone's camera. This ensured that each photograph was taken at the same height and centred in the middle of the bucket (Figure 10). These photographs were analysed using Photoblique v2.0.122, which allows the user to set the spatial scale of the photographs using a reference photograph with a ruler in the bottom of the bucket and then measure the shell length of each individual shellfish (Figure 10). The shell length measurements made using Photoblique were exported as a csv and used to calculate the number of juveniles and adults, and to estimate the biomass of hū ai/cockles. Hū ai/cockles 15mm or greater in shell length, kōkota/pipi 18mm or greater and hanikura/wedge shell 30mm or greater were classified as adults.

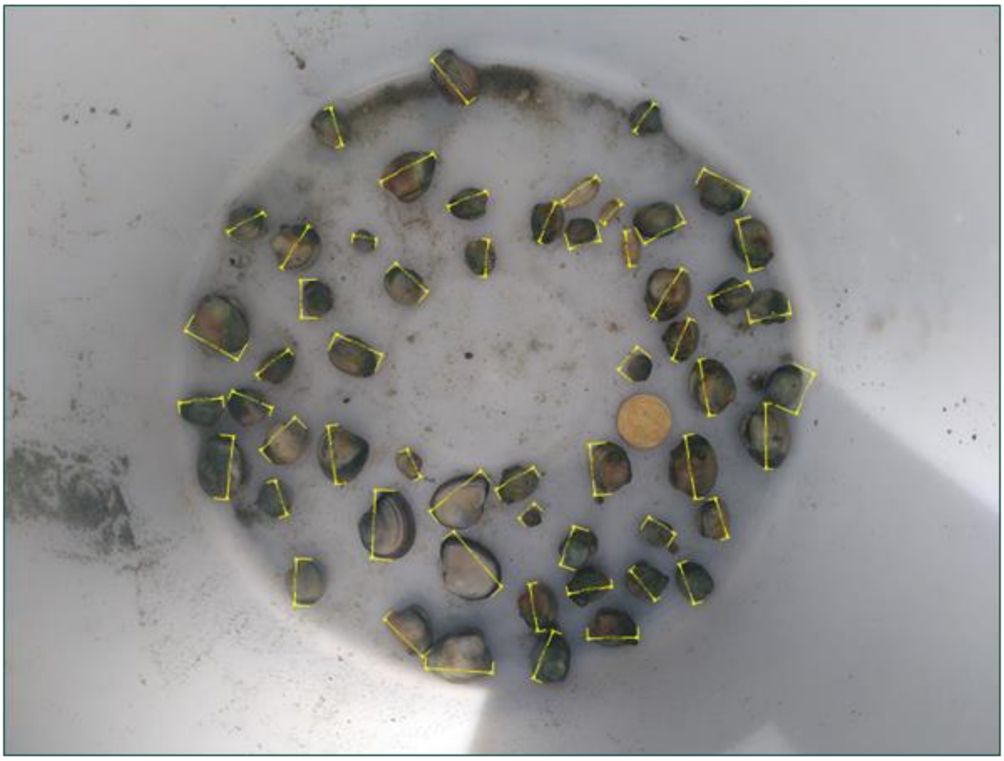


**Figure 10.** Shellfish measurements using Photoblique v2.0.122.

Following an ecological classification method developed by Hewitt & Funnel (2005), an area was classified as a hū ai/cockle habitat if adult densities were greater than 226 individuals per square metre, and an area was classified as Kōkota/pipi habitat if adult densities were greater than 226 individuals per square metre. Hanikura/wedge shell habitat was identified using a classification system developed by Needham *et al*. (2013), which classified hanikura/wedge shell habitat if densities were equal or greater than four adult individuals (≥30mm shell length) from a 15 x 15cm area (177 individuals per square metre).

The mean density (per square metre) and standard error was estimated for juvenile and adult shellfish within areas identified as shellfish habitat/beds. The total population for each bed was estimated by calculating the average density (per square metre) and then multiplying this by the area of the SEA using the formula:

$$Total\ population\ (X) = \sum \sum_{i-1} W_i\, \bar{x}_i$$

Where: $W_i$ is the stratum area ($m^2$), and $\bar{x}_i$ is the average density (per square metre) in stratum i.

## Shellfish metal contamination

In order to assess any metal contamination of shellfish within the estuary, 15 hū ai and 15 kōkota were collected from the intertidal sand flat in the river section of the estuary (Figure 9) and sent to Watercare Laboratory Services for analysis. The shellfish flesh was analysed for: total copper; total lead; total zinc; total chromium; total arsenic; total mercury; total nickel; and total cadmium (wet weight of the shellfish).

## Avifauna (birds)

Bird counts were undertaken on each sampling visit, using a similar method to the five-minute bird count (Hartley & Greene, 2012) used for forested areas. All birds seen or heard within a 150m radius were recorded within a 5-minute period, with care taken not to knowingly record the same bird twice.

## Environmental DNA (eDNA)

A Wilderlab eDNA VC mini kit was used to collect a sample from the river section of the Waipū Estuary (Figure 9). A water sample was collected using a 200ml plastic pottle from 30cm water depth and a 60ml syringe was then used to draw 50ml of water from the pottle. A filter was then attached to the syringe and the water was forced out of the syringe and through the filter. The filter was removed and a further 50ml of seawater drawn into the syringe. This process was repeated 20 times until 1L of water had passed through the filter. A cap was then attached to the filter, and the filter removed from the 60ml syringe and attached to a second syringe containing preservative. The preservative in the syringe was then injected into the filter. The filter was placed into a clear zip-lock bag with the syringe and cap still attached and sent to Wilderlab NZ Ltd. for analysis.

## Water quality monitoring

Council undertakes monthly coastal water quality sampling at two sites in Waipū Estuary as part of its coastal water quality monitoring network (Figure 9). Samples are analysed for a suite of 17 parameters, which includes indicators of nutrient enrichment, water clarity and microbial contamination bacteria. Results are assessed against the relevant coastal water quality standards in the Proposed Regional Plan for Northland (Northland Regional Council, 2019) (Table 3).

**Table 3.** Relevant coastal water quality standards.

| Values | Water Quality Parameter | Compliance metric | Estuary |
|---|---|---|---|
| Ecosystem Health Water clarity | Turbidity (NTU) | Annual median | <6.9 |
| Ecosystem Health Trophic state | Dissolved oxygen (mg/L) | Minimum | >4.6 |
| | Dissolved oxygen (mg/L) | Annual median | <6.9 |
| | Chlorophyll-a (mg/L) | Annual median | <0.004 |
| | Total nitrogen (mg/L) | Annual median | <0.22 |
| | Ammoniacal nitrogen | Annual median | <0.023 |
| | Nitrite-nitrate nitrogen | Annual median | <0.048 |
| | Total phosphorus (mg/L) | Annual median | <0.040 |
| | Dissolved reactive phosphorus (mg/L) | Annual median | <0.021 |
| Recreation | Enterococci (CFU per 100mL) | Annual 95$^{th}$ percentile | ≤200 |
| Shellfish consumption | Faecal coliforms (CFU per 100mL) | Annual median | Not applicable |
| | Faecal coliforms (CFU per 100mL) | Annual 90$^{th}$ percentile | Not applicable |

# Results

# Cultural health assessment

The results of the takutai health analysis from Waipū SEA are summarised in Figure 11. The catchment score for both sites is three due to the inherent naturalness of both environments, and because the houses that are bordering the sites are of low interference.

The takutai scores are four for the estuary and the two for the lagoon. The lagoon has a high presence of mud, and although this may be a naturally muddy environment, the groyne adds a barrier to the open ocean. This may be affecting the natural hydrodynamics and movement of sand, which could reduce flushing affecting the overall functioning of this location. In the river section of the estuary, a score of four was decided based on the high cleanliness of the sand and shoreline.

In places the estuary water clarity presents as beautiful clear, turquoise water. There was a minor presence of foam and discoloured water from the stormwater pipe flowing into the estuary from beneath the urupa which could contain a number of contaminants. As mentioned earlier, the lagoon had a high presence of red algae and the presence of light surface foam at different sites.

Kaimoana abundance is low for the lagoon, as there is virtually no edible shellfish, but there would likely be ika such as kanae, mullet and pātiki, flounder present at other tides. The river section however, has a multitude of kaimoana in moderate abundance, making it a fairly common place for local hapū members to access ika such as kahawai and kanae, and kūtai, pipi and tio.

Low scores for whanaungatanga occurred due to little presence of all size classes of shellfish. For example, if pipi were found they were mostly within 2-3cm of each other in shell length. For the whanaungatanga at this site to score highly, we'd need to see lots of big, mature pipi, as well as evidence of strong recruitment (smaller 1cm size classes). When there is little spread across size classes of within species, we interpret this as a weakened sense of whanaungatanga in that population.

Whakapapa relates to biodiversity and interspecific connectivity within the population, which can help us to understand how well the wider ecosystem is working together. A score of four was given to the estuary, representing a decent level of ecosystem health and functioning due to the presence of a number of different species of manu, and kaimoana such as ika and shellfish. For the lagoon, the presence of manu species was slightly higher than the estuary, however not nearly as many shellfish such as pipi, kūtai and tio, and a presence of ika only at high tide.

Low kaimoana quality was observed in the lagoon as a result of the toxicity arising from the latest algal bloom, causing many kaimoana to die due to low dissolved oxygen in the water. Kaimoana quality is also based on a "taste test" including smell, touch, sight, flavour, quality and condition. In this instance, our kaitaiao were not keen to taste the kaimoana from the lagoon, as they did not look fresh, fat or tasty. Thus, a low kaimoana quality score was given for the lagoon. Some kūtai were harvested from the estuary and reports of a pungent taste and smell were noted from the kaitaiao. Tasting and smelling very similar to the red algae that filled the lagoon earlier in the year. Poor overall quality, but still edible and didn't cause food poisoning scoring that site a two.

The mauri indicator almost acts as a cumulative score for all of the indicators. The natural amenity of the estuary is high and attracts many people to the area. The wildlife, in terms of taonga and native species like tara iti brings a good feeling to people visiting the site. This is what comes into the score of mauri. The kaimoana are harvestable and fishing is often good, and the water clarity is great for swimming and kayaking. The hau (breath) of this site is strong, and there is an uplifting feeling in your wairua after visiting this place.

The mauri at the lagoon is similar to the estuary, but slightly lower due to a subtle, but different felt sense. It is still a beautiful place riddled with wildlife, but at the time of the survey, the mauri had been impacted by the presence of the groyne and the hau of the site was less apparent.

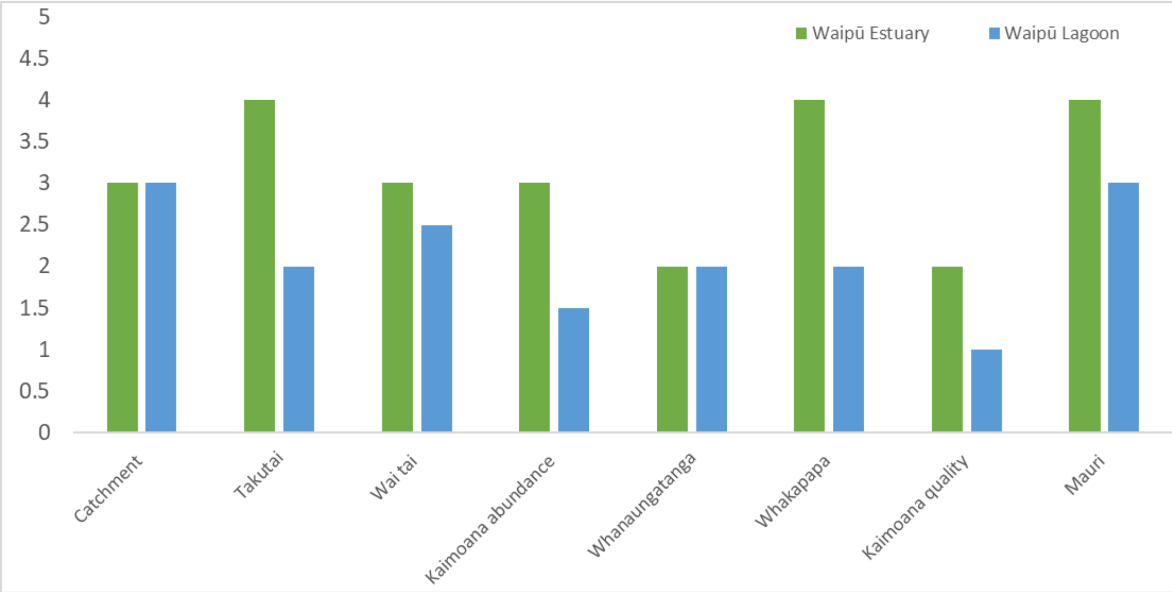



**Figure 11.** Takutai health analysis results from Waipū Estuary SEA (Patuharakeke Taiao unit, 2021).

# Ecological assessment

## Substrate

Substrate in the river area of the estuary was predominately firm sand and firm sand/mud upstream of the first bend of the river. In the more dynamic area near the mouth of the estuary the substrate comprised mainly mobile sand (Figure 13). In the lagoon area of the estuary the substate was predominately firm sand and firm sand/mud with an area of soft mud found towards the southern end of the lagoon (Figure 13).

## Seagrass

Seagrass was recorded at 16 quadrat stations in the lagoon (Figures 12 & 14) and large areas of seagrass were observed during the site visits. No seagrass was recorded or observed in the river area of the estuary (Figure 14).

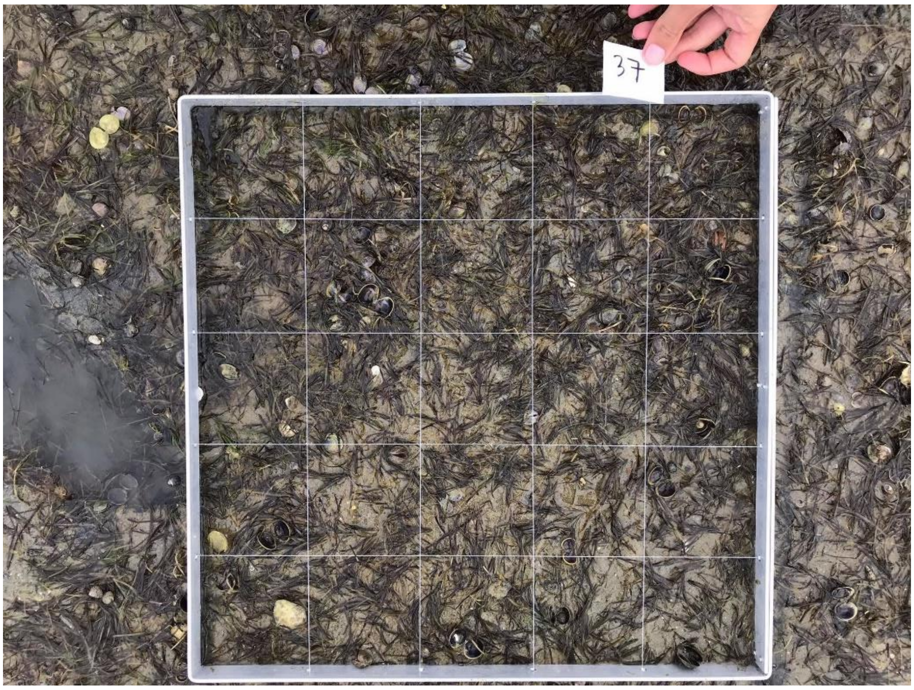



**Figure 12.** Seagrass observed in one of the quadrat samples in Waipū Estuary.

## Algae

Algae was recorded at 19 of the 63 quadrat stations. The majority of the observations were in the lagoon area of the Estuary and 11 observations were made at sites where seagrass was also recorded.


**Figure 13.** Substate type recorded at quadrat sample site in Wāipu Estuary.


**Figure 14**. Seagrass habitat recorded at quadrat sample site in Wāipu Estuary.

## Epifauna

In total, 14 different taxa of benthic invertebrate were recorded from the 63 quadrats (Table 4). The taxa found were similar to species recorded in similar habitats in other Northland estuaries and are indicative of a healthy sand flat. No non-native taxa were recorded.

**Table 4.** Epifauna recorded in Waipū.

| Taxa | Māori name | Common name |
|---|---|---|
| *Austrovenus stutchburyi* | Hū ai, | Cockle |
| *Diloma subrostratum* | Whetiko | Top shell |
| *Austrominius modestus* | | Estuarine barnacle |
| *Zeacumantus lutulentus* | Koeti | Horn shell, Spire shell |
| *Chiton glaucus* | Papatua kakāriki, | Chiton |
| *Cominella glandiformis* | | Mud flat whelk |
| *Amphibola crenata* | Karahue, | Mudflat snail |
| *Anthopleura sp.* | Humenga, | Anemone |
| Notoacmea helmsi | | Limpet |
| *Patiriella sp* | | Cushion star |
| *Halicarcinus whitei* | Päpaka, | Estuarine pillbox crab |
| Unidentified crab | | Unidentified crab |
| *Lunella smaragda* | Ataata, | Cats eye snail |
| Unidentified bubble snail | Pupu-waharoa, | Unidentified bubble snail |

## Shellfish

**Hū ai/cockle (*Austrovenus stutchburyi*)**

Hū ai were quite widely distributed throughout the lagoon although the highest densities were found in the northern area of the lagoon (Figure 15). In the river section of the estuary, hū ai were almost exclusively located upstream of the first bend on intertidal sand flat. Two hū ai beds, where the adult density exceeded 226 individuals per $m^2$, were identified (Figure 15), one in the river section and one in the lagoon. The population of the bed in the river section of the estuary was estimated to be 90.21 and the population of the bed identified in the lagoon section was estimated to be 63 million (Table 5). There is a relatively high standard error associated with these estimated due to the small sample sizes.

**Table 5**. Hū ai (*Austrovenus stutchburyi)* density and population found in Wāipu Estuary.

| | Wāipu River | Wāipu Lagoon |
|---|---|---|
| Sample size | 8 | 7 |
| Mean density per square metre | 1375 | 724 |
| Standard error | 291 | 142 |
| Stratum (bed) area ($m^2$) | 65572.33 | 86481.16 |
| Total population (millions) | 90.21 | 62.57 |

**Kōkota/pipi (*Paphies australis*)**

Kōkota were found at 24 sites in the river section of the estuary but only at one site in the lagoon (Figure 16). Juvenile kōkota were widespread through the river section of the estuary, but adult Kōkota were only found in high abundances within the river channel. Although adult kōkota were found in densities that exceeded 226 individuals per $m^2$ at 10 sites, which is sufficient to be classified as kōkota habitat, no obvious kōkota bed was identified (Figure 16).

### Hanikura/wedge shell (*Macomona Liliana*)

Hanikura were found at 36 sites in the estuary (Figure 17). Juvenile hanikura were widely distributed throughout the lagoon (23 sites), but adult hanikura were only found at three sites, all towards the northern end of the lagoon. In the river section of the estuary, juvenile and adult hanikura were only found upstream of the first bend on the intertidal sand flat.

Although adult hanikura (shell length ≥30mm) were not found in sufficient density to be classified as hanikura habitat, juvenile and adult hanikura combined were found in sufficient densities at eight sites, in the river section of the estuary, to be classified as hanikura habitat (Figure 17). The total population of Hanikura in this bed was estimated to be 20.63 million (Table 6).

**Table 6**. Hanikura (*Macomona Liliana)* density and population found in Wāipu Estuary.

| Taxa | Wāipu River |
|---|---|
| Sample size | 8 |
| Mean density per square metre | 269 |
| Standard error | 16 |
| Stratum (bed) area ($m^2$) | 76744 |
| Total population (millions) | 20.63 |

a) b) c)

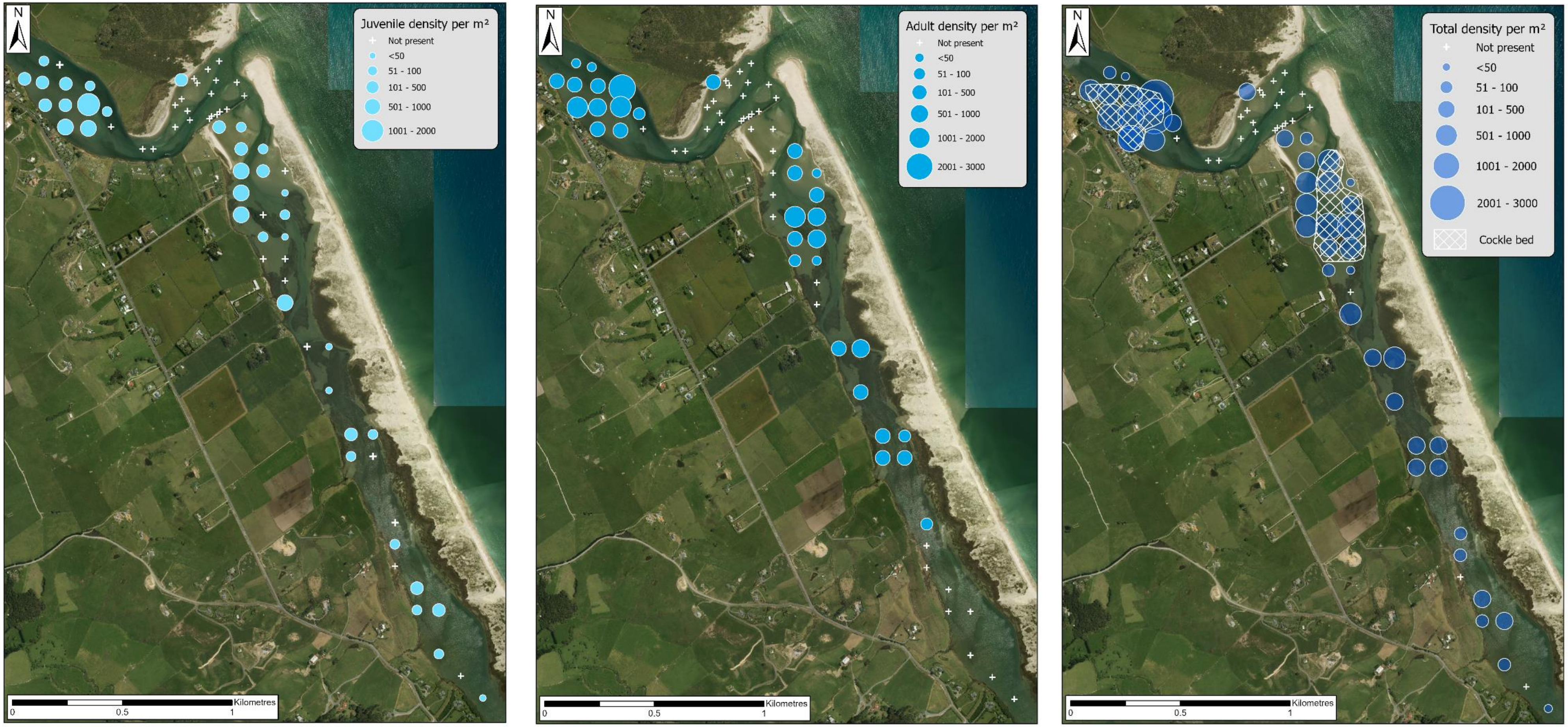



**Figure 15.** Hū ai (*Austrovenus stutchburyi*) density in Wāipu Estuary. a) juvenile density, b) adult density, c) total density.

a)

b)

c)

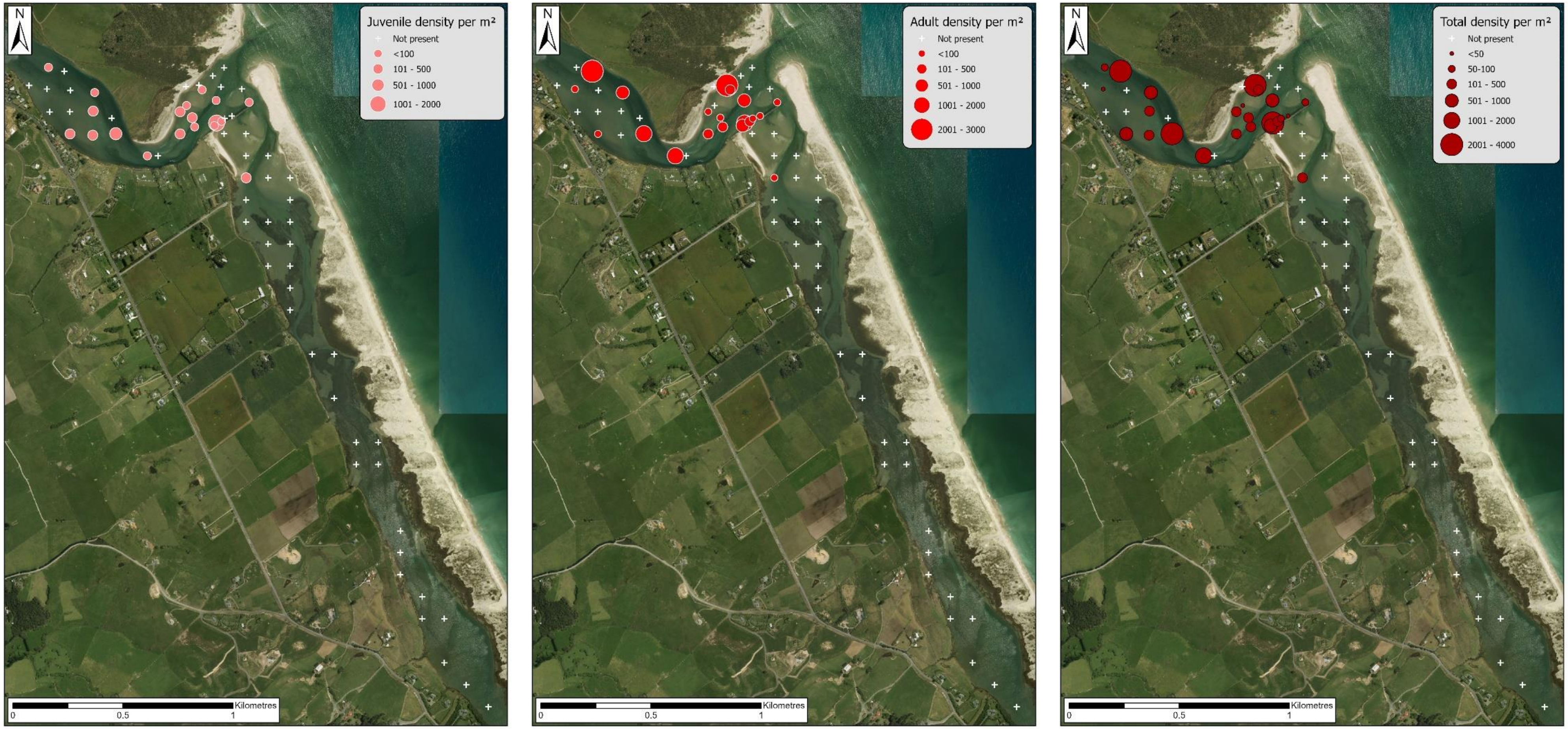



**Figure 16.** Kōkota (*Paphies australis*) density in Waipū Estuary. a) juvenile density, b) adult density, c) total density.

a) b) c)

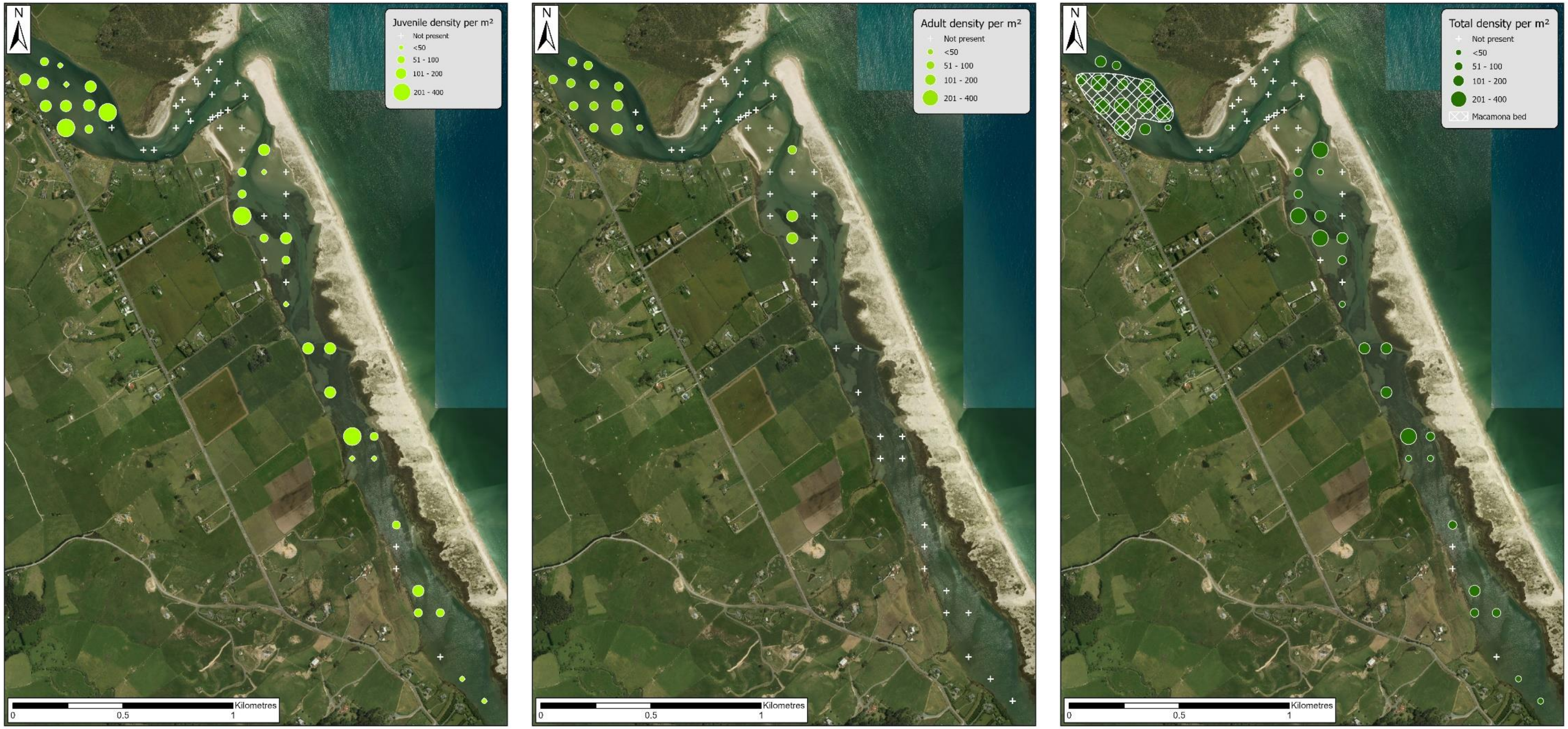



**Figure 17.** Hanikura (*Macamona*) density in Waipū Estuary. a) juvenile density, b) adult density, c) total density.

## Shellfish metal contamination

Concentrations of cadmium and copper found in the flesh of kōkota were an order of magnitude higher than the concentrations found in hū ai (Table 7). In contrast, concentations of mercury found in hū ai were higher than the concentrations found in kōkota. Both kōkota and hū ai had levels of cadmium, lead and mercury below the maximum allowable level for the safe consumption of shellfish, set by Food Standards Australia New Zealand (FSANZ, 2008) (Table 7). Unfortunately, the FSANZ (2008) provide a guideline for inorganic arsenic not total arsenic. As inorganic arsenic is estimated to be 10% of total arsenic (United States Food and Drug Administration, 1993), the concentration of inorganic arsenic in hū ai was estimated to be 0.34 mg/kg and 0.26 mg/kg in Kōkota, which would be below the FSANZ maximum allowable levels.

The FSANZ do not provide maximum allowable levels for copper, chromium, nickel or zinc in shellfish, but the U.S. Food and Drug administration (USFDA) has set a limit for the maximum daily consumption of chromium and nickel (Table 7). Using the USFDA limit for maximum daily consumption for chromium, a person could eat a maximum of 105 grams of hū ai/cockle or 125 grams of kōkota/pipi each day, assuming no other food containing chromium was consumed. Using the USFDA limit for the maximum daily consumption for nickel, a person could eat a maximum of 600 grams of hū ai/cockle or 857 grams of kōkota/pipi, assuming no other food containing nickel was consumed.

**Table 7.** Hū ai and Kōkota metal data from Waipū Estuary, 2021.

| Waipū Estuary | Hū ai | Kōkota | Maximum allowable levels of metals in food (FSANZ, 2008) | Maximum consumption mg/per day (USFDA, 1993) |
|---|---|---|---|---|
| Arsenic (mg/kg) | 3.4 | 2.6 | 1* | 0.13* |
| Cadmium (mg/kg) | 0.066 | 0.16 | 2 | N/A |
| Chromium (mg/kg) | 1.9 | 1.6 | N/A | 0.2 |
| Copper (mg/kg) | 2.3 | 38 | N/A | N/A |
| Lead (mg/kg) | 0.031 | 0.04 | 2 | N/A |
| Mercury (mg/kg) | 0.014 | 0.0056 | 0.5 | N/A |
| Nickel (mg/kg) | 2 | 1.4 | N/A | 1.2 |
| Zinc (mg/kg) | 11 | 12 | N/A | N/A |

*Maximum allowable level is for inorganic arsenic (FSANZ, 2008). Inorganic arsenic is estimated to be 10% of total arsenic (USFDA 1993).

## Avifauna (birds)

In total 26 species of bird were identified in the Waipū Estuary at the nine sites, sampled over three days in February and April (Table 8). Five birds are endemic and a further 18 are native to New Zealand. Of those species, 13 are classed as either "Threatened" or "At Risk" under the 2016 Department of Conservation Threat classification series (Robertson *et al.,* 2017). One of the species identified, the Black-billed gull (*Larus bulleri*) has the highest threat classification (Nationally Critical). The two individuals counted were located in the river section of the estuary. Three non-native species were observed, the mallard duck (*Anas platyrhynchos*), the myna (*Acridotheres* tristis) and the sparrow (*Passer domesticus*).

Site 55 in the lagoon had the highest species richness with 14 species (Figure 18) recorded on the 12$^{th}$ of February. Site 55 also had the highest number of individuals recorded on both the 11$^{th}$ and 12$^{th}$ of February with 162 and 163 individuals respectively. However, most of these individuals at site

55 on the 11th of February were the variable oyster catcher (*Haematopus unicolor*). The lowest species richness was recorded at site 46 on the 11th February (five species) and at site 19 on the 12th of February (also five species).

The variable oyster catcher (*Haematopus unicolor*) was the most abundant species across all sites (Figure 18) with the red-billed gulls (*Larus novaehollandiae*) and pied stilt (*Himantopus Himantopus*) also present at most sites. In contrast, the banded dotterel (*Charadrius bicinctus*) and the sacred kingfisher (*Todiramphus sanctus*) were only found at one site each. Individuals were concentrated at sites 52, 55, and 75, with 449 or 74.5% of all individuals recorded at these sites.

**Table 8.** Species identified in the Waipū Estuary and lagoon. Red colouring indicates the highest threat level among the species identified, orange is 2nd and yellow is 3rd.

| Scientific name | Māori name | Common name | Endemism | Threat classification |
|---|---|---|---|---|
| *Limosa lapponica* | Kuaka | Bar-tailed Godwit | Native | At risk - Declining |
| *Charadrius bicinctus* | Tūturiwhatu | Dotterel, Banded | Endemic | T - Nationally vulnerable |
| *Charadrius obscurus* | Tuturiwhatu pukunui | Dotterel, New Zealand | Endemic | At risk - Recovering |
| *Anas platyrhynchos* | Rakiraki | Duck, Mallard | Introduced | Naturalised |
| *Larus dominicanus* | Karoro | Gull, Southern black-backed | Native | Not Threatened |
| *Larus bulleri* | Tarāpuka | Gull, Black-billed | Endemic | T - Nationally Critical |
| *Larus novaehollandiae* | Tarāpunga | Gull, Red-billed | Native | AR - Declining |
| *Circus approximans* | Kāhu | Harrier, Swamp | Native | Not Threatened |
| *Egretta novaehollandiae* | Matuku moana | Heron, White-faced | Native | Not Threatened |
| *Todiramphus sanctus* | Kōtare | Kingfisher, Sacred | Native | Not Threatened |
| *Calidris canutus* | Huahou | Knot, Lesser | Native | T - Nationally vulnerable |
| *Acridotheres tristis* | Maina | Myna | Introduced | Naturalised |
| *Haematopus finschi* | Tōrea tuawhenua | Oyster Catcher, South Island Pied | Endemic | AR - Declining |
| *Haematopus unicolor* | Tōrea pango | Oyster Catcher, Variable | Endemic | AR - Recovering |
| *Vanellus miles* | Tuturuatu | Plover, Spur-winged | Native | Not Threatened |
| *Phalacrocorax melanoleucos* | Kawau paka | Shag, Little | Native | Not Threatened |
| *Phalacrocorax sulcirostris* | Kawau tūi | Shag, Little black | Native | AR - Naturally Uncommon |
| *Phalacrocorax varius* | Kawau | Shag, Pied | Native | AR - Recovering |
| *Passer domesticus* | Tiu | Sparrow | Introduced | Naturalised |
| *Platalea regia* | Kōtuku ngutupapa | Spoonbill, Royal | Native | AR - Naturally Uncommon |
| *Himantopus himantopus* | Poaka | Stilt, Pied | Native | Not Threatened |
| *Hirundo neoxena* | Warou | Swallow, Welcome | Native | Not Threatened |
| *Cygnus atratus* | Kakīānau | Swan, Black | Native | Not Threatened |
| *Hydroprogne caspia* | Taranui | Tern, Caspian | Native | T - Nationally vulnerable |
| *Sterna striata* | Tara | Tern, White-fronted | Native | AR - Declining |
| *Arenaria interpres* | | Turnstone, Ruddy | Native | Migrant |
| | | **Species Richness = 26** | | **AR = At Risk** |
| | | | | **T = Threatened** |

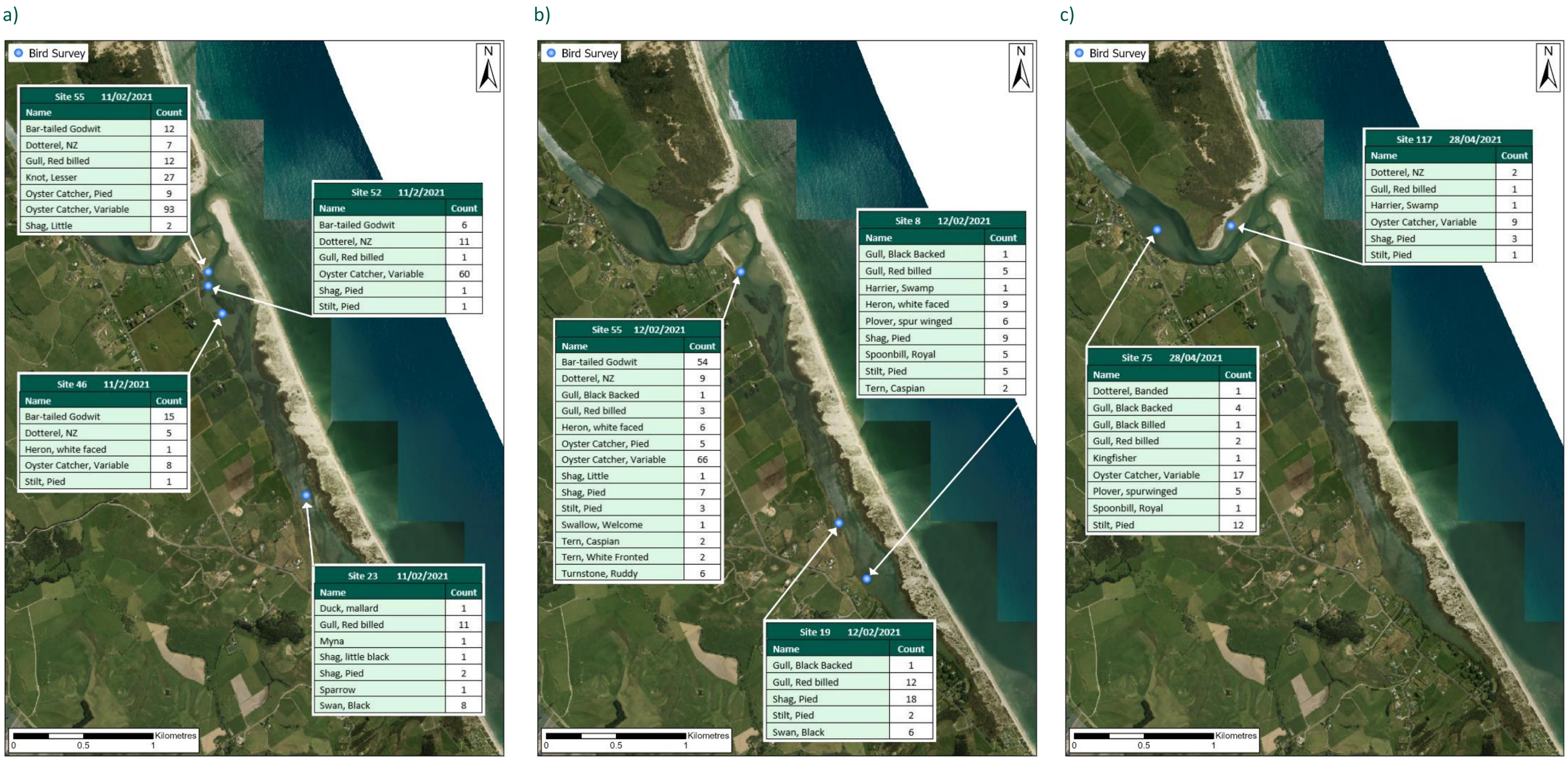



**Figure 18.** Bird survey data recorded in Wāipu Estuary on a) 11 February 2021 b) 12 February 2021 and c) 28 April 2021.

# eDNA

Analysis of the eDNA sample identified eDNA signatures from 36 different taxa (Table 9). Nineteen taxa of fish were identified including several important cultural and commercial species such as Kanae (mullet), Kahawai, Tāmure (snapper), Ihe (piper), and Kātaha (yellow-eye mullet). Other marine taxa included the estuarine mud snail *Potamopyrgus estuarinus,* three taxa of crustacean and five taxa of cnidaria taxa. Signatures of two bird taxa were also identified, the genus *Larus* (gull) and the genus *Haematopus* (oystercatcher), which were both recorded in the bird surveys. No non-native marine taxa were identified. Signatures from several non-marine taxa were also identified, including three mammals (human, dog and cattle) and the class *Insecta* (insects) (Table 9).

Only two of the invertebrate taxa identified in the quadrat survey were recorded in the eDNA sample, but nine additional taxa were identified in the eDNA sample. The poor overlap may be due to the limited eDNA sampling carried out (only one sample in the river section of the estuary) or may indicate that both methods may be required to capture the full species richness of the estuary. Only two bird taxa were identified by the eDNA sample, the genus's *Larus* and *Haematopus* despite 26 different taxa being identified in the bird surveys. The low number of bird taxa recorded in the eDNA sample may be partly due to the limited eDNA sampling and because sampling only took place in the river section and not the lagoon.

**Table 9.** Taxa identified from the eDNA collected in Waipū Estuary.

| Scientific Name | Common Name | Description |
|---|---|---|
| *Mugil cephalus* | Grey mullet | Fish |
| *Girella tricuspidata* | Parore | Fish |
| *Aldrichetta forsteri* | Yelloweye mullet | Fish |
| *Hyporhamphus ihi* | Piper | Fish |
| *Arripis trutta* | Kahawai | Fish |
| *Retropinna retropinna* | Common smelt | Fish |
| *Seriola lalandi* | Yellowtail kingfish | Fish |
| *Forsterygion nigripenne* | Estuarine triplefin | Fish |
| *Rhombosolea tapirina* | Greenback flounder | Fish |
| *Rhombosolea retiaria* | Black Flounder | Fish |
| *Sardinops neopilchardus* | Pilchard | Fish |
| Pagrus auratus | Snapper | Fish |
| Sardinella | * | Fish |
| Mugil | Mullets | Fish |
| Hyporhamphus | Halfbeak | Fish |
| Gobiidae | Burrowing gobies | Fish |
| Mugiliformes | Mullets | Fish |
| Gobiiformes | Gobies and sleepers | Fish |
| Teleostei | Teleost fishes | Teleost fish |
| *Potamopyrgus estuarinus* | Mud Snail | Molluscs |
| *Pseudevadne tergestina* | * | Crustaceans |
| Podonidae | * | Crustaceans |
| Diplostraca | * | Crustaceans |
| Proboscidactyla sp. | * | Cnidarians |
| *Lovenella haichangensis* | * | Cnidarians |
| Clytia gracilis | Hydroid | Cnidarians |
| Anthopleura | Sea anemone | Cnidarians |
| Actiniaria | Actinians | Cnidarians |
| Rhodophyta | Red algae | Red algae |
| Gigartinales | Red algae | Red algae |
| Haematopus | Oystercatchers | Birds |
| Larus | Seagull | Birds |
| Cellular organisms | * | Other |
| Insecta | Insects | Other |
| *Homo sapiens* | Human | Mammals |
| *Canis lupus familiaris* | Dog | Mammals |
| *Bos taurus* | Cattle | Mammals |

* no common name

# Water quality

***Enterococci***

Concentrations of enterococci indicate that water quality at the Waipū River site was not suitable for contact recreation, with the 95th percentile (1877 enterococci/100mL) above the standard of ≤200 enterococci/100mL (Table 10). However, water in the lagoon was suitable for contact recreation, with only one result above 200 enterococci/100mL, over the three-year period. This exceedance occurred following a rain event (75.6mm in the preceding 72 hours).

**Table 10.** Enterococci (CFU/100mL) data collected from Waipū 2018-2020.

| | n | Minimum | Maximum | Median | 95th percentile | Standard achieved |
|---|---|---|---|---|---|---|
| Waipū River | 35 | <10 | 14136 | 20 | 1877 | × |
| Waipū Lagoon | 35 | <10 | 231 | 5 | 104 | ✓ |

**Faecal coliforms**

The median and the 90th percentile of data from Waipū River site indicate that the water is not suitable for shellfish consumption (Table 11). The highest results were again recorded after rain events, with the highest result on the 20th September 2018 (9900 CFU/100mL) after 46.2 mm of rain had fallen in the preceding 72 hours. At the sampling site in lagoon, although the median was below the standard of 14 CFU/100mL, the 90th percentile exceeded the standard, which indicates that the water in the lagoon is also not suitable for shellfish consumption (Table 11). Again, the highest result was recorded after the rain event on the 20th September 2018 (850 CFU/100mL).

**Table 11.** Faecal Coliforms (presumptive) (CFU/100ml) data collected from Waipū 2018-2020.

| | n | Minimum | Maximum | Median | 90th percentile | Standard achieved |
|---|---|---|---|---|---|---|
| Waipū River | 34 | <1.7 | 9900 | 18 | 405 | × |
| Waipū Lagoon | 35 | <1.6 | 850 | 7 | 130 | × |

**Turbidity**

Results indicate that water clarity at both sites was generally good (Table 12), with the median turbidity at both sites below the coastal water quality standard. The highest results at both sites were generally recorded after heavy rainfall. At Waipū River the three highest turbidity readings (60.4 FNU on 20 September 2018, 46.9 FNU on 27th June 2018 and 34.9 FNU on 26 March 2018) were all recorded following rain events (46.2mm, 75.6mm and 39.9mm over the preceding 72 hours).

**Table 12.** Turbidity (FNU) data 2018-2020.

| | n | Minimum | Maximum | Median | Standard achieved |
|---|---|---|---|---|---|
| Waipū River | 35 | 0.58 | 60.4 | 2.3 | ✓ |
| Waipū Lagoon | 35 | 0.57 | 11.2 | 1.6 | ✓ |

**Nutrients, *chlorophyll*-a and dissolved oxygen**

Results from the Waipū Estuary site indicate that chlorophyll-*a* and all nutrient concentrations except ammoniacal nitrogen were below the relevant coastal water quality standards (Table 13). Again, the highest concentrations of nutrients were generally recorded after rainfall events. The median dissolved oxygen (7.9 mg/L) was above the standard and the lowest concentration (5.9mg/L) recorded was above the minimum standard (4.6 mg/L).

**Table 13.** Nutrient and chlorophyll-a data collected from Waipū Estuary 2018-2020.

| | n | Min | Max | Median | Standard | Standard achieved |
|---|---|---|---|---|---|---|
| Dissolved oxygen | 35 | 5.9 | 9.9 | 7.9 | >6.9 | ✓ |
| Chlorophyll-*a* (mg/L) | 35 | <0.0006 | 0.0089 | 0.0008 | <0.004 | ✓ |
| Total nitrogen (mg/L) | 35 | 0.029 | 2.100 | 0.150 | <0.220 | ✓ |
| Ammoniacal nitrogen (mg/L) | 30 | <0.005 | 0.130 | 0.025 | <0.023 | × |
| Nitrate-nitrite nitrogen (mg/L) | 35 | <0.002 | 0.590 | 0.012 | <0.048 | ✓ |
| Total phosphorus (mg/L) | 35 | 0.009 | 0.150 | 0.016 | <0.030 | ✓ |
| Dissolved reactive phosphorus (mg/L) | 35 | 0.002 | 0.036 | 0.013 | <0.017 | ✓ |

Results from Waipū lagoon indicate that chlorophyll-*a* and all nutrient concentrations were below the relevant coastal water quality standards (Table 14). Again, the highest concentrations of nutrients were generally recorded after rainfall events. The median dissolved oxygen (8.4 mg/L) was above the standard and the lowest concentration (6.1 mg/L was above the minimum standard (4.6 mg/L).

**Table 14.** Nutrient and chlorophyll-a data collected from Waipū Lagoon 2018-2020.

| | n | Min | Max | Median | Standard | Standard achieved |
|---|---|---|---|---|---|---|
| Dissolved oxygen | 35 | 6.1 | 9.9 | 8.4 | >6.9 | ✓ |
| Chlorophyll-*a* (mg/L) | 35 | <0.0006 | 0.004 | 0.001 | <0.004 | ✓ |
| Total nitrogen (mg/L) | 35 | 0.048 | 0.380 | 0.130 | <0.220 | ✓ |
| Ammoniacal nitrogen (mg/L) | 30 | <0.005 | 0.096 | 0.014 | <0.023 | ✓ |
| Nitrate-nitrite nitrogen (mg/L) | 35 | <0.002 | 0.170 | 0.006 | <0.048 | ✓ |
| Total phosphorus (mg/L) | 35 | 0.008 | 0.060 | 0.014 | <0.030 | ✓ |
| Dissolved reactive phosphorus (mg/L) | 35 | 0.006 | 0.022 | 0.011 | <0.017 | ✓ |

# Summary

**Ecological Assessment**

Results from the ecological survey undertaken by Council staff and Patuharakeke Kaitiaki, identified extensive areas of seagrass in the lagoons and productive hū ai/cockle and hanikura/wedge shell beds in the estuary.  The Waipū Estuary was classified as a significant ecological marine area owing to the high ranks for its ecological context (Kerr, 2016). These high ranks for its ecological context were on account of the shellfish and seagrass beds present, and the important support the estuary provided for various life stages of benthic invertebrates, shorebirds and the role it plays as a nursery for coastal fish species.  The survey therefore supports Kerr's assessment of the estuary.

Seagrass was recorded at 16 sites in the lagoon and covers large areas of the lagoon.  Hū ai/cockle and hanikura/wedge shell were widely distributed throughout the estuary and the total populations and biomass of these shellfish are likely to be significant.  Within just the defined hū ai/cockle and hanikura/wedge shell habitat, we estimate that there were 150 million hū ai and 20 million hanikura induvial respectively.  However, outside these defined beds, there are likely to be significant populations of both shellfish.

In addition, high densities of adult kōkato/pipi were found at subtidal sites in the river channel and although no well-defined kōkata bed was identified, the population is still likely to be important. More intensive sampling, targeting the river cannel may have identified a more defined Kōkata bed.

These shellfish populations will be an important food for the shorebirds found in the estuary and other species of fish and invertebrates.  High abundances of the variable oyster catcher (*Haematopus unicolor*) were recorded during the bird surveys and this species is known to consume large numbers of hū ai.

The mud whelk (*Cominella glandiformis*) is also an important predator of cockles and was found in quadrat samples throughout the estuary (Appendix 2).  In addition, to its role as a food source for other animals, hū ai provide important habitat for other invertebrates including the mud flat anemone (*Anthopleura aureoradiata*), the barnacle (*Austrominius modestusi*) and the limpet (*Notoacmea helmsi*) that use cockle shells as substrate for attachment.

The important support that the estuary provided for various life stages of shorebirds, identified by Kerr (2016), was also supported by our bird count data, with 23 species of native or endemic bird recorded, including the black billed gull (*Larus bulleri*) which is classified as nationally critical, and the banded dotterel (*Charadrius bicinctus)*, the lesser knot *Calidris canutus* and the Caspian turn (*Hydroprogne caspia)*, which are all classified as nationally vulnerable.

The role that the estuary plays as a nursery for coastal fish species was also supported by the eDNA sampling, which identified eDNA signatures from 19 taxa of fish which included several important cultural and commercial species such as such Kanae (mullet), Kahawai, Tāmure (snapper), Ihe (piper), and Kātaha (yellow-eye mullet).

**Water**

Results from council's routine water quality sampling, indicate that most water quality parameters were below the relevant coastal water quality standards.  However, concentrations of micro-bacteria indicate that the water in the river section of the estuary was not suitable for contact recreation and that water in both the river and the lagoon are not suitable for shellfish consumption. While micro-bacteria contamination does not impact on the ecological health of the SEA, it will impact on the amenity value and cultural health of the estuary.

**Cultural Health Assessment**

In summary, there is room for improvement in both sites. A mauri score of three for the lagoon highlights areas for restoration and revitalisation of mauri. In particular, whakapapa, kaimoana abundance and quality were poor scores which we would like to see improving into the future. It is difficult to pinpoint the exact cause/s of the red algal blooms and high mud content. However, with mass ika die-offs and pungent stenches seasonally riddling the site, it's hard to not want to learn more about this area. Restoration activities could include seeking expert advice on the groyne to understand more about the natural movement of sand in the system, including advice on large scale dune system dynamics while exploring the pros and cons of removing the groyne to ensure the mud and sand resettle in a natural way, that could bring back a stronger hau and mauri of the location. Furthermore, it is likely that a combination of warming sea surface temperatures and nutrient imbalance are causing the algae blooms observed along Waipū coast. In 2022, Patuharakeke plan to partner with local groups such as Waipū Water Group and Piroa-Brynderwyns Landcare into the future to understand how farmers can drastically decrease the nutrient runoff as the warming climate is likely to continue to exacerbate such blooms into the future. As well as working with Cawthron and NIWA to understand the science of the ecosystem imbalances, and what different action steps could be taken, such as removing washed up algae for garden fertilizer etc.

In the estuary, the mauri was given a score of four. The water clarity presents as beautiful clear, turquoise water, but this does not discount some of the poor scores observed, such as kaimoana quality and whanaungatanga. Kaimoana quality could definitely improve through the above actions as the lagoon is not separate from the estuary and any improvements to the lagoon will definitely be seen in the estuary.

There was a minor presence of foam and discoloured water from the stormwater pipe flowing into the estuary from beneath the urupa which could contain a number of contaminants. This is an interesting point for our cultural health assessment because there is often more going on here than meets the eye. Our kaitaiao have knowledge about the farming practices that are occurring in the upper catchment and we can understand the possibility of contaminants. It is for this reason that these scores are not high, even though there is high water clarity. In the future, we'd like the opportunity to investigate the upper reaches of the estuary, to understand more about what contaminants are entering the water as this has direct effects on safety of kaimoana, as well as CHI scores such as waitai. Patuharakeke aspire to upskill our kaitaiao to be able to undertake Paralytic shellfish poisoning (PSP) tests at the estuary to keep our whānau safe when gathering kaimoana.

Patuharakeke understand that these issues are not going to be fixed overnight, but we hope that by the next time we undertake a cultural health assessment in these locations the mauri will have improved and the hau of the location will be strong and vibrant. Mauri ora.

# References

Department of Conservation (2010). New Zealand Coastal Policy Statement 2010. Wellington. Department of Conservation. pp 22.

Chetham J. & Shortland T. (2013) Kauri Cultural Health Indicators – Monitoring Framework. Prepared for the Kauri Dieback Joint Agency Response, Tangata Whenua Roopupp. pp 74.

Food standards Australia New Zealand (FSANZ) (2008). Australia New Zealand Food Standards Code (incorporating amendments up to and including Amendment 97.) Anstat Pty Ltd., Melbourne.

Hartley L. & Greene T. (2012). Birds: incomplete counts – five-minute bird counts. Version 1.0. Department of Conservation. Wellington. pp 22.

Hewitt J.E & Funnell G.A. (2005). Benthic marine habitats and communities of the southern Kaipara. Prepared by NIWA for Auckland Regional Council. Auckland Regional Council. Technical Publication 275pp.

Kerr, V. (2016). Significant Ecological Marine Area Assessment Sheet Name: Waipū Estuary Marine Values. https://www.nrc.govt.nz/media/n55btqsm/Waipūestuarysignificantecologicalmarineareaassessmentsheet.pdf

Landcare Research New Zealand Ltd. (2020). Land Cover Database version 5.0.

Needham H. R., Townsend M., Hewitt J. E & Hailes, S. (2013). Intertidal habitat mapping for ecosystem goods and services: Waikato estuaries. Hamilton, NZ: Waikato Regional Council. pp64.

Nelson W. (2018). Macroalgae at Waipū, Northland. Prepared for Northland Regional Council. National Institute of Water & Atmospheric Research Ltd, Wellington . pp 47.

Northland Regional Council (2019). *Proposed Regional Plan for Northland*. Decisions Version. pp 303.

Northland Regional Council (2016). Regional Policy Statement for Northland. 178pp

Resource Management Act (1991). Retrieved from: http://www.legislation.govt.nz/act/public/1991/0069/latest/DLM230265.html

Robertson B.M; Gillespie P.A; Asher R.A, Frisk S, Keeley N.B.; Hopkins G.A.; Thompson S.J.; Tuckey B.J. (2002). Estuarine environmental; Assessment and Monitoring: A National Protocol. Part A. Development, Part B. Appendices, and Part C. Application. Prepared for supporting Councils and the Ministry of Environment, Sustainable Management Fund Contract No. 5096. Part A. 93pp. Part B. 159pp. Part C. 40pp plus field sheets.

Robertson H.A, Baird K., Dowding J.E., Elliott G.P., Hitchmough R.A., Miskelly C.M., McArthur N., O'Donnell C.F., Sagar P.M., Scofield R.P. & Taylor G.A. (2017). Conservation status of New Zealand birds, 2016. Department of Conservation, Wellington. pp 23.

Tipa G. & Teirney L. (2006). A Cultural Health Index for Stream and Waterways: A tool for nationwide use. Prepared for the Ministry for the Environment. pp 54.

United States Food and Drug Administration (1993). Food and drug Administration guidance for arsenic in shellfish. DHHS/PHS/FDA/CFSAN/Office of seafood, Washington, D.C.

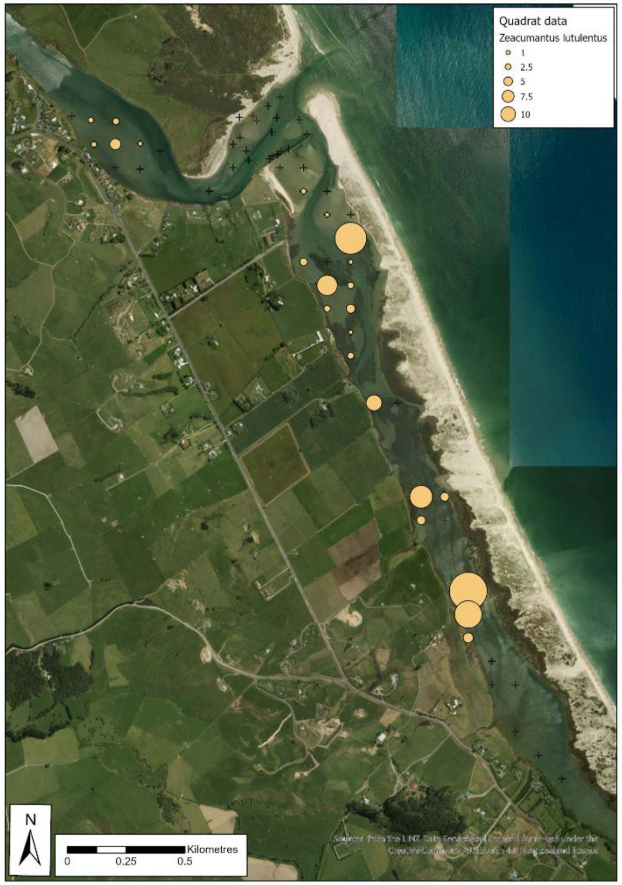
# Appendices

**Appendix 1.** Land cover in the Waipū Estuary catchment, from the New Zealand Land Cover Database v5.0 (2020). (Land cover <1% of total catchment not presented).

| Land cover | Area (hectare) | Percentage |
|---|---|---|
| High producing exotic grassland | 11601.3 | 51.9 |
| Indigenous forest | 5109.8 | 22.9 |
| Exotic forest | 3215.0 | 14.4 |
| Manuka and/or Kanuka | 1045.3 | 4.7 |
| Broadleaved indigenous hardwoods | 430.5 | 1.9 |
| Forest - harvested | 316.9 | 1.4 |
| Total | 22338.5 | |

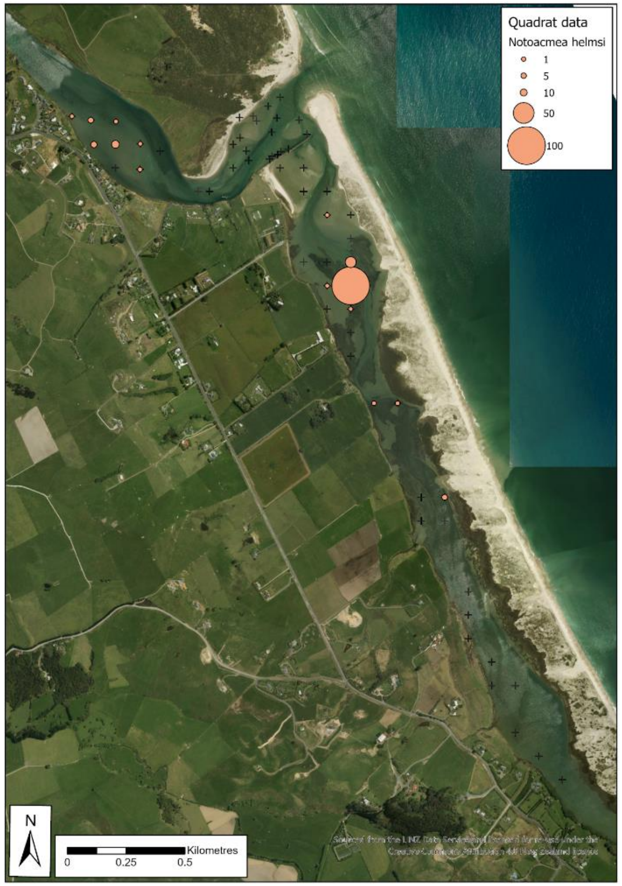
**Appendix 2.** Distribution of invertebrate taxa recorded in the quadrat survey.


*Anthopleura* sp. density in Wāipu Estuary




*Zeacumantus lutulentus* density in Wāipu Estuary.


*Austrominius modestus* density in Wāipu Estuary.



*Austrovenus stutchburyi* density in Wāipu Estuary.

*Notoacmea helmsi* density in Wāipu Estuary.

*Cominella glandiformis* density in Wāipu Estuary.


*Diloma subrostratum* density in Wāipu Estuary


Crustacean burrow density in Wāipu Estuary

**Patuharakeke Te Iwi Trust Board**
PO Box 557, Whangarei

Takahiwai Marae
229 Takahiwai Rd
Takahiwai

**Northland Regional Council**

**P** 0800 002 004

**E** info@nrc.govt.nz

**W** www.nrc.govt.nz