Fisheries New Zealand
Tini a Tangaroa

Intertidal shellfish monitoring in the northern North Island region, 2025–26

New Zealand Fisheries Assessment Report 2026/22

K. Berkenbusch,
T. Hill-Moana

ISSN 1179-5352 (online)
ISBN 978-1-997337-42-3 (online)

July 2026

Te Kāwanatanga o Aotearoa
New Zealand Government

Requests for further copies should be directed to:

Fisheries Science Editor
Fisheries New Zealand
Ministry for Primary Industries
PO Box 2526
Wellington 6140
NEW ZEALAND

Email: Fisheries-Science.Editor@mpi.govt.nz
Telephone: 0800 00 83 33

This publication is also available on the Ministry for Primary Industries websites at:
http://www.mpi.govt.nz/news-and-resources/publications
http://fs.fish.govt.nz go to Document library/Research reports

Please cite this report as:

Berkenbusch, K.; Hill-Moana, T. (2026). Intertidal shellfish monitoring in the northern North Island region, 2025–26. *New Zealand Fisheries Assessment Report 2026/22*. 112 p.

TABLE OF CONTENTS

PLAIN LANGUAGE SUMMARY

The collection of seafood is an important recreational activity and of significant cultural importance in New Zealand. This recreational and customary fishing includes the hand-picking and gathering of intertidal bivalves, such as cockles and pipi, which occur on beaches and in estuaries and harbours throughout the country. To ensure the persistence of their populations, regular monitoring is carried out in northern North Island, collecting information of their abundance, density and sizes at a range of sites in Northland, Auckland, Waikato, and Bay of Plenty. This report provides the monitoring information for the 2025–26 fishing year, based on surveys carried out at Bowentown Beach, Eastern Beach, Grahams Beach, Hokianga Harbour, Little Waihi Estuary, Mangawhai Harbour, Marsden Bank, Ngunguru Estuary, Umupuia Beach, Whangamatā Harbour, and Whangateau Harbour. Across sites, cockle populations varied in their size and densities, although all sites had cockle populations of several million individuals. Cockle densities were high at most sites, with hundreds to over one thousand individuals per square metre. The pipi populations were generally smaller and also varied in size, with notable differences in the estimated densities of pipi. The lowest density estimates were 7 and 11 pipi per square metre, compared with over 600 pipi per square metre at one of the sites.

EXECUTIVE SUMMARY

Berkenbusch, K.[1]; Hill-Moana, T.[1] (2026). Intertidal shellfish monitoring in the northern North Island region, 2025–26.

***New Zealand Fisheries Assessment Report 2026/22*. 112 p.**

The collection of seafood is an important recreational activity and of significant cultural importance in New Zealand. This non-commercial fishing includes the hand-picking and gathering of intertidal bivalves, such as cockle/tuangi (*Austrovenus stutchburyi*) and pipi (*Paphies australis*). Both species are widely distributed throughout the country and are key target species in customary and recreational fisheries. Their accessibility and frequent proximity to urban centres make cockle and pipi populations vulnerable to overfishing, particularly in coastal areas exposed to other human impacts.

To support their sustainable management, cockle and pipi populations across northern North Island are part of a long-standing monitoring programme by Fisheries New Zealand. The monitoring focuses on populations targeted by non-commercial fisheries across a range of intertidal environments in the wider Auckland, Northland, Waikato, and Bay of Plenty regions. Regular and frequent (e.g., biennial) monitoring at most sites, and the use of consistent survey methods since the 1999–2000 fishing year, have led to an extensive time series of population data for these northern bivalve populations. For cockles, the addition of a sediment sampling programme in 2013–14 (refined in 2015–16) also provides baseline information of benthic habitat quality.

The present assessment provides the survey findings for the 2025–26 fishing year, presenting bivalve population data for 11 northern North Island sites (in alphabetical order): Bowentown Beach, Eastern Beach, Grahams Beach, Hokianga Harbour, Little Waihi Estuary, Mangawhai Harbour, Marsden Bank, Ngunguru Estuary, Umupuia Beach, Whangamatā Harbour, and Whangateau Harbour.

Ten sites contained cockle populations (excluding Marsden Bank), and abundance and density estimates varied greatly across sites. The smallest cockle population was at Grahams Beach, where their abundance was estimated at 6.91 million (coefficient of variation, CV: 19.38%) cockles, and their average density at 26 cockles per m^2. The most abundant population was at Whangateau Harbour, with an estimated 506.88 million (CV: 11.53%) individuals.The corresponding density estimate was 457 cockles per m^2, while the highest density estimate was at Bowentown Beach, with an estimated 1362 (CV: 6.15%) cockles per m^2. Density estimates were similarly high at Ngunguru Estuary and Whangamatā Harbour, exceeding 1000 individuals per m^2. All cockle population estimates had CV values below 20%, except for Little Waihi Estuary, where additional sampling effort did not succeed in lowering the CV below this target value.

Pipi were present at eight sites, Bowentown Beach, Grahams Beach, Hokianga Harbour, Little Waihi Estuary, Marsden Bank, Ngunguru Estuary, and Whangamatā and Whangateau harbours. Pipi abundance estimates ranged from 0.17 million (CV: 15.76%) pipi at Bowentown Beach to 115.37 million (CV: 12.77%) pipi at Little Waihi Estuary. The pipi population at Little Waihi Estuary also had the highest density estimate of 695 pipi per m^2. Density estimates were also high (i.e., several hundred individuals per m^2) at Hokianga Harbour, Marsden Bank, and Ngunguru Estuary. The CV values associated with the estimates were above 20% at Grahams Beach and Whangateau Harbour, in spite of increased sampling effort aimed at lowering the uncertainty of the estimates. At both sites, pipi were highly localised. At Grahams Beach, the low abundance of pipi and their patchy distribution (of mostly recruits) led to high uncertainty around the population estimates. At Whangateau Harbour, pipi were confined to a designated pipi bed, but missing from the overall sampling extent, leading to the high CV value for the population estimate overall.

Sediment collected in the cockle beds at each site was characterised by a low organic matter content, with averages ranging between 0.8 and 2.6% across sites. The sediment grain size composition was

[1]Dragonfly Data Science, New Zealand.

largely determined by fine and medium sands (grain sizes >125 and >250 µm), which varied in their relative proportions depending on the site. Although the average proportion of sediment fines (<63 µm) was small, this grain size fraction exceeded 10% in individual samples at Bowentown Beach, Hokianga Harbour, Umupuia Beach, and Whangamatā and Whangateau harbours.

The relationship between cockle abundance and sediment grain size composition was investigated with principal component analysis. For cockle sites with discernible patterns, the association of cockle abundance depended on the site, and there was no universal pattern across sites or surveys.

Geostatistical models were used to assess spatio-temporal patterns in predicted cockle densities at each of the cockle sites. This visual assessment allowed the tracking of high-density areas (or "hotspots") over time. At Eastern Beach and Umupuia Beach, hotspots were determined by large cockles, which diminished in recent surveys. A reduction in predicted total cockle densities and their spatial extent was apparent at Hokianga Harbour and Ngunguru Estuary. In contrast, at Little Waihi Estuary, Mangawhai Harbour, Whangamatā and Whangateau harbours, there was little change in total densities and in spatial patterns over time.

1. INTRODUCTION

Intertidal bivalves in New Zealand's coastal environments are exposed to a range of impacts from human activities that directly and indirectly affect their populations (Grant & Hay 2003, Lohrer et al. 2012). These impacts range from large-scale landuse changes and habitat degradation to localised pollution and fishing. The latter activities include non-commercial fisheries, such as the hand-picking and gathering of bivalves in soft-sediment environments. Two key bivalve species targeted in recreational and customary fisheries are cockles/tuangi (*Austrovenus stutchburyi*) and pipi (*Paphies australis*) (Hartill et al. 2005, Heinemann & Gray 2024). Both species are widely distributed throughout the country, often in close proximity to urban centres, and frequently form high-density beds of several hundred individuals per square metre (Hooker 1995, Tricklebank et al. 2021). Their widespread occurrence and accessibility makes both species popular fishing targets, and they also hold significant cultural importance as a traditional food source (Kainamu-Murchie et al. 2018, Kettle 2021).

In view of their importance as fishery species and the potential impacts of fishing and other human activities, cockle and pipi populations have been monitored in different parts of New Zealand (Berkenbusch et al. 2015, Beentjes 2021). Across northern North Island, regular monitoring surveys commissioned by Fisheries New Zealand provide population information of cockle and pipi beds targeted in non-commercial fisheries (e.g., see Berkenbusch & Hill-Moana 2025). The monitoring surveys initially started in the early 1990s in Auckland, and were subsequently extended to sites in the wider Auckland, Northland, Waikato and Bay of Plenty regions (Morrison et al. 1999, Pawley & Ford 2007). Following the initial surveys, the methods were subsequently refined, leading to a consistent survey approach since the 1999–2000 fishing year. This consistency and the frequent (i.e., biennial) monitoring of a number of northern sites have led to an extensive dataset of cockle and pipi populations over time.

The population data provide abundance and density estimates for each species, and also length-frequency distributions to document the population size structure at each site. The length-frequency distributions include size thresholds that distinguish different size classes for each population. In this context, the size at maturity for cockles is estimated at a minimum shell length of 18 mm (Larcombe 1971), and for pipi at a shell length of 40 mm (Hooker & Creese 1995).

Since 2013–14, the surveys have also provided benthic habitat information, collecting baseline data of sediment organic content and grain size composition (Berkenbusch et al. 2015). Sediment characteristics, such as sediment mud content (silt and clay, grain size <63 micron), can significantly influence the distribution and abundance of cockles and pipi (Thrush et al. 2005, Anderson 2008); for example, increased sediment loads and high resuspension rates may interfere with suspension-feeding (Hewitt et al. 2001). The current sediment sampling methods were refined in 2015–16 to support formal analyses of cockle population data in relation to sediment properties (Neubauer et al. 2021).

Presented here are survey findings from the northern bivalve monitoring programme for the 2025–26 fishing year. Population and sediment data are provided for 11 sites across the northern North Island regions (in alphabetical order): Bowentown Beach, Eastern Beach, Grahams Beach, Hokianga Harbour, Little Waihi Estuary, Mangawhai Harbour, Marsden Bank, Ngunguru Estuary, Umupuia Beach, Whangamatā Harbour, and Whangateau Harbour (Figure 1).

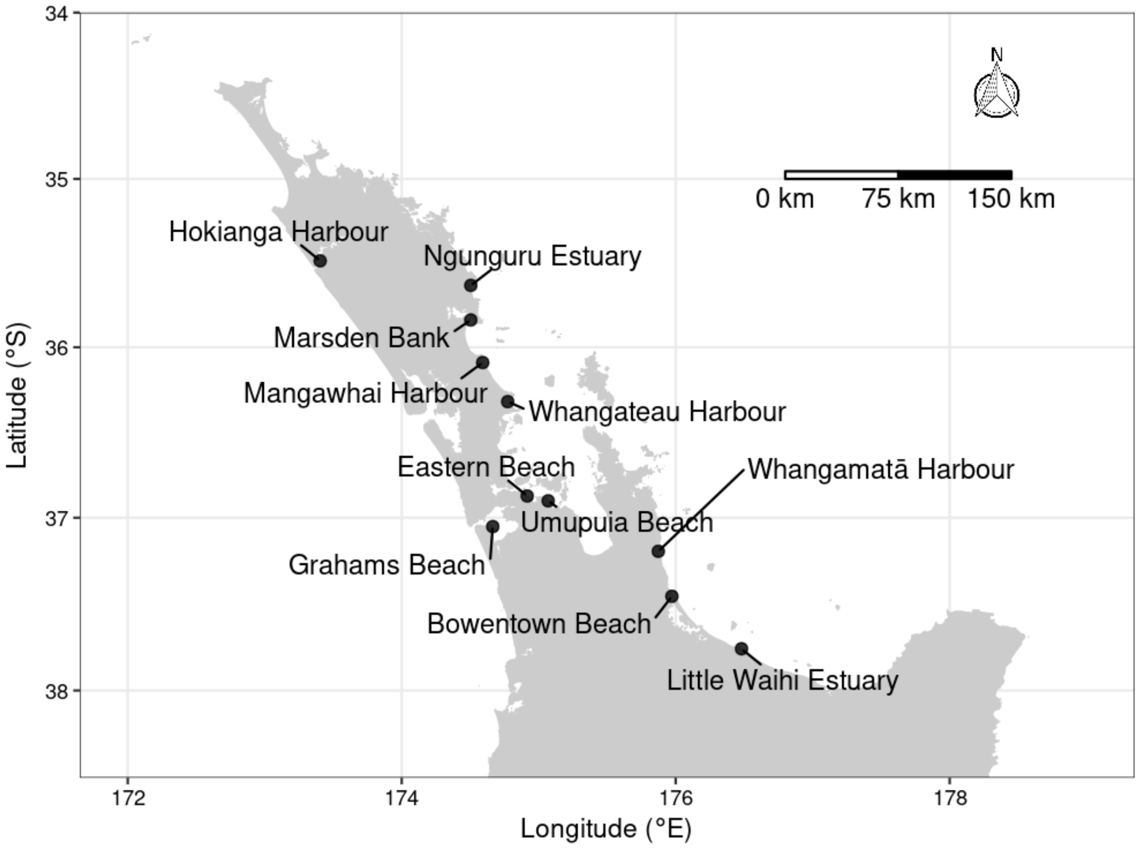

Figure 1: Sites included in the northern North Island intertidal bivalve survey in 2025–26.

2. METHODS

The methods used in the present study were based on previous bivalve assessments that provided temporal comparisons across the northern survey series. Since 1996, the general sampling protocol of the northern North Island bivalve surveys has used a combination of a systematic design and a two-phase stratified random design (Pawley & Ford 2007).

The methods used in recent surveys are described in detail by Berkenbusch & Neubauer (2016, 2017). For completeness, the methods are included here, including updates for the 2025–26 survey.

2.1 Survey methods

At each site, the intertidal areas sampled were identified based on existing information and input from local communities and stakeholders. This preliminary exploration also included extensive reconnaissance of the sampling areas at each site, with the on-site determination of population boundaries, defined as fewer than 10 individuals per m^2 (see Pawley 2011). Establishing population boundaries included the acquisition of geographical information through the use of global positioning system (GPS). During sampling, GPS units were used to determine the location of each sampling point.

Preliminary analyses of cockle density data from previous surveys (2013–14 to 2016–17) using GPS-referenced samples indicated that the previous stratification at individual sites rarely delimited areas of similar characteristics (e.g., homogenous densities) and, therefore, did not necessarily lead to reductions in variance in the estimation of cockle population sizes and densities. For this reason, the high-resolution spatial data (GPS-referenced samples) from previous surveys were used to re-define cockle strata based on the spatial distribution and variability of previous samples (see Berkenbusch & Neubauer 2016).

The number of sampling points for each bivalve population was determined by the population size and variability within each stratum, informed by data from previous surveys. For each stratum, a regular grid was generated, with the size and shape of the grid cells reflecting the desired sampling density and the orientation of the stratum. For strata with irregular shapes, the number of grid cells did not necessarily reflect the number of desired samples; if there were more grid cells than sampling points, not all cells had sampling points allocated to them. In this case, sampling points were allocated across all cells with a probability proportional to the area of the cells.

The position of the point within a cell was randomly allocated. All sampling points were pre-calculated for two phases before the sampling began. All phase-1 points were sampled, whereas sampling of phase-2 points was only carried out when the coefficient of variation (CV) of the total abundance estimate after first-phase sampling exceeded the target value of 20% for either cockle or pipi. Based on recommendations by the Shellfish Fishery Working Group (at its meeting in November 2021), the number of allocated phase-2 points was limited to about 10% of the overall sampling effort (see also Francis 2006).

Owing to the importance of sediment properties for infaunal bivalves, recent previous surveys included a sediment sampling programme to determine the sediment organic content and grain size at each site (see Berkenbusch et al. 2015, Berkenbusch & Neubauer 2015). The initial sediment sampling provided general baseline information; subsequent improvements to the sediment sampling design in 2015–16 allowed the analysis of spatial patterns in sediment variables and of gradients in cockle abundance in relation to sediment properties (Neubauer et al. 2015, Berkenbusch & Neubauer 2016, Neubauer et al. 2021).

The sediment sampling was restricted to cockles, because pipi populations frequently extend into subtidal waters deeper than 0.5 m, so that only parts of the population are sampled. Following the stratification of sites, a total of 24 sediment sampling points was allocated at each site. The sediment sampling point allocation was based on a subset of sediment sampling points that was randomly allocated within each cockle stratum, corresponding with a randomly-allocated cockle sampling point. Data from the sediment sampling were used to provide baseline information of current sediment properties, and to build a data set that allows spatial and temporal comparisons as data get updated.

The most recent analysis of sediment properties was conducted in 2019–20, based on data from five years of monitoring (Neubauer et al. 2021). This analysis provided a spatial and temporal assessment of the relationship between cockles and sediment grain size properties. It included a principal component analysis, and the modelling of cockle population abundances as a function of different grain size fractions, for all cockles and also for individuals in the large size class (i.e., exceeding 30-mm shell length).

2.2 Field sampling – bivalves

The field survey across the 11 northern North Island sites was conducted in January and February 2026. The survey sampled bivalve populations at each site during periods of low tide (see sampling dates for the present and previous surveys in Appendix A, Tables A-1, A-2).

Bivalves were sampled using the same sampling unit as in previous surveys, consisting of a pair of benthic cores that were 15-cm diameter each; the combined cores sampled a surface area of 0.035 m^2. The cores were sampled to a sediment depth of 15 cm; this sampling depth included the maximum burrowing depths of cockles and pipi, which reside in the top 10 cm of the sediment (i.e., 1–3 cm for cockles, Hewitt & Cummings 2013; and 8–10 cm for pipi, Morton & Miller 1973).

Sampling points within each stratum were located using GPS units. For pipi populations, the intertidal sampling extended to 0.5 m water depth (at low tide) in channels that included pipi populations (following the sampling approach of previous surveys). At each sampling point, the cores were placed directly adjacent to each other and pushed 15 cm into the sediment. The cores were excavated, and all sediment from each core was sieved in the field on 5-mm mesh. All cockles and pipi retained on the sieve were counted and measured (length of the maximum dimension, to the nearest millimetre), before returning them to the benthos.

For strata with population densities exceeding 2000 individuals per m^2, the recording of shell length measurements involved subsampling (see Pawley 2011). The subsampling was only used when the number of individuals in both cores exceeded 70 (equating to 2000 individuals per m^2) and there were at least 50 individuals in the first core. The subsampling consisted of recording shell length measurements for all individuals in the first core, whereas bivalves in the second core were not measured. When there were fewer than 50 individuals in the first core, all bivalves were measured in both cores.

2.3 Field sampling – sediment

The sediment sampling used a subset of sediment cores (5-cm diameter, sampled to a depth of 10 cm) that were collected within existing cockle strata. Subsequent analyses included the grain size distribution and organic content of the sediment samples.

The grain size analysis was based on wet sieving to ascertain the proportion of different size classes, ranging from sediment fines (silt and clay, $\leq$63 µm grain size) to different sand fractions of very fine to very coarse sands and gravel (i.e., grain sizes 125 to 2000 µm) (Eleftheriou & McIntyre 2005). Each sample was homogenised before processing through a stack of sieves to determine the proportion in each sediment grain size fraction (i.e., >63, >125, >250, >500, and >2000 µm). Sediment retained on each sieve was subsequently dried to constant weight at 60 °C before weighing it (accuracy ± 0.0001 g).

The sediment organic content of each sample was determined by loss on ignition (4 hours at 500 °C) after drying the sample to constant weight at 60 °C (Eleftheriou & McIntyre 2005).

Descriptive sediment data from these analyses include the percentage organic content and proportions of different sediment grain size fractions for each sample (see detailed information in Appendix B).

2.4 Data analysis – bivalves

2.4.1 Survey-based population estimates

For each survey site and species combination, the data analysis focused on estimating abundance, population density, and the size (length) frequency distribution, both within and across strata. Results from the present survey were compared with previous surveys using the Fisheries New Zealand *beach* database. Comparisons with previous surveys from 1999–2000 onwards were made for estimates of abundance and population density. Length-frequency distributions from the present survey were compared with the two preceding surveys.

The data analysis followed the previous approach (e.g., Berkenbusch et al. 2015). Consistent with previous surveys, the two cores within each grid cell were considered a single sampling unit. Bivalve abundance within the sampled strata at each site was estimated by extrapolating local density (individuals per m^2), calculated from the number of individuals per sampling unit, to the stratum size:

$$\hat{y}_k = \frac{1}{S_k} \sum_{s=1}^{S} \frac{n_{s,k}}{0.035}, \tag{1a}$$

$$\hat{N} = \sum_{k=1}^{K} A_k \hat{y}_k, \tag{1b}$$

where $n_{s,k}$ is the number of individuals in sample s within stratum k, S_k is the total number of samples processed in stratum k, and $\hat{y}_k$ is the estimated density of bivalves (individuals per m^2) within the stratum. The total number $\hat{N}$ of bivalves at each site is then the sum of total abundance within each stratum, estimated by multiplying the density within each stratum by the stratum area A_k.

The variance $\sigma^2_{\hat{N}}$ of the total abundance was estimated as:

$$\hat{\sigma}^2_N = \sum_{k=1}^{K} \frac{A_k^2 \sigma^2_{\hat{y}_k}}{S_k},$$

where $\sigma^2_{\hat{y}_k}$ is the variance of the estimated density per sample. The corresponding coefficient of variation (CV, in %) is then:

$$CV = 100 \times \frac{\sigma_{\hat{N}}}{\hat{N}}.$$

To estimate the length-frequency distributions at each site, measured individuals were allocated to size classes (millimetre-length). Within each size class l, the number $n^m_{l,s}$ of measured (superscript m) individuals within each sample s was scaled up to the estimated total number at length within the sample ($\hat{n}_{l,s}$) by dividing by the proportion p^m_s of measured individuals within the sample, so that:

$$\hat{n}_{l,s} = \frac{n^m_{l,s}}{p^m_s}.$$

The numbers at length over all strata were then calculated according to equations 1a and 1b for each length class l. The same procedure was used to estimate the abundance of large-size individuals (defined as $\geq$30-mm shell length for cockles, and $\geq$50-mm shell length for pipi) at each site, summing numbers at length of individuals greater than the reference length r for each species:

$$\hat{n}_{l \geq r,s} = \sum_{l=r}^{\max(l)} \hat{N}_l.$$

In addition to large-sized bivalves, the population assessments also considered the proportion of recruits within the bivalve populations at the sites surveyed. Recruits were defined as cockles that were $\leq$15 mm and pipi that were $\leq$20 mm in shell length.

2.4.2 Model-based population estimates

Since 2013–14, the field data have included high-resolution spatial data, providing the accurate position of each sampling point. Since 2015–16, these high-resolution spatial data have been used in geostatistical models of cockle densities to determine the optimal shape and location of cockle strata based on the spatial distribution and variability of previous samples (see Berkenbusch & Neubauer 2016). Although the re-stratification has been regularly applied since 2015–16 to determine cockle strata at each site prior to the field sampling, population estimates continue to be derived from sampling-based estimators to ensure comparability of population data throughout the survey series.

At some sites, unpredictable shifts in high-density cockle patches between surveys and resultant high uncertainty in the estimates prompted the exploration of geostatistical models to also derive population estimates (Tremblay-Boyer et al. 2021). Model-based geostatistical estimators interpolate between observations to generate site-wide predictions, while accounting for the correlation between observations as the distance increases between them.

The initial exploration provided a comparison between model-based geostatistical estimates and survey-based estimates for the northern sites included in the 2019–20 survey. It also included a temporal correlation structure, which allowed the inclusion of multiple years of survey data in spatio-temporal models. In general, these spatio-temporal models appeared more robust and provided more precise population estimates than single-year models for most sites (Tremblay-Boyer et al. 2021).

Based on the initial development of geostatistical models, the current analysis continued this modelling approach in parallel with the survey-based estimation. For this modelling, the spatio-temporal models were updated with the 2025–26 survey data from the current sites. These models were used to predict total cockle density and the density of large cockles over a spatial scale of one square metre. For each of the current sites with cockle populations and multiple-year survey data, the predicted densities were mapped over time (see Appendix C). Although the population estimates provided here continue to be survey-based, the maps allowed the visual inspection of spatio-temporal patterns of predicted cockle densities at the northern sites.

The current update of the geostatistical modelling detected an error with the data inputs for the large cockle models, which erroneously included the medium size class. This error was corrected, and the updated maps of predicted large cockle densities accurately represent spatio-temporal patterns of this size class. Some of the updated patterns differ from previous patterns, and the updates negate earlier maps for this size class. This error did not affect any of the survey-based estimates or the spatio-temporal maps of predicted total cockle densities.

2.5 Sediment data

For each site, sediment data from the sample processing provided information of the organic content and grain size composition. Sediment organic content is presented as percentage of the total, in addition to percentages of the individual sediment grain size fractions. These data were also summarised for a comparison across the sites included in the current survey.

Previous analyses have examined the relationship between cockle abundance and sediment characteristics (Neubauer et al. 2015, Neubauer et al. 2021). The most recent assessment used data to 2019–20 in principal component analyses (PCAs) to explore relationships of the total cockle population and of large cockles with sediment grain size (see Neubauer et al. 2021). This data exploration based on PCA was updated here, following the addition of sediment data from the current survey.

3. RESULTS

3.1 Bowentown Beach

Bowentown Beach is in the western area of Tauranga Harbour, adjacent to the northern harbour entrance. There have been a total of nine surveys at this site, at a biennial frequency in recent years. Throughout the survey series, the sampling extent has remained the same (see Appendix A, Tables A-1, A-2). In 2025–26, cockles and pipi were sampled across three strata in a total of 110 sampling points, including 10 points in phase 2.

Across the three strata, sediment samples were low in organic content (less than 4%), and characterised by fine and medium sands (grain sizes >63 µm and >125 µm) (Figure 2; and see details in Appendix B, Table B-1). Several samples contained a relatively high proportion of sediment fines (grain size <63 µm), with four samples containing about 10% of sediment in this grain size fraction.

The cockle population was evenly distributed throughout the sampling extent (Figure 3, Table 1). The total population estimate was 20.40 million (CV: 6.15%) cockles, with an estimated density of 1362 cockles per m^2 (Table 2). Both population estimates were decreases from the preceding estimates of 27.60 million (CV: 4.65%) cockles and 1843 cockles per m^2 in 2023–24, but this population has been characterised by fluctuations over time. The population contained only a small number of large individuals (≥30 mm shell length), with an estimated 0.86 million (CV: 10.12%) cockles in this size class, occurring at a density of 58 large individuals per m^2. Although this size class remained small, it underwent a marked increase in the recent survey, e.g., the density of large cockles increased over four-fold from the estimate in 2023–24.

The population size structure explained some of the observed population fluctuations, particularly changes in the proportion of recruits (≤15 mm shell length) (Table 3, Figure 4). For example, in 2025–26, this size class made up 3.44% of the population compared with 20.87% in the preceding survey. Overall, the largely unimodal population was dominated by medium-sized cockles, with mean and modal sizes of 23.36 mm and 23 mm shell length in 2025–26, respectively.

Cockle abundance in relation to sediment grain size was mostly associated with sediment fines and very fine sand, as indicated in the principal component analysis (Figure 5). This pattern was also evident for large cockles.

Pipi at Bowentown Beach were mostly associated with a tidal side channel of the harbour, in stratum B (Figure 6, Table 4). The total population estimate was 0.17 million (CV: 15.76%) pipi, signifying a marked population decline from the preceding abundance estimate of 0.79 million (CV: 14.46%) individuals in 2023–24 (Table 5). This decline was also evident in the estimated pipi density of 11 individuals per m^2 compared with 53 individuals per m^2 in 2023–24. Large pipi (≥50 mm shell length) have been consistently scarce at this site, and estimates for this size class have considerable uncertainty (i.e., CV values exceeding 30%), including in the present assessment.

Most (75.91%) of the population consisted of medium-sized pipi, with similar proportions (about 12%) of large individuals and recruits (≤20 mm shell length) (Table 6, Figure 7). Between 2023–24 and 2025–26, the unimodal population structure became less distinct, as individuals in the medium size class grew to larger sizes, including into the large size class. There was a concomitant increase in mean shell length over this period, from 30.86 mm to 35.29 mm. Nevertheless, the modal shell length changed little, decreasing by one mm to 29 mm in 2025–26.

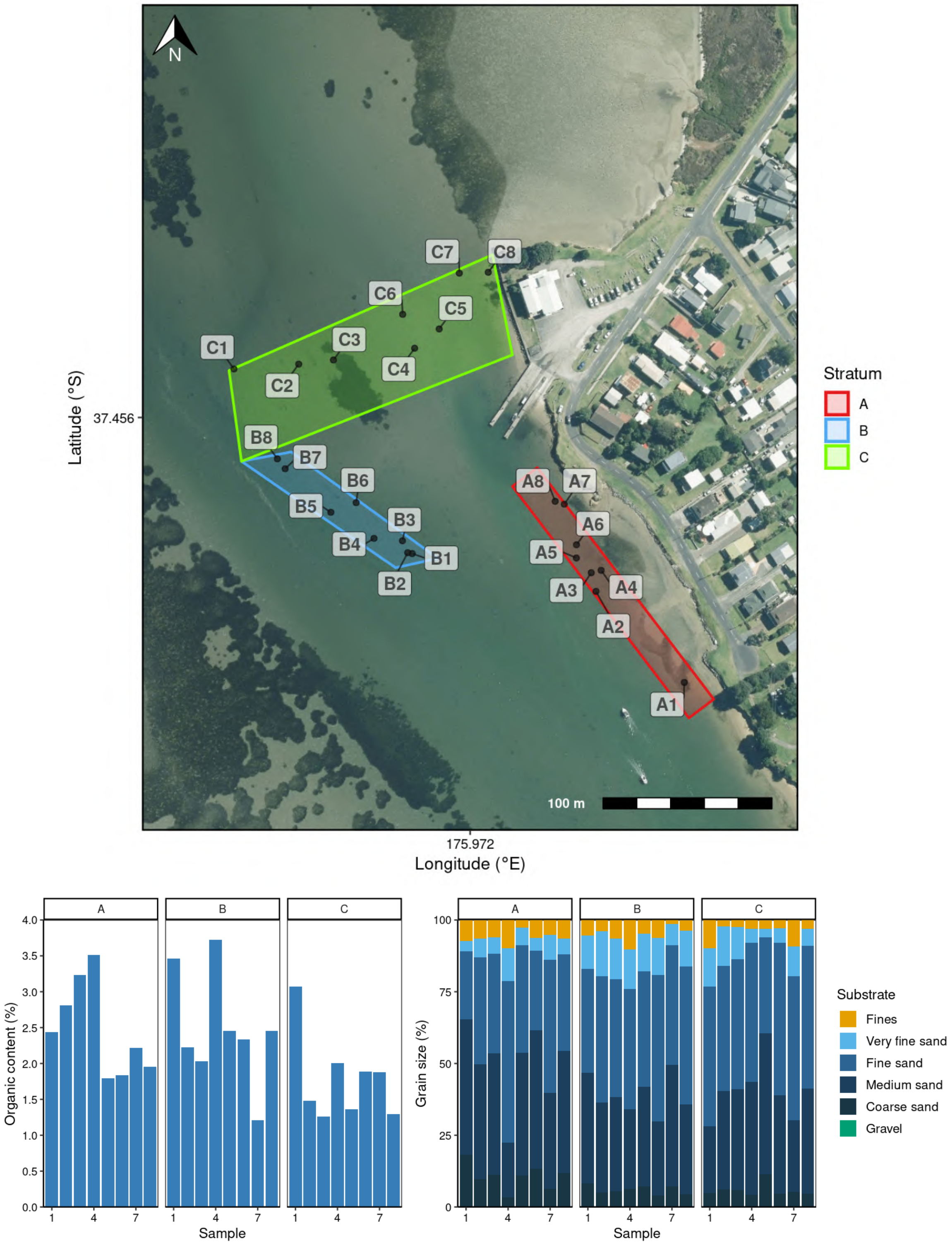

Figure 2: Sediment sample locations and characteristics at Bowentown Beach. Labels correspond to stratum and sample number. Graphs show organic content (% dry weight) and cumulative grain size (%). Sediment grain size fractions include fines (silt and clay, ≤63 µm), sands (very fine, >63 µm; fine, >125 µm; medium, >250 µm; coarse, >500 µm), and gravel (>2000 µm) (see details in Table B-1).

3.1.1 Cockles at Bowentown Beach

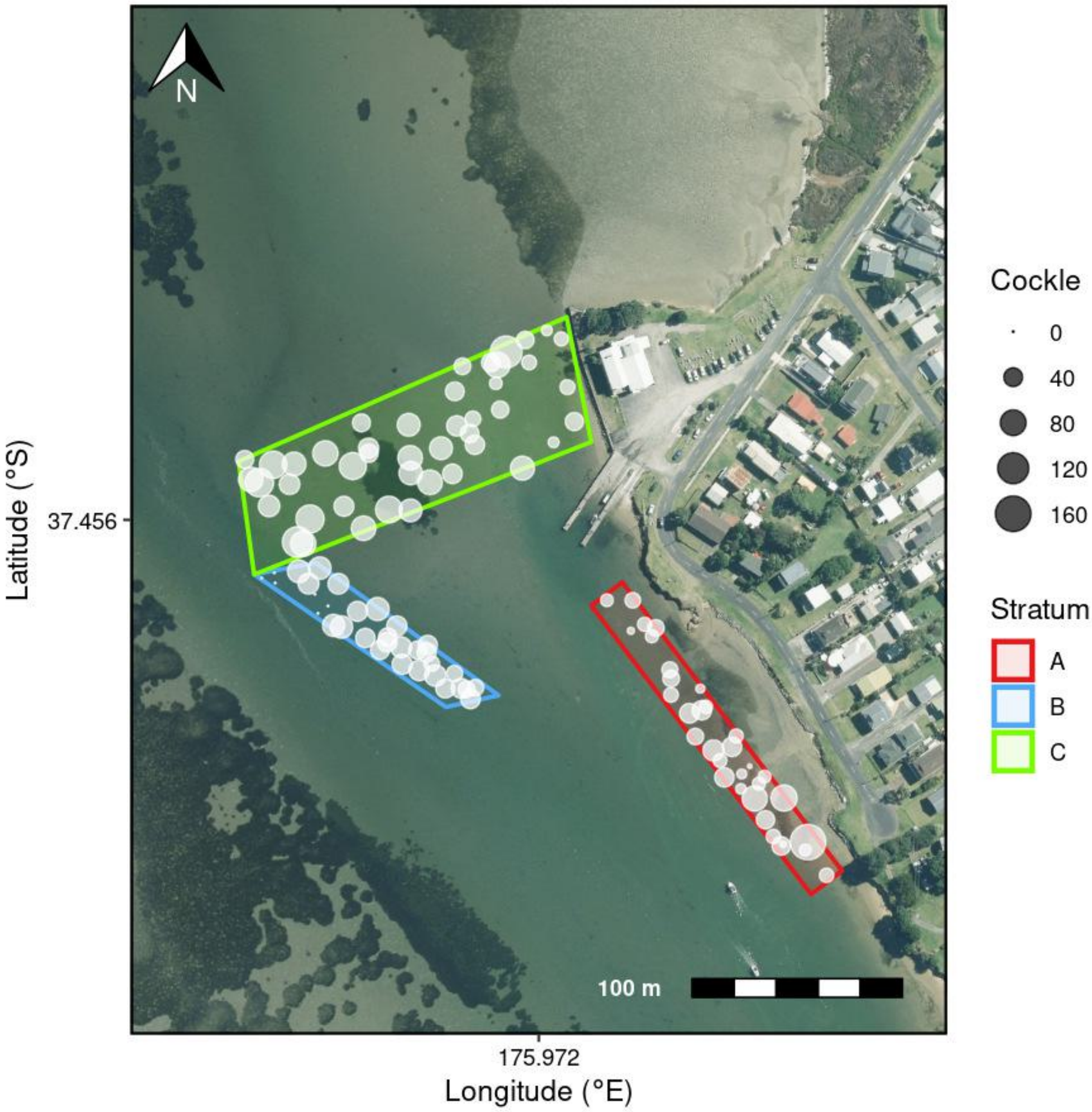

Figure 3: Map of sample strata and individual sample locations for cockles at Bowentown Beach, with the size of the circles proportional to the number of cockles (per 0.035 m^2) found at each location. Samples with zero counts are shown as small dots.

Table 1: Estimates of cockle abundance at Bowentown Beach, by stratum, for 2025–26. Presented are the area surveyed, the number of points and the number of cockles sampled, the mean total estimate, the mean density, and the coefficient of variation (CV).

Stratum		Sample		Population estimate		
	Area (ha)	Points	Cockle	Total (millions)	Density (m^{-2})	CV (%)
A	0.3	33	1 028	2.83	890	16.63
B	0.2	33	1 231	2.36	1 066	9.33
C	1.0	44	2 444	15.21	1 587	7.50

Table 2: Estimates of cockle abundance at Bowentown Beach for all sizes and large size (≥30 mm) cockles. Columns include the mean total estimate, mean density, and coefficient of variation (CV).

Year	Extent (ha)	Population estimate			Population ≥ 30 mm		
		Total (millions)	Density (m^{-2})	CV (%)	Total (millions)	Density (m^{-2})	CV (%)
2001–02	1.6	4.75	301	5.42	1.41	89	7.61
2010–11	1.6	18.56	1 175	9.18	0.08	5	33.18
2012–13	1.6	25.05	1 586	5.59	0.07	4	42.60
2015–16	1.5	26.95	1 799	5.17	0.03	2	34.77
2017–18	1.5	30.07	2 008	6.25	0.16	10	20.55
2019–20	1.5	24.80	1 656	5.97	0.12	8	17.30
2021–22	1.5	16.00	1 068	7.35	0.09	6	22.32
2023–24	1.5	27.60	1 843	4.65	0.18	12	18.87
2025–26	1.5	20.40	1 362	6.15	0.86	58	10.12

Table 3: Summary statistics of the length-frequency (LF) distribution of cockles at Bowentown Beach. The LF distributions (in mm) were estimated for all strata in each survey and subsequently summed for the distribution of total LFs. Recruits were defined by a shell length of ≤15 mm and large individuals by a shell length of ≥30 mm.

Year	Mean	Mode	Range	Recruits (%)	Medium (%)	Large (%)
2021–22	20.47	22	5–37	14.19	85.23	0.58
2023–24	19.26	18	5–36	20.87	78.49	0.64
2025–26	23.36	23	5–37	3.44	92.32	4.24

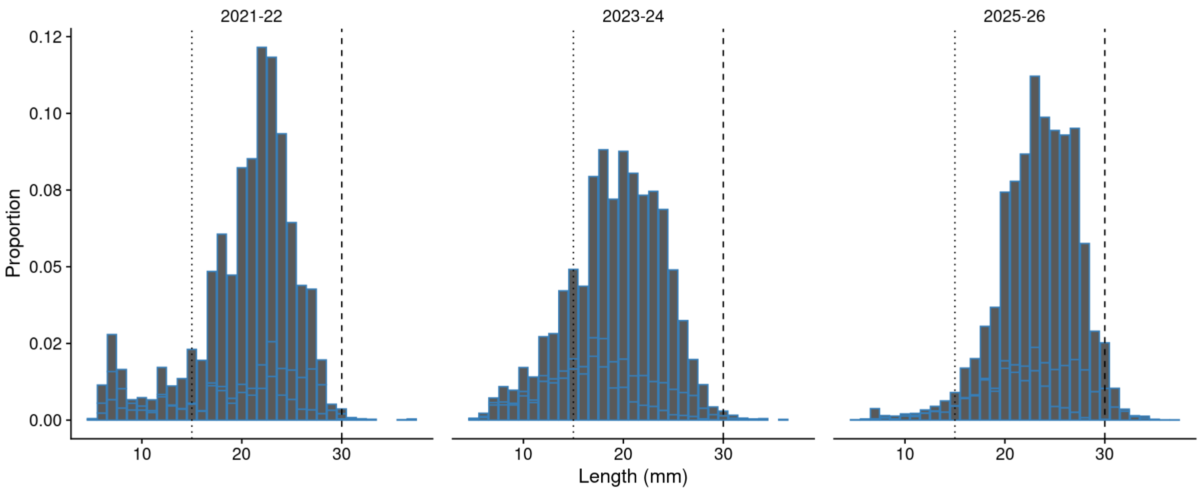

Figure 4: Weighted length-frequency (LF) distribution of cockles for the present and previous surveys at Bowentown Beach. Vertical dotted and dashed lines indicate the cut-off sizes for recruits and large individuals, respectively.

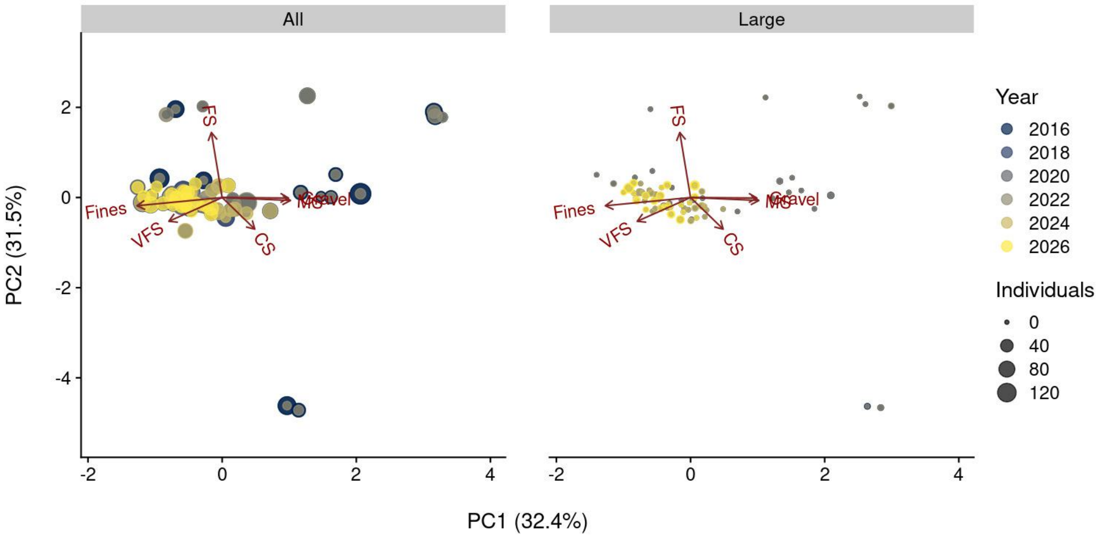

Figure 5: Cockle abundance along two principal components (standardised PCs, including % variance explained) of sediment granulometry for all cockle size classes (all) and large cockles (≥30 mm shell length) at Bowentown Beach. Sediment grain size fractions are defined as fines (silt and clay) ≤63 µm, very fine sand (VFS) >63 µm, fine sand (FS) >125 µm, medium sand (MS) >250 µm, coarse sand (CS) >500 µm, and gravel >2000 µm.

3.1.2 Pipi at Bowentown Beach

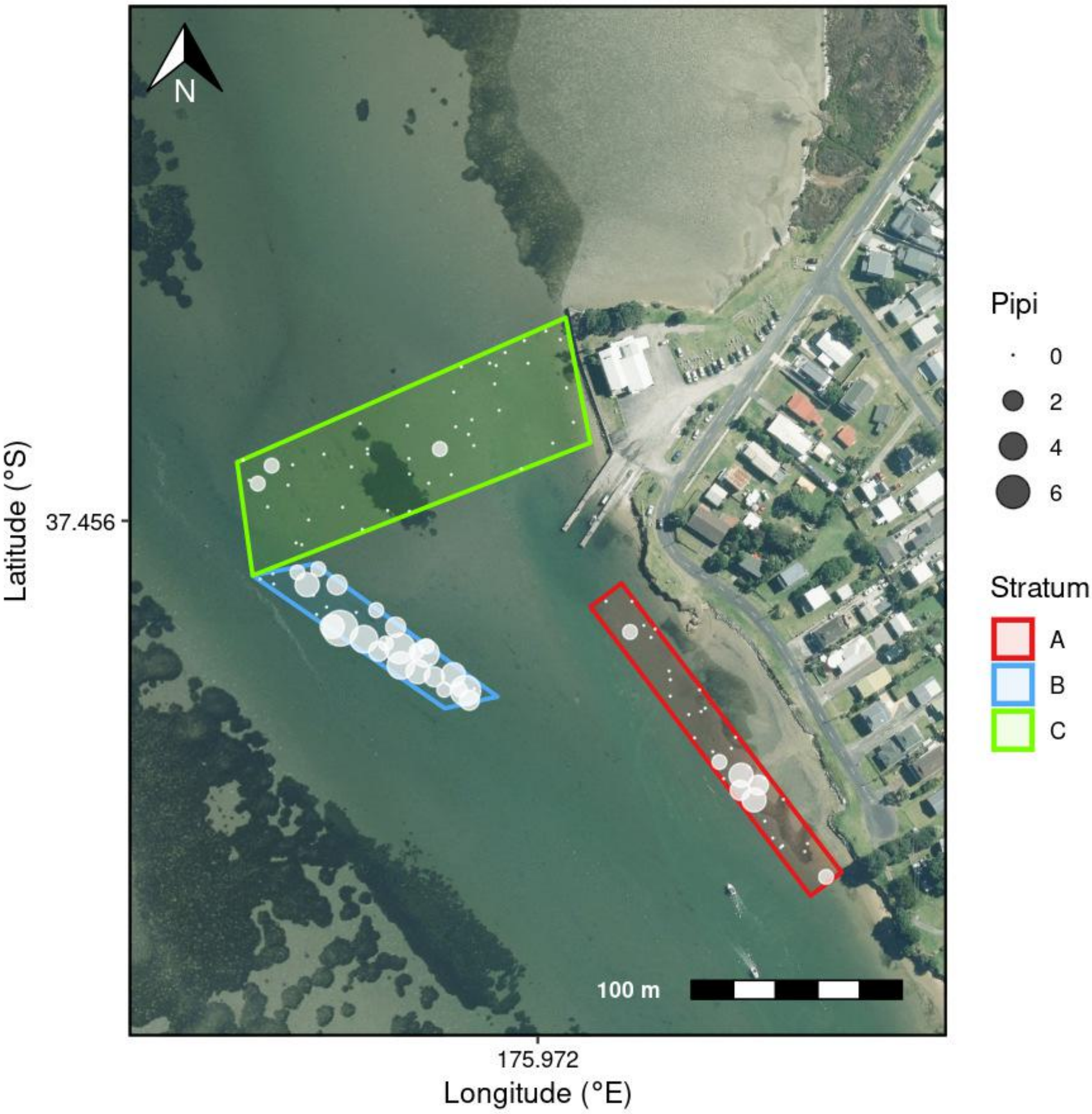

Figure 6: Map of sample strata and individual sample locations for pipi at Bowentown Beach, with the size of the circles proportional to the number of pipi (per 0.035 m^2) found at each location. Samples with zero counts are shown as small dots.

Table 4: Estimates of pipi abundance at Bowentown Beach, by stratum, for 2025–26. Presented are the area surveyed, the number of points and the number of pipi sampled, the mean total estimate, the mean density, and the coefficient of variation (CV).

Stratum		Sample		Population estimate		
	Area (ha)	Points	Pipi	Total (millions)	Density (m^{-2})	CV (%)
A	0.3	33	13	0.04	11	38.17
B	0.2	33	59	0.11	51	17.68
C	1.0	44	3	0.02	2	56.38

Table 5: Estimates of pipi abundance at Bowentown Beach for all sizes and large size (≥50 mm) pipi. Columns include the mean total estimate, mean density, and coefficient of variation (CV).

Year	Extent (ha)	Population estimate			Population ≥ 50 mm		
		Total (millions)	Density (m^{-2})	CV (%)	Total (millions)	Density (m^{-2})	CV (%)
2001–02	1.6	0.01	<1	25.46	0.00	<1	0
2010–11	1.6	0.18	12	22.86	0.00	<1	>100
2012–13	1.6	0.34	21	82.82	0.00	0	
2015–16	1.5	0.15	10	16.60	0.01	<1	72.82
2017–18	1.5	0.48	32	32.31	0.00	<1	>100
2019–20	1.5	0.29	19	15.16	0.01	<1	75.2
2021–22	1.5	0.46	30	23.00	0.01	<1	63.45
2023–24	1.5	0.79	53	14.46	0.00	<1	71.82
2025–26	1.5	0.17	11	15.76	0.02	1	38.05

Table 6: Summary statistics of the length-frequency (LF) distribution of pipi at Bowentown Beach. The LF distributions (in mm) were estimated for all strata in each survey and subsequently summed for the distribution of total LFs. Recruits were defined by a shell length of ≤20 mm and large individuals by a shell length of ≥50 mm.

Year	Mean	Mode	Range	Recruits (%)	Medium (%)	Large (%)
2021–22	26.27	12	10–52	32.58	65.88	1.54
2023–24	30.86	30	10–53	4.70	94.77	0.53
2025–26	35.29	29	9–54	12.66	75.91	11.44

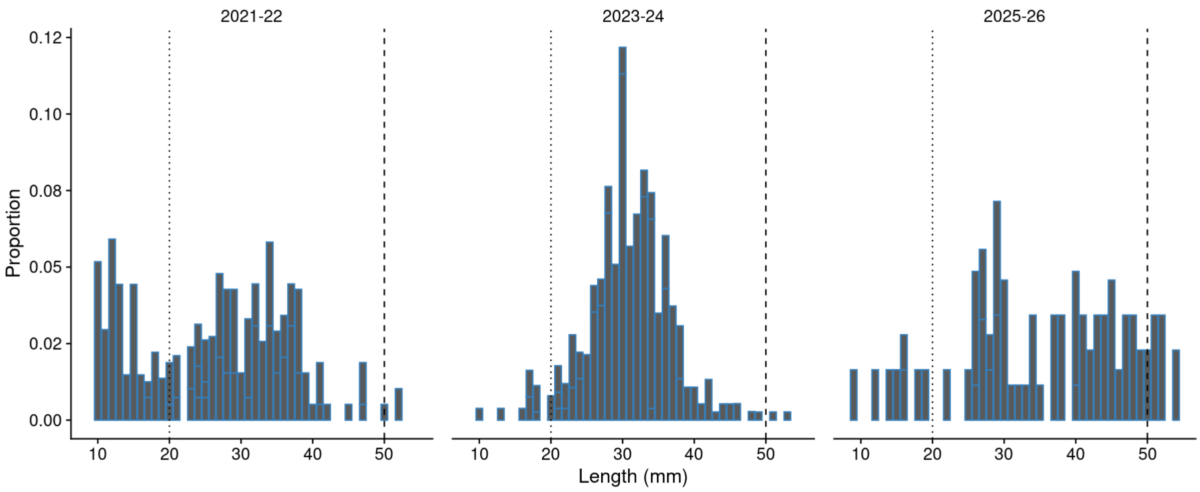

Figure 7: Weighted length-frequency (LF) distribution of pipi for the present and previous surveys at Bowentown Beach. Vertical dotted and dashed lines indicate the cut-off sizes for recruits and large individuals, respectively.

3.2 Eastern Beach

Eastern Beach is one of the metropolitan Auckland sites and part of the Hauraki Gulf Marine Park. This beach has been closed to the take of shellfish since 1994 (Department of Internal Affairs 1994, 1995). It was first included in the survey series in 1999–2000, with a total of seven surveys since then, including the current assessment (see Appendix A, Tables A-1, A-2). The beach only contains cockles, and population surveys have focused on a similar sampling extent along the length of the beach since 2016–17. In 2025–26, the sampling extent was divided into two strata, and the data collection included a total of 90 sampling points.

The sediment samples contained a small amount of organic matter (i.e., less than 2.1%), and no or only a small proportion (less than 2.2%) of sediment fines (grain size $\leq$63 µm) (Figure 8; and see details in Appendix B, Table B-1). Most of the sediment consisted of fine sand (grain size >125 µm), with up to 91.3% of sediment composed of this grain size fraction.

The distribution of the cockle population extended along the entire beach, at generally similar densities (Figure 9, Table 7). The total population estimate was 56.70 million (CV: 11.80%) cockles in 2025–26, signifying a population increase from the 2022–23 estimate of 43.24 million (CV: 15.43%) cockles (Table 8). Similarly, the estimated cockle density increased from an average of 193 cockles per m^2 to 252 cockles per m^2 over the same period. The cockle population continued to include a notable number of large individuals ($\geq$30 mm shell length), and their abundance was estimated at 15.84 million (CV: 20.81%) cockles in 2025–26; the corresponding density estimate was 70 large individuals per m^2.

Large cockles made up 27.94% of the current population, which was dominated by medium-sized individuals (Table 9). In contrast, recruits ($\leq$15 mm shell length) contributed few individuals to the total population, although their proportion showed an increase to 7.20% from 1.57% in 2022–23. The length-frequency distributions indicated a change from a generally unimodal size structure in the two preceding surveys to a bimodal population in 2025–26 (Figure 10). This change was caused by a number of medium-sized cockles growing towards and past the upper cut-off of this size class.

Principal component analysis of cockle abundance in relation to sediment grain size indicated that comparatively high cockle abundance was associated with fine and very fine sand fractions (Figure 11).

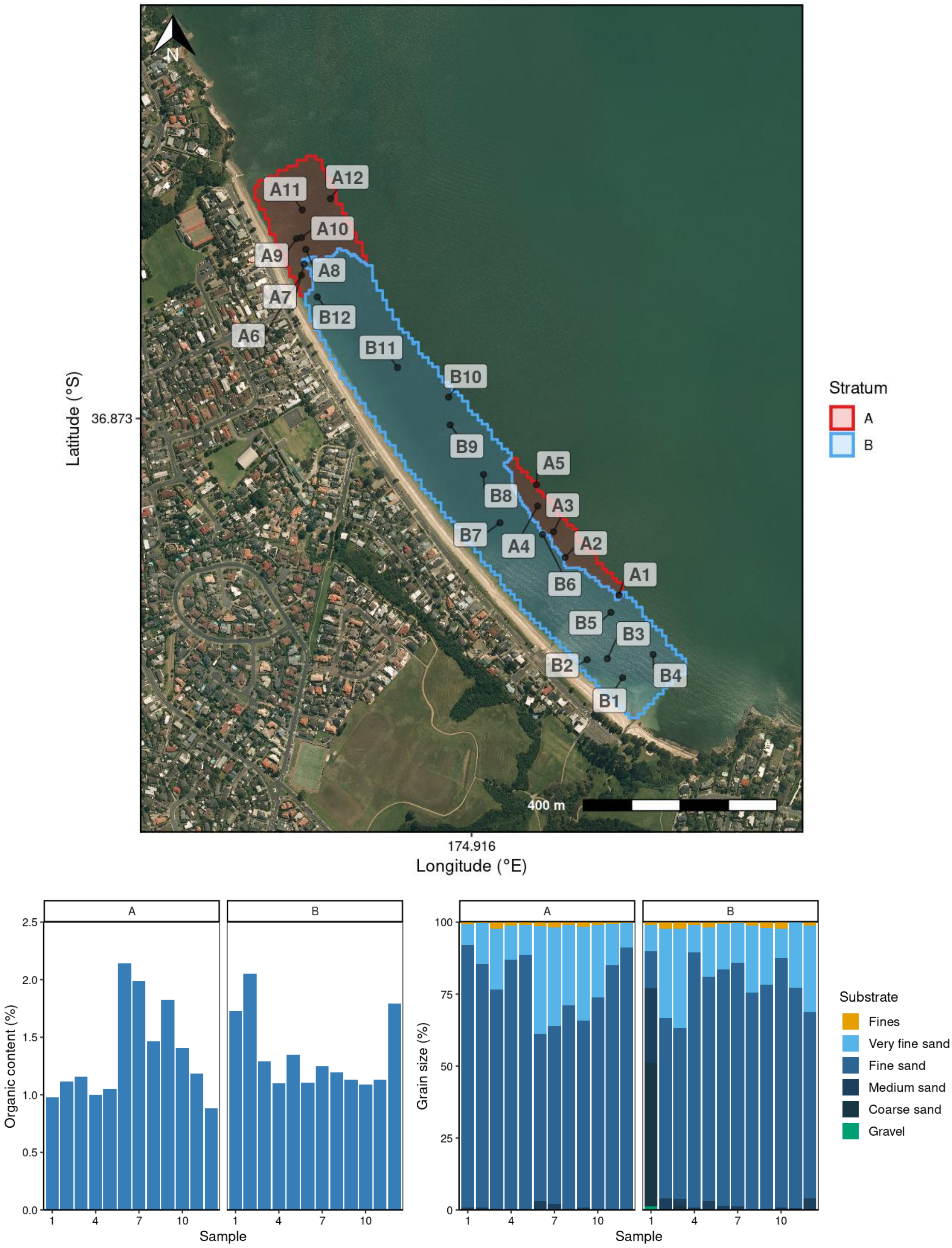

Figure 8: Sediment sample locations and characteristics at Eastern Beach. Labels correspond to stratum and sample number. Graphs show organic content (% dry weight) and cumulative grain size (%). Sediment grain size fractions include fines (silt and clay, ≤63 µm), sands (very fine, >63 µm; fine, >125 µm; medium, >250 µm; coarse, >500 µm), and gravel (>2000 µm) (see details in Table B-1).

3.2.1 Cockles at Eastern Beach

Figure 9: Map of sample strata and individual sample locations for cockles at Eastern Beach, with the size of the circles proportional to the number of cockles (per 0.035 m^2) found at each location. Samples with zero counts are shown as small dots.

Table 7: Estimates of cockle abundance at Eastern Beach, by stratum, for 2025–26. Presented are the area surveyed, the number of points and the number of cockles sampled, the mean total estimate, the mean density, and the coefficient of variation (CV).

Stratum		Sample		Population estimate		
	Area (ha)	Points	Cockle	Total (millions)	Density (m^{-2})	CV (%)
A	4.8	20	176	11.99	251	28.88
B	17.7	70	618	44.71	252	12.80

Table 8: Estimates of cockle abundance at Eastern Beach for all sizes and large size ($\geq$30 mm) cockles. Columns include the mean total estimate, mean density, and coefficient of variation (CV).

Year	Extent (ha)	Population estimate			Population $\geq$ 30 mm		
		Total (millions)	Density (m^{-2})	CV (%)	Total (millions)	Density (m^{-2})	CV (%)
1999–00	48.0	6.39	13	17.17	0.00	0	
2001–02	43.4	13.07	30	17.58	3.00	7	29.93
2014–15	41.4	28.16	68	16.59	12.84	31	26.54
2016–17	22.6	176.91	784	13.05	15.07	67	17.38
2019–20	22.6	117.16	519	12.98	17.49	77	20.74
2022–23	22.4	43.24	193	15.43	12.02	54	23.77
2025–26	22.5	56.70	252	11.80	15.84	70	20.81

Table 9: Summary statistics of the length-frequency (LF) distribution of cockles at Eastern Beach. The LF distributions (in mm) were estimated for all strata in each survey and subsequently summed for the distribution of total LFs. Recruits were defined by a shell length of $\leq$15 mm and large individuals by a shell length of $\geq$30 mm.

Year	Mean	Mode	Range	Recruits (%)	Medium (%)	Large (%)
2019–20	23.88	22	10–40	3.98	81.09	14.93
2022–23	27.01	27	7–38	1.57	70.63	27.80
2025–26	24.63	20	6–44	7.20	64.86	27.94

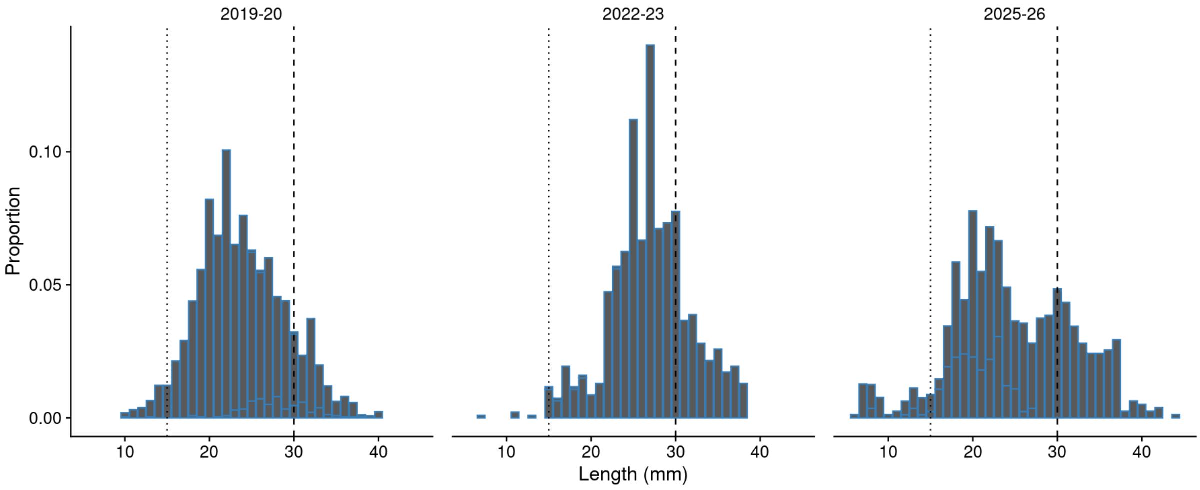

Figure 10: Weighted length-frequency (LF) distribution of cockles for the present and previous surveys at Eastern Beach. Vertical dotted and dashed lines indicate the cut-off sizes for recruits and large individuals, respectively.

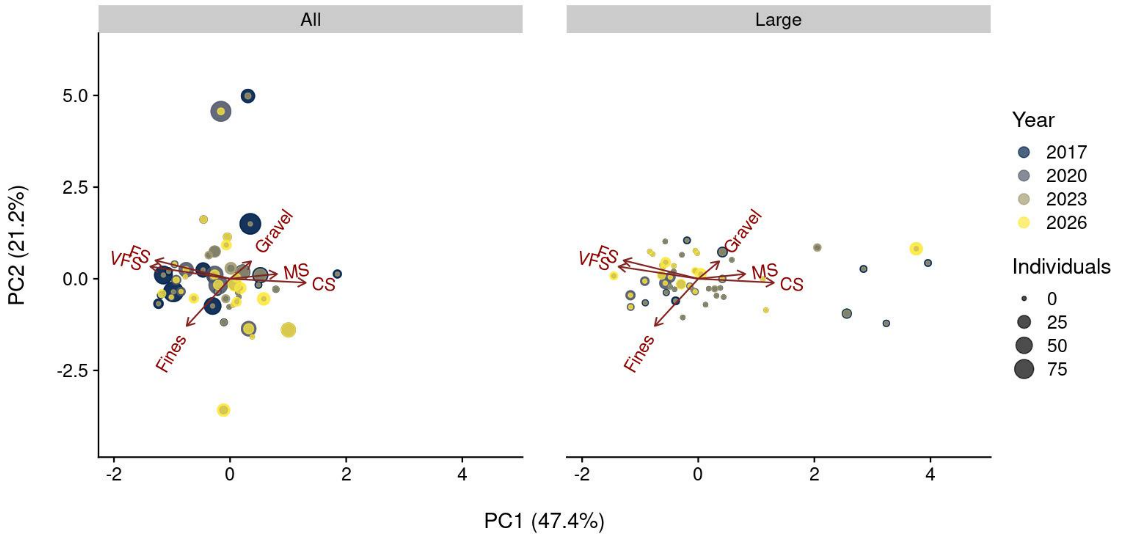

Figure 11: Cockle abundance along two principal components (standardised PCs, including % variance explained) of sediment granulometry for all cockle size classes (all) and large cockles (≥30 mm shell length) at Eastern Beach. Sediment grain size fractions are defined as fines (silt and clay) ≤63 µm, very fine sand (VFS) >63 µm, fine sand (FS) >125 µm, medium sand (MS) >250 µm, coarse sand (CS) >500 µm, and gravel >2000 µm.

3.3 Grahams Beach

Grahams Beach is a sheltered beach in Manukau Harbour, on Āwhitu Peninsula in the wider Auckland region. This site has been included in eight previous surveys, starting in 2006–07 (see Appendix A, Tables A-1, A-2). Throughout the monitoring programme, the surveys covered a similar sampling extent along the length of the beach. In 2025–26, the survey effort was split across three strata, in a total of 99 sampling points, including nine phase-2 points.

Sediment samples across the beach were low in organic content, with most samples containing about 1% of organic matter (Figure 12; and see details in Appendix B, Table B-1). The sediment composition was mostly characterised by medium sand (grain size >250 µm), followed by fine sand (grain size >125 µm) (Figure 12; and see details in Appendix B, Table B-1). The proportion of sediment fines (grain size <63 µm) was small (i.e., 0 to 3%) in most samples, but one sample contained almost 9% of sediment fines.

Cockles were distributed along the entire beach, but mostly restricted to the higher intertidal area, strata A and B (Figure 13, Table 10). Across the sampling extent, there were an estimated 6.91 million (CV: 19.38%) cockles, occurring at an estimated density of 26 cockles per m^2 (Table 11). Both estimates were marked increases from the previous survey in 2022–23, when total abundance and density estimates were 4.42 million (CV: 25.91%) cockles and 17 cockles per m^2. Large cockles were consistently scarce in the population, and their estimates were unreliable with high uncertainty.

In contrast, recruits (≤15 mm shell length) constituted the largest proportion of the current population, with 80.19% of all individuals in this size class; medium-sized cockles made up 18.66% (Table 12, Figure 14). A similar population size structure was evident in 2019–20, before this pattern was reversed in the interim survey as individuals grew into the medium size class. These changes in population size composition document regular, strong recruitment events at Graham Beach, and the influence of recruits on the population overall. For the consistently unimodal population, the fluctuation in recruitment led to fluctuations in mean and modal sizes; in 2025–26, the mean shell length was 11.25 mm and the modal shell length was 8 mm.

Principal component analysis indicated comparatively high total cockle abundance associated with very fine and fine sand fractions in earlier surveys, but less so in recent assessments (Figure 15).

Pipi at Grahams Beach were only present at low numbers and in highly-localised areas: the total sample size was 36 pipi in 2025–26 (Figure 16, Table 13). The small sample size meant that their population estimates had high uncertainty, with a CV value of 33.54% for the abundance estimate of 2.84 million pipi and the density estimate of 11 pipi per m^2 (Table 14). This finding was consistent across the survey series, and pipi were absent in the initial assessment in 2006–07 (Pawley & Ford 2007). Subsequent surveys consistently documented the presence of pipi at the beach, but only at low abundances and densities, and with high uncertainty (CV values) of their population estimates. In addition, there was a general lack of large pipi (≥50 mm shell length), including in 2025–26.

The population also lacked medium-sized pipi, with recruits (≤20 mm shell length) making up 91.38% of the current population (Table 15, Figure 17). This size class made up a similar proportion (79.12%) of the total population in the preceding survey in 2022–23, indicating strong recruitment events. Recruits formed the single cohort in the three most recent surveys, with mean and modal sizes well below the medium size class cut-off of 20 mm shell length. In 2025–26, mean and modal shell lengths were similar at 14.36 mm and 15 mm, respectively. This population size structure confirmed that the strong influx of recruits did not subsequently contribute to the medium size class, but failed to become established. In addition, the pipi population continued to decline through the decrease in medium-sized individuals.

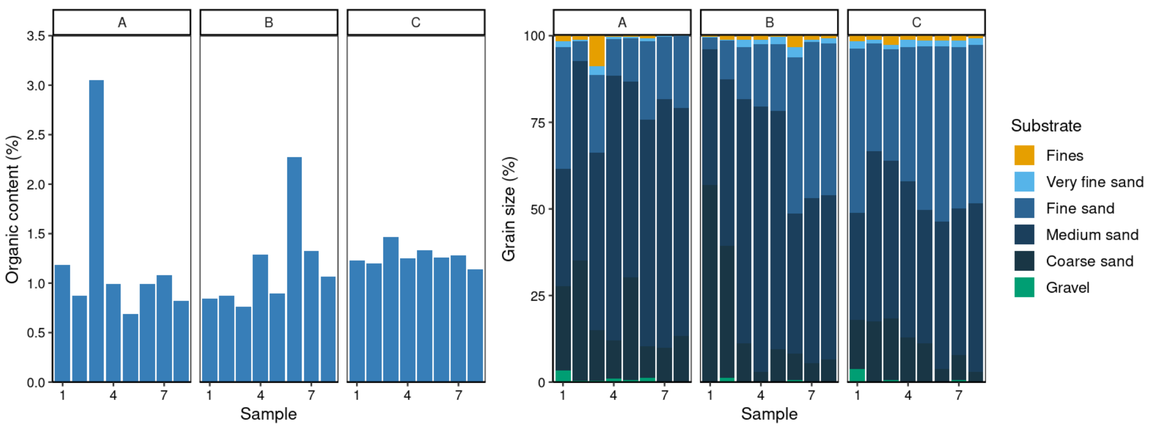

Figure 12: Sediment sample locations and characteristics at Grahams Beach. Labels correspond to stratum and sample number. Graphs show organic content (% dry weight) and cumulative grain size (%). Sediment grain size fractions include fines (silt and clay, ≤63 µm), sands (very fine, >63 µm; fine, >125 µm; medium, >250 µm; coarse, >500 µm), and gravel (>2000 µm) (see details in Table B-1).

3.3.1 Cockles at Grahams Beach

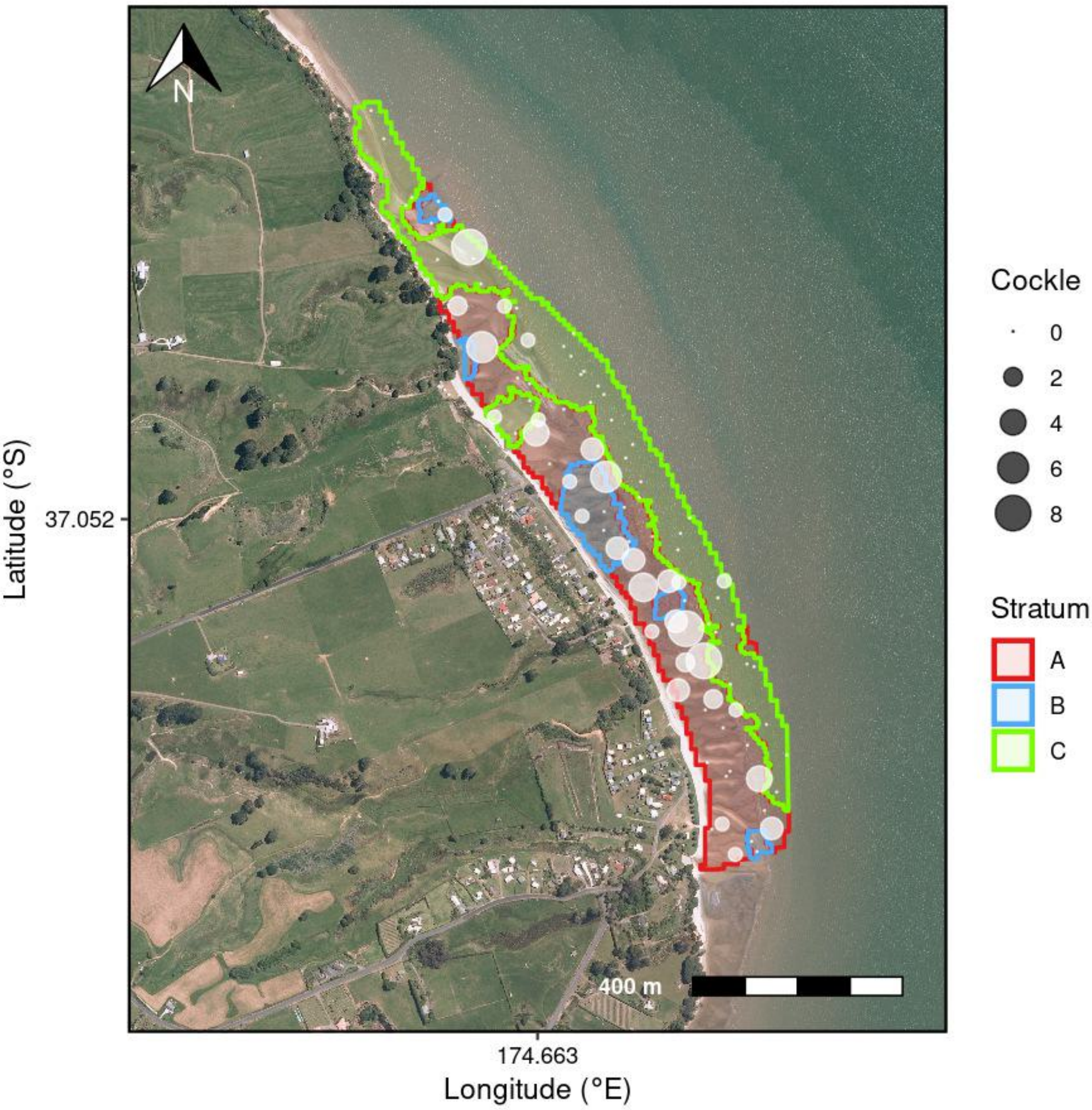

Figure 13: Map of sample strata and individual sample locations for cockles at Grahams Beach, with the size of the circles proportional to the number of cockles (per 0.035 m^2) found at each location. Samples with zero counts are shown as small dots.

Table 10: Estimates of cockle abundance at Grahams Beach, by stratum, for 2025–26. Presented are the area surveyed, the number of points and the number of cockles sampled, the mean total estimate, the mean density, and the coefficient of variation (CV).

Stratum		Sample		Population estimate		
	Area (ha)	Points	Cockle	Total (millions)	Density (m^{-2})	CV (%)
A	12.1	44	67	5.27	44	20.97
B	2.4	11	11	0.69	29	57.21
C	12.2	44	12	0.95	8	67.82

Table 11: Estimates of cockle abundance at Grahams Beach for all sizes and large size (≥30 mm) cockles. Columns include the mean total estimate, mean density, and coefficient of variation (CV).

Year	Extent (ha)	Population estimate			Population ≥ 30 mm		
		Total (millions)	Density (m^{-2})	CV (%)	Total (millions)	Density (m^{-2})	CV (%)
2006–07	24.8	4.90	20	32.99	0.00	0	
2010–11	25.1	25.22	100	20.39	0.02	<1	>100
2012–13	20.1	4.23	21	21.00	0.00	0	
2013–14	26.8	4.70	18	19.10	0.12	<1	>100
2016–17	26.8	17.09	64	21.82	0.00	0	
2019–20	26.8	11.40	43	19.89	0.00	0	
2022–23	26.5	4.42	17	25.91	0.00	0	
2025–26	26.7	6.91	26	19.38	0.08	<1	>100

Table 12: Summary statistics of the length-frequency (LF) distribution of cockles at Grahams Beach. The LF distributions (in mm) were estimated for all strata in each survey and subsequently summed for the distribution of total LFs. Recruits were defined by a shell length of ≤15 mm and large individuals by a shell length of ≥30 mm.

Year	Mean	Mode	Range	Recruits (%)	Medium (%)	Large (%)
2019–20	10.90	9	5–26	87.12	12.88	0.00
2022–23	17.81	19	7–26	24.08	75.92	0.00
2025–26	11.25	8	6–31	80.19	18.66	1.15

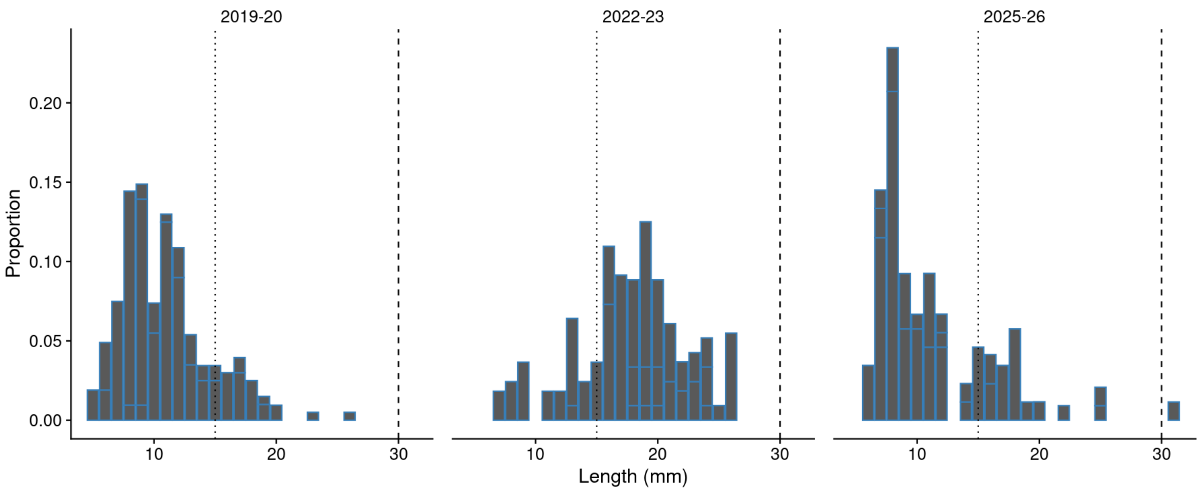

Figure 14: Weighted length-frequency (LF) distribution of cockles for the present and previous surveys at Grahams Beach. Vertical dotted and dashed lines indicate the cut-off sizes for recruits and large individuals, respectively.

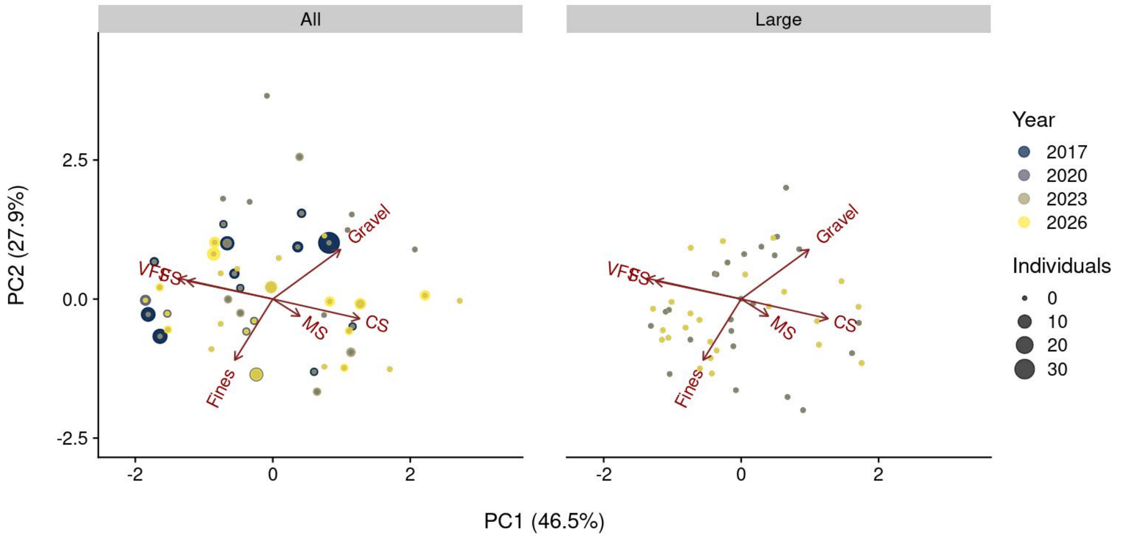

Figure 15: Cockle abundance along two principal components (standardised PCs, including % variance explained) of sediment granulometry for all cockle size classes (all) and large cockles (≥30 mm shell length) at Grahams Beach. Sediment grain size fractions are defined as fines (silt and clay) ≤63 µm, very fine sand (VFS) >63 µm, fine sand (FS) >125 µm, medium sand (MS) >250 µm, coarse sand (CS) >500 µm, and gravel >2000 µm.

3.3.2 Pipi at Grahams Beach

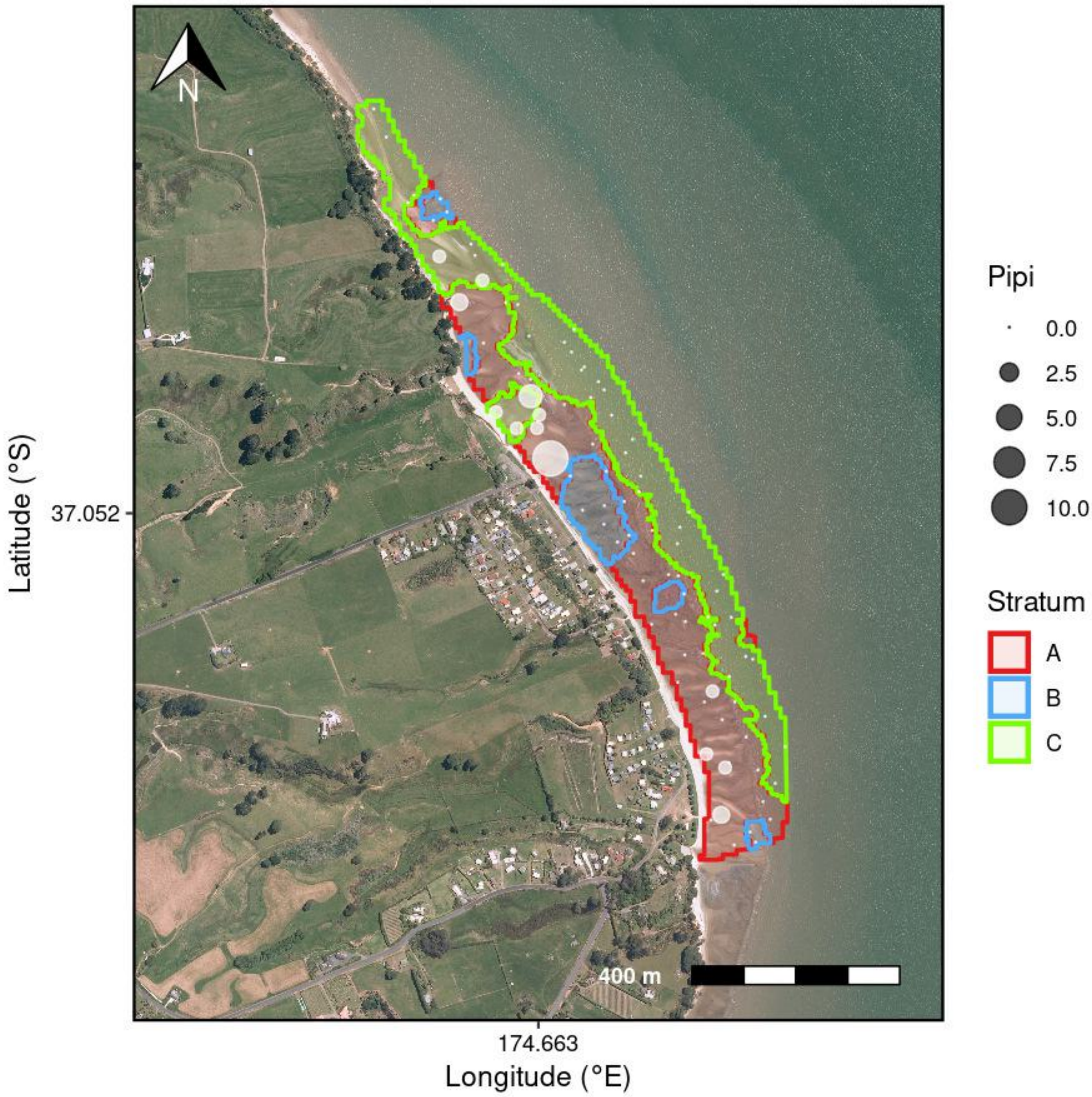

Figure 16: Map of sample strata and individual sample locations for pipi at Grahams Beach, with the size of the circles proportional to the number of pipi (per 0.035 m^2) found at each location. Samples with zero counts are shown as small dots.

Table 13: Estimates of pipi abundance at Grahams Beach, by stratum, for 2025–26. Presented are the area surveyed, the number of points and the number of pipi sampled, the mean total estimate, the mean density, and the coefficient of variation (CV).

Stratum		Sample		Population estimate		
	Area (ha)	Points	Pipi	Total (millions)	Density (m^{-2})	CV (%)
A	12.1	44	28	2.20	18	40.26
B	2.4	11	0	0.00	0	
C	12.2	44	8	0.63	5	54.45

Table 14: Estimates of pipi abundance at Grahams Beach for all sizes and large size (≥50 mm) pipi. Columns include the mean total estimate, mean density, and coefficient of variation (CV).

Year	Extent (ha)	Population estimate			Population ≥ 50 mm		
		Total (millions)	Density (m^{-2})	CV (%)	Total (millions)	Density (m^{-2})	CV (%)
2010–11	25.1	3.75	15	27.65	0.00	0	
2012–13	20.1	2.93	15	35.01	0.00	0	
2013–14	26.8	12.34	46	21.63	0.06	<1	>100
2016–17	26.8	8.77	33	25.66	0.00	0	
2019–20	26.8	4.21	16	23.21	0.34	1	48.11
2022–23	26.5	4.51	17	32.09	0.00	0	
2025–26	26.7	2.84	11	33.54	0.00	0	

Table 15: Summary statistics of the length-frequency (LF) distribution of pipi at Grahams Beach. The LF distributions (in mm) were estimated for all strata in each survey and subsequently summed for the distribution of total LFs. Recruits were defined by a shell length of ≤20 mm and large individuals by a shell length of ≥50 mm.

Year	Mean	Mode	Range	Recruits (%)	Medium (%)	Large (%)
2019–20	25.30	9	6–56	51.56	40.37	8.07
2022–23	14.53	9	6–32	79.12	20.88	0.00
2025–26	14.36	15	7–32	91.38	8.62	0.00

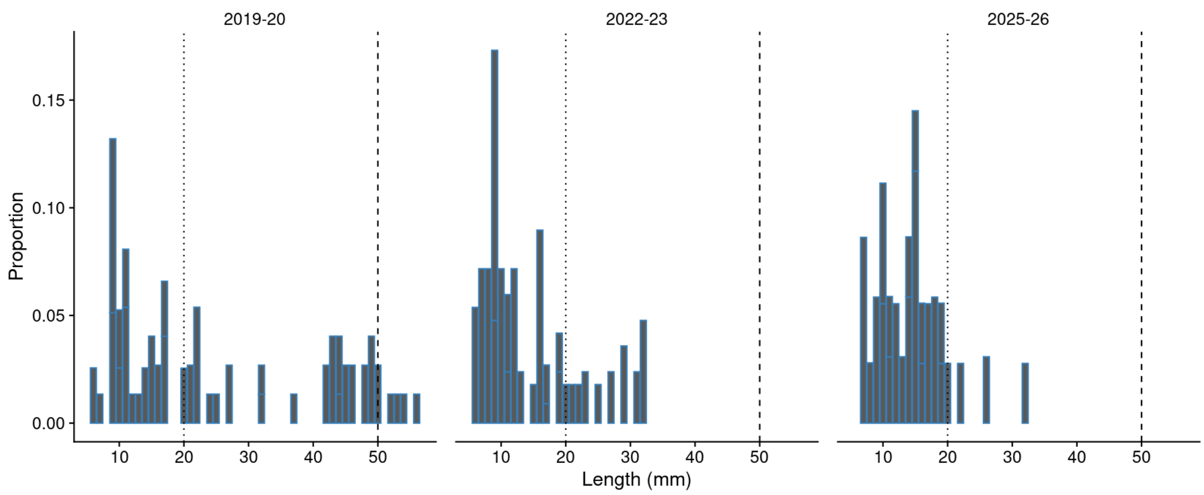

Figure 17: Weighted length-frequency (LF) distribution of pipi for the present and previous surveys at Grahams Beach. Vertical dotted and dashed lines indicate the cut-off sizes for recruits and large individuals, respectively.

3.4 Hokianga Harbour

Hokianga Harbour on Northland's west coast is the most northern site in the monitoring programme. The first bivalve survey at this site was in 2018–19, with two subsequent surveys since then, including the present assessment (see Appendix A, Tables A-1, A-2). The sampling extent has remained the same across all surveys with three separate strata, consisting of a cockle and a pipi bed each at Pakanae, and a pipi bed in the intertidal beach area at Koutou. The present assessment sampled bivalves at a total of 100 sampling points across the three strata.

Sediment samples from the cockle bed at Pakanae documented a low organic content of between 1.5 and 4.6% (Figure 18, and see details in Appendix B, Table B-1). Medium and fine sands (grain sizes $>$125 µm and $>$250 µm) were the prevalent grain size fractions, and there was also a marked proportion (up to 50%) of gravel (grain size $>$2000 µm) in all sediment samples. The proportion of sediment fines (grain size $\leq$63 µm) varied across samples, with a maximum of 13.4% of sediment at this grain size.

Cockles were distributed across all three strata, with highest densities in the designated cockle bed in stratum B (Figure 19, Table 16). Based on the entire sampling area, total cockle abundance was estimated at 31.92 million (CV: 12.60%) individuals, occurring at an estimated density of 317 cockles per m^2 (Table 17). These estimates documented a continued increase in the cockle population since the initial survey in 2018–19. Over the same time frame, there have been few large individuals ($\geq$30 mm shell length) within the overall population, and their abundance and density estimates contained high uncertainty with CV values around 50%.

Most of the cockle population consisted of medium-sized individuals, with regular and consistent contributions from recruits ($\leq$15 mm shell length) in the three surveys to date (Table 18, Figure 20). In 2025–26, medium-sized cockles made up 76.04% of the population, compared with 23.50% of recruits. The generally unimodal size structure remained relatively unchanged across surveys, with a strong cohort of medium-sized cockles, and mean and modal shell lengths of 18.45 mm and 17 mm in 2025–26, respectively.

Examination of cockle abundance in relation to sediment grain sizes via principal component analysis indicated higher total abundance associated with coarser sediment size fractions, compared with very fine sand and sediment fines (Figure 21).

The pipi population was distributed across the three strata, excluding the lower area of the pipi bed in stratum C at Koutou (Figure 22, Table 19). The 2025–26 population estimates for this species documented a total abundance of 33.48 million (CV: 12.46%) pipi, with an estimated mean density of 333 pipi per m^2 (Table 20). Current estimates were decreases from the preceding surveys, although the decline was smaller than the previous 50% decline between 2018–19 and 2022–23. In addition, the current population included a small number of large pipi ($\geq$50 mm shell length), following their absence in the two preceding surveys; however, abundance and density estimates for this size class were unreliable owing to the marked uncertainty (CV: 93.95%).

The population consisted predominantly of medium-sized pipi, contributing 70.88% of individuals, compared with 28.92% of recruits ($\leq$20 mm shell length) (Table 21, Figure 23). The proportions of both size classes were stable across surveys, although there were some small changes in mean and modal sizes over time. Mean shell length fluctuated slightly, decreasing to 24.18 mm in 2025–26, whereas modal size continued to increase to 27 mm shell length. The bimodal population in 2022–23 returned to a unimodal size structure in 2025–26, caused by increases in shell length of small individuals and a concomitant reduction of larger pipi in the medium size class.

Similar to the cockle population, these findings indicated a relatively stable pipi population of medium-sized individuals, augmented by regular strong recruitment at this site.

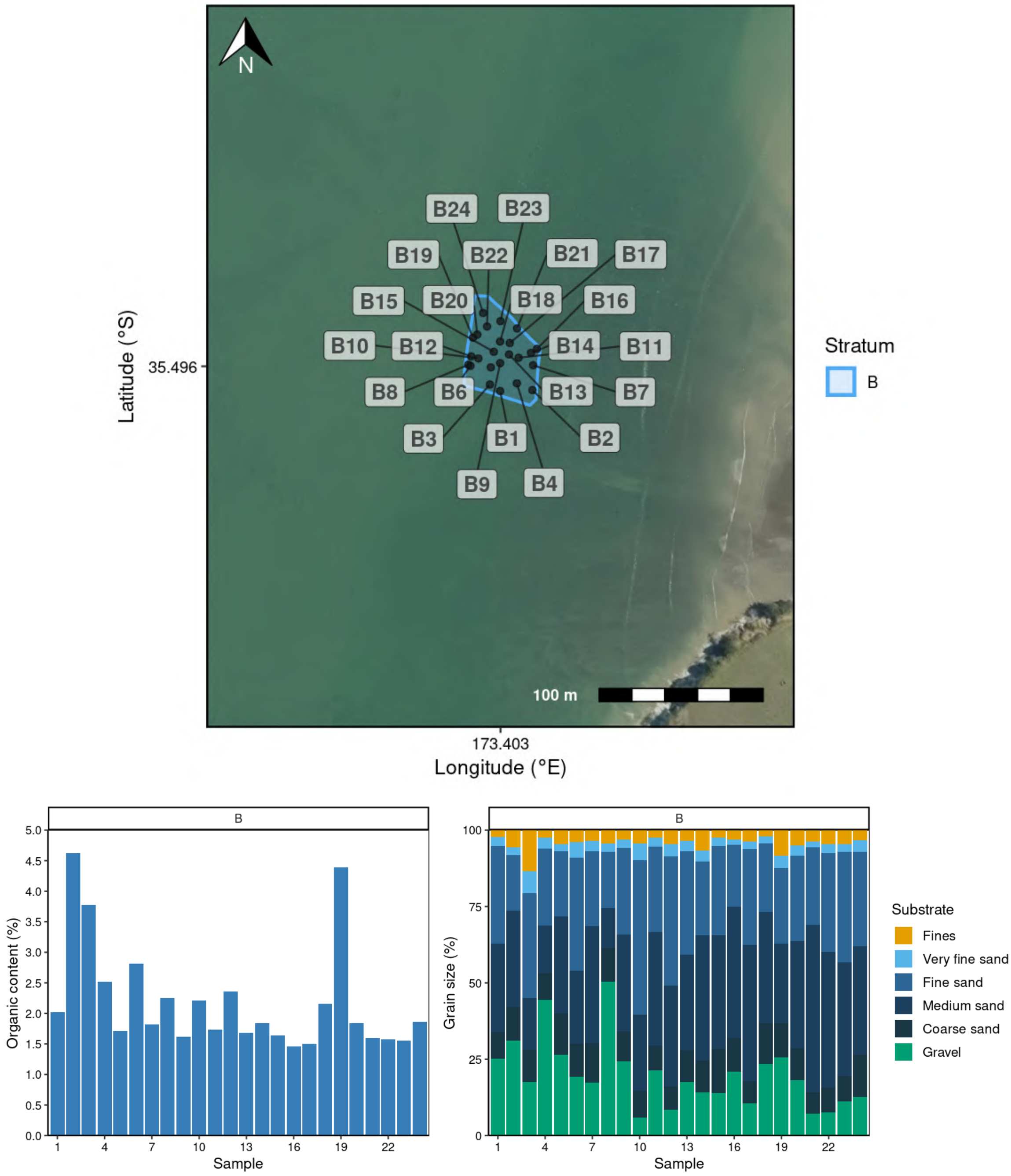

Figure 18: Sediment sample locations and characteristics at Hokianga Harbour. Labels correspond to stratum and sample number. Graphs show organic content (% dry weight) and cumulative grain size (%). Sediment grain size fractions include fines (silt and clay, ≤63 µm), sands (very fine, >63 µm; fine, >125 µm; medium, >250 µm; coarse, >500 µm), and gravel (>2000 µm) (see details in Table B-1).

3.4.1 Cockles at Hokianga Harbour

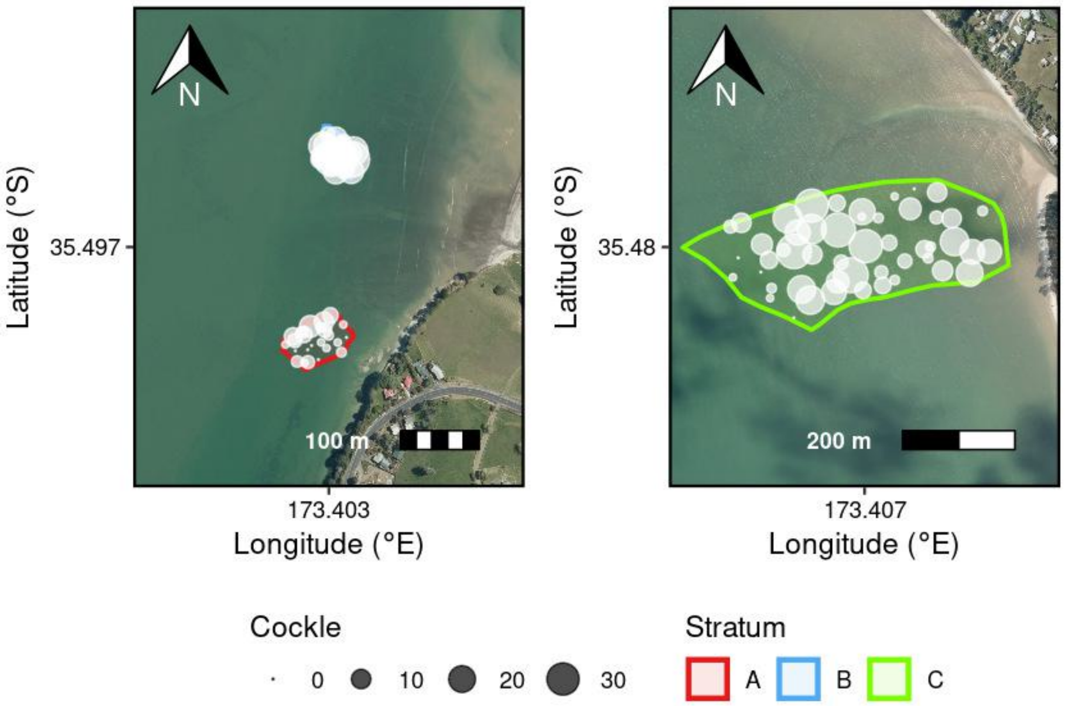

Figure 19: Map of sample strata and individual sample locations for cockles at Hokianga Harbour, with the size of the circles proportional to the number of cockles (per 0.035 m^2) found at each location. Samples with zero counts are shown as small dots.

Table 16: Estimates of cockle abundance at Hokianga Harbour, by stratum, for 2025–26. Presented are the area surveyed, the number of points and the number of cockles sampled, the mean total estimate, the mean density, and the coefficient of variation (CV).

Stratum		Sample		Population estimate		
	Area (ha)	Points	Cockle	Total (millions)	Density (m^{-2})	CV (%)
A	0.4	25	76	0.34	87	22.83
B	0.2	25	356	0.86	407	11.91
C	9.5	50	568	30.72	325	13.09

Table 17: Estimates of cockle abundance at Hokianga Harbour for all sizes and large size (≥30 mm) cockles. Columns include the mean total estimate, mean density, and coefficient of variation (CV).

Year	Extent (ha)	Population estimate			Population ≥ 30 mm		
		Total (millions)	Density (m^{-2})	CV (%)	Total (millions)	Density (m^{-2})	CV (%)
2018–19	10.1	25.54	254	11.88	0.32	3	49.47
2022–23	10.1	27.19	270	12.89	0.12	1	51.31
2025–26	10.1	31.92	317	12.60	0.15	1	54.37

Table 18: Summary statistics of the length-frequency (LF) distribution of cockles at Hokianga Harbour. The LF distributions (in mm) were estimated for all strata in each survey and subsequently summed for the distribution of total LFs. Recruits were defined by a shell length of ≤15 mm and large individuals by a shell length of ≥30 mm.

Year	Mean	Mode	Range	Recruits (%)	Medium (%)	Large (%)
2018–19	18.13	18	5–34	34.06	64.69	1.25
2022–23	17.85	17	5–33	26.19	73.36	0.45
2025–26	18.45	17	7–43	23.50	76.04	0.46

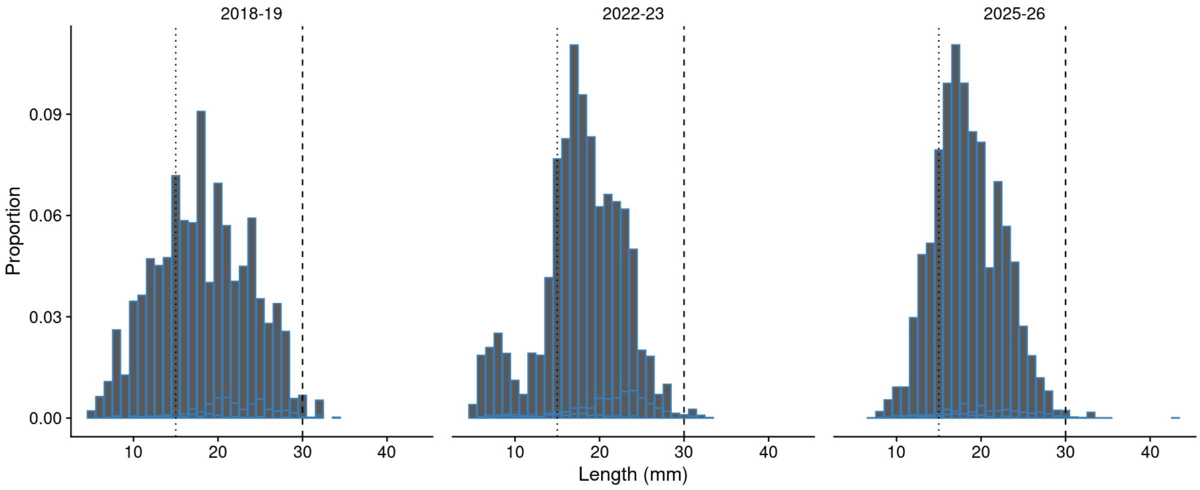

Figure 20: Weighted length-frequency (LF) distribution of cockles for the present survey at Hokianga Harbour. Vertical dotted and dashed lines indicate the cut-off sizes for recruits and large individuals, respectively.

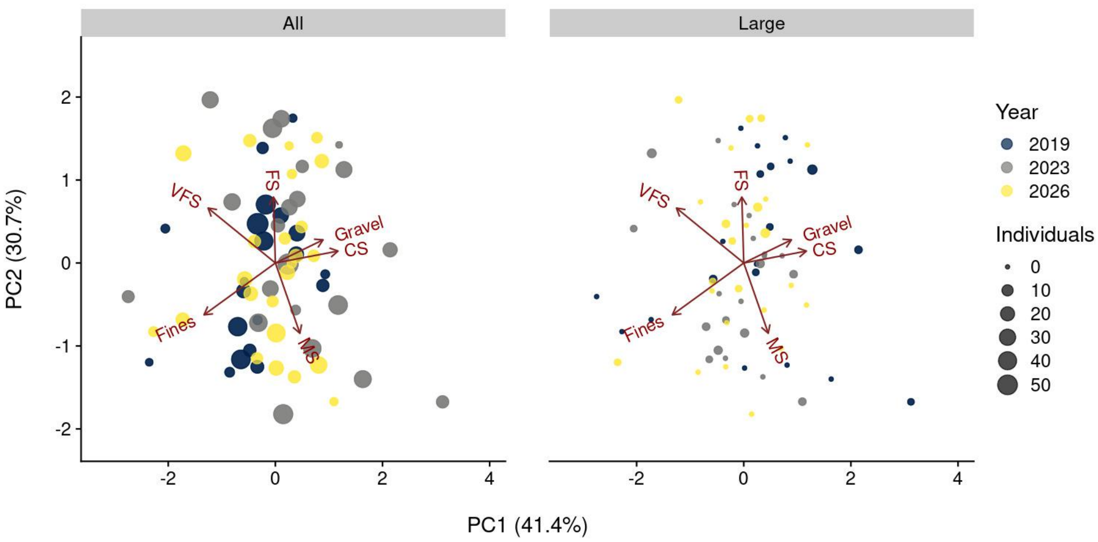

Figure 21: Cockle abundance along two principal components (standardised PCs, including % variance explained) of sediment granulometry for all cockle size classes (all) and large cockles (≥30 mm shell length) at Hokianga Harbour. Sediment grain size fractions are defined as fines (silt and clay) ≤63 µm, very fine sand (VFS) >63 µm, fine sand (FS) >125 µm, medium sand (MS) >250 µm, coarse sand (CS) >500 µm, and gravel >2000 µm.

3.4.2 Pipi at Hokianga Harbour

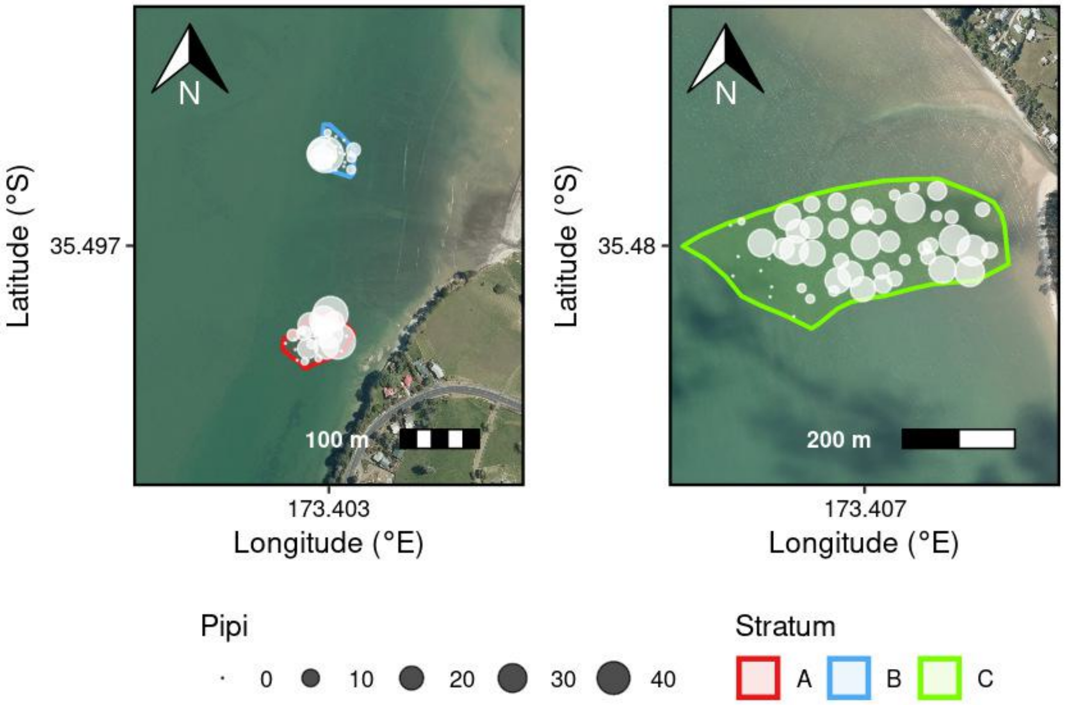

Figure 22: Map of sample strata and individual sample locations for pipi at Hokianga Harbour, with the size of the circles proportional to the number of pipi (per 0.035 m^2) found at each location. Samples with zero counts are shown as small dots.

Table 19: Estimates of pipi abundance at Hokianga Harbour, by stratum, for 2025–26. Presented are the area surveyed, the number of points and the number of pipi sampled, the mean total estimate, the mean density, and the coefficient of variation (CV).

Stratum		Sample		Population estimate		
	Area (ha)	Points	Pipi	Total (millions)	Density (m^{-2})	CV (%)
A	0.4	25	264	1.18	302	27.41
B	0.2	25	115	0.28	131	50.61
C	9.5	50	592	32.02	338	12.98

Table 20: Estimates of pipi abundance at Hokianga Harbour for all sizes and large size (≥50 mm) pipi. Columns include the mean total estimate, mean density, and coefficient of variation (CV).

Year	Extent (ha)	Population estimate			Population ≥ 50 mm		
		Total (millions)	Density (m^{-2})	CV (%)	Total (millions)	Density (m^{-2})	CV (%)
2018–19	10.1	87.39	868	10.87	0.00	<1	>100
2022–23	10.1	39.27	390	14.37	0.00	<1	>100
2025–26	10.1	33.48	333	12.46	0.07	<1	93.95

Table 21: Summary statistics of the length-frequency (LF) distribution of pipi at Hokianga Harbour. The LF distributions (in mm) were estimated for all strata in each survey and subsequently summed for the distribution of total LFs. Recruits were defined by a shell length of $\leq$20 mm and large individuals by a shell length of $\geq$50 mm.

Year	Mean	Mode	Range	Recruits (%)	Medium (%)	Large (%)
2018–19	24.09	22	7–54	36.17	63.82	0.00
2022–23	25.06	24	7–51	31.40	68.59	0.01
2025–26	24.18	27	8–56	28.92	70.88	0.20

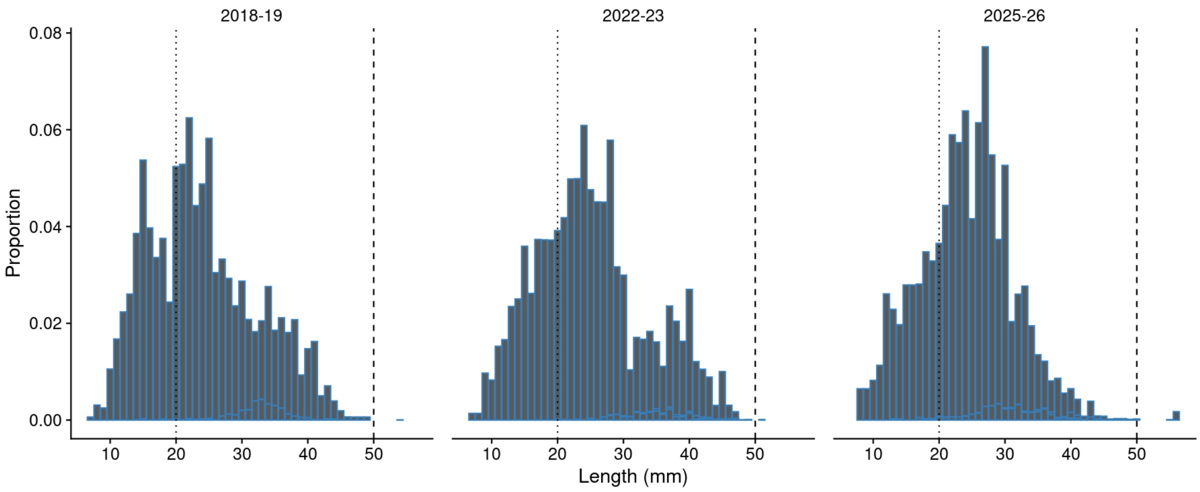

Figure 23: Weighted length-frequency (LF) distribution of pipi for the present survey at Hokianga Harbour. Vertical dotted and dashed lines indicate the cut-off sizes for recruits and large individuals, respectively.

3.5 Little Waihi Estuary

Little Waihi Estuary is in western Bay of Plenty, close to Maketū. Bivalves in this estuary have been assessed since 2000–01, with biennial surveys since 2013–14. The sampling extent has remained similar across recent surveys (i.e., since 2013–14)), covering the lower estuary in its entirety (see Appendix A, Tables A-1, A-2). The sampling effort in 2025–26 was spread across two strata and consisted of a total of 187 points, with 17 points sampled in phase 2.

The sediment sampling indicated estuary sediment that was generally low in organic content (maximum of 5.3%), and a similarly small proportion of sediment fines (grain size <63 µm) (Figure 24; and see details in Appendix B, Table B-1). Most of the sediment consisted of fine to medium sands (grain sizes >125 µm and >250 µm), with only small proportions in the remaining grain size fractions.

The distribution of cockles in the estuary was mostly restricted to high intertidal areas and the mudflat in the southern part of the sampling extent (Figure 25, Table 22). The current population estimates were a total of 37.50 million (CV: 20.59%) cockles and an average density of 226 individuals per m^2 (Table 23). The current estimates signified a continuing population increase over the three most recent surveys. The population consistently included few large cockles (≥30 mm), and their current abundance estimate of 0.89 million (CV: 97.95%) large individuals had considerable uncertainty (CV: 97.95%), similar to estimates in the preceding surveys.

Across the three most recent surveys, recruits (≤15 mm) made up a considerable proportion of the population, and their marked influx in 2025–26 resulted in their proportion increasing to 51.75% of the population (Table 24, Figure 26). There was a concomitant 5-mm downward shift in modal size to 13 mm shell length, below the 15-mm cut off for the recruits size class. The population size structure remained unimodal, but the influx of recruits shifted the single cohort towards these smaller-sized individuals.

Considering cockle abundance in relation to sediment grain size fractions showed no distinct patterns in the principal component analysis across the survey series (Figure 27).

Pipi at Little Waihi Estuary were associated with the two channels on either side of the sampling extent (Figure 28, Table 25). Their total abundance and density estimates were 115.37 million (CV: 12.77%) pipi and 695 pipi per m^2, respectively (Table 26). Across the survey series, this population exhibited marked fluctuations, and the two most recent estimates were notable increases from low values in the 2021–22 assessment. The population contained few large individuals (≥50 mm), particularly in recent surveys, when their abundance and density estimates were low and accompanied by high uncertainty (i.e., CV values exceeding 30%).

The low abundance of large pipi meant that this size class only contributed few individuals (i.e., 1 to 2%) to the total population (Table 27, Figure 29). Across the three recent surveys, the population was largely determined by medium-sized pipi and recruits (≤20 mm); the latter size class made up at least 20% of the population, with strong recruitment in 2025–26 resulting in 35.71% of the population consisting of recruits. The recent increase in this size class also led to a change from a unimodal to a bimodal population size structure, accompanied by a shift in modal shell length from 27 to 11 mm between 2023–24 and 2025–26.

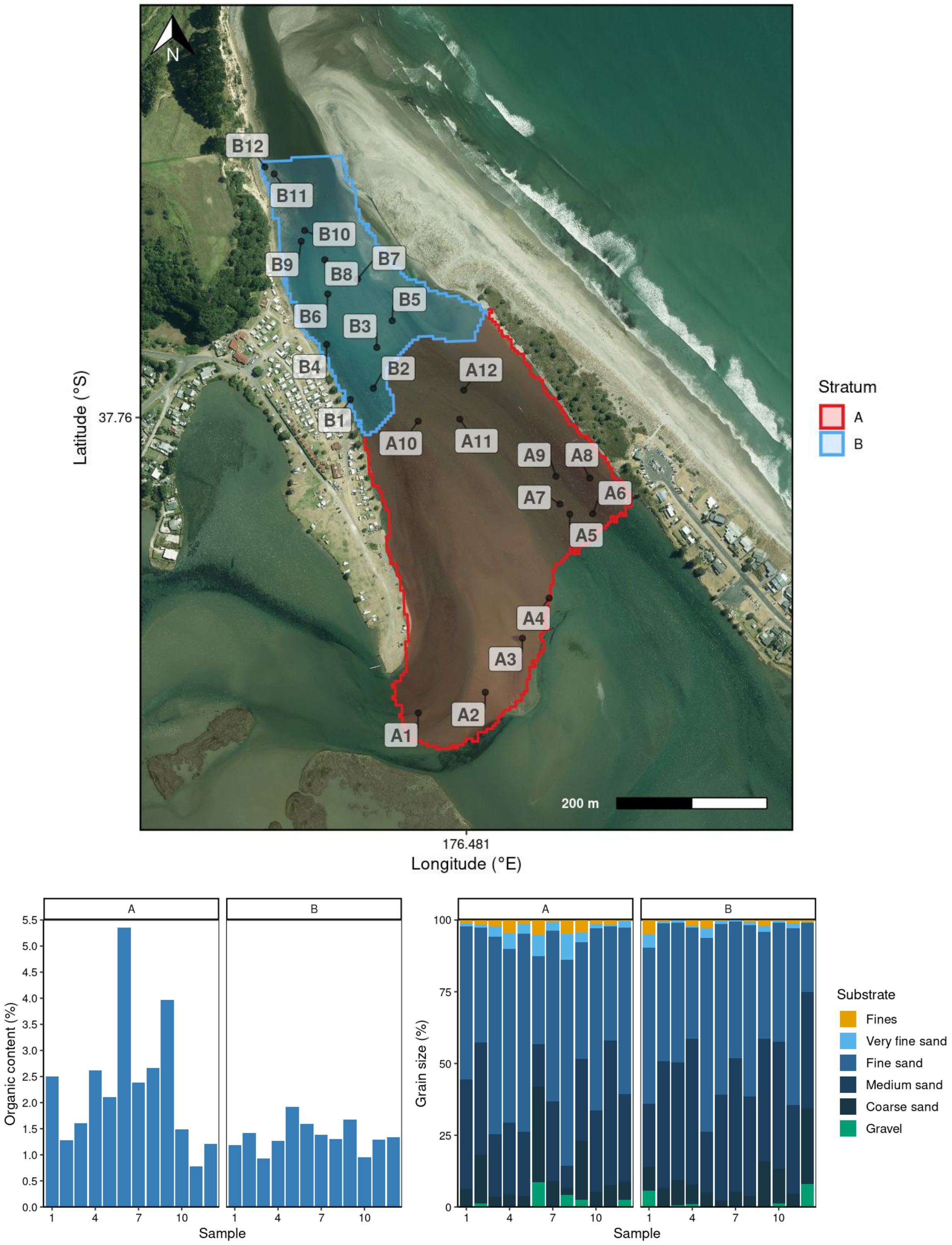

Figure 24: Sediment sample locations and characteristics at Little Waihi Estuary. Labels correspond to stratum and sample number. Graphs show organic content (% dry weight) and cumulative grain size (%). Sediment grain size fractions include fines (silt and clay, ≤63 µm), sands (very fine, >63 µm; fine, >125 µm; medium, >250 µm; coarse, >500 µm), and gravel (>2000 µm) (see details in Table B-1).

3.5.1 Cockles at Little Waihi Estuary

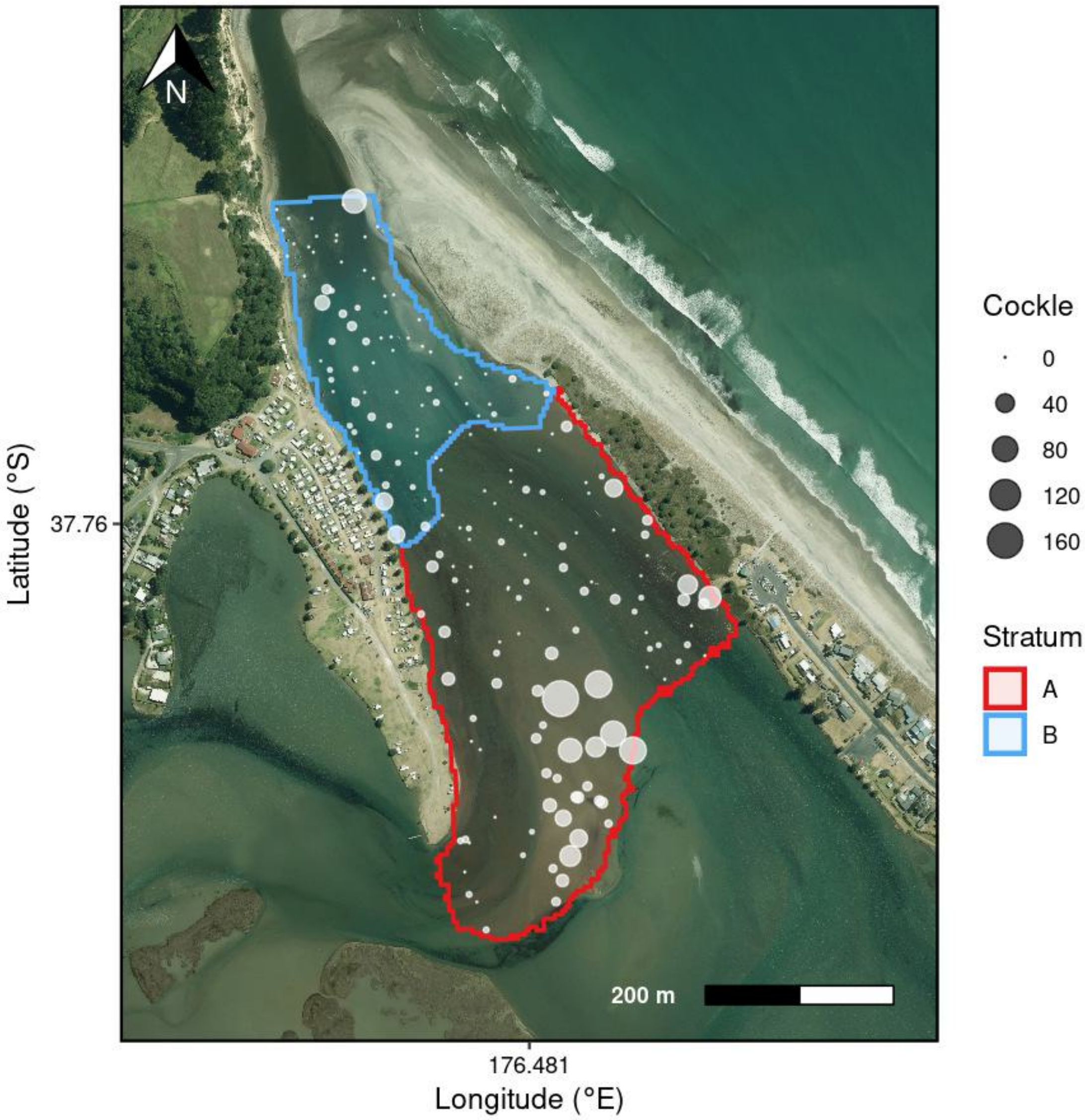

Figure 25: Map of sample strata and individual sample locations for cockles at Little Waihi Estuary, with the size of the circles proportional to the number of cockles (per 0.035 m^2) found at each location. Samples with zero counts are shown as small dots.

Table 22: Estimates of cockle abundance at Little Waihi Estuary, by stratum, for 2025–26. Presented are the area surveyed, the number of points and the number of cockles sampled, the mean total estimate, the mean density, and the coefficient of variation (CV).

Stratum		Sample		Population estimate		
	Area (ha)	Points	Cockle	Total (millions)	Density (m^{-2})	CV (%)
A	11.9	110	1 086	33.64	282	22.54
B	4.7	77	223	3.86	83	37.77

Table 23: Estimates of cockle abundance at Little Waihi Estuary for all sizes and large size (≥30 mm) cockles. Columns include the mean total estimate, mean density, and coefficient of variation (CV).

Year	Extent (ha)	Population estimate			Population ≥ 30 mm		
		Total (millions)	Density (m^{-2})	CV (%)	Total (millions)	Density (m^{-2})	CV (%)
2000–01	3.0	4.44	148	11.06	0.95	32	9.2
2002–03	3.0	0.96	32	5.98	0.07	2	20.47
2003–04	3.1	3.92	125	8.01	0.40	13	15.92
2004–05	3.8	3.73	99	9.65	0.17	4	18.32
2006–07	3.2	2.09	66	18.32	0.01	<1	>100
2009–10	13.9	20.55	148	16.57	0.08	<1	76.43
2012–13	15.4	17.77	115	18.58	0.20	1	56.95
2013–14	17.1	27.32	160	16.62	0.35	2	59.9
2015–16	18.4	30.40	165	12.74	0.26	1	51.69
2017–18	18.4	15.50	84	26.09	0.36	2	>100
2019–20	16.8	39.37	235	18.00	0.26	2	42.8
2021–22	16.6	23.45	141	17.48	0.44	3	45.75
2023–24	16.6	34.24	206	19.55	0.24	1	74.62
2025–26	16.6	37.50	226	20.59	0.89	5	97.95

Table 24: Summary statistics of the length-frequency (LF) distribution of cockles at Little Waihi Estuary. The LF distributions (in mm) were estimated for all strata in each survey and subsequently summed for the distribution of total LFs. Recruits were defined by a shell length of ≤15 mm and large individuals by a shell length of ≥30 mm.

Year	Mean	Mode	Range	Recruits (%)	Medium (%)	Large (%)
2021–22	18.18	17	5–40	31.62	66.50	1.88
2023–24	17.99	18	5–48	30.24	69.06	0.70
2025–26	16.08	13	6–49	51.75	45.86	2.39

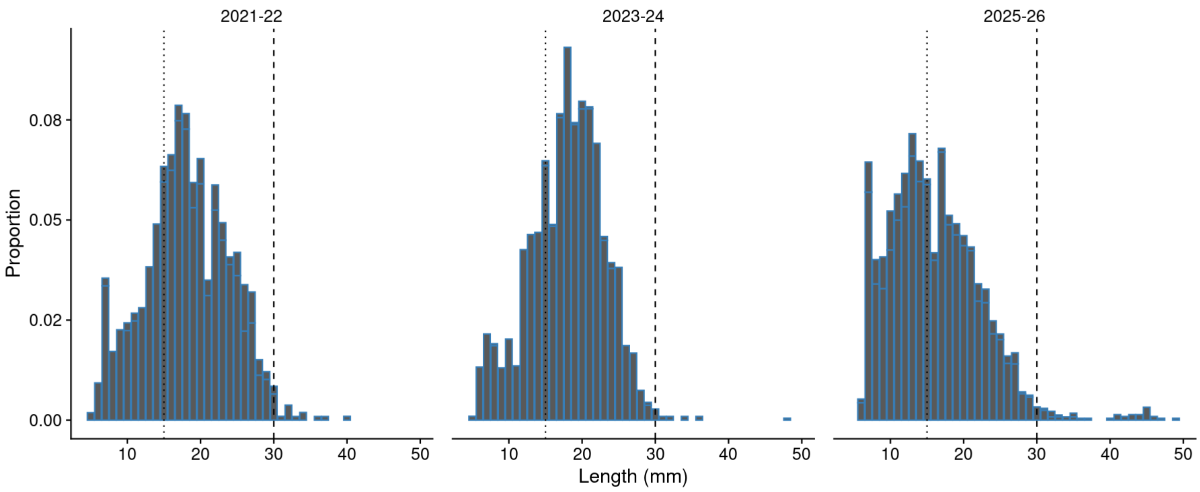

Figure 26: Weighted length-frequency (LF) distribution of cockles for the present and previous surveys at Little Waihi Estuary. Vertical dotted and dashed lines indicate the cut-off sizes for recruits and large individuals, respectively.

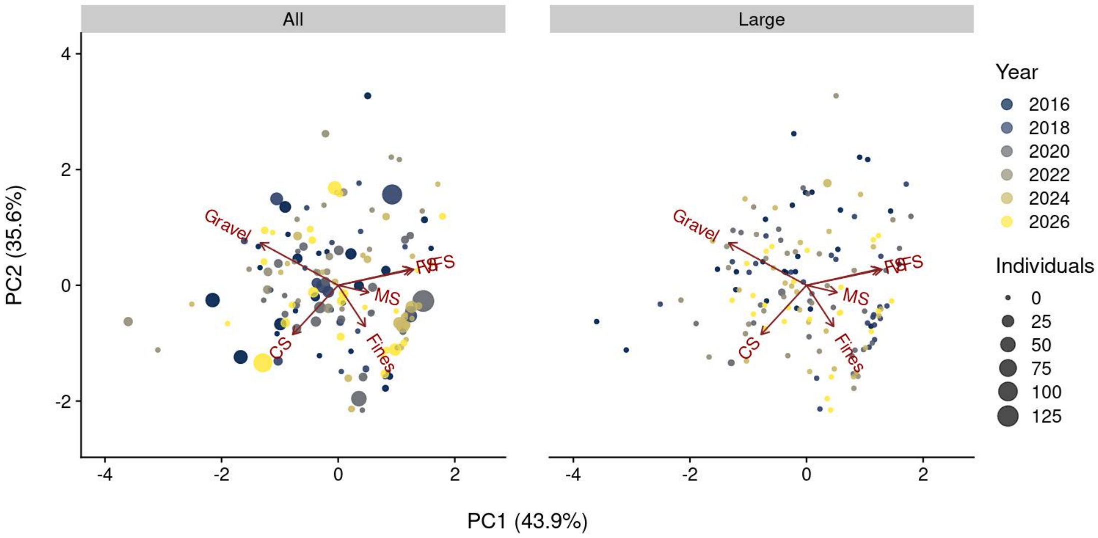

Figure 27: Cockle abundance along two principal components (standardised PCs, including % variance explained) of sediment granulometry for all cockle size classes (all) and large cockles (≥30 mm shell length) at Little Waihi Estuary. Sediment grain size fractions are defined as fines (silt and clay) ≤63 µm, very fine sand (VFS) >63 µm, fine sand (FS) >125 µm, medium sand (MS) >250 µm, coarse sand (CS) >500 µm, and gravel >2000 µm.

3.5.2 Pipi at Little Waihi Estuary

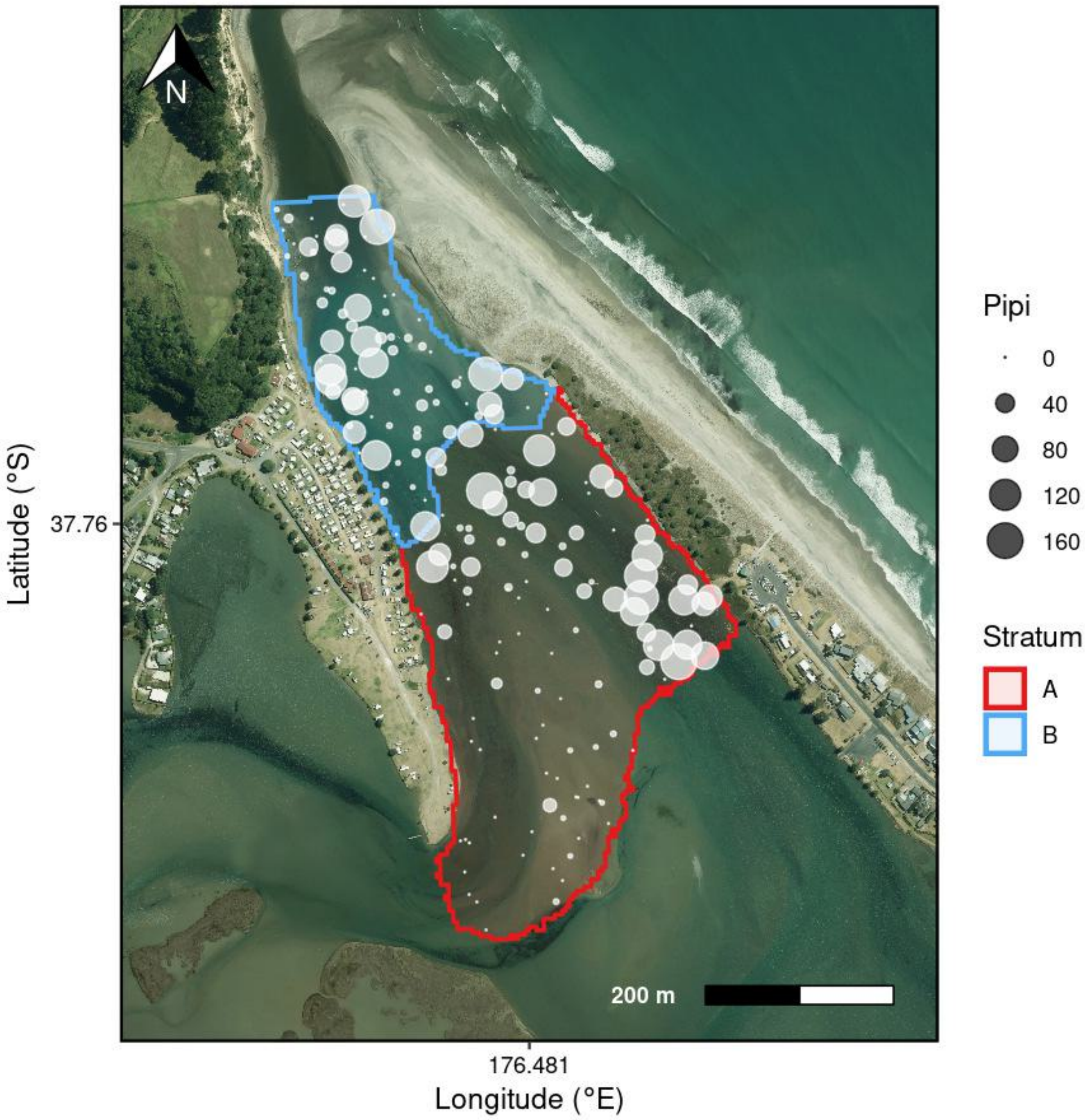

Figure 28: Map of sample strata and individual sample locations for pipi at Little Waihi Estuary, with the size of the circles proportional to the number of pipi (per 0.035 m^2) found at each location. Samples with zero counts are shown as small dots.

Table 25: Estimates of pipi abundance at Little Waihi Estuary, by stratum, for 2025–26. Presented are the area surveyed, the number of points and the number of pipi sampled, the mean total estimate, the mean density, and the coefficient of variation (CV).

Stratum		Sample		Population estimate		
	Area (ha)	Points	Pipi	Total (millions)	Density (m^{-2})	CV (%)
A	11.9	110	2 630	81.47	683	16.36
B	4.7	77	1 958	33.89	727	18.49

Table 26: Estimates of pipi abundance at Little Waihi Estuary for all sizes and large size (≥50 mm) pipi. Columns include the mean total estimate, mean density, and coefficient of variation (CV).

Year	Extent (ha)	Population estimate			Population ≥ 50 mm		
		Total (millions)	Density (m^{-2})	CV (%)	Total (millions)	Density (m^{-2})	CV (%)
2000–01	3.0	28.69	956	8.78	3.74	125	8.46
2002–03	3.0	5.82	194	7.38	0.48	16	9.56
2003–04	3.1	7.05	226	9.15	0.84	27	13.52
2004–05	3.8	48.00	1 280	6.16	1.90	51	10.25
2006–07	3.2	44.52	1 409	7.47	2.00	63	10.76
2009–10	13.9	271.99	1 954	11.54	10.12	73	20.25
2012–13	15.4	219.43	1 423	7.88	10.26	67	27.03
2013–14	17.1	170.82	1 000	12.70	4.58	27	31.30
2015–16	18.4	83.84	456	16.62	2.35	13	43.62
2017–18	18.4	79.10	430	26.04	5.44	30	64.08
2019–20	16.8	142.30	849	13.35	15.59	93	18.74
2021–22	16.6	65.19	392	20.37	1.45	9	45.27
2023–24	16.6	108.92	655	15.50	1.14	7	39.51
2025–26	16.6	115.37	695	12.77	1.31	8	33.30

Table 27: Summary statistics of the length-frequency (LF) distribution of pipi at Little Waihi Estuary. The LF distributions (in mm) were estimated for all strata in each survey and subsequently summed for the distribution of total LFs. Recruits were defined by a shell length of ≤20 mm and large individuals by a shell length of ≥50 mm.

Year	Mean	Mode	Range	Recruits (%)	Medium (%)	Large (%)
2021–22	31.77	42	6–57	22.03	75.74	2.22
2023–24	28.41	27	7–54	26.87	72.08	1.05
2025–26	27.63	11	5–55	35.71	63.16	1.14

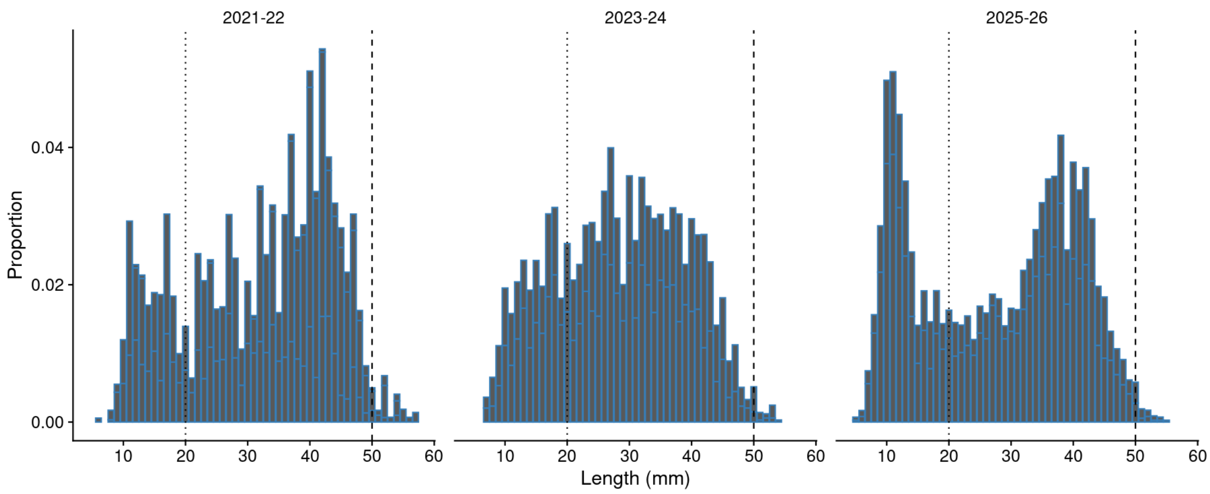

Figure 29: Weighted length-frequency (LF) distribution of pipi for the present and previous surveys at Little Waihi Estuary. Vertical dotted and dashed lines indicate the cut-off sizes for recruits and large individuals, respectively.

3.6 Mangawhai Harbour

Mangawhai Harbour is part of an extensive estuary system on the Northland east coast. Bivalves in the harbour have been regularly surveyed since 1999–2000, with 11 surveys prior to the present study (see Appendix A, Tables A-1, A-2). Since 2021–22, the surveys have only included cockles, after pipi beds disappeared or became inaccessible. The current sampling extent covered two separate areas in the harbour, divided into four strata, with a survey effort of 135 sampling points.

Mangawhai Harbour sediment contained little organic matter, ranging between zero and 1.4% (Figure 30; and see details in Appendix B, Table B-1). The sediment grain size composition was characterised by a prevalence of fine sand (grain size >125 µm), followed by medium sand (>250 µm). There were only small proportions (up to 2.0%) of sediment fines (<63 µm) in some samples, with most samples not including this grain size fraction in the sediment.

Cockles were distributed throughout all strata, but were predominantly in stratum A, close to the harbour entrance, and stratum D, adjacent to the main channel (Figure 31, Table 28). For the entire sampling extent, the total population abundance was estimated at 64.83 million (CV: 8.68%) cockles, and the average density at 904 cockles per m^2 (Table 29). These estimates were an increase from the immediately preceding abundance and density estimates of 50.38 million (CV: 10.83%) individuals occurring at a density of 702 cockles per m^2 in 2023–24. There was a small number of large cockles ($\geq$30 mm) included in the total population, and this size class consisted of 1.82 million (CV: 23.30%) individuals with an estimated average density of 25 large cockles per m^2. The recent reduction in this size class was accompanied by an increase in the CV value to over 20%.

Corresponding with their low abundance, large cockles contributed only a small proportion of individuals, particularly in 2025–26, when only 2.81% of the population was in the large size class (Table 30, Figure 32). At the same time, medium-sized cockles consistently determined the population in the three most recent surveys; 79.80% of all individuals were in this size class in 2025–26. Recruits ($\leq$15 mm) contributed between 10.62% and 17.39% of the total population between 2021–22 and 2025–26. The population size structure remained unchanged over this period, with a unimodal composition and similar mean and modal shell lengths around 20 and 23–24 mm shell length.

Principal component analysis indicated relatively high total cockle abundance associated with coarse and sand grain size fractions, excepting gravel (Figure 33).

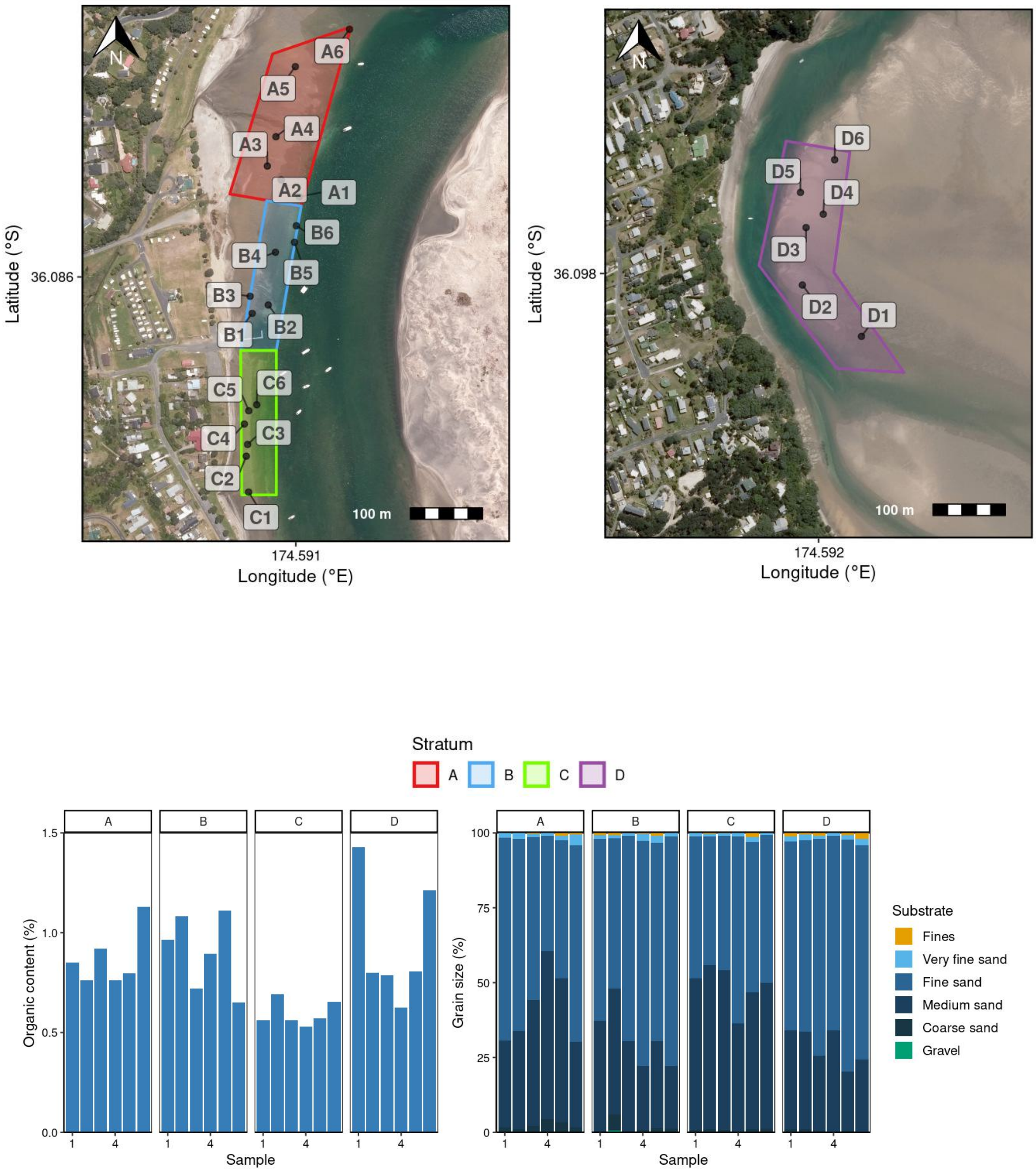

Figure 30: Sediment sample locations and characteristics at Mangawhai Harbour. Labels correspond to stratum and sample number. Graphs show organic content (% dry weight) and cumulative grain size (%). Sediment grain size fractions include fines (silt and clay, ≤63 µm), sands (very fine, >63 µm; fine, >125 µm; medium, >250 µm; coarse, >500 µm), and gravel (>2000 µm) (see details in Table B-1).

3.6.1 Cockles at Mangawhai Harbour

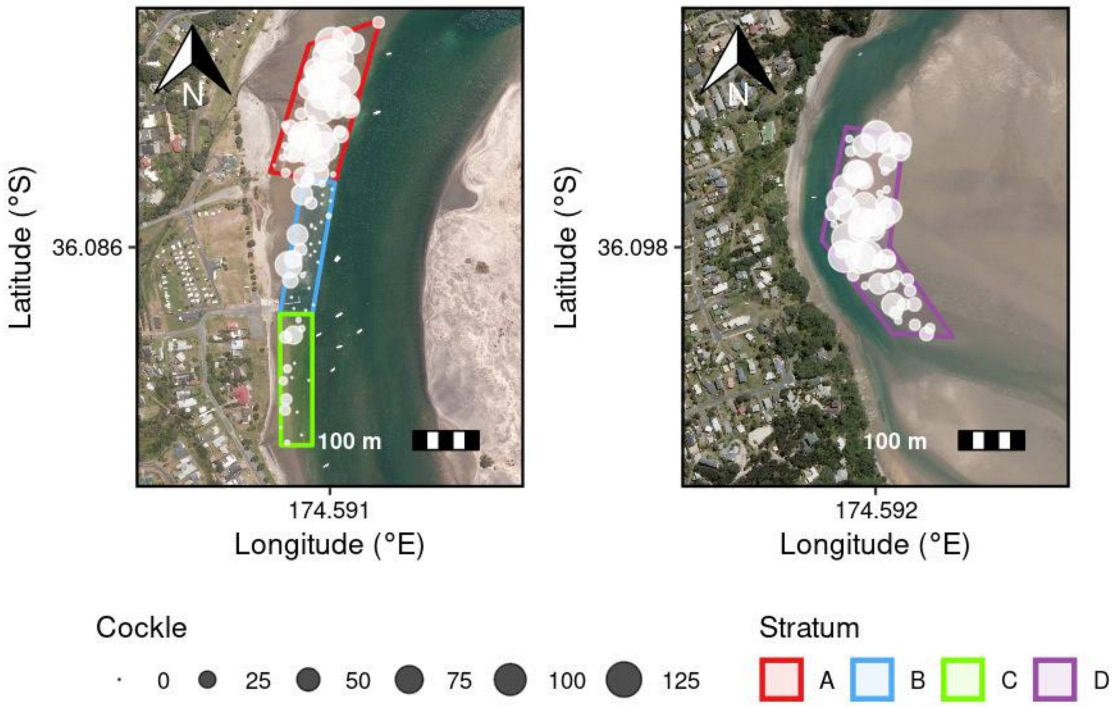

Figure 31: Map of sample strata and individual sample locations for cockles at Mangawhai Harbour, with the size of the circles proportional to the number of cockles (per 0.035 m^2) found at each location. Samples with zero counts are shown as small dots.

Table 28: Estimates of cockle abundance at Mangawhai Harbour, by stratum, for 2025–26. Presented are the area surveyed, the number of points and the number of cockles sampled, the mean total estimate, the mean density, and the coefficient of variation (CV).

Stratum		Sample		Population estimate		
	Area (ha)	Points	Cockle	Total (millions)	Density (m^{-2})	CV (%)
A	2.2	40	1 907	30.33	1 362	13.54
B	1.0	30	235	2.25	224	37.68
C	1.0	15	69	1.28	131	43.16
D	3.0	50	1 827	30.97	1 044	12.00

Table 29: Estimates of cockle abundance at Mangawhai Harbour for all sizes and large size (≥30 mm) cockles. Columns include the mean total estimate, mean density, and coefficient of variation (CV).

Year	Extent (ha)	Population estimate			Population ≥ 30 mm		
		Total (millions)	Density (m^{-2})	CV (%)	Total (millions)	Density (m^{-2})	CV (%)
1999–00	9.4	98.71	1 050	4.54	28.56	304	7.17
2000–01	8.4	76.61	912	4.35	45.27	539	4.35
2001–02	8.4	28.54	340	5.80	8.75	104	7.48
2002–03	8.4	46.14	549	5.46	20.46	244	6.47
2003–04	8.4	50.77	604	4.71	17.43	207	6.24
2010–11	9.0	61.78	686	9.15	8.28	92	17.41
2014–15	8.6	52.73	617	7.58	2.05	24	15.95
2016–17	7.4	58.97	794	13.89	1.46	17	28.67
2018–19	7.2	78.89	1 091	8.56	2.48	34	17.36
2021–22	7.2	65.64	915	8.84	5.68	79	17.56
2023–24	7.2	50.38	702	10.83	2.09	29	18.32
2025–26	7.2	64.83	904	8.68	1.82	25	23.30

Table 30: Summary statistics of the length-frequency (LF) distribution of cockles at Mangawhai Harbour. The LF distributions (in mm) were estimated for all strata in each survey and subsequently summed for the distribution of total LFs. Recruits were defined by a shell length of ≤15 mm and large individuals by a shell length of ≥30 mm.

Year	Mean	Mode	Range	Recruits (%)	Medium (%)	Large (%)
2021–22	22.33	23	6–39	10.62	80.72	8.66
2023–24	20.48	24	5–37	19.44	76.41	4.15
2025–26	20.49	23	5–37	17.39	79.80	2.81

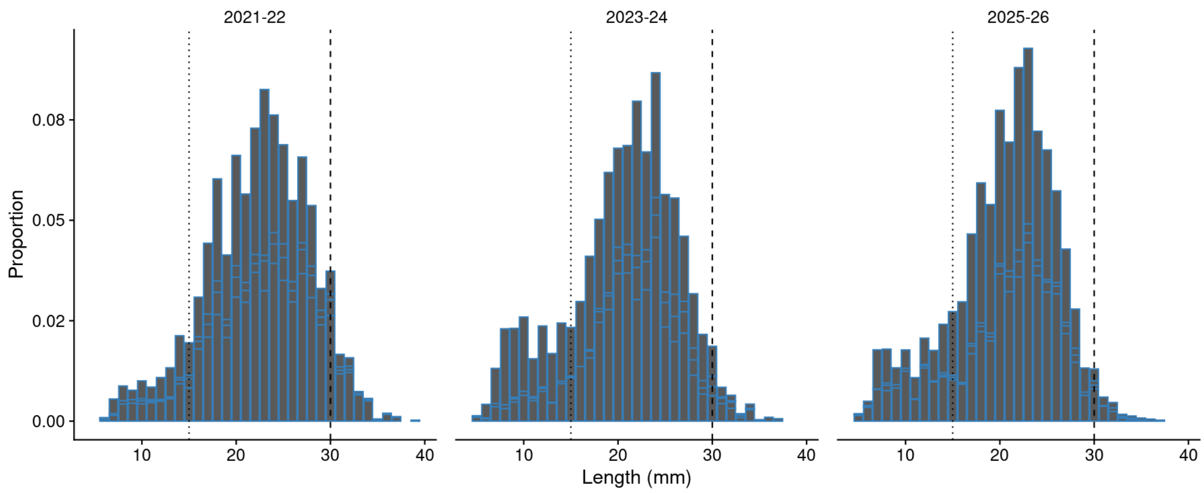

Figure 32: Weighted length-frequency (LF) distribution of cockles for the present and previous surveys at Mangawhai Harbour. Vertical dotted and dashed lines indicate the cut-off sizes for recruits and large individuals, respectively.

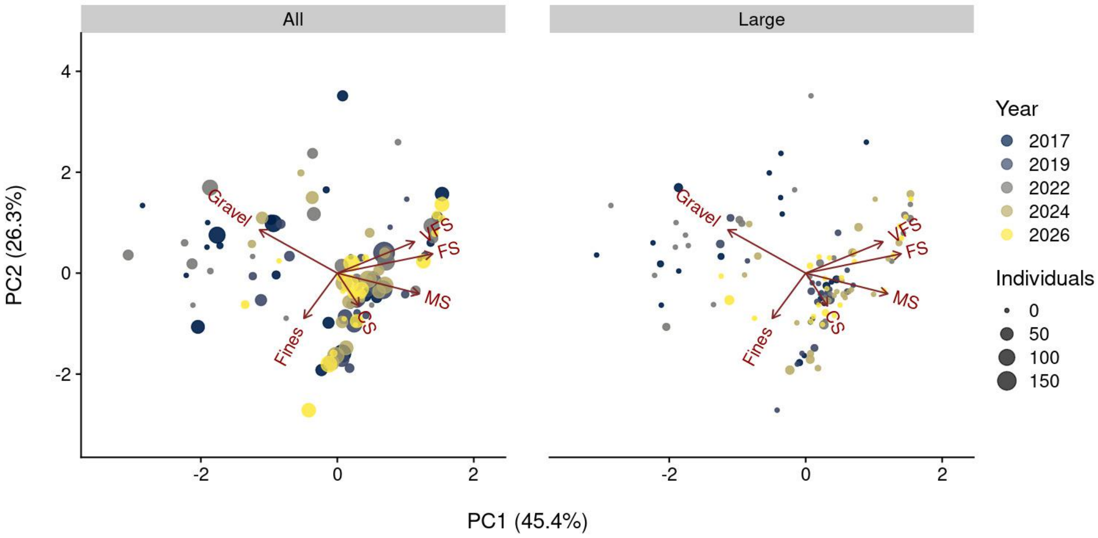

Figure 33: Cockle abundance along two principal components (standardised PCs, including % variance explained) of sediment granulometry for all cockle size classes (all) and large cockles (≥30 mm shell length) at Mangawhai Harbour. Sediment grain size fractions are defined as fines (silt and clay) ≤63 µm, very fine sand (VFS) >63 µm, fine sand (FS) >125 µm, medium sand (MS) >250 µm, coarse sand (CS) >500 µm, and gravel >2000 µm.

3.7 Marsden Bank

Marsden Bank is on Northland’s east coast, directly adjacent to the entrance of Whangārei Harbour. The bank and neighbouring Mair Bank are currently closed to the collection of all shellfish (Department of Internal Affairs 2022). Pipi at Marsden Bank have been part of seven surveys in this monitoring series, starting in 2009–10 (see Appendix A, Tables A-1, A-2); there are no cockles at this site. Assessments of the pipi (kōkota) population, habitat, and health (e.g., presence of toxins and intracellular bacteria) have also been regularly conducted by Patuharakeke Te Iwi Trust Board (e.g., Shirkey 2024, Patuharakeke Te Iwi Trust Board 2025a, Patuharakeke Te Iwi Trust Board 2025b). Repeated mass mortality events in the Whangārei Harbour area have also led to research towards a health baseline for resident pipi, focusing on intracellular bacteria *Endozoicomonas* species (Howells et al. 2024).

Throughout the survey series, the marked decline of pipi at Marsden Bank has led to considerable changes in the location and area of the sampling extent. The current survey focused on a similar sampling extent as the immediately-preceding assessment in 2023–24, encompassing a small area in the northern part of the bank, associated with the harbour channel (Figure 34, Table 31). In this area, pipi were sampled in a total of 80 points within a single stratum.

Based on the field sampling, the 2025–26 pipi population had an estimated total abundance of 0.96 million (CV: 16.37%) individuals, with an estimated density of 205 pipi per m^2 (Table 32). Both estimates reflected marked population increases from the immediately-preceding abundance and density estimates in 2023–24 of 0.45 million (CV: 15.66%) pipi and 120 pipi per m^2. These recent estimates confirmed the return of the pipi population, albeit at a small scale, particularly following their absence in the 2021–22 survey at Marsden Bank. In addition, following the lack of large pipi ($\geq$50 mm shell length) since 2012–13, the present population included a small number of large individuals. Their estimated abundance was 0.12 million (CV: 24.81%) individuals, occurring at an estimated average density of 25 large pipi per m^2.

Growth to larger sizes was also evident in the recruits size class: after forming most (87.57%) of the total population in 2023–24, their recent growth beyond the 20-mm cut-off augmented the medium size class, which in turn contributed 80.57% of all individuals in 2025–26 (Table 33, Figure 35). Mean and modal shell lengths increased between the two recent surveys from 15.49 mm and 13 mm shell length, respectively in 2023–24 to 38.01 mm and 35 mm shell length, respectively in 2025–26. The shift in the composition of the population was also evident in the change from a unimodal to a bimodal population size structure.

3.7.1 Pipi at Marsden Bank

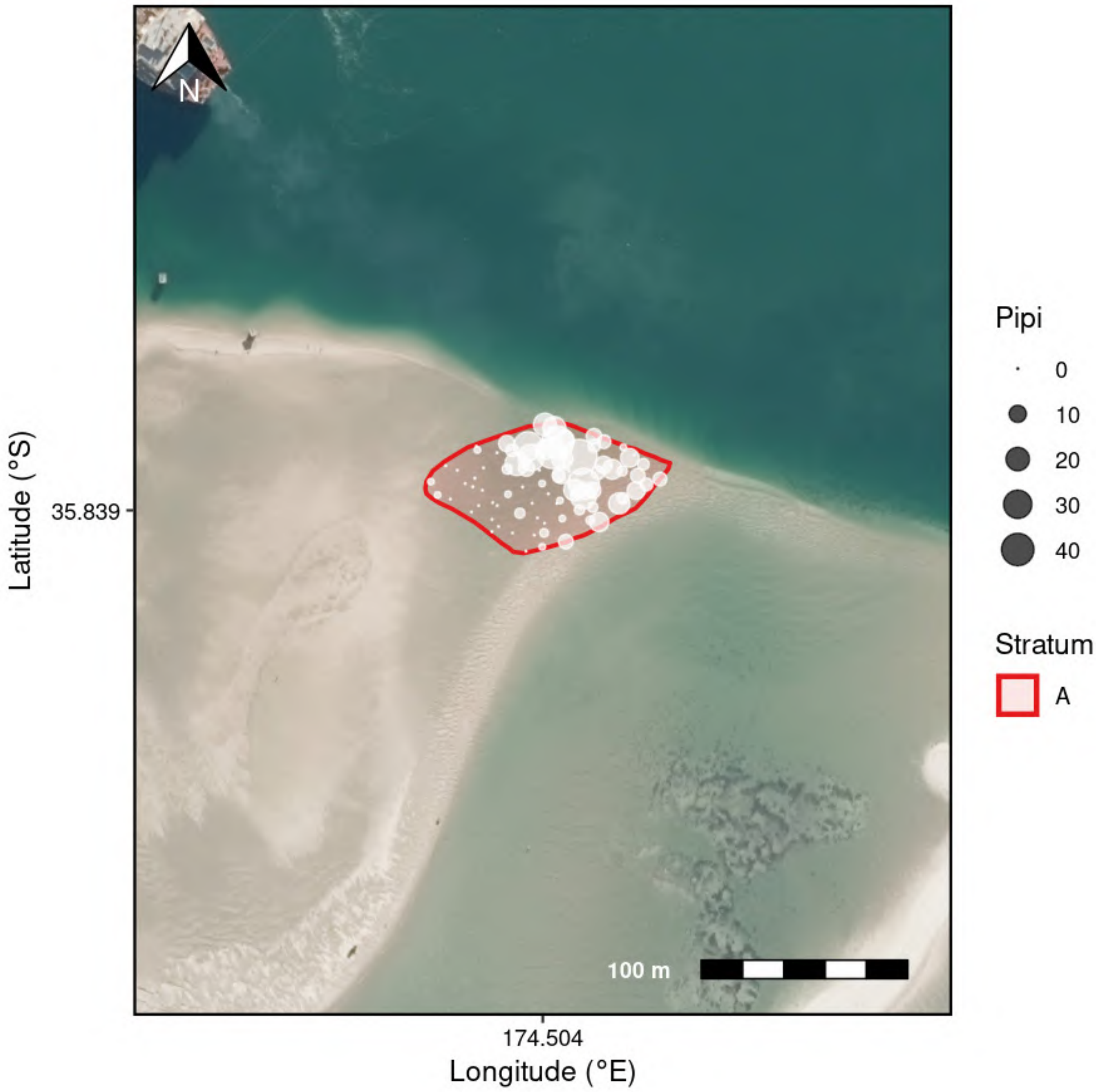

Figure 34: Map of sample strata and individual sample locations for pipi at Marsden Bank, with the size of the circles proportional to the number of pipi (per 0.035 m^2) found at each location. Samples with zero counts are shown as small dots.

Table 31: Estimates of pipi abundance at Marsden Bank, by stratum, for 2025–26. Presented are the area surveyed, the number of points and the number of pipi sampled, the mean total estimate, the mean density, and the coefficient of variation (CV).

Stratum		Sample		Population estimate		
	Area (ha)	Points	Pipi	Total (millions)	Density (m^{-2})	CV (%)
A	0.5	80	574	0.96	205	16.37

Table 32: Estimates of pipi abundance at Marsden Bank for all sizes and large size (≥50 mm) pipi. Columns include the mean total estimate, mean density, and coefficient of variation (CV).

Year	Extent (ha)	Population estimate			Population ≥ 50 mm		
		Total (millions)	Density (m^{-2})	CV (%)	Total (millions)	Density (m^{-2})	CV (%)
2009–10	11.5	210.88	1 833	20.28	8.00	69	41.49
2012–13	6.3	60.53	959	19.79	0.00	0	
2013–14	15.4	3.88	25	51.70	0.00	0	
2017–18	0.9	10.93	1 284	19.17	0.00	0	
2021–22	0.9	0.00	0		0.00	0	
2023–24	0.4	0.45	120	15.66	0.00	0	
2025–26	0.5	0.96	205	16.37	0.12	25	24.81

Table 33: Summary statistics of the length-frequency (LF) distribution of pipi at Marsden Bank. The LF distributions (in mm) were estimated for all strata in each survey and subsequently summed for the distribution of total LFs. Recruits were defined by a shell length of ≤20 mm and large individuals by a shell length of ≥50 mm.

Year	Mean	Mode	Range	Recruits (%)	Medium (%)	Large (%)
2023–24	15.49	13	7–34	87.57	12.43	0.00
2025–26	38.01	35	5–56	7.35	80.57	12.09

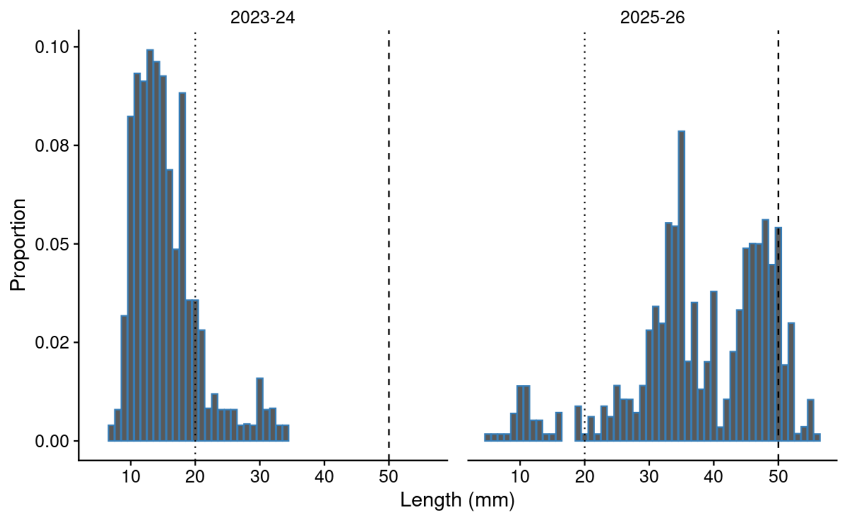

Figure 35: Weighted length-frequency (LF) distribution of pipi for the present and previous surveys at Marsden Bank. Vertical dotted and dashed lines indicate the cut-off sizes for recruits and large individuals, respectively.

3.8 Ngunguru Estuary

Ngunguru Estuary is in the Northland region, just north of Whangārei. At this site, the take of shellfish has been prohibited under temporary closures since 2016, most recently in 2024 (Department of Internal Affairs 2024a). The bivalve monitoring in the estuary started in 2003–04, and the current assessment was the ninth survey in the series (see Appendix A, Tables A-1, A-2). The sampling extent has remained relatively unchanged since 2014–15, but included some changes to the pipi beds over time. In 2025–26, the field sampling covered four separate strata, including a designated pipi bed in the lower part of the main channel. Bivalves were assessed in a total of 110 points.

Sediment organic content across the cockle strata did not exceed 3%, and the proportion of sediment fines (<63 µm) was also generally small at about 2% (Figure 36; and see details in Appendix B, Table B-1). Most of the sediment consisted of fine sand (grain size >125 µm), with varying proportions of medium and coarse sands (grain sizes >250 µm and >500 µm).

The cockle population extended across the four strata, but was particularly widespread and abundant in stratum C (Figure 37, Table 34). The current population estimates documented a continued decline in cockles across the three most recent surveys, with an estimated total 62.19 million (CV: 12.78%) cockles in 2025–26 compared with 75.02 million (CV: 8.44%) cockles in 2023–24 (Table 35). The density estimate also decreased but remained high at an estimated 1083 cockles per m^2 in 2025–26 (cf. 1247 cockles per m^2 in the preceding assessment). The cockle population contained a small number of large individuals, with an estimated 1.19 million large cockles, and a density estimate of 21 large individuals per m^2; however, the associated CV was 40.61%.

Length-frequency distributions confirmed the small overall contribution of large individuals, with a population largely formed by medium-sized cockles and, to a lesser extent, recruits (≤15 mm shell length) (Table 36, Figure 38). The unimodal population size structure was stable across the three most recent surveys, with three quarters of all individuals in the medium size class (76.70% in 2025–26). The strength of this cohort was reflected in the mean and modal sizes of 19.50 mm and 22 mm shell length, respectively. The population was augmented by regular recruitment events that were of similar strength, leading to the influx of about 20 to 26% of recruits in each assessment year.

There was no clear pattern in the principal component analysis of cockle abundance in relation to sediment grain size fractions (Figure 39).

The distribution of pipi was restricted to stratum D, the designated pipi bed within the estuary channel (Figure 40, Table 37). Based on the entire sampling extent, the current total abundance estimate for this species was 11.92 million (CV: 10.74%) pipi, and their average density was 207 pipi per m^2 (Table 38). Both estimates signified continuous population decreases across the three most recent surveys after comparatively high estimates in 2018–19. For example, the current estimates reflected a 50% decline from the total abundance and density estimates of 23.84 million (CV: 12.56%) pipi and 396 pipi per m^2 in 2023–24. There was also a small decline in the number of large pipi (≥50 mm), but this size class has been consistently small throughout the survey series. In 2025–26, there were an estimated 0.30 million (CV: 18.75%) individuals in this size class, with a corresponding density estimate of 5 large pipi per m^2.

The proportion of large pipi in the population was small (<8%) in recent surveys, whereas the prevalence of recruits (≤20 mm shell length) and medium-sized pipi varied between 2021–22 and 2025–26 (Table 39, Figure 41). There was low recruitment in 2025–26, reflected in the small proportion (3.68%) of recruits, after considerable recruitment events in 2021–22 and 2023–24 when over 60% of the population consisted of these small-sized individuals. The recent change in the relative proportions of recruits and medium-sized pipi led to marked increases in mean and modal lengths; e.g., modal size increased from 14 mm shell length in 2023–24 to 40 mm in 2025–26. This change was reflected in the shift to a unimodal from a previously bimodal population size structure.

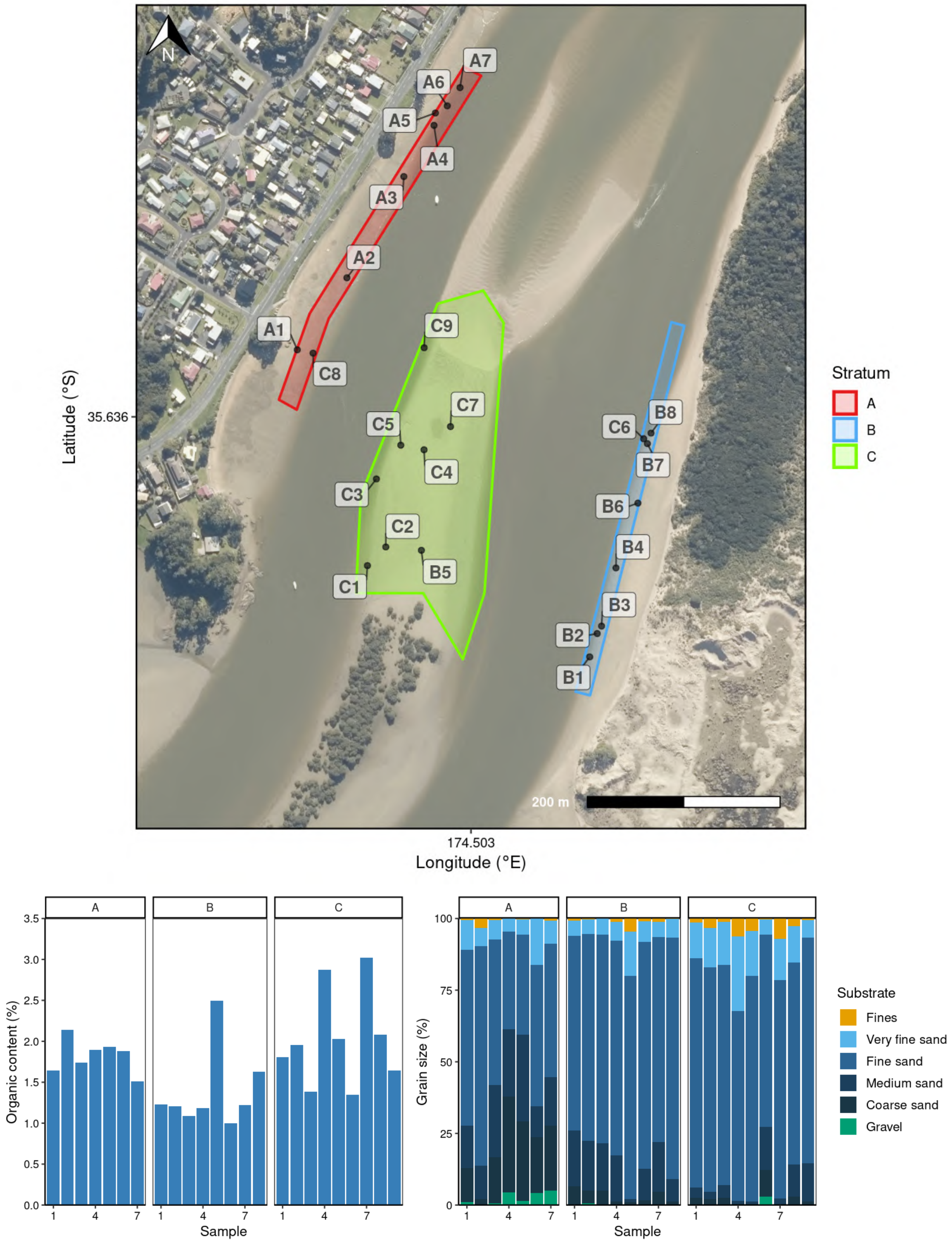

Figure 36: Sediment sample locations and characteristics at Ngunguru Estuary. Labels correspond to stratum and sample number. Graphs show organic content (% dry weight) and cumulative grain size (%). Sediment grain size fractions include fines (silt and clay, ≤63 µm), sands (very fine, >63 µm; fine, >125 µm; medium, >250 µm; coarse, >500 µm), and gravel (>2000 µm) (see details in Table B-1).

3.8.1 Cockles at Ngunguru Estuary

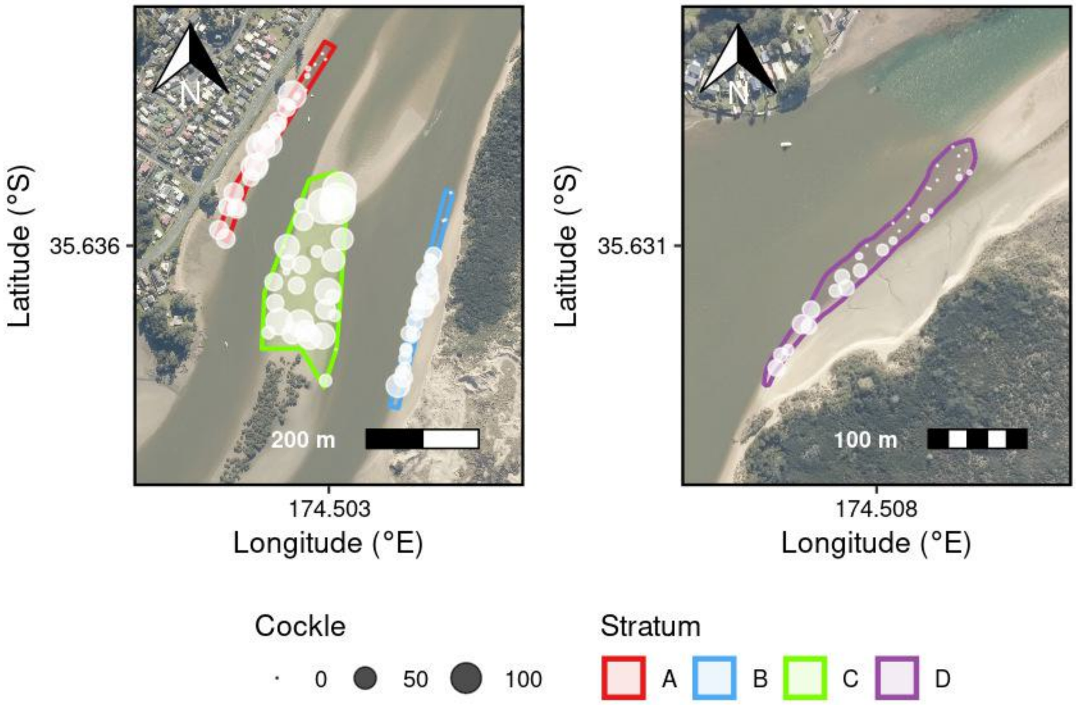

Figure 37: Map of sample strata and individual sample locations for cockles at Ngunguru Estuary, with the size of the circles proportional to the number of cockles (per 0.035 m^2) found at each location. Samples with zero counts are shown as small dots.

Table 34: Estimates of cockle abundance at Ngunguru Estuary, by stratum, for 2025–26. Presented are the area surveyed, the number of points and the number of cockles sampled, the mean total estimate, the mean density, and the coefficient of variation (CV).

Stratum		Sample		Population estimate		
	Area (ha)	Points	Cockle	Total (millions)	Density (m^{-2})	CV (%)
A	0.8	25	751	6.84	858	18.49
B	0.6	25	539	3.60	616	16.76
C	3.6	30	1 443	50.12	1 374	15.59
D	0.7	30	238	1.62	227	24.22

Table 35: Estimates of cockle abundance at Ngunguru Estuary for all sizes and large size (≥30 mm) cockles. Columns include the mean total estimate, mean density, and coefficient of variation (CV).

Year	Extent (ha)	Population estimate			Population ≥ 30 mm		
		Total (millions)	Density (m^{-2})	CV (%)	Total (millions)	Density (m^{-2})	CV (%)
2003–04	1.7	8.63	508	6.71	0.64	38	11.70
2004–05	1.8	9.79	544	7.77	0.34	19	18.85
2010–11	1.8	19.55	1 086	10.72	0.07	4	35.49
2014–15	5.5	92.67	1 696	7.53	0.38	7	32.11
2016–17	6.3	91.81	1 461	7.19	0.22	3	48.15
2018–19	6.5	129.23	1 997	6.57	0.28	4	51.20
2021–22	6.3	112.60	1 774	12.24	0.72	11	46.61
2023–24	6.0	75.02	1 247	8.44	0.45	8	28.75
2025–26	5.7	62.19	1 083	12.78	1.19	21	40.61

Table 36: Summary statistics of the length-frequency (LF) distribution of cockles at Ngunguru Estuary. The LF distributions (in mm) were estimated for all strata in each survey and subsequently summed for the distribution of total LFs. Recruits were defined by a shell length of ≤15 mm and large individuals by a shell length of ≥30 mm.

Year	Mean	Mode	Range	Recruits (%)	Medium (%)	Large (%)
2021–22	18.35	17	5–34	26.39	73.00	0.61
2023–24	18.65	20	5–34	25.59	73.81	0.60
2025–26	19.50	22	5–38	21.38	76.70	1.92

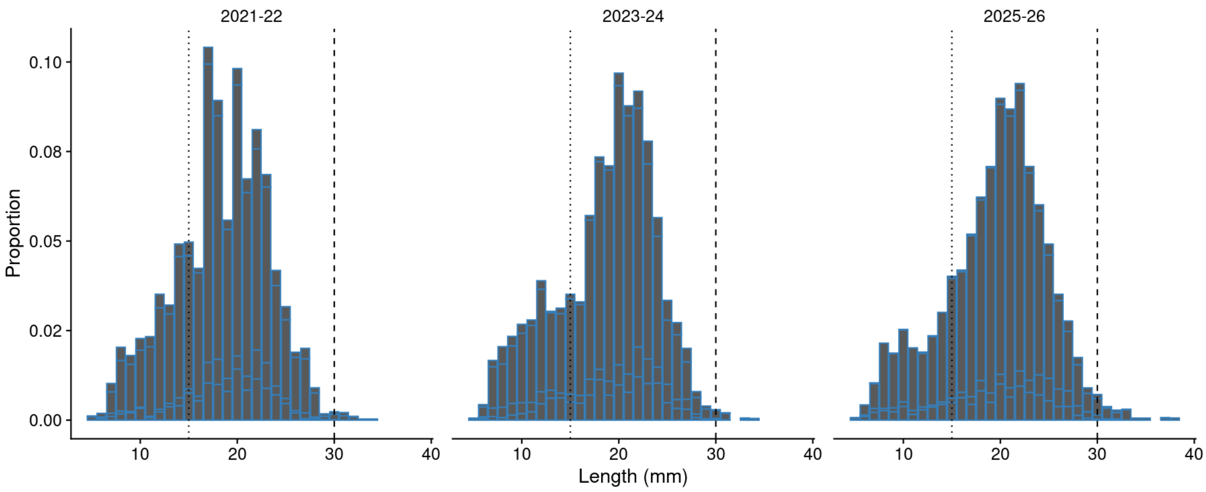

Figure 38: Weighted length-frequency (LF) distribution of cockles for the present and previous surveys at Ngunguru Estuary. Vertical dotted and dashed lines indicate the cut-off sizes for recruits and large individuals, respectively.

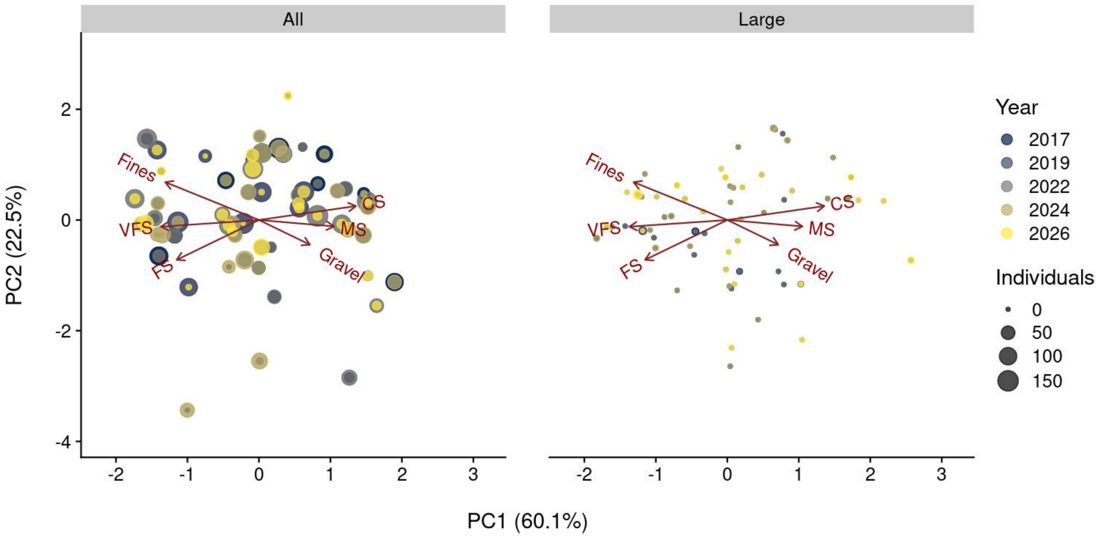

Figure 39: Cockle abundance along two principal components (standardised PCs, including % variance explained) of sediment granulometry for all cockle size classes (all) and large cockles (≥30 mm shell length) at Ngunguru Estuary. Sediment grain size fractions are defined as fines (silt and clay) ≤63 µm, very fine sand (VFS) >63 µm, fine sand (FS) >125 µm, medium sand (MS) >250 µm, coarse sand (CS) >500 µm, and gravel >2000 µm.

3.8.2 Pipi at Ngunguru Estuary

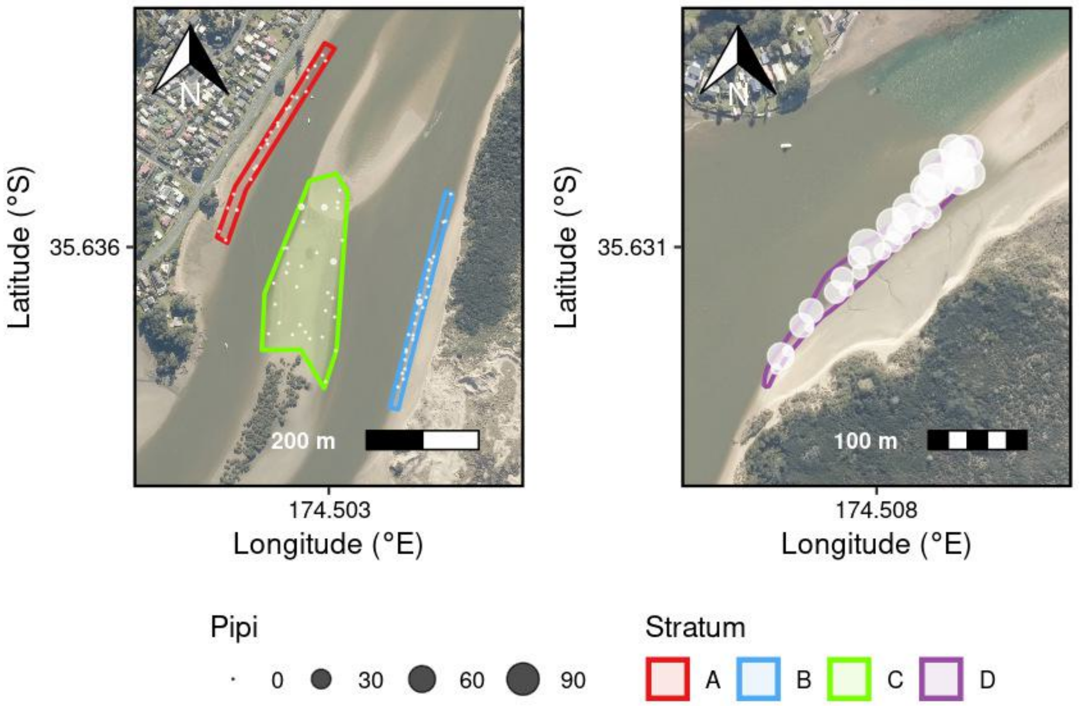

Figure 40: Map of sample strata and individual sample locations for pipi at Ngunguru Estuary, with the size of the circles proportional to the number of pipi (per 0.035 m^2) found at each location. Samples with zero counts are shown as small dots.

Table 37: Estimates of pipi abundance at Ngunguru Estuary, by stratum, for 2025–26. Presented are the area surveyed, the number of points and the number of pipi sampled, the mean total estimate, the mean density, and the coefficient of variation (CV).

Stratum		Sample		Population estimate		
	Area (ha)	Points	Pipi	Total (millions)	Density (m^{-2})	CV (%)
A	0.8	25	0	0.00	0	
B	0.6	25	1	0.01	1	>100
C	3.6	30	3	0.10	3	55.71
D	0.7	30	1 733	11.81	1 650	10.83

Table 38: Estimates of pipi abundance at Ngunguru Estuary for all sizes and large size (≥50 mm) pipi. Columns include the mean total estimate, mean density, and coefficient of variation (CV).

Year	Extent (ha)	Population estimate			Population ≥ 50 mm		
		Total (millions)	Density (m^{-2})	CV (%)	Total (millions)	Density (m^{-2})	CV (%)
2003–04	1.7	1.87	110	8.73	0.87	51	9.04
2004–05	1.8	2.23	124	5.37	0.95	53	7.83
2010–11	1.8	0.73	40	16.60	0.25	14	19.25
2014–15	5.5	0.74	14	34.26	0.00	0	
2016–17	6.3	28.43	453	6.03	0.23	4	31.61
2018–19	6.5	42.39	655	11.76	0.40	6	43.99
2021–22	6.3	34.54	544	9.81	2.74	43	21.58
2023–24	6.0	23.84	396	12.56	0.40	7	24.64
2025–26	5.7	11.92	207	10.74	0.30	5	18.75

Table 39: Summary statistics of the length-frequency (LF) distribution of pipi at Ngunguru Estuary. The LF distributions (in mm) were estimated for all strata in each survey and subsequently summed for the distribution of total LFs. Recruits were defined by a shell length of ≤20 mm and large individuals by a shell length of ≥50 mm.

Year	Mean	Mode	Range	Recruits (%)	Medium (%)	Large (%)
2021–22	29.79	14	7–59	40.49	51.58	7.93
2023–24	22.10	14	7–55	63.40	34.91	1.69
2025–26	38.24	40	9–57	3.68	93.84	2.48

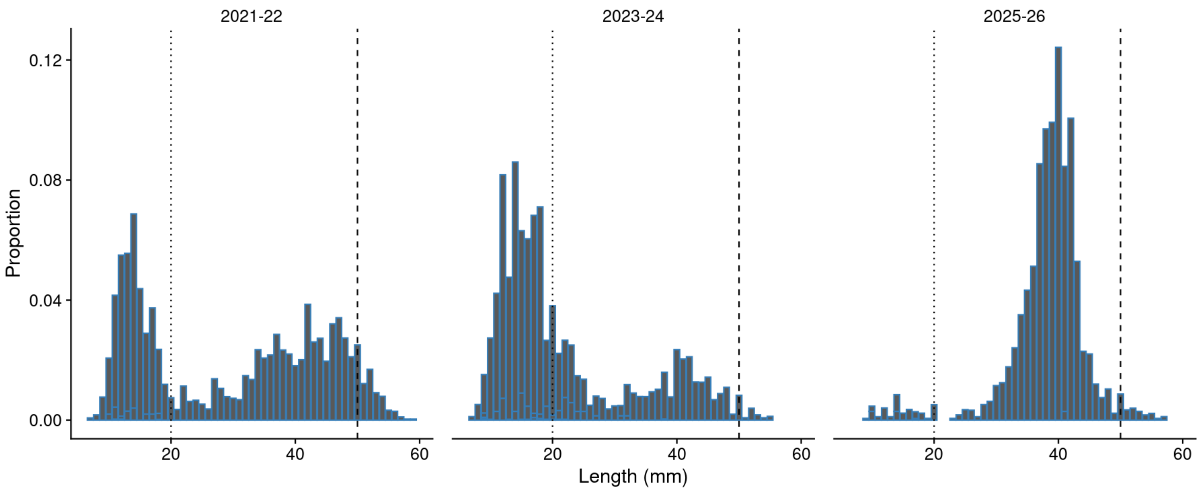

Figure 41: Weighted length-frequency (LF) distribution of pipi for the present and previous surveys at Ngunguru Estuary. Vertical dotted and dashed lines indicate the cut-off sizes for recruits and large individuals, respectively.

3.9 Umupuia Beach

Umupuia Beach is in the wider Auckland area, on the south-eastern coast. There are only cockles at this site, and the beach has been closed to their collection since 2018 (Department of Internal Affairs 2024b). Following the initial survey in 1999–2000, there have been 17 assessments at this beach, including the present survey (see Appendix A, Tables A-1, A-2). The sampling extent has remained similar throughout the monitoring series, covering most of the beach. The present field survey sampled cockles in a total of 100 points across two strata.

Most sediment samples at Umupuia Beach had a small proportion of organic matter, but it exceeded 4% in four samples (Figure 42; and see details in Appendix B, Table B-1). The same samples also contained a high proportion (23.6 to 72.2%) of sediment fines (grain size <63 μm), compared with remaining samples, which had less than 6% of this grain size fractions. The most prevalent grain size fractions were very fine sand (>63 μm) and fine sand (>125 μm).

The distribution of cockles was relatively patchy and mostly limited to stratum A (Figure 43, Table 40). Current abundance and density estimates were 40.82 million (CV: 18.34%) cockles and 121 cockles per m^2 (Table 41). These estimates revealed a further decline in the cockle population, although to a lesser extent than the initial decreases following high estimates in 2013–14. A similar declining trend was also evident early in the survey series, between 2000–01 and 2006–07, followed by an increase to the high estimates in 2013–14. These fluctuations were also evident in the population of large cockles (≥30 mm shell length), and this size class underwent a further decrease in 2025–26, from an estimated abundance of 24.14 million (CV: 22.23%) cockles in 2023–24 to 16.33 million (CV: 25.71%) cockles in 2025–26. Their estimated density decreased from an average 71 to 48 individuals per m^2 over the same period.

In spite of the decrease in large cockles, this size class continued to represent a notable proportion of the total population, with 40.00% of large individuals in the current population (Table 42, Figure 44). This finding was consistent with the two preceding surveys; however, the present assessment also revealed a considerable influx of recruits (≤15 mm shell length); this size class was small in 2021–22 and 2023–24 with proportions of 0.76% and 6.81%, respectively, but increased to 25.97% in 2025–26. This strong recruitment and the persistence of large cockles resulted in a bimodal population with distinct cohorts around the lower and upper cut-off sizes for the medium size class. The recent influx of recruits resulted in a small modal length of 14-mm shell length, signifying a 20-mm reduction compared with the modal size in 2023–24. There was a similar reduction in the mean shell length to 14 mm in 2025–26.

Principal component analysis of cockle abundance and sediment grain size fractions indicated that both total and large cockle abundances were associated with sand fractions, excepting coarse sand (Figure 45).

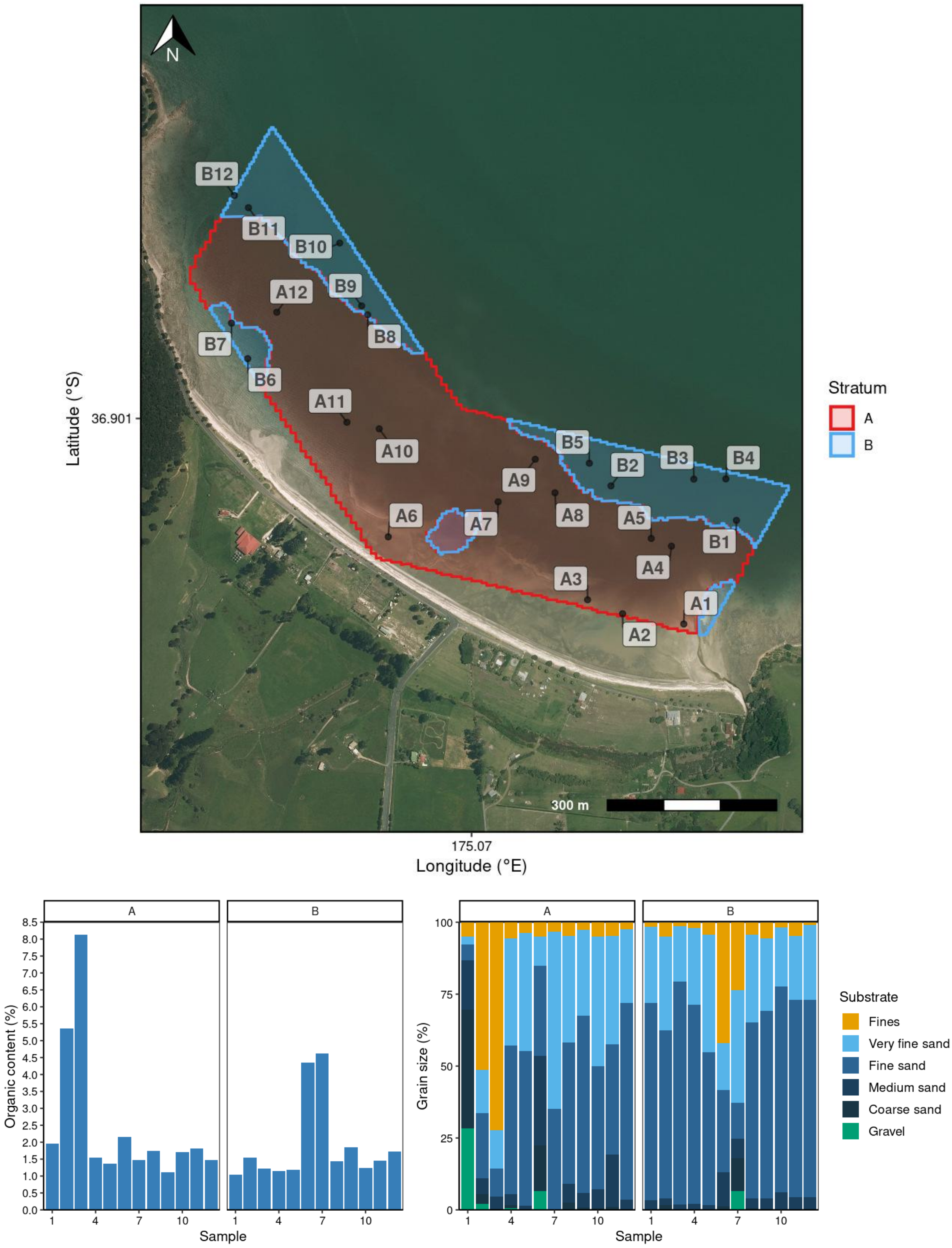

Figure 42: Sediment sample locations and characteristics at Umupuia Beach. Labels correspond to stratum and sample number. Graphs show organic content (% dry weight) and cumulative grain size (%). Sediment grain size fractions include fines (silt and clay, ≤63 µm), sands (very fine, >63 µm; fine, >125 µm; medium, >250 µm; coarse, >500 µm), and gravel (>2000 µm) (see details in Table B-1).

3.9.1 Cockles at Umupuia Beach

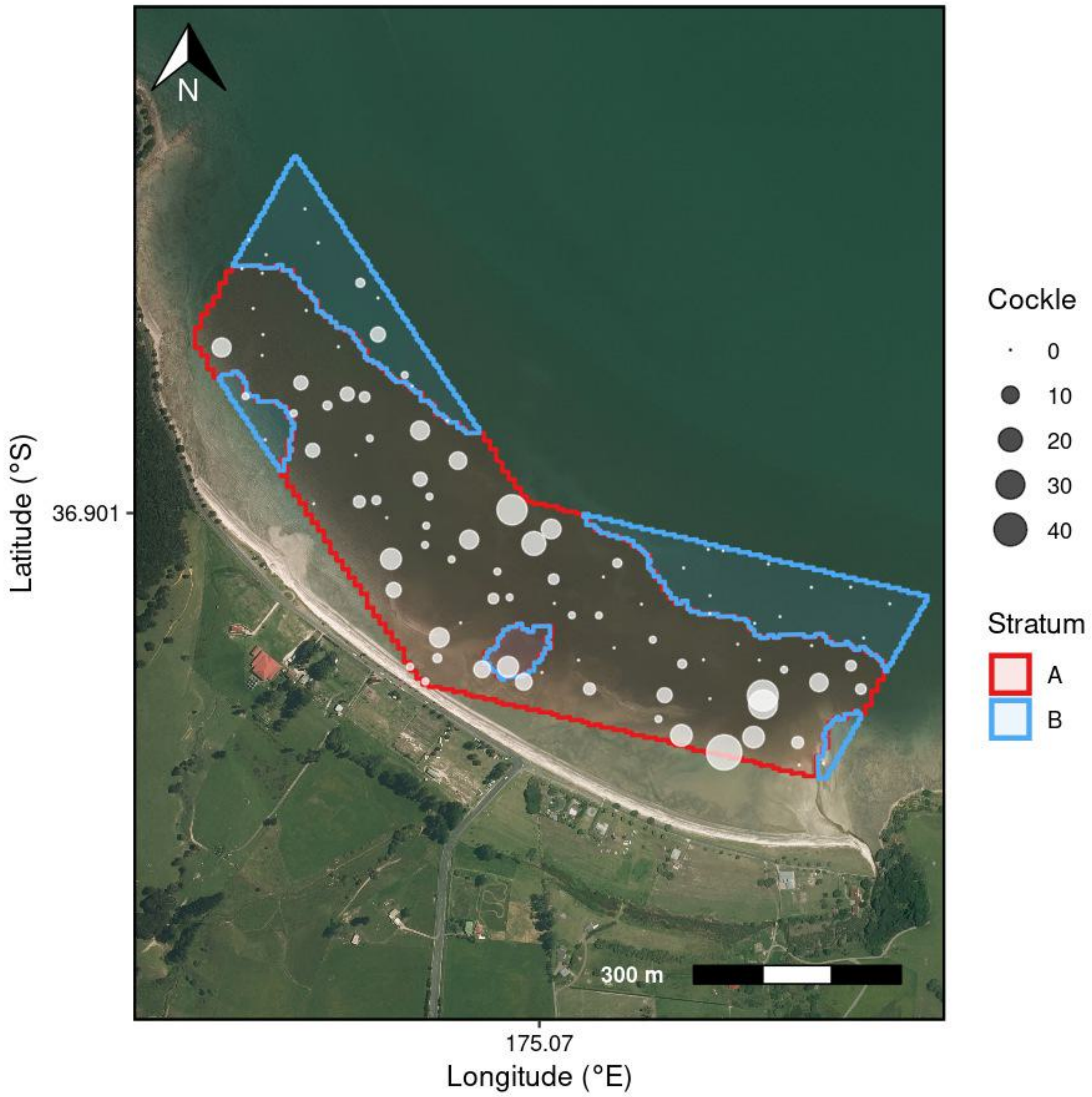

Figure 43: Map of sample strata and individual sample locations for cockles at Umupuia Beach, with the size of the circles proportional to the number of cockles (per 0.035 m^2) found at each location. Samples with zero counts are shown as small dots.

Table 40: Estimates of cockle abundance at Umupuia Beach, by stratum, for 2025–26. Presented are the area surveyed, the number of points and the number of cockles sampled, the mean total estimate, the mean density, and the coefficient of variation (CV).

Stratum		Sample		Population estimate		
	Area (ha)	Points	Cockle	Total (millions)	Density (m^{-2})	CV (%)
A	24.9	75	402	38.17	153	19.13
B	8.9	25	26	2.66	30	62.43

Table 41: Estimates of cockle abundance at Umupuia Beach for all sizes and large size (≥30 mm) cockles. Columns include the mean total estimate, mean density, and coefficient of variation (CV).

Year	Extent (ha)	Population estimate			Population ≥ 30 mm		
		Total (millions)	Density (m^{-2})	CV (%)	Total (millions)	Density (m^{-2})	CV (%)
1999–00	25.0	84.41	338	5.51	18.59	74	7.99
2000–01	36.0	177.48	493	5.50	66.98	186	8.32
2001–02	36.0	66.22	184	7.00	29.49	82	9.42
2002–03	36.0	64.43	179	5.26	24.96	69	7.87
2003–04	36.0	29.94	83	9.53	21.62	60	11.44
2004–05	36.0	41.49	115	6.95	30.72	85	7.97
2005–06	36.0	26.86	75	9.99	14.53	40	15.93
2006–07	36.0	11.59	32	13.84	5.07	14	23.91
2009–10	36.0	61.58	171	11.30	1.89	5	20.84
2010–11	36.0	103.08	286	9.96	9.32	26	17.10
2012–13	36.0	125.18	348	14.17	47.99	133	14.64
2013–14	33.9	170.35	503	16.79	44.29	131	17.80
2015–16	33.9	98.88	292	15.93	39.12	115	10.61
2017–18	33.4	92.15	276	19.27	41.70	125	22.25
2019–20	33.4	90.05	269	18.45	32.61	98	21.90
2021–22	32.7	52.05	159	17.18	23.41	72	17.12
2023–24	33.9	44.86	132	19.47	24.14	71	22.23
2025–26	33.9	40.82	121	18.34	16.33	48	25.71

Table 42: Summary statistics of the length-frequency (LF) distribution of cockles at Umupuia Beach. The LF distributions (in mm) were estimated for all strata in each survey and subsequently summed for the distribution of total LFs. Recruits were defined by a shell length of ≤15 mm and large individuals by a shell length of ≥30 mm.

Year	Mean	Mode	Range	Recruits (%)	Medium (%)	Large (%)
2021–22	29.02	27	13–46	0.76	54.26	44.98
2023–24	28.73	34	5–44	6.81	39.27	53.92
2025–26	24.60	14	6–42	25.97	34.03	40.00

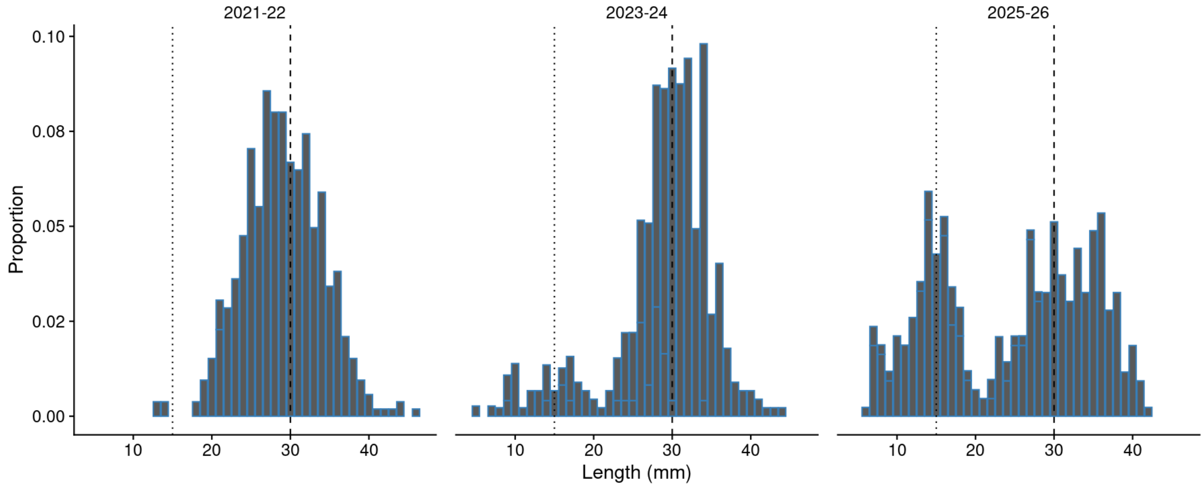

Figure 44: Weighted length-frequency (LF) distribution of cockles for the present and previous surveys at Umupuia Beach. Vertical dotted and dashed lines indicate the cut-off sizes for recruits and large individuals, respectively.

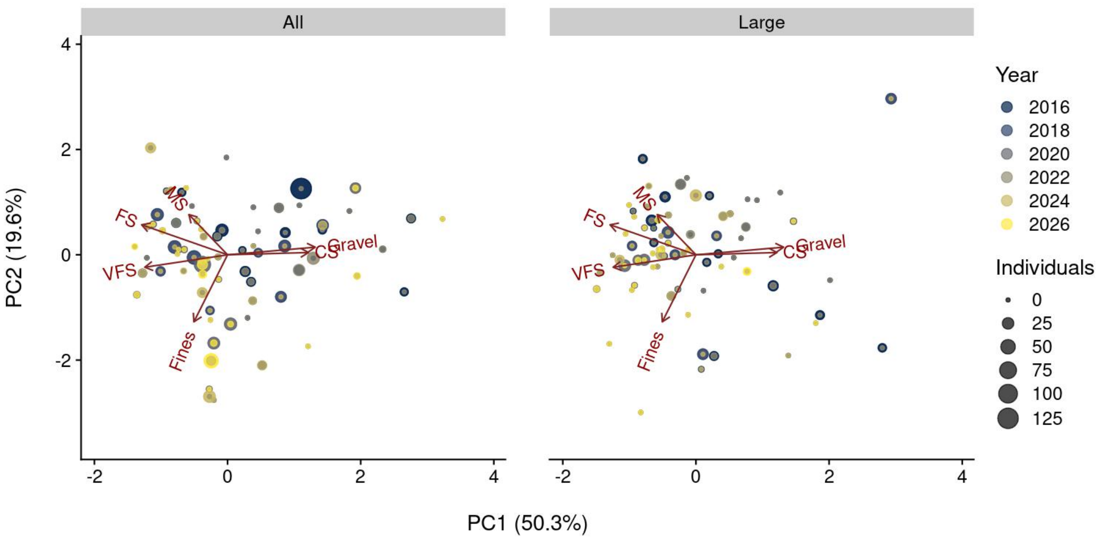

Figure 45: Cockle abundance along two principal components (standardised PCs, including % variance explained) of sediment granulometry for all cockle size classes (all) and large cockles (≥30 mm shell length) at Umupuia Beach. Sediment grain size fractions are defined as fines (silt and clay) ≤63 µm, very fine sand (VFS) >63 µm, fine sand (FS) >125 µm, medium sand (MS) >250 µm, coarse sand (CS) >500 µm, and gravel >2000 µm.

3.10 Whangamatā Harbour

Whangamatā Harbour is on the eastern side of Coromandel Peninsula, in the Waikato region. The northern bivalve surveys have included this site in 13 previous assessments, most recently in 2022–23 (see Appendix A, Tables A-1, A-2). Across surveys, the sampling extent has remained similar since 2014–15, covering two areas on either side of the tidal channel into Moanaanuanu Estuary. The 2025–26 sampling effort comprised a total of 92 points, distributed across three strata, including a separate pipi stratum.

Across the cockle strata, sediment organic content varied between 1.7 and 6.0% (Figure 46, and see details in Appendix B, Table B-1). The sediment samples were characterised by a prevalence of fine sand (grain size >125 µm), followed by varying proportions of medium sand (>250 µm). The proportion of sediment fines (grain size ≤63 µm) was small, except for one sample that contained 21.2% of this grain size fraction.

The cockle population at this site was confined to stratum A, the high-intertidal zone in both sampling areas (Figure 47, Table 43). For the entire sampling extent, population estimates reflected a total abundance of 88.52 million (CV: 9.51%) cockles, with a corresponding mean density of 1080 individuals per m^2 (Table 44). Both population estimates were lower than immediately-preceding estimates but were within the population fluctuations over time, with the density estimate continuing to exceed 1000 cockles per m^2. Included in the total population was a small number of large cockles (≥30 mm shell length) with an estimated 1.67 million (CV: 29.25%) individuals in this size class. Their estimated density was 20 large cockles per m^2.

The population size composition remained similar in the three most recent surveys, documenting a unimodal population largely formed by a cohort of recruits (≤15 mm shell length) and medium-sized cockles (Table 45, Figure 48). The relative proportions of each size class also remained similar; in 2025–26, medium-sized cockles made up the largest proportion (62.05%), followed by recruits (36.07%) and a small proportion of large individuals. Mean and modal sizes of 17.68 mm and 20 mm shell length highlighted the relatively small sizes of cockles within the medium size class.

Considering potential associations between cockle abundance and sediment grain size fractions via principal component analysis did not reveal a distinct pattern across the survey series (Figure 49).

The pipi population was associated with the main harbour channel close to the entrance, mostly in stratum C (Figure 50, Table 46). The estimated pipi abundance was a total of 7.84 million (CV: 15.96%) pipi in 2025–26, indicating a marked increase from the abundance estimate of 4.57 million (CV: 13.03%) pipi in 2022–23 (Table 47). There was a similar increase in the estimated mean density, from 56 pipi per m^2 in 2022–23 to 96 individuals per m^2 in 2025–26. The population included an estimated 1.83 million (CV: 16.78%) large pipi (≥50 mm shell length), and their mean density was estimated at 22 individuals per m^2.

Large pipi made up 23.38% of the population, similar to their proportions in the two most recent preceding assessments (Table 48, Figure 51). In contrast, there was a marked decrease in the proportion of recruits (≤20 mm shell length), from 25.05% in 2022–23 to 5.85% in 2025–26. The low recruitment shifted the bimodal population towards a unimodal size composition, with a stronger cohort of medium-sized pipi, and also growth into the large size class. Mean shell length increased from 35.28 mm to 40.24 mm, but modal size decreased from 47 mm to 38 mm shell length between 2022–23 and 2025–26.

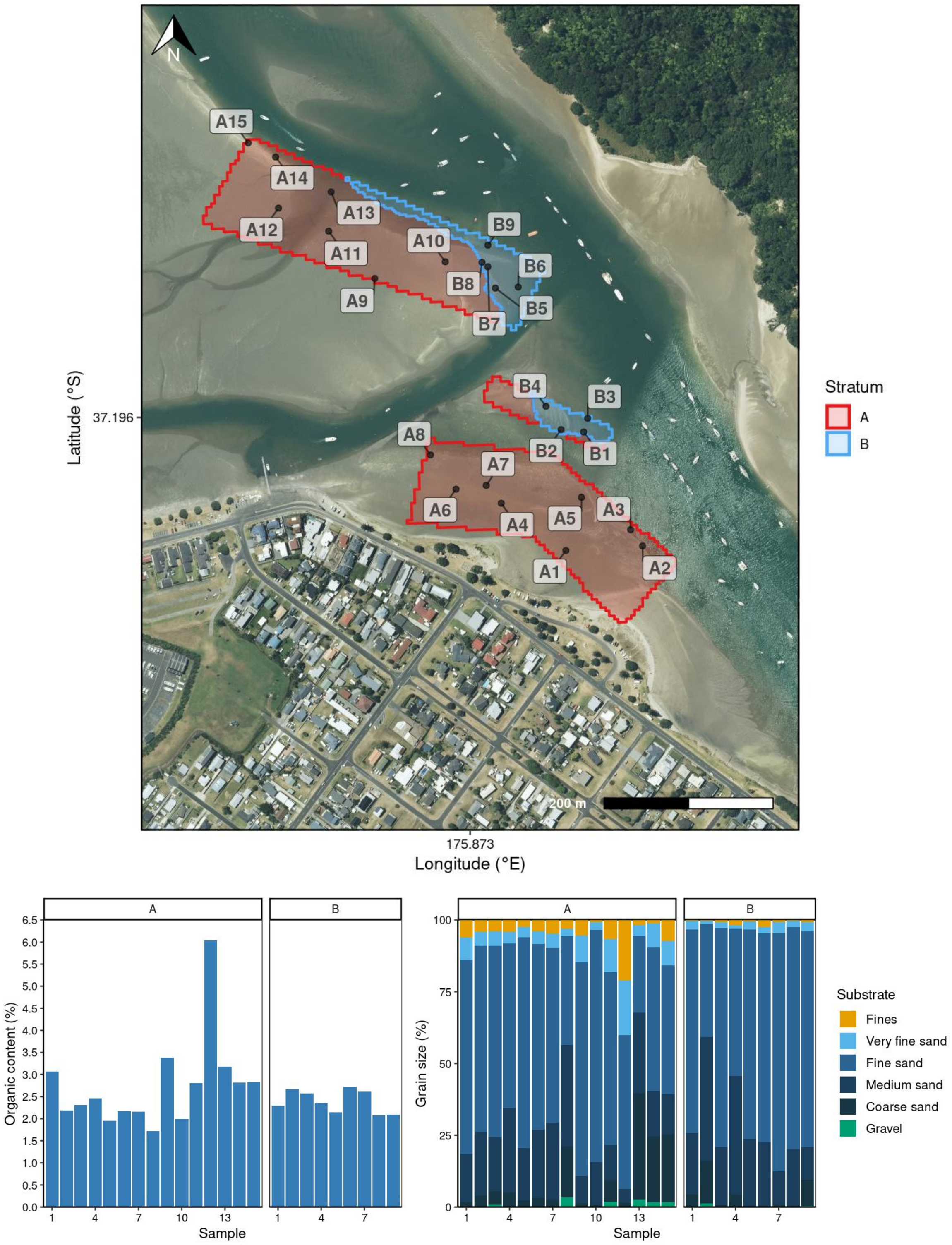

Figure 46: Sediment sample locations and characteristics at Whangamatā Harbour. Labels correspond to stratum and sample number. Graphs show organic content (% dry weight) and cumulative grain size (%). Sediment grain size fractions include fines (silt and clay, ≤63 µm), sands (very fine, >63 µm; fine, >125 µm; medium, >250 µm; coarse, >500 µm), and gravel (>2000 µm) (see details in Table B-1).

3.10.1 Cockles at Whangamatā Harbour

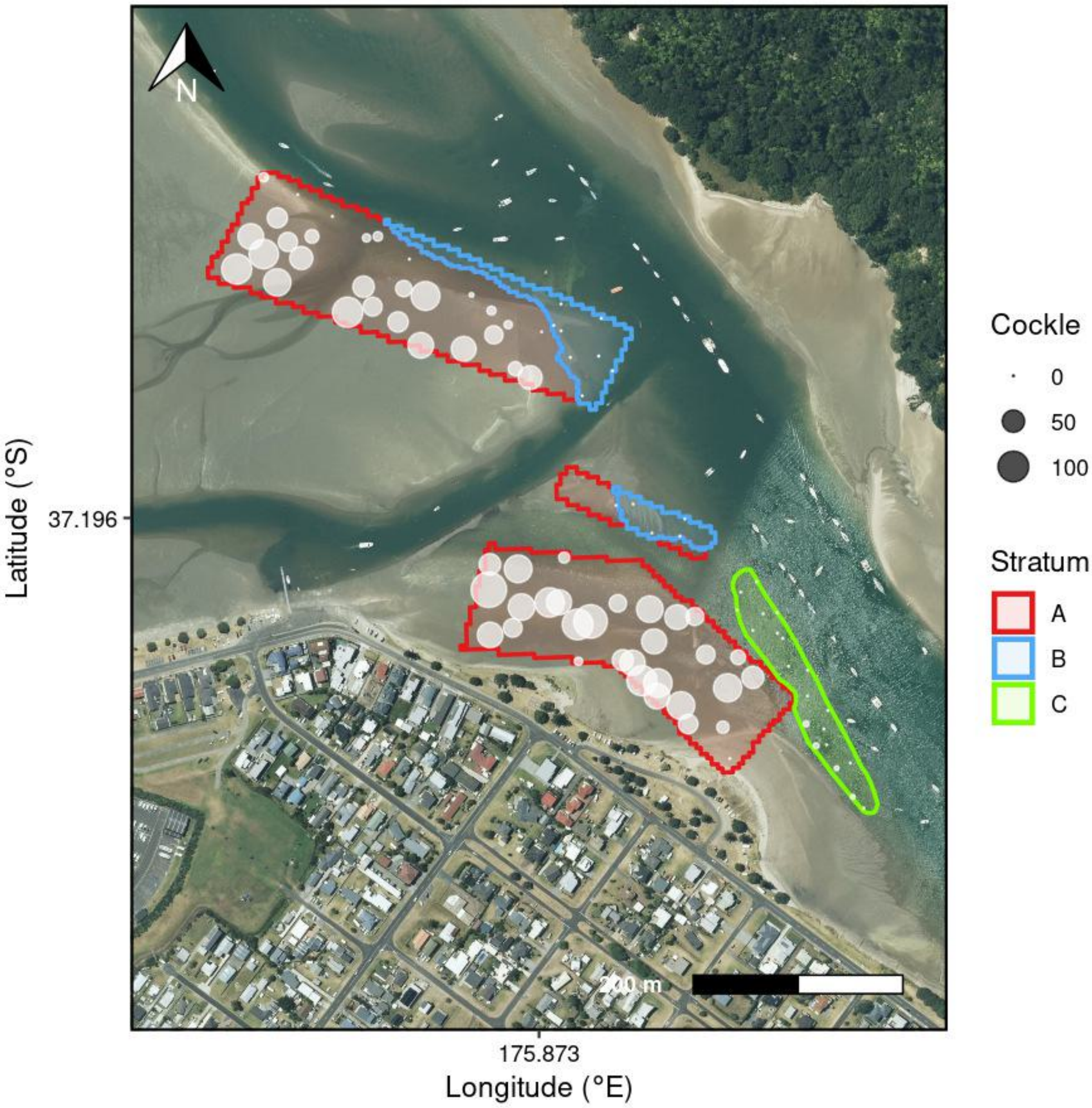

Figure 47: Map of sample strata and individual sample locations for cockles at Whangamatā Harbour, with the size of the circles proportional to the number of cockles (per 0.035 m^2) found at each location. Samples with zero counts are shown as small dots.

Table 43: Estimates of cockle abundance at Whangamatā Harbour, by stratum, for 2025–26. Presented are the area surveyed, the number of points and the number of cockles sampled, the mean total estimate, the mean density, and the coefficient of variation (CV).

Stratum		Sample		Population estimate		
	Area (ha)	Points	Cockle	Total (millions)	Density (m^{-2})	CV (%)
A	6.5	60	2 842	88.45	1 353	9.52
B	0.9	12	0	0.00	0	
C	0.8	20	6	0.06	9	48.97

Table 44: Estimates of cockle abundance at Whangamatā Harbour for all sizes and large size (≥30 mm) cockles. Columns include the mean total estimate, mean density, and coefficient of variation (CV).

Year	Extent (ha)	Population estimate			Population ≥ 30 mm		
		Total (millions)	Density (m^{-2})	CV (%)	Total (millions)	Density (m^{-2})	CV (%)
1999–00	5.5	70.55	1 287	4.31	17.14	313	6.65
2000–01	5.5	60.33	1 101	4.29	13.95	255	7.60
2001–02	5.5	38.80	708	4.08	6.87	125	7.24
2002–03	5.5	29.78	543	6.61	8.03	146	9.27
2003–04	5.5	43.47	793	4.18	13.10	239	5.18
2004–05	5.5	38.85	709	4.64	9.94	181	4.62
2006–07	24.6	348.01	1 414	0.71	2.86	12	12.99
2010–11	5.9	84.83	1 441	7.06	1.38	23	18.66
2014–15	7.6	104.53	1 372	6.59	2.73	36	19.83
2016–17	7.7	86.78	1 125	7.86	4.00	52	24.60
2018–19	7.5	78.98	1 047	11.38	2.41	32	36.69
2020–21	8.2	61.20	748	8.70	3.49	43	19.09
2022–23	8.1	97.58	1 206	9.32	1.88	23	29.45
2025–26	8.2	88.52	1 080	9.51	1.67	20	29.25

Table 45: Summary statistics of the length-frequency (LF) distribution of cockles at Whangamatā Harbour. The LF distributions (in mm) were estimated for all strata in each survey and subsequently summed for the distribution of total LFs. Recruits were defined by a shell length of ≤15 mm and large individuals by a shell length of ≥30 mm.

Year	Mean	Mode	Range	Recruits (%)	Medium (%)	Large (%)
2020–21	20.38	24	5–42	23.79	70.52	5.70
2022–23	18.04	17	5–41	35.31	62.76	1.93
2025–26	17.68	20	5–39	36.07	62.05	1.88

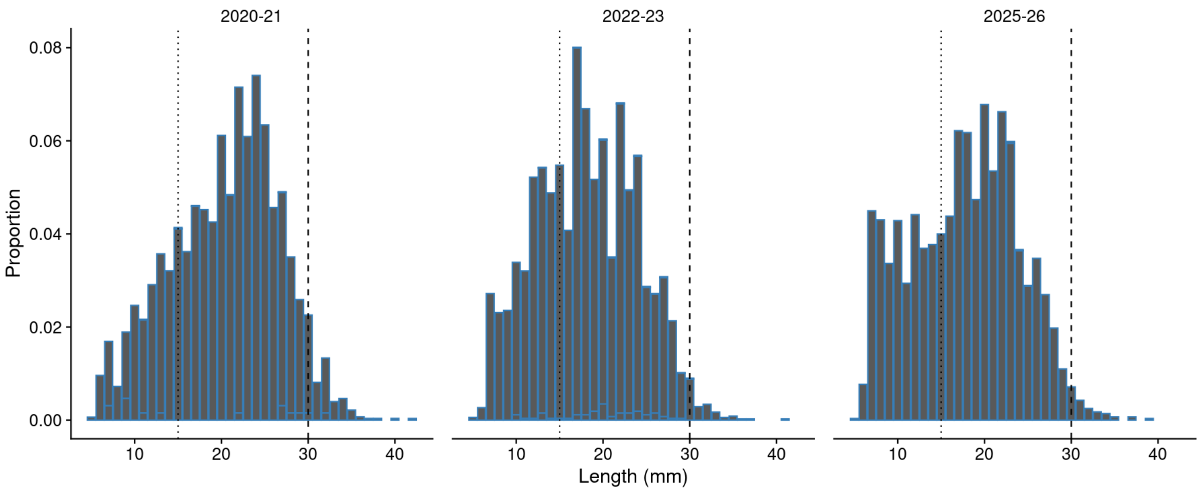

Figure 48: Weighted length-frequency (LF) distribution of cockles for the present and previous surveys at Whangamatā Harbour. Vertical dotted and dashed lines indicate the cut-off sizes for recruits and large individuals, respectively.

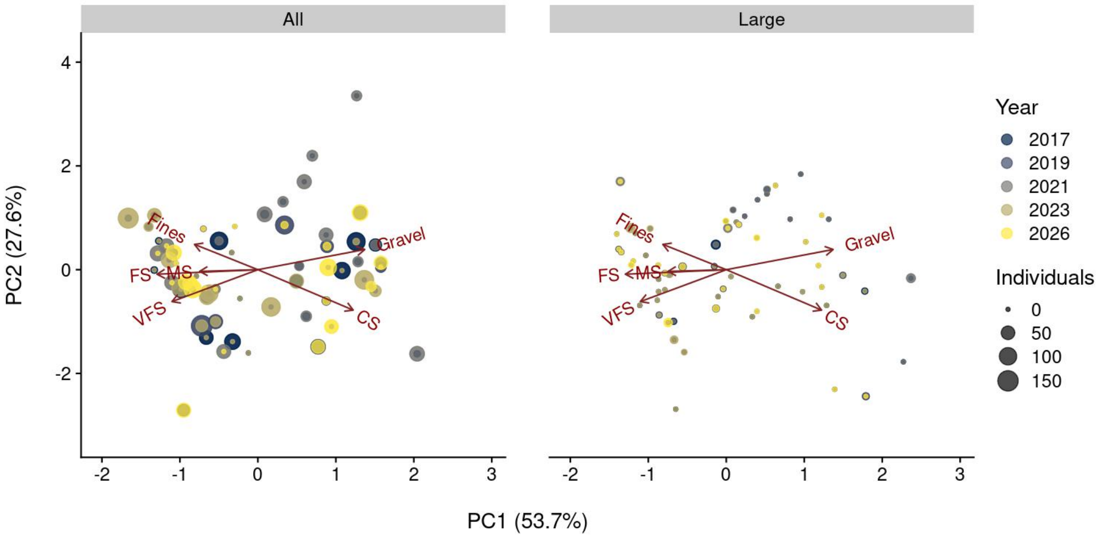

Figure 49: Cockle abundance along two principal components (standardised PCs, including % variance explained) of sediment granulometry for all cockle size classes (all) and large cockles (≥30 mm shell length) at Whangamatā Harbour. Sediment grain size fractions are defined as fines (silt and clay) ≤63 µm, very fine sand (VFS) >63 µm, fine sand (FS) >125 µm, medium sand (MS) >250 µm, coarse sand (CS) >500 µm, and gravel >2000 µm.

3.10.2 Pipi at Whangamatā Harbour

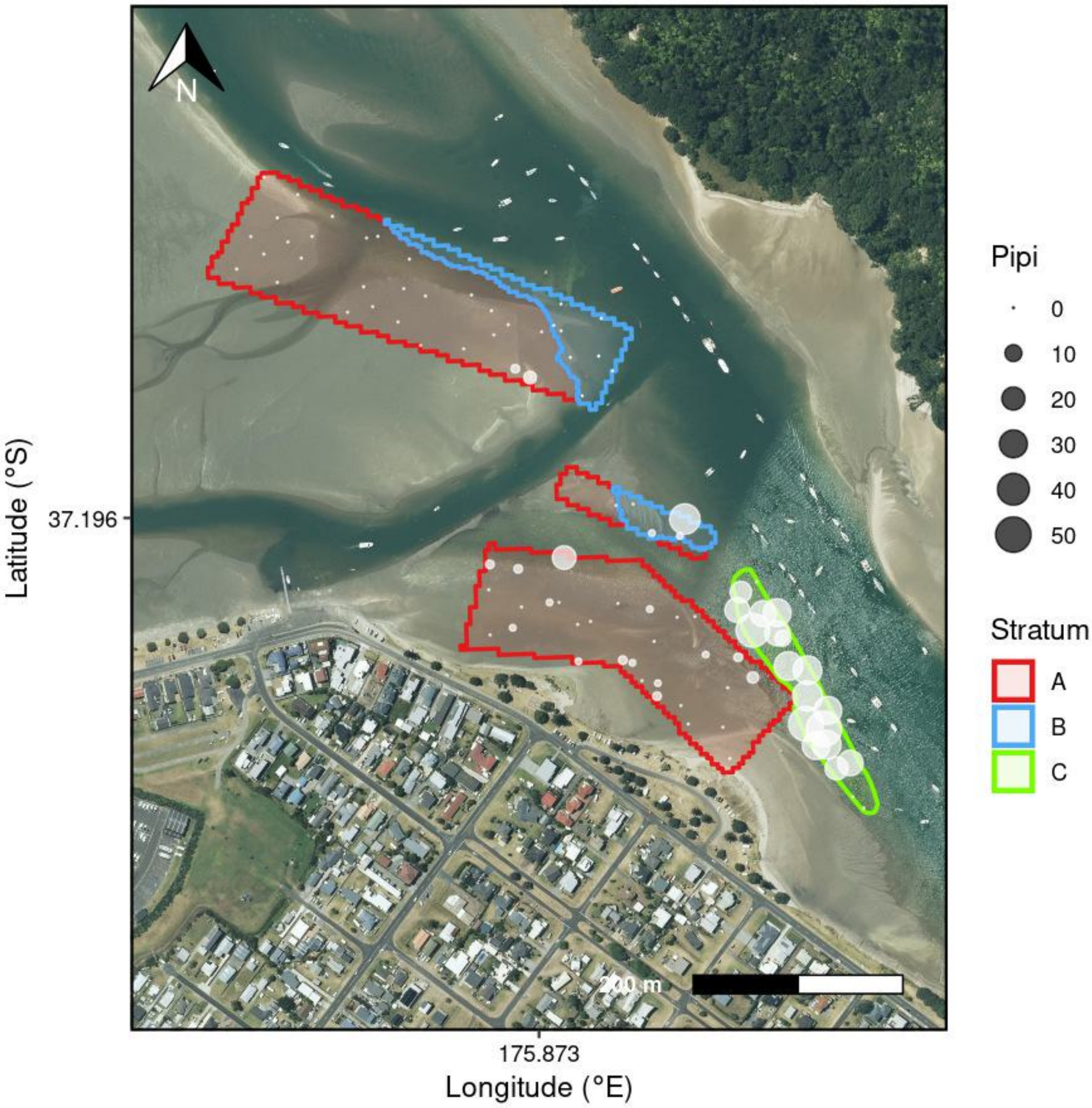

Figure 50: Map of sample strata and individual sample locations for pipi at Whangamatā Harbour, with the size of the circles proportional to the number of pipi (per 0.035 m^2) found at each location. Samples with zero counts are shown as small dots.

Table 46: Estimates of pipi abundance at Whangamatā Harbour, by stratum, for 2025–26. Presented are the area surveyed, the number of points and the number of pipi sampled, the mean total estimate, the mean density, and the coefficient of variation (CV).

Stratum		Sample		Population estimate		
	Area (ha)	Points	Pipi	Total (millions)	Density (m^{-2})	CV (%)
A	6.5	60	49	1.53	23	44.76
B	0.9	12	38	0.82	90	94.32
C	0.8	20	508	5.50	726	12.93

Table 47: Estimates of pipi abundance at Whangamatā Harbour for all sizes and large size ($\geq$50 mm) pipi. Columns include the mean total estimate, mean density, and coefficient of variation (CV).

Year	Extent (ha)	Population estimate			Population $\geq$ 50 mm		
		Total (millions)	Density (m^{-2})	CV (%)	Total (millions)	Density (m^{-2})	CV (%)
1999–00	5.5	15.07	275	9.25	7.25	132	10.78
2000–01	5.5	11.86	216	11.17	5.05	92	21.86
2001–02	5.5	6.38	116	10.45	2.71	50	19.77
2002–03	5.5	5.95	109	10.95	1.60	29	10.55
2003–04	5.5	4.84	88	7.82	2.03	37	9.50
2004–05	5.5	2.30	42	11.13	1.26	23	12.05
2006–07	24.6	3.26	13	7.50	1.49	6	15.43
2010–11	5.9	5.56	94	15.02	1.62	27	39.20
2014–15	7.6	3.79	50	19.69	1.53	20	75.18
2016–17	7.7	7.65	99	24.21	3.87	50	20.49
2018–19	7.5	10.01	133	27.66	2.79	37	43.95
2020–21	8.2	7.79	95	8.64	1.79	22	18.97
2022–23	8.1	4.57	56	13.03	0.77	10	25.44
2025–26	8.2	7.84	96	15.96	1.83	22	16.78

Table 48: Summary statistics of the length-frequency (LF) distribution of pipi at Whangamatā Harbour. The LF distributions (in mm) were estimated for all strata in each survey and subsequently summed for the distribution of total LFs. Recruits were defined by a shell length of $\leq$20 mm and large individuals by a shell length of $\geq$50 mm.

Year	Mean	Mode	Range	Recruits (%)	Medium (%)	Large (%)
2020–21	43.31	46	14–62	1.26	75.72	23.01
2022–23	35.28	47	10–60	25.05	58.02	16.93
2025–26	40.24	38	9–69	5.85	70.78	23.38

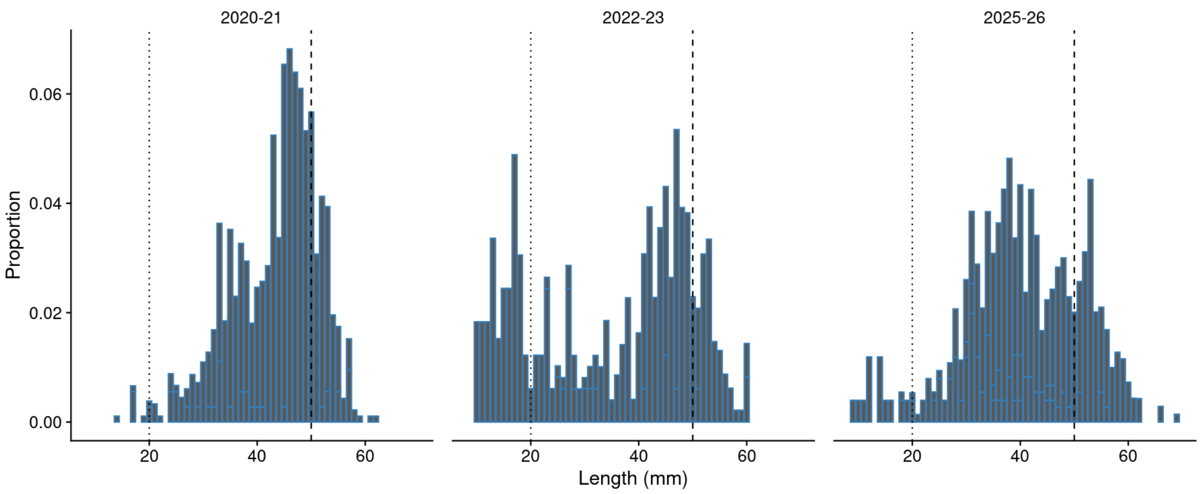

Figure 51: Weighted length-frequency (LF) distribution of pipi for the present and previous surveys at Whangamatā Harbour. Vertical dotted and dashed lines indicate the cut-off sizes for recruits and large individuals, respectively.

3.11 Whangateau Harbour

Whangateau Harbour is an extensive estuary north of Auckland, on the east coast and within Tīkapa Moana (Hauraki Gulf). It has been closed to the collection of cockles and pipi since 2010 (Department of Internal Affairs 2015). Resident bivalve population have been part of the northern surveys since 2001–02, and this survey was the 14th assessment of this site (see Appendix A, Tables A-1, A-2). Since 2013–14, the sampling extent has remained consistent, including two separate extensive mudflat areas opposite to the harbour entrance and within Waikōkopu Creek, respectively. The sampling was based on five strata in 2025–26, including a designated pipi bed. The total sampling effort was 111 points, including 11 phase-2 points.

Sediment across the cockle strata had a low organic content of less than 2.6% across all samples (Figure 52; and see details in Appendix B, Table B-1). The proportion of sediment fines (grain size <63 µm) was also generally small, but two samples contained over 8% of sediment in this grain size fraction. Depending on the stratum, the prevalent grain size fraction was either fine sand (grain size >125 µm) or medium sand (>250 µm).

The cockle population was confined to two strata, A and D, with no or few individuals in the other strata (Figure 53, Table 49). Their overall abundance was estimated at 506.88 million (CV: 11.53%) cockles and the mean density at 457 cockles per m^2 (Table 50). Following a marked decrease in the preceding survey in 2023–24, these estimates indicated a further population decline; e.g., the preceding density estimate was 545 cockles per m^2. The population continued to include a small number of large cockles (>30 mm shell length), and their estimates remained relatively unchanged. Their estimated abundance was 23.31 million large individuals and their average density 21 cockles per m^2; however, these estimates had high uncertainty (CV: 41.02%).

Large cockles contributed 4.60% of individuals to the total population, which was characterised by a strong cohort of medium-sized cockles, augmented by recruits (≤ 15 mm shell length) (Table 51, Figure 54). The population composition was similar across the three most recent surveys, albeit with a smaller proportion of recruits, with 14.87% of all individuals in this size class in 2025–26. In comparison, recruits made up over 25% of the total population in both 2021–22 and 2023–24. Mean and modal sizes increased compared with these two preceding surveys to 20.31 mm and 20 mm shell length, respectively.

Principal component analysis, used to explore the potential relationship between cocke abundance and sediment grain size, did not reveal any notable patterns associated with particular grain size fractions (Figure 55).

Pipi were almost exclusively in the designated pipi bed, in stratum E, with a few individuals in localised spots in stratum D (Figure 56, Table 52). Their population estimates indicated a considerable decrease in pipi abundance and density from 22.80 million (CV: 48.18%) pipi and 20 pipi per m^2 in 2023–24 to the current population size and density estimates of 7.60 million (CV: 32.51%) individuals and 7 pipi per m^2 (Table 53). The decline in population size may be attributed to the smaller size of the pipi bed in 2025–26 compared with 2023–24 (0.3 versus 0.8 ha), but the population density underwent a similar decrease. The population continued to include few large pipi (≥ 50 mm), with an estimated 0.39 million (CV: 15.57%) individuals in this size class and an estimated density of <1 large individual per m^2.

Corresponding with their low abundance, large individuals only made up 5.19% of the total population, compared with 59.42% of medium-sized pipi and 35.38% of recruits (≤ 20 mm) (Table 54, Figure 57). There was no distinct cohort within the pipi population, with individuals at a range of shell lengths within each of the recruits and medium size class. Nevertheless, there was some growth of medium-sized individuals towards the upper cut-off of this size class. Corresponding mean and modal shell lengths were 28.03 mm and 20 mm, respectively.

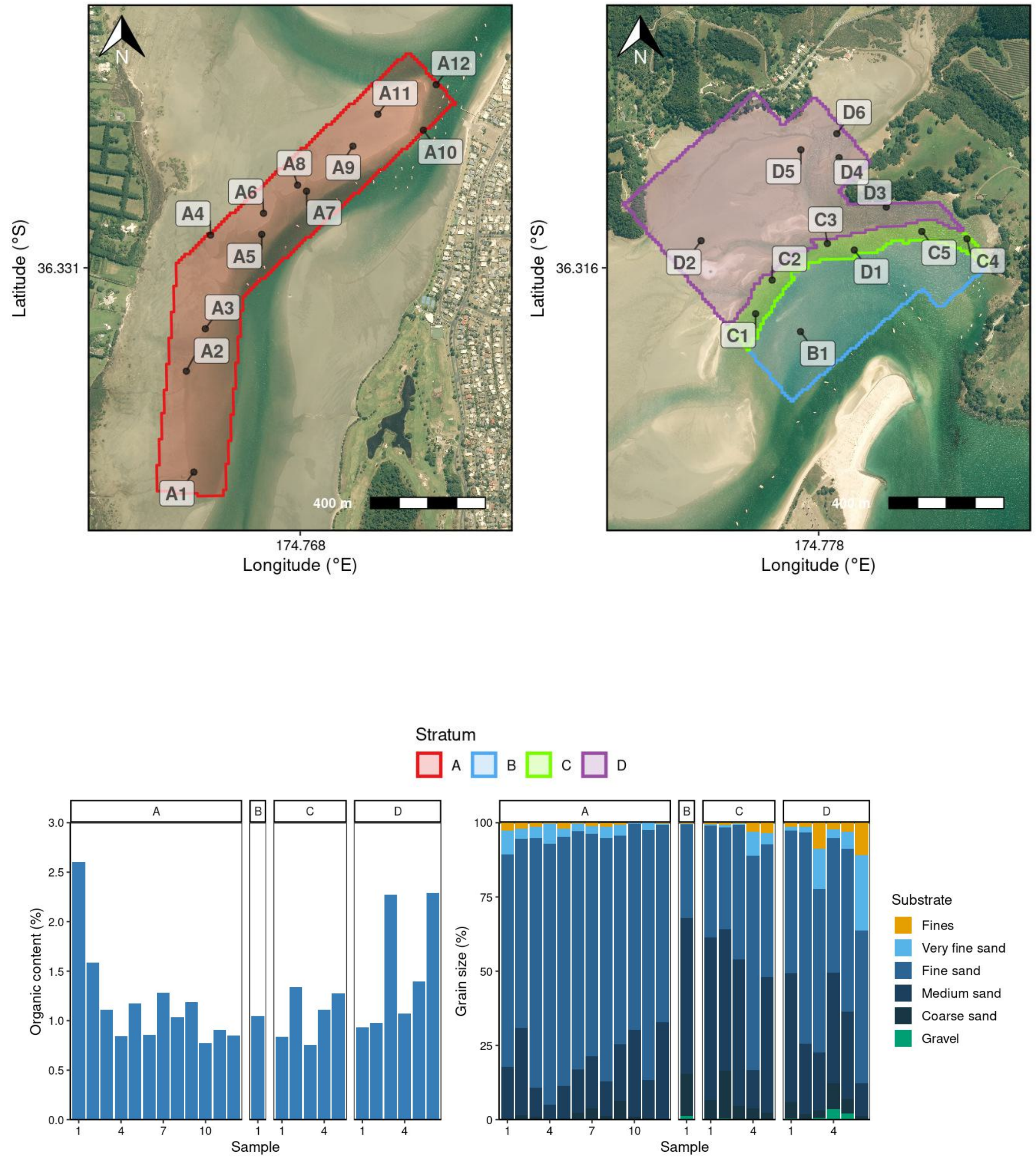

Figure 52: Sediment sample locations and characteristics at Whangateau Harbour. Labels correspond to stratum and sample number. Graphs show organic content (% dry weight) and cumulative grain size (%). Sediment grain size fractions include fines (silt and clay, ≤63 µm), sands (very fine, >63 µm; fine, >125 µm; medium, >250 µm; coarse, >500 µm), and gravel (>2000 µm) (see details in Table B-1).

3.11.1 Cockles at Whangateau Harbour

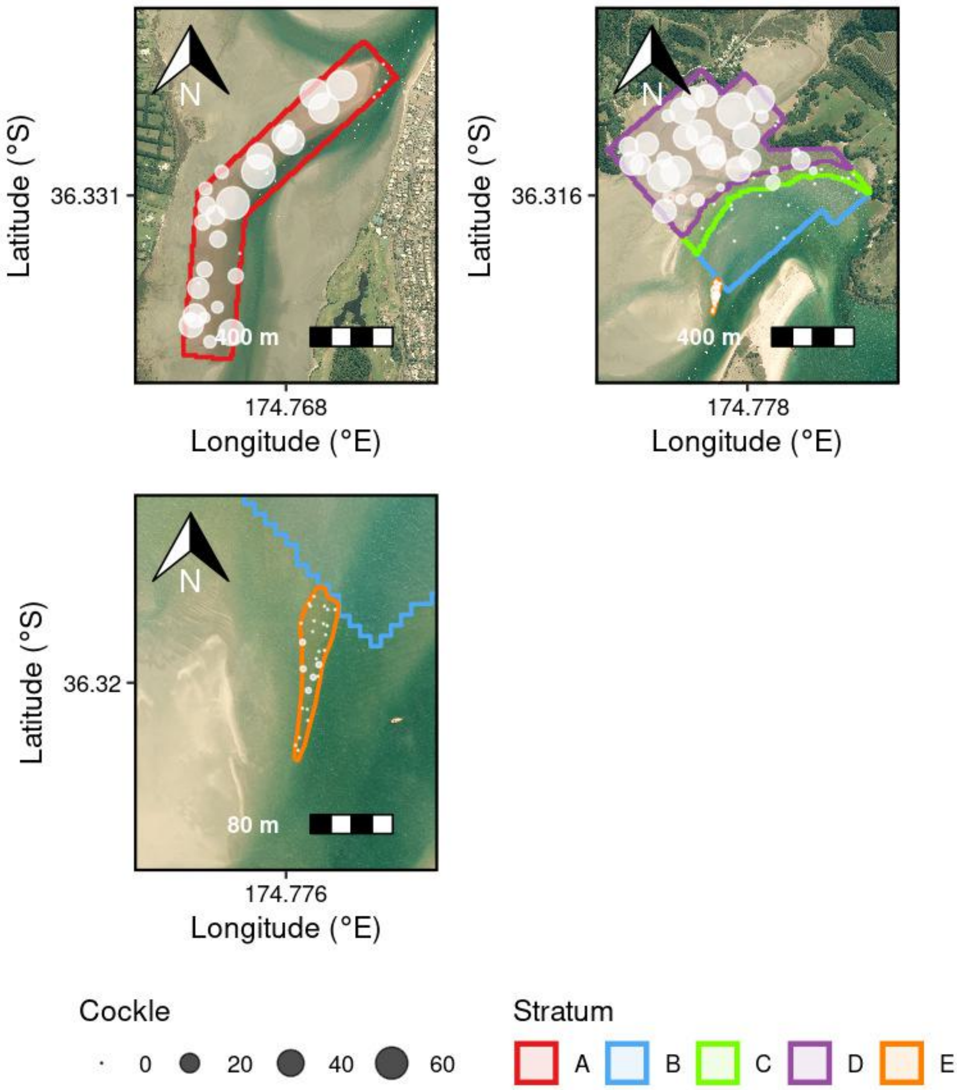

Figure 53: Map of sample strata and individual sample locations for cockles at Whangateau Harbour, with the size of the circles proportional to the number of cockles (per 0.035 m^2) found at each location. Samples with zero counts are shown as small dots.

Table 49: Estimates of cockle abundance at Whangateau Harbour, by stratum, for 2025–26. Presented are the area surveyed, the number of points and the number of cockles sampled, the mean total estimate, the mean density, and the coefficient of variation (CV).

Stratum		Sample		Population estimate		
	Area (ha)	Points	Cockle	Total (millions)	Density (m^{-2})	CV (%)
A	43.0	33	649	241.57	562	18.05
B	20.9	9	0	0.00	0	
C	7.1	9	12	2.72	38	82.92
D	39.5	33	768	262.57	665	14.79
E	0.3	27	5	0.02	5	41.14

Table 50: Estimates of cockle abundance at Whangateau Harbour for all sizes and large size (≥30 mm) cockles. Columns include the mean total estimate, mean density, and coefficient of variation (CV).

Year	Extent (ha)	Population estimate			Population ≥ 30 mm		
		Total (millions)	Density (m^{-2})	CV (%)	Total (millions)	Density (m^{-2})	CV (%)
2001–02	64.2	253.26	395	6.51	62.36	97	16.17
2003–04	64.2	376.68	587	5.80	56.85	89	12.66
2004–05	64.2	349.04	544	8.52	59.52	93	13.12
2006–07	64.2	266.04	415	8.24	35.20	55	21.91
2009–10	64.5	230.55	357	7.16	16.16	25	25.71
2010–11	64.2	239.27	373	5.06	19.77	31	16.19
2012–13	64.2	363.72	567	5.87	30.84	48	14.67
2013–14	110.9	730.89	659	5.70	44.50	40	13.45
2015–16	110.7	742.44	671	7.02	45.43	41	18.77
2017–18	110.9	852.27	768	9.28	33.69	30	28.12
2019–20	110.9	887.67	801	10.72	32.10	29	37.02
2021–22	111.2	983.06	884	9.91	34.49	31	37.90
2023–24	111.3	606.56	545	10.68	25.43	23	41.02
2025–26	110.9	506.88	457	11.53	23.31	21	41.12

Table 51: Summary statistics of the length-frequency (LF) distribution of cockles at Whangateau Harbour. The LF distributions (in mm) were estimated for all strata in each survey and subsequently summed for the distribution of total LFs. Recruits were defined by a shell length of ≤15 mm and large individuals by a shell length of ≥30 mm.

Year	Mean	Mode	Range	Recruits (%)	Medium (%)	Large (%)
2021–22	18.87	17	6–40	29.04	67.46	3.51
2023–24	18.70	17	6–37	25.40	70.40	4.19
2025–26	20.31	20	5–35	14.87	80.53	4.60

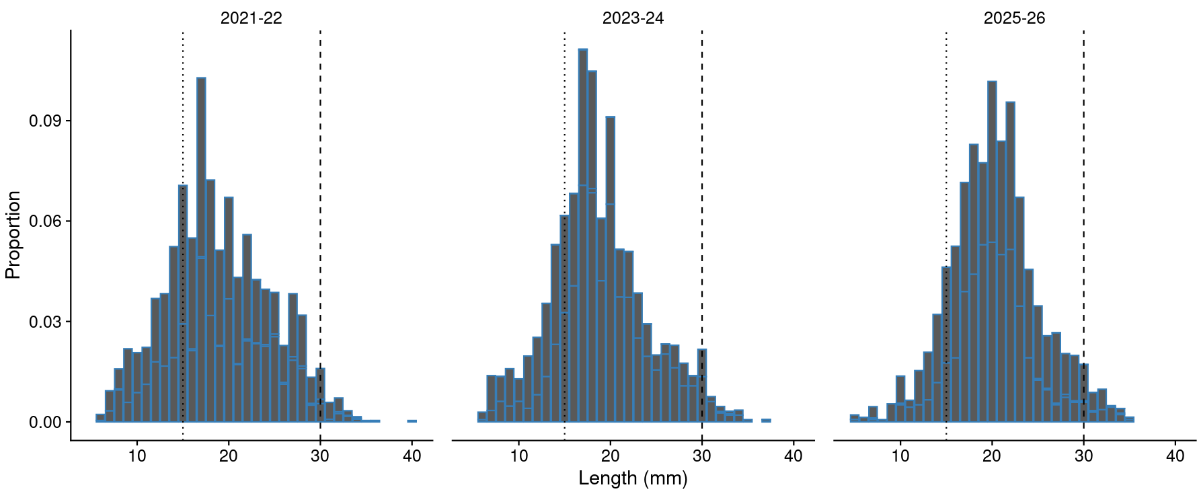

Figure 54: Weighted length-frequency (LF) distribution of cockles for the present and previous surveys at Whangateau Harbour. Vertical dotted and dashed lines indicate the cut-off sizes for recruits and large individuals, respectively.

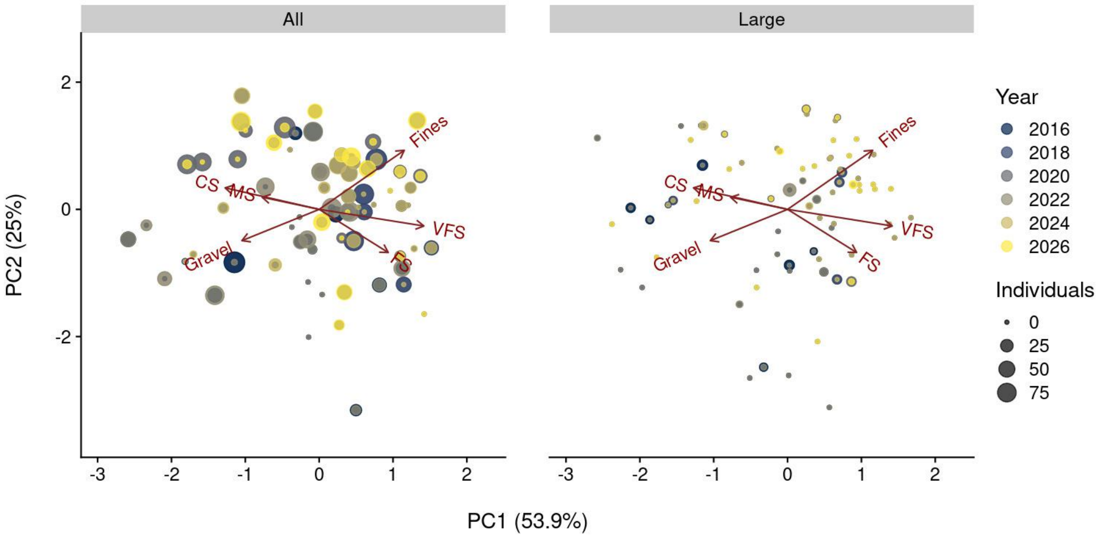

Figure 55: Cockle abundance along two principal components (standardised PCs, including % variance explained) of sediment granulometry for all cockle size classes (all) and large cockles (≥30 mm shell length) at Whangateau Harbour. Sediment grain size fractions are defined as fines (silt and clay) ≤63 µm, very fine sand (VFS) >63 µm, fine sand (FS) >125 µm, medium sand (MS) >250 µm, coarse sand (CS) >500 µm, and gravel >2000 µm.

3.11.2 Pipi at Whangateau Harbour

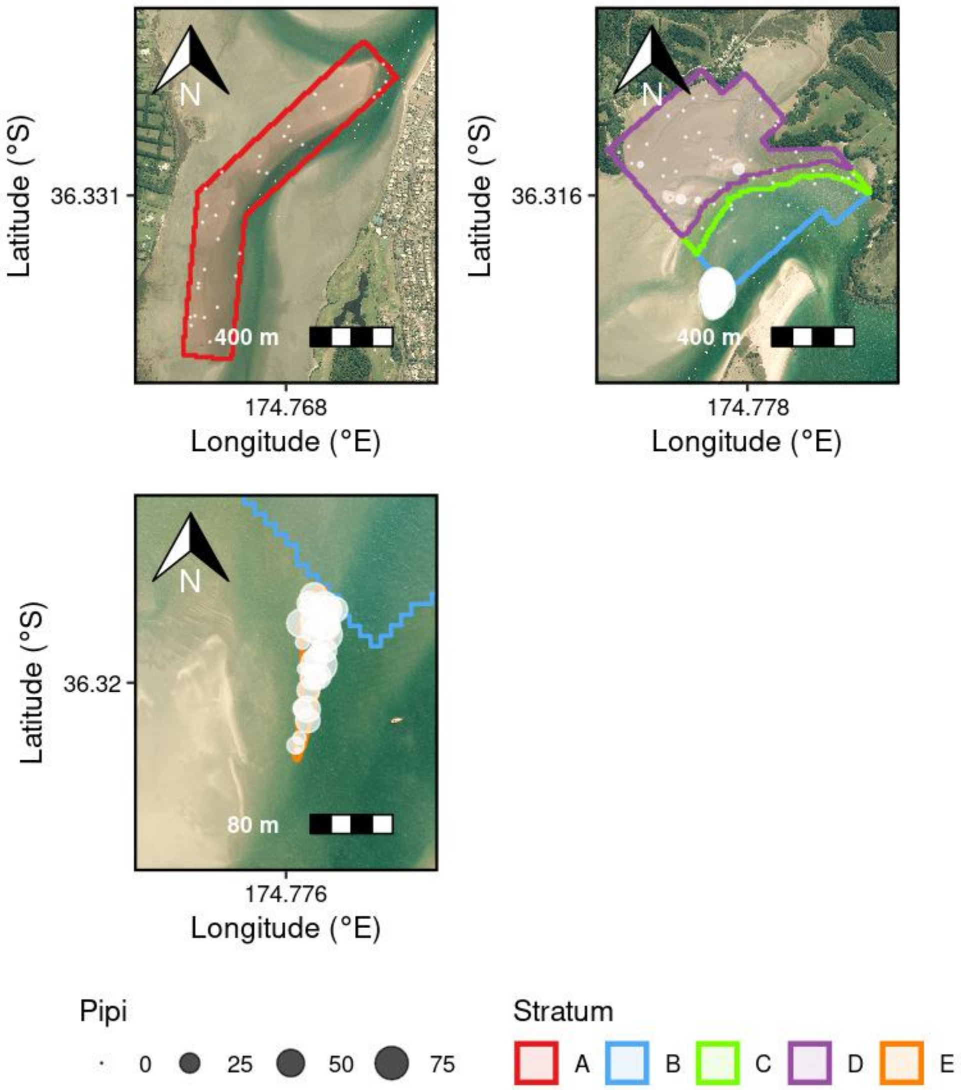

Figure 56: Map of sample strata and individual sample locations for pipi at Whangateau Harbour, with the size of the circles proportional to the number of pipi (per 0.035 m^2) found at each location. Samples with zero counts are shown as small dots.

Table 52: Estimates of pipi abundance at Whangateau Harbour, by stratum, for 2025–26. Presented are the area surveyed, the number of points and the number of pipi sampled, the mean total estimate, the mean density, and the coefficient of variation (CV).

Stratum		Sample		Population estimate		
	Area (ha)	Points	Pipi	Total (millions)	Density (m^{-2})	CV (%)
A	43.0	33	0	0.00	0	
B	20.9	9	0	0.00	0	
C	7.1	9	0	0.00	0	
D	39.5	33	12	4.10	10	59.62
E	0.3	27	1 040	3.50	1 101	10.16

Table 53: Estimates of pipi abundance at Whangateau Harbour for all sizes and large size (≥50 mm) pipi. Columns include the mean total estimate, mean density, and coefficient of variation (CV).

Year	Extent (ha)	Population estimate			Population ≥ 50 mm		
		Total (millions)	Density (m^{-2})	CV (%)	Total (millions)	Density (m^{-2})	CV (%)
2001–02	64.2	1.83	3	31.83	0.31	<1	>100
2003–04	64.2	0.48	<1	10.18	0.42	<1	9.85
2004–05	64.2	6.85	11	22.46	0.58	<1	9.72
2006–07	64.2	10.56	16	33.78	0.05	<1	>100
2009–10	64.5	17.58	27	33.35	0.11	<1	>100
2010–11	64.2	9.31	15	17.74	1.57	2	22.52
2012–13	64.2	19.58	30	16.89	0.60	<1	42.05
2013–14	110.9	55.39	50	26.92	0.68	<1	24.04
2015–16	110.7	15.00	14	23.20	0.40	<1	9.04
2017–18	110.9	20.13	18	42.77	0.09	<1	28.79
2019–20	110.9	29.96	27	72.05	0.26	<1	22.41
2021–22	111.2	20.03	18	12.34	0.50	<1	22.32
2023–24	111.3	22.80	20	48.18	0.09	<1	35.55
2025–26	110.9	7.60	7	32.51	0.39	<1	15.57

Table 54: Summary statistics of the length-frequency (LF) distribution of pipi at Whangateau Harbour. The LF distributions (in mm) were estimated for all strata in each survey and subsequently summed for the distribution of total LFs. Recruits were defined by a shell length of ≤20 mm and large individuals by a shell length of ≥50 mm.

Year	Mean	Mode	Range	Recruits (%)	Medium (%)	Large (%)
2021–22	29.37	34	8–58	20.32	77.18	2.51
2023–24	20.74	18	7–54	63.32	36.30	0.38
2025–26	28.03	20	9–61	35.38	59.42	5.19

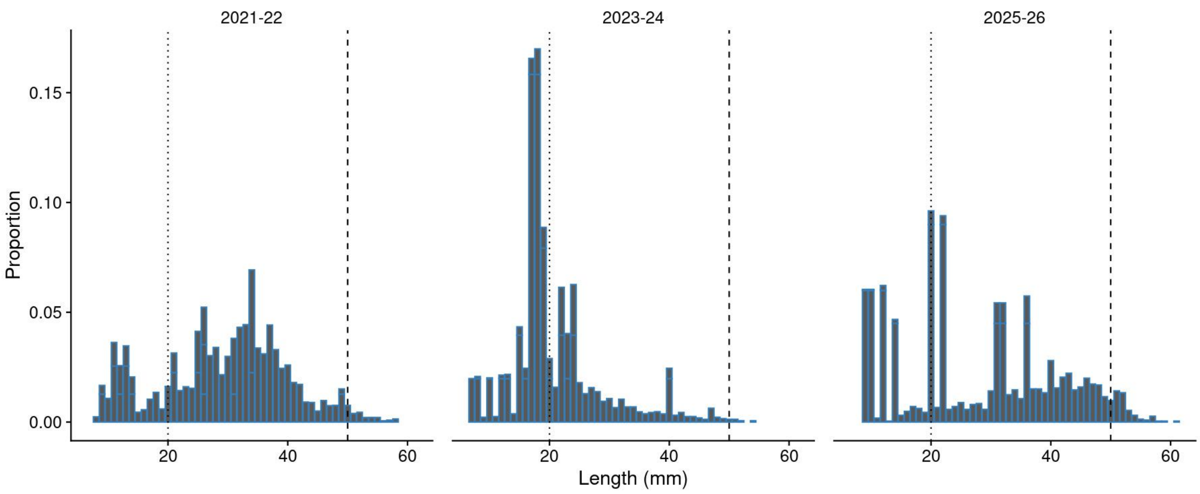

Figure 57: Weighted length-frequency (LF) distribution of pipi for the present and previous surveys at Whangateau Harbour. Vertical dotted and dashed lines indicate the cut-off sizes for recruits and large individuals, respectively.

4. SUMMARIES

4.1 Cockle populations

Cockle populations were present at ten of the 2025–26 northern sites, encompassing different intertidal habitats and environments. At Eastern Beach, Grahams Beach and Umupuia Beach, the field sampling encompassed most of the intertidal beach area; at Little Waihi Estuary, it included the entire lower estuary. At Bowentown Beach, Hokianga Harbour, Mangawhai Harbour, Ngunguru Estuary, and Whangamatā and Whangateau harbours, the bivalve sampling focused on particular cockle beds.

Across these different habitats, the estimated abundance of resident cockle populations varied, from a small population size of 6.91 million (CV: 19.38%) cockles at Grahams Beach to a particularly high estimate of 506.88 (CV: 11.53%) million individuals at Whangateau Harbour (Table 55). Except for Grahams Beach and Little Waihi Estuary, the population estimates had low uncertainty, with CV values well below 20%. At the latter site, the CV exceeded this threshold, in spite of increased sampling effort via phase 2. Grahams Beach also had the lowest density of cockles, with an estimated 26 cockles per m^2. In comparison, density estimates were several hundred individuals per square metre at the other sites; they were particularly high at Bowentown Beach, Ngunguru Estuary, and Whangamatā Harbour, where they exceeded 1000 individuals per square metre. Large cockles ($\geq$30 mm shell length) were scarce across the northern populations, and their estimates frequently had high uncertainty. The highest abundance estimates for this size class were at Eastern Beach, Umupuia Beach, and Whangateau Harbour, ranging from 15.84 million (CV: 20.81%) to 23.31 million (CV: 41.12%) individuals. Their highest density estimates was also at Eastern Beach, with an estimated 70 large cockles per m^2.

Time-series data and inter-site comparisons revealed distinct differences in cockle densities between some of the sites (Figure 58). Throughout the survey series, cockles at Grahams Beach had comparatively low densities overall, with fluctuations over time resulting in low estimates in recent surveys. Recent (and ongoing) declines were also evident at other sites, such as Bowentown Beach, Ngunguru Estuary, and Whangamatā and Whangateau harbours, but density estimates remained relatively high overall. At Eastern Beach and Umupuia Beach, cockles remained a low densities, following marked decreases earlier in the survey series.

Population size compositions, combined for all sites, documented the consistent strength of the medium cockle size class over time (Figure 59). Medium-sized cockles dominated the unimodal populations, with varying numbers of recruits indicating variable recruitment across surveys. Large individuals were scarce throughout most of the survey series, with few populations containing cockles at shell length above the 30-mm threshold, particularly since 2006–07.

Temporal trends in the densities of large cockles documented marked declines early in the survey series at most sites, excepting Eastern Beach and Hokianga Harbour (Figure 60). At Eastern Beach, large cockle densities increased steadily after lacking at this beach at the start of the survey series. At Hokianga Harbour, large cockles were consistently scarce, with considerable uncertainty around their low estimates. At Bowentown Beach, the marked decline early in the time series was followed by a lack of this size class in most surveys, except in the current assessment. At the remaining sites, the considerable decline in large cockles at some point has led to their continued absence or scarcity.

Table 55: Estimates of cockle abundance for all sites where more than ten cockles were found in the 2025–26 survey. For each site, the table includes the estimated mean number, the mean density, and coefficient of variation (CV) for all cockles (total) and for large cockles (≥30 mm shell length).

Survey site	Population estimate			Population ≥30 mm		
	Total (millions)	Density (m^{-2})	CV (%)	Total (millions)	Density (m^{-2})	CV (%)
Bowentown Beach	20.40	1 362	6.15	0.86	58	10.12
Eastern Beach	56.70	252	11.80	15.84	70	20.81
Grahams Beach	6.91	26	19.38	0.08	<1	>100
Hokianga Harbour	31.92	317	12.60	0.15	1	54.37
Little Waihi Estuary	37.50	226	20.59	0.89	5	97.95
Mangawhai Harbour	64.83	904	8.68	1.82	25	23.3
Ngunguru Estuary	62.19	1 083	12.78	1.19	21	40.61
Umupuia Beach	40.82	121	18.34	16.33	48	25.71
Whangamatā Harbour	88.52	1 080	9.51	1.67	20	29.25
Whangateau Harbour	506.88	457	11.53	23.31	21	41.12

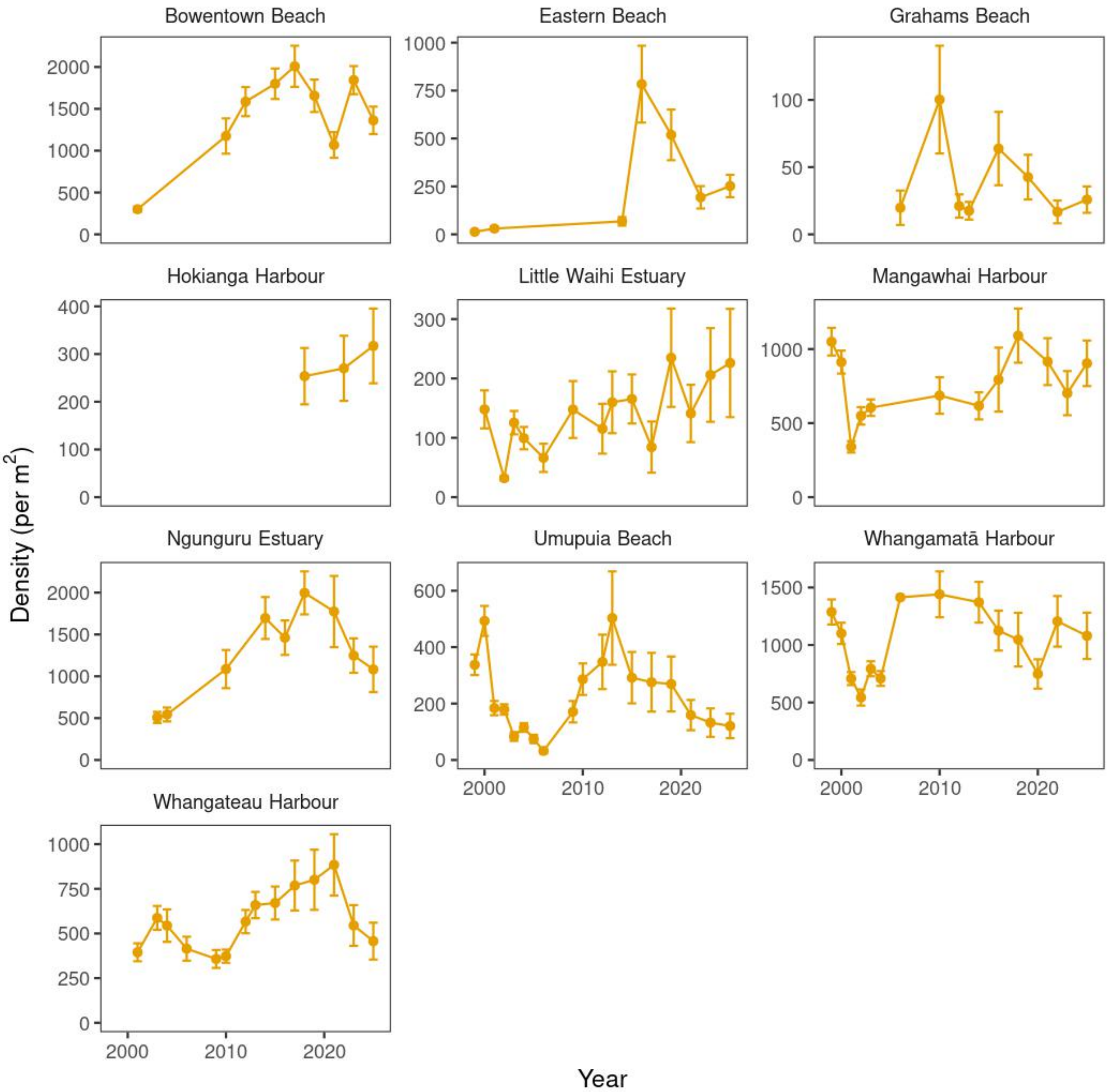

Figure 58: Estimated density of cockles for all sites supporting cockle populations in the 2025–26 survey. Shown are the mean estimated densities across years, with bars indicating the 95% confidence interval. (Note different scales on the y-axes. Not all sites were surveyed each year, and the sampling extent may vary across years.)

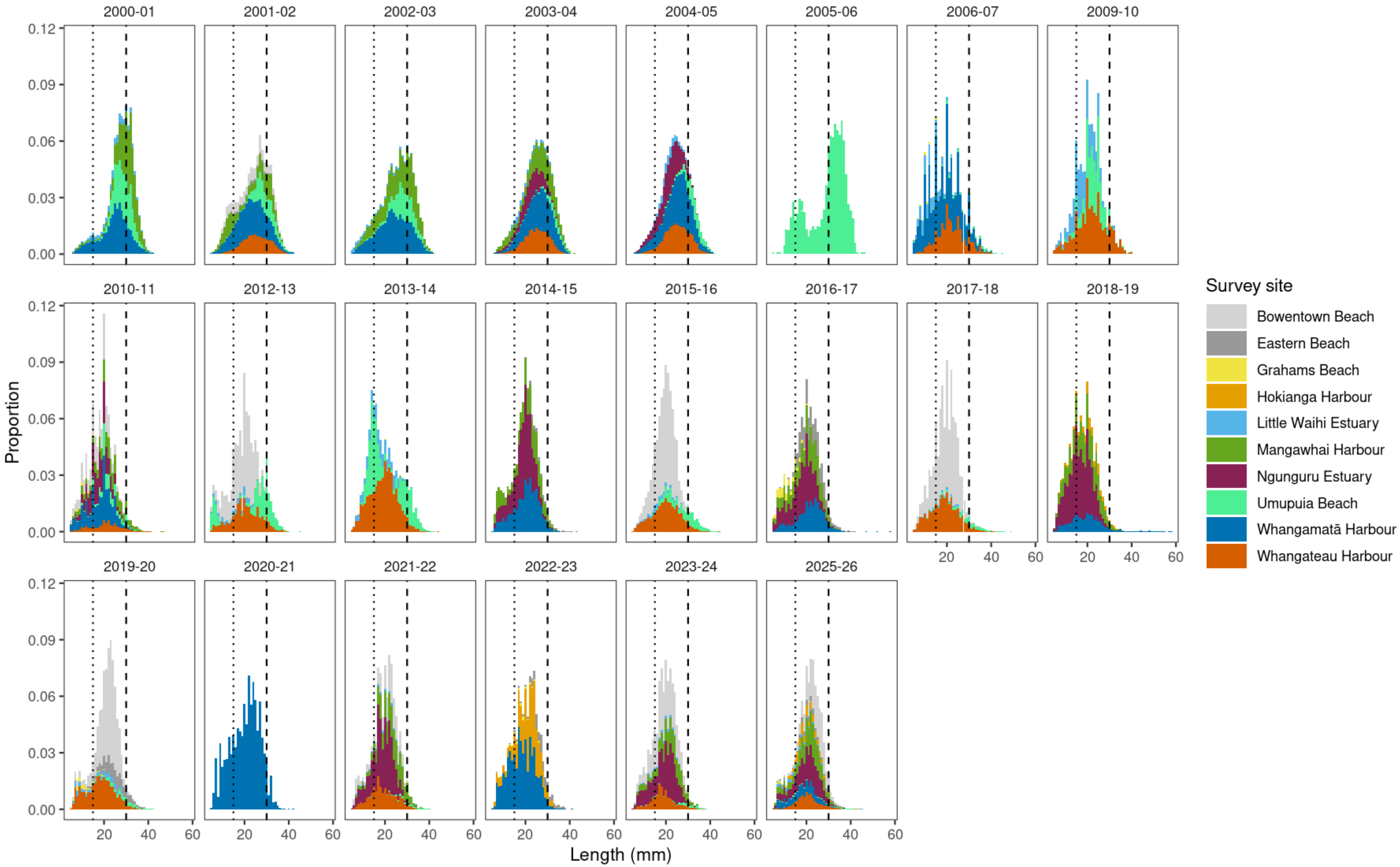

Figure 59: Weighted length-frequency (LF) distributions of cockles over time at sites included in the 2025–26 survey. LF distributions were estimated independently for all strata in each survey to provide the total LF distribution. Vertical dotted and dashed lines indicate the cut-off sizes for recruits and large individuals, respectively. (Note, not all sites were surveyed each year, and the sampling extent may vary across years.)

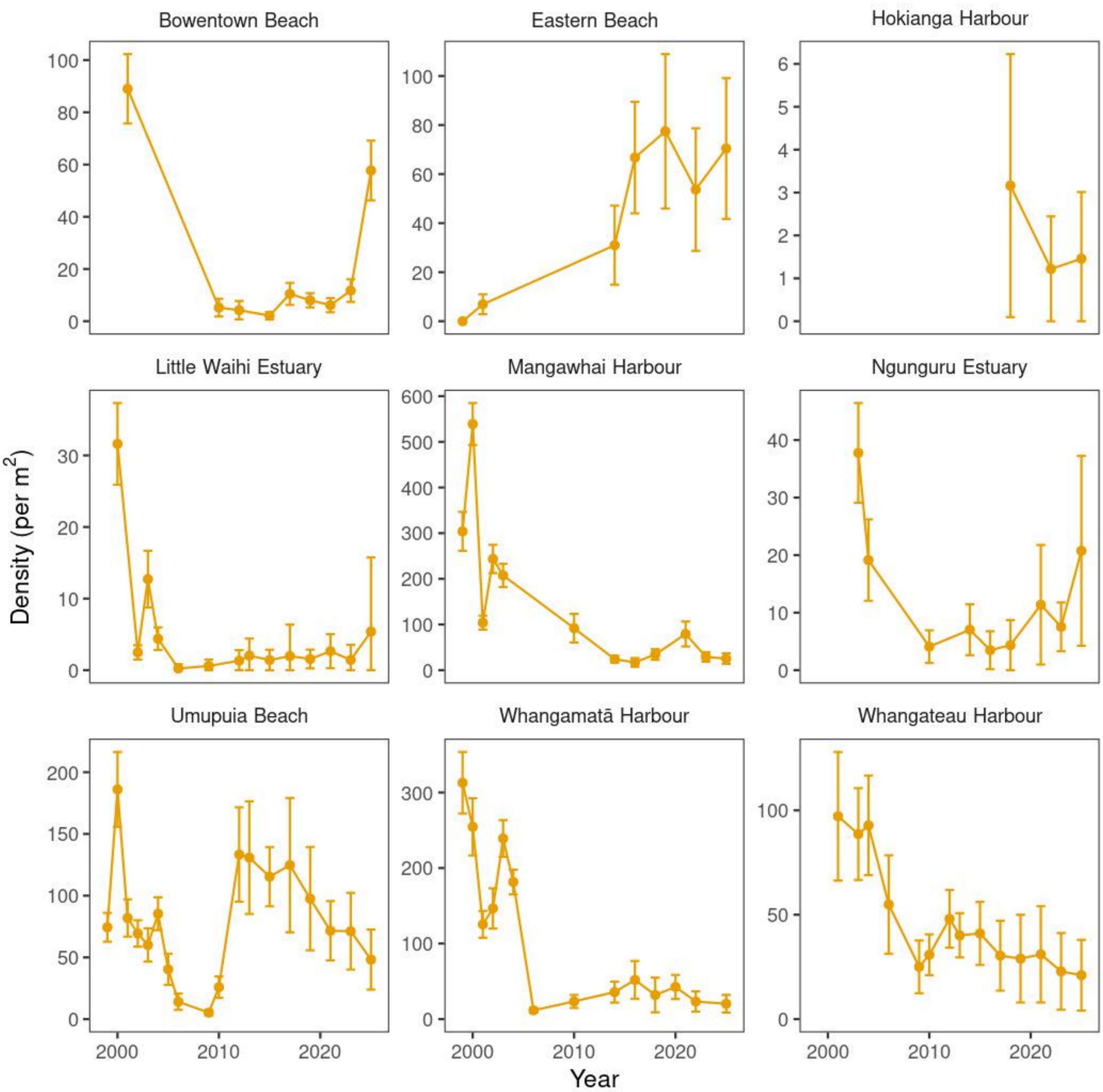

Figure 60: Estimated density of large cockles (≥30 mm shell length) for all 2025–26 sites where cockles in this size class were present in at least one survey. Shown are the mean estimated densities across years, with bars indicating the 95% confidence interval. (Note, different scales on the y-axes. Not all sites were surveyed each year, and the sampling extent may vary across years.)

4.2 Pipi populations

Pipi populations were present at eight of the sites, with considerable variation in their abundance and density estimates (Table 56). Total abundance estimates were particularly low at Bowentown Beach and Marsden Bank with an estimated 0.17 million (CV: 15.76%) and 0.96 million (CV: 16.37%) individuals, respectively. The most-abundant pipi population was at Little Waihi Estuary, based on an estimated 115.37 million (CV: 12.77%) individuals. At two sites, Grahams Beach and Whangateau Harbour, the CV associated with population estimates exceeded 20%, in spite of phase-2 sampling. At Grahams Beach, individual pipi were scarce across the sampling extent, and only present in highly-localised spots; there was no designated pipi bed. At Whangateau Harbour, the CV was high for estimates based on the entire sampling extent, which included four cockle strata, while pipi were confined to a high-density bed (i.e., $\geq$1000 per m^2) in a separate stratum. At Little Waihi Estuary, the high pipi abundance estimate was accompanied by the highest density, estimated at 695 pipi per m^2, followed by Hokianga Harbour with 333 (CV: 12.46%) pipi per m^2. Notable populations of large pipi ($\geq$50 mm shell length), with densities exceeding single-digit estimates, were only included in two populations: at Marsden Bank, their average density was estimated at 25 (CV: 24.81%) large pipi per m^2, and at Whangamatā Harbour at 22 (CV: 16.78%) large pipi per m^2.

Considering temporal trends in pipi populations across surveys documented declines at each site, but the timing and magnitude of the decline varied across some of the sites (Figure 61). At Grahams Beach, Little Waihi Estuary, Marsden Bank, and Whangamatā and Whangateau harbours, marked decreases in pipi densities occurred early or part-way through the survey series, and failed to subsequently return to initial high estimates. This finding was particularly pronounced at Marsden Bank, where high densities in early surveys were followed by a lack of pipi in 2021–22. At Bowentown Beach, Hokianga Harbour, and Ngunguru Estuary, densities declined in recent years, but remained comparatively high at the latter two sites.

Combined length-frequency distributions illustrated changes in population size structure over time, most notably shifts between unimodal and bimodal population compositions (Figure 62). Medium-sized pipi consistently formed the strongest cohort, augmented by varying proportions of large pipi, dependent on the survey year. At the same time, a strong influx of recruits in some years resulted in a second, smaller cohort formed by this size class.

Time series data of large pipi were characterised by density estimates that had considerable uncertainty (i.e., the 95% confidence intervals) (Figure 63). Across the seven sites where large pipi were present in at least one survey, current estimates for this size class were markedly lower than in earlier surveys, reflecting the general scarcity of this size class. For example, only Marsden Bank and Whangamatā Harbour had notable density estimates of large pipi in this assessment, exceeding twenty large individuals per square metre. At Marsden Bank, the present estimate documented a return of individuals in this size class following their absence since 2009–10.

Table 56: Estimates of pipi abundance for all sites where more than ten pipi were sampled in the 2025–26 survey. For each site, the table includes the estimated mean number, the mean density, and coefficient of variation (CV) for all pipi (total) and for large pipi ($\geq$50 mm shell length).

Survey site	Population estimate			Population $\geq$50 mm		
	Total (millions)	Density (m^{-2})	CV (%)	Total (millions)	Density (m^{-2})	CV (%)
Bowentown Beach	0.17	11	15.76	0.02	1	38.05
Grahams Beach	2.84	11	33.54	0.00	0	
Hokianga Harbour	33.48	333	12.46	0.07	<1	93.95
Little Waihi Estuary	115.37	695	12.77	1.31	8	33.30
Marsden Bank	0.96	205	16.37	0.12	25	24.81
Ngunguru Estuary	11.92	207	10.74	0.30	5	18.75
Whangamatā Harbour	7.84	96	15.96	1.83	22	16.78
Whangateau Harbour	7.60	7	32.51	0.39	<1	15.57

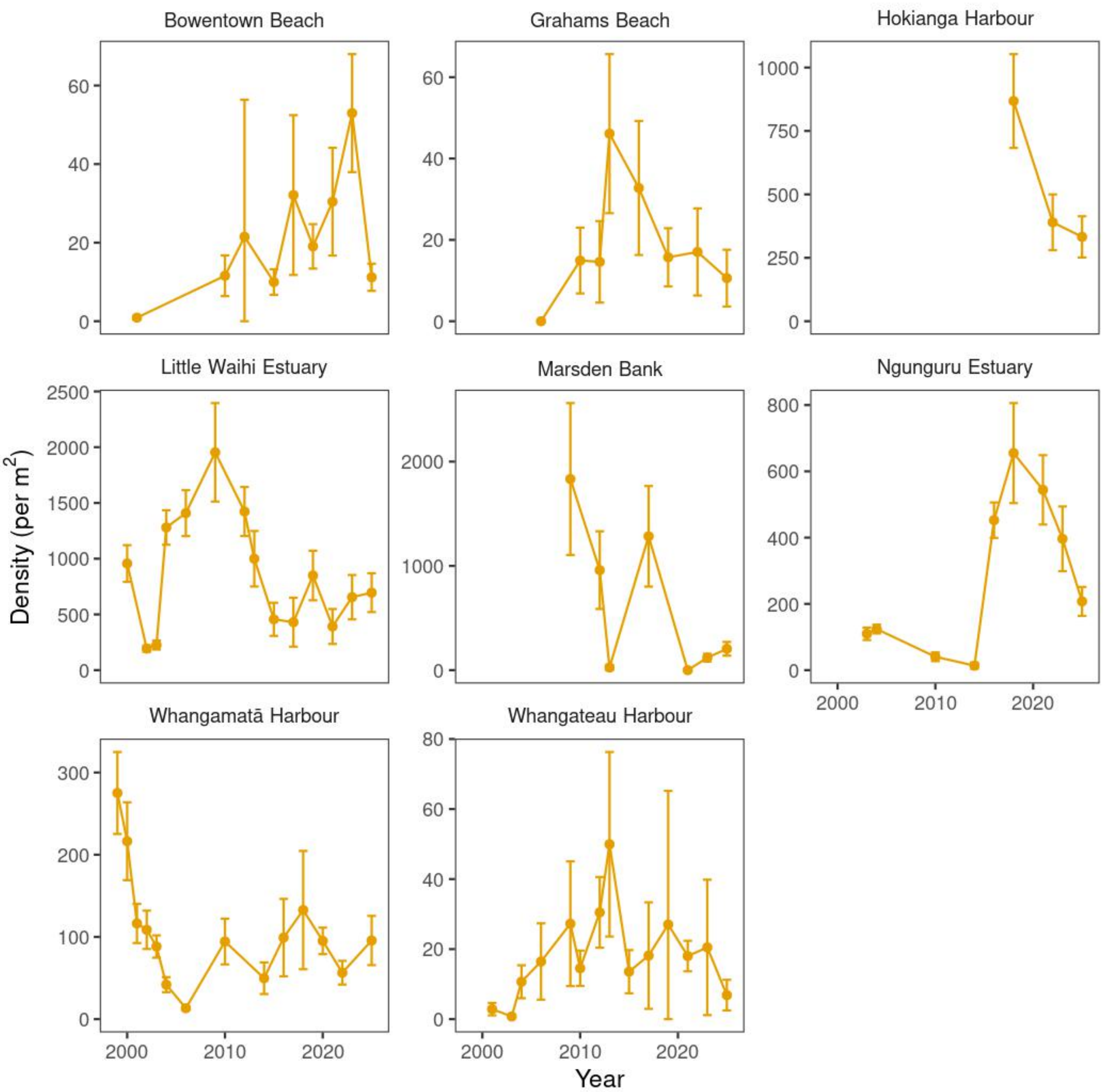

Figure 61: Estimated density of pipi for all sites supporting pipi populations in the 2025–26 survey. Shown are the mean estimated densities across years, with bars indicating the 95% confidence interval. (Note different scales on the y-axes. Not all sites were surveyed each year, and the sampling extent may vary across years.)

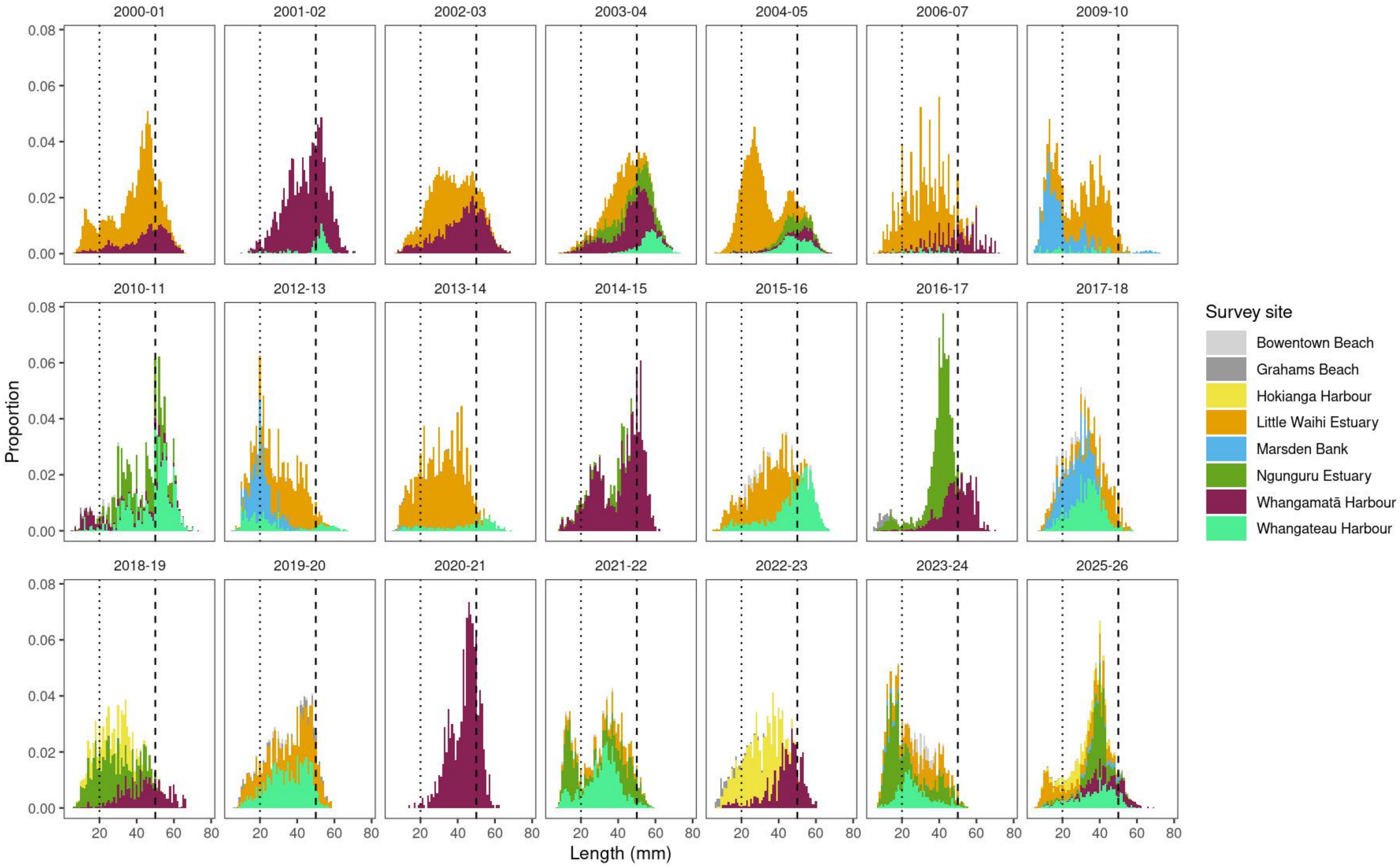

Figure 62: Weighted length-frequency (LF) distributions of pipi over time at sites included in the 2025–26 survey. LF distributions were estimated independently for all strata in each survey to provide the total LF distribution. Vertical dotted and dashed lines indicate the cut-off sizes for recruits and large individuals, respectively. (Note, not all sites were surveyed each year, and the sampling extent may vary across years.)

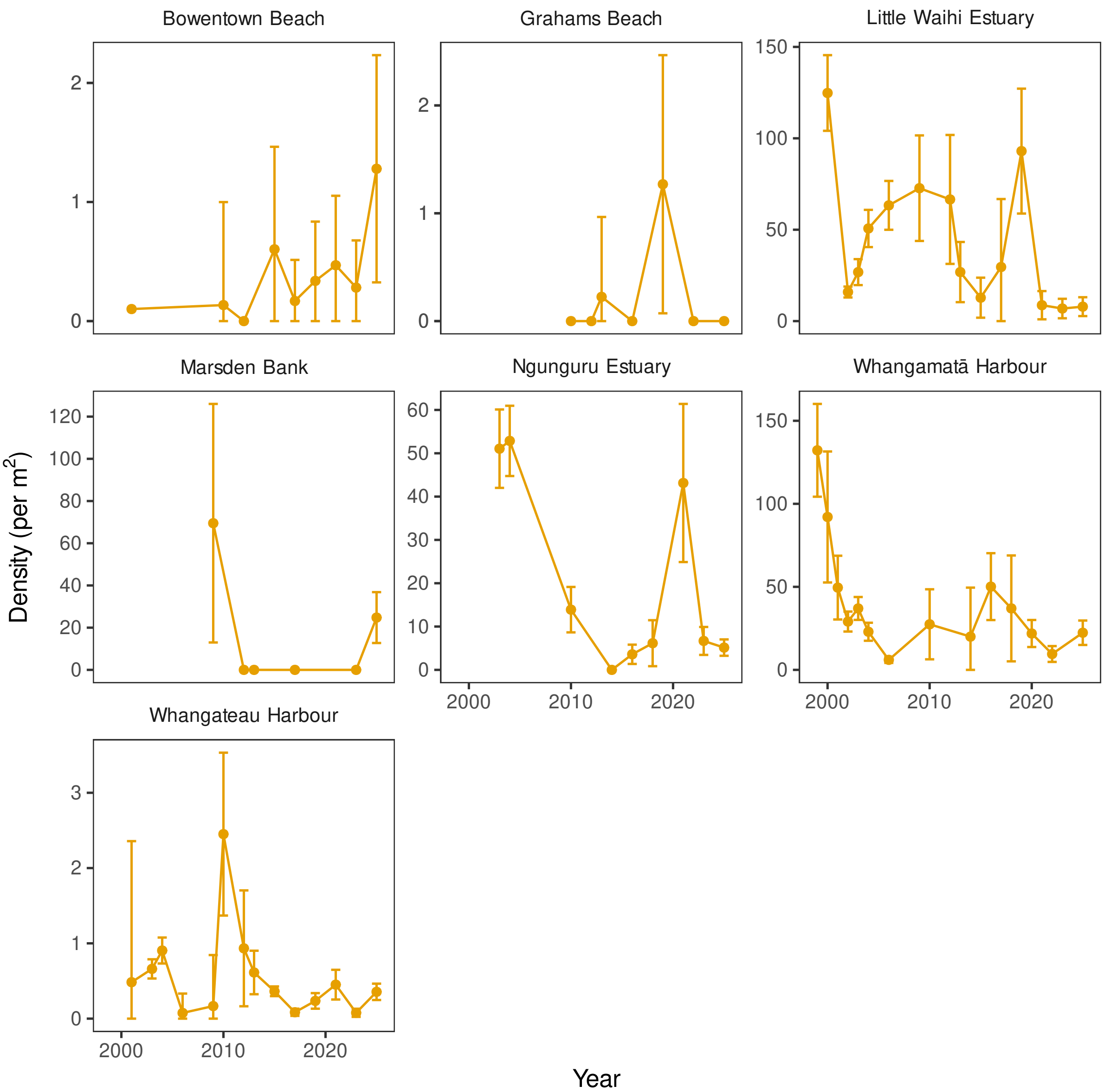

Figure 63: Estimated density of large pipi (≥50 mm shell length) for all 2025–26 sites where pipi in this size class were present in at least one survey. Shown are the mean estimated densities across years, with bars indicating the 95% confidence interval. (Note, different scales on the y-axes. Not all sites were surveyed each year, and the sampling extent may vary across years.)

4.3 Sediment data

Comparison of sediment samples from the cockle strata documented sediment low in organic content at each site, with organic matter averaging between 0.8% (Mangawhai Harbour) and 2.6% (Whangateau Harbour) (Figure 64). The most prevalent grain size fractions were fine sand (grain size >125 µm) and medium sand (>250 µm) across all sites.

Hokianga Harbour was the only site which also contained a considerable proportion of gravel (grain size >2000 µm), an average 19.8%. Most sites only had a small average proportion of sediment fines (<63 µm); however, individual samples at Bowentown Beach, Hokianga Harbour, Umupuia Beach, and Whangamatā and Whangateau harbours contained over 10% of sediment fines. At Umupuia Beach, high proportions (up to 72.2%) of sediment fines in several samples led to an average of 11% of sediment at this grain size fraction.

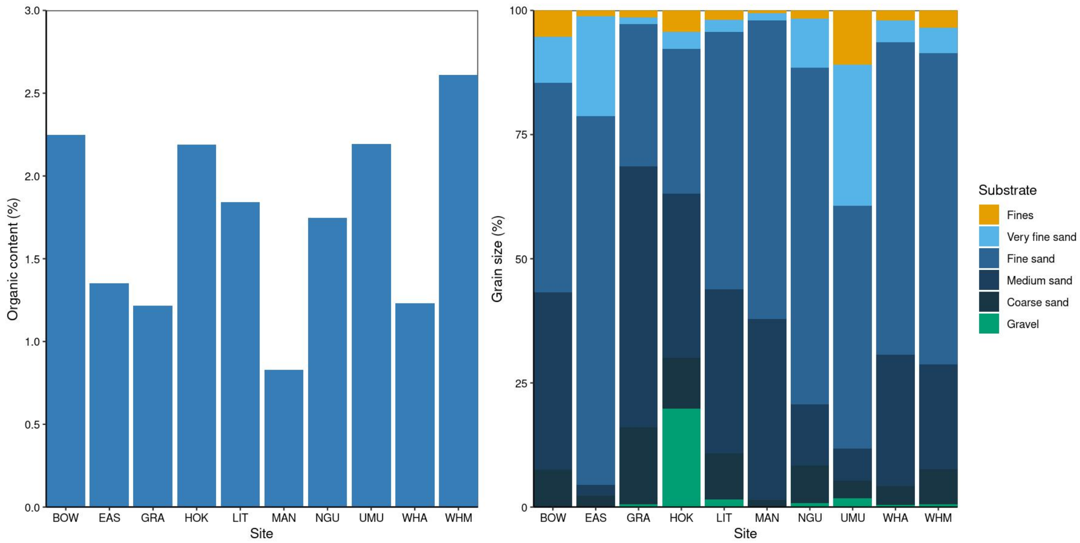

Figure 64: Sediment organic content and grain size composition (averages per site) at the 2025–26 northern survey sites with cockle strata. Sediment grain size fractions are defined as fines (silt and clay) ≤63 µm, very fine sand >63 µm, fine sand >125 µm, medium sand >250 µm, coarse sand >500 µm, and gravel >2000 µm. The sites were Bowentown Beach, Eastern Beach, Grahams Beach, Hokianga Harbour, Little Waihi Estuary, Mangawhai Harbour, Ngunguru Estuary, Umupuia Beach, Whangateau Harbour, and Whangamatā Harbour.

4.4 Geostatistical model predictions of cockle density

Geostatistical models were updated for all of the sites with cockle populations, allowing the visual inspection of spatial patterns in predicted cockle densities over time (see Appendix C, Figures C-1 to C-10). The current update included corrections from the previous modelling for the large cockle size class, as earlier models included data for the medium size class.

At Eastern Beach, high-density areas ("hotspots") of the total cockle population determined by the large cockle size class, with an overall reduction in densities indicated for the two most recent surveys (Figure C-2). Similar patterns and temporal trends were evident at Umupuia Beach (Figure C-8). There were no distinct high-density large cockle areas at any of the remaining sites. In addition, there were no high-density cockle areas overall at Grahams Beach (Figure C-3).

At Hokianga Harbour and Ngunguru Estuary, both the overall density and the spatial extent of the high-density areas were markedly reduced in 2025–26 (Figures C-4 and C-7).

At Little Waihi Estuary, Mangawhai Harbour, Whangamatā and Whangateau harbours, densities remained relatively unchanged and with consistent spatial patterns over time (Figures C-5, C-6, C-9, and C-10).

5. DISCUSSION

The 2025–26 survey assessed bivalve population at a range of sites across the northern North Island region. There were four sites in the Auckland region: Eastern Beach, Grahams Beach, Umupuia Beach, and Whangateau Harbour; four sites in Northland: Hokianga Harbour, Mangawhai Harbour, and Ngunguru Estuary, and Marsden Bank; one site in Waikato: Whangamatā Harbour; and two sites in Bay of Plenty: Bowentown Beach and Little Waihi Estuary. The intertidal habitats ranged from sheltered beaches to different-sized estuaries and tidal inlets.

All of the cockle and pipi populations have been repeatedly surveyed previously, in usually biennial assessments in recent years. Dependent on the site, the survey frequency varied from three assessments at Hokianga Harbour to 18 surveys at Umupuia Beach. Hokianga Harbour was added to the survey programme relatively recently, in 2018–19, whereas the remaining longer-standing sites were surveyed between 7 and 14 times.

The frequent population surveys have provided extensive time-series data that allow the examination of trends over time. The latter include documented fluctuations in recruitment for both bivalve species, which have influenced the population size and composition at a number of sites. Examples include the cockle populations at Grahams Beach, Little Waihi Estuary, and Whangamatā Harbour, where strong recruitment augmented the population overall, indicated by the high proportion (i.e., over 25%) of individuals in the recruits size class. At Grahams Beach, recruits made up about 80% of the present population, with fluctuations in the proportions of recruits and medium-sized cockles in recent surveys. This pattern was similar for the pipi population at Grahams Beach, highlighting the importance of recruitment events to sustain the bivalve populations at this site. Nevertheless, it also documented the failure of recruits to consistently contribute to larger size classes to support the formation of a stable population, particularly for pipi.

At Marsden Bank, marked declines leading to the loss of the pipi population in 2021–22 were followed by substantial recruitment in 2023–24, when over 87% of the pipi population consisted of recruits. The current estimates documented the successful retention of a high number of these recruits, and also their growth into the medium size class, following the loss of the pipi population in 2021–22. In addition, growth of individuals also led to an increase in the large pipi size class, following their absence since 2012–13. These data indicate some recovery and re-establishment of the pipi population at Marsden Bank, although their overall distribution remained limited to a small area close to a main channel. Ongoing surveys of the pipi kōkotoa population by Patuharakeke Te Iwi Trust Board document similar findings, with notable increases in pipi abundance and individual sizes recorded between 2024 and 2025 (Patuharakeke Te Iwi Trust Board 2025b). The same survey also reported a pipi mass mortality event in April 2025, which was tentatively linked to adverse temperatures and light intensity.

Frequent and strong recruitment is an important requirement for sustaining bivalve populations, and recruits are particularly vulnerable to predation and other factors impacting their successful settlement and retention. For cockles, post-settlement success of recruits has been shown to be influenced by the density of large cockles (i.e., exceeding 38 mm shell length), highlighting the importance of large individuals for maintaining stable populations (Fenton et al. 2024).

Large individuals were generally scarce or absent in both cockle and pipi populations across the 2025–26 northern sites. For cockles, only the populations at Eastern Beach and Umupuia Beach supported notable proportions (i.e., over 25%) of large individuals. This finding was consistent with earlier surveys (e.g., see Berkenbusch & Neubauer 2020, Berkenbusch et al. 2022), indicating the persistence of large cockles at these sites. Both beaches have been closed to the take of bivalves for a considerable time, and as large individuals are considered to be preferentially taken in shellfish collections (Hartill et al. 2005), the closures may have supported the persistence of this size class within the resident cockle populations.

In contrast, the ongoing closure of Whangateau Harbour has not been reflected in the cockle population size composition, with only few large individuals at this site. This scarcity of large cockles has been ongoing since 2017–18 (Berkenbusch & Neubauer 2020), with less than 5% of all individuals in this size class. A comprehensive analysis of cockle population data has highlighted the considerable decline of large cockles in the harbour following a mass mortality event in 2009 (Tricklebank et al. 2021). Although this size class has persisted since then, large cockles have remained at low densities compared with a high abundance and density preceding the mortality event.

An important factor influencing the distribution and abundance of cockles (and pipi) is the sediment mud content (sediment fines, grain size <63 micron) (Thrush et al. 2005, Anderson 2008). Increases in sediment fines have been shown to lead to decreases in the abundance of both species. Cockles appear to prefer sediment that contains less than 11% in this grain size fraction, evident in their comparatively higher abundances when the proportion of fines is below this percentage.

At five of the 2025–26 sites, the proportion of sediment fines exceeded 10%, including single samples at Bowentown Beach, Hokianga Harbour, and Whangamatā and Whangateau harbours. At Umupuia Beach, four samples contained sediment with a high proportion of fines, ranging from 23.5 to 72.2%. This finding is consistent with previous sediment analyses (e.g., Berkenbusch et al. 2022, Berkenbusch & Hill-Moana 2024), indicating the degradation of cockle habitat at this beach.

The use of geostatistial models was first investigated in 2015–16 to determine the optimal shape and location of strata at each site prior to the field sampling (Berkenbusch & Neubauer 2016); this approach continues to be used for the stratification of survey sites. The exploration of the geostatistical modelling was extended in 2021 to derive geostatistical estimates and compare them to survey-based estimates of the cockle populations (Tremblay-Boyer et al. 2021). The outcomes of the comparison varied, with more precise estimates for some sites, but with some sensitivity to the model configuration and implausible estimates for other sites. For this reason, the monitoring series has continued to use survey-based estimates for the assessment of cockle populations. Nevertheless, geostatistical models have been used since 2021–22 for the visual inspection of temporal and spatial patterns in predicted cockle densities, including the tracking of shifts in high-density hotspots over time (Berkenbusch et al. 2022). This modelling aimed to provide separate maps for the total population and the large cockle size class; however, the current update uncovered that the data inputs for models of the large size class erroneously included medium-sized cockles, and only omitted recruits. This error has been corrected in the current update. The updated maps accurately reflect predictions of large cockle densities, negating previous maps for this size class. Maps of predicted total cockle densities have not been affected by this error.

The current maps of predicted large cockle densities highlighted the scarcity of this size class at most sites. The dearth of large cockles means that the geostatistical modelling provides little information about which size class may be determining the observed density patterns, including over time (e.g., see Figures C-1 and C-4). At the same time, at sites with strong recruitment events, geostatistical predictions for this size class may provide valuable information of its spatial extent and changes over time. Tracking the spatial distribution of predicted recruits densities across surveys would provide a visual assessment of their contribution to the total population; e.g., by comparing density hotspots between the total population and recruits, and assessing changes over time (see example in Appendix D, Figure D-1). The inclusion of the recruits (and large) size class may be decided based on their relative contribution to the total population (e.g., 25% of all individuals), to gain an improved understanding of spatio-temporal population dynamics through the application of geostatistical models.

6. FULFILMENT OF BROADER OUTCOMES

As required under Government Procurement rules,[2] Fisheries New Zealand considered broader outcomes (secondary benefits such as environmental, social, economic or cultural benefits) that would be generated by this project.

Provided below are the broader outcomes specific to this project.

- The findings from the surveys support local iwi and hapū in their efforts to look after kaimoana species and coastal environments. We actively engage with iwi contacts to provide information about the survey, with subsequent updates about the survey outcomes.
- The project supports local businesses across the northern North Island region, including rental car companies, accommodation providers, and food stores. As the timing of the field surveys is outside of holiday periods, this support complements the main tourism income for many of these businesses, including in relatively remote locations.
- As part of this project, we are purposefully transferring knowledge and responsibility from the experienced project lead to the early-career scientist who is part of the Dragonfly project team. This transfer has been planned as a gradual process, allowing the development of skills and expertise over the course of the project, with ongoing support from the senior project lead. This aspect is also relevant in the context of supporting a Māori graduate in their professional development, and expanding their research skills towards leading fisheries research (and other) projects in the future.
- The fixed-term recruitment of staff members for the field surveys provides postgraduate students and recent graduates in relevant earth science domains with practical research and work experience. In addition to expanding their skillset, this work experience also provides an income opportunity over the summer months.
- Both project scientists are female, and recruitment to the survey team is open to candidates from a range of ethnic backgrounds and gender identification. Past survey teams have reflected this diversity, and we continue our inclusive approach regarding all aspects of this project.
- One of the project scientists is affiliated to hapū and iwi of Waikato-Tainui, Rongowhakaata and Te Aitanga a Mahaki. For her, being involved in this project builds stronger connections with tangata whenua around the motu and enables her to exercise kaitiakitanga of the taiao and taonga species.
- At a number of beaches, the bivalve surveys are important for resident communities, iwi, and hapū, where these coastal environments are an intrinsic part of cultural identity and wellbeing. To support this aspect, we endeavour to engage with local communities through their contacts, informing them of the surveys and the survey outcomes. This engagement also includes regional councils and unitary authorities that manage coastal environments and resources on behalf of their residents.

[2] https://www.procurement.govt.nz/principles-charter-and-rules/government-procurement-rules/planning-your-procurement/broader-outcomes/

7. ACKNOWLEDGEMENTS

We are grateful to the field team for helping collect the survey data: Calum Doughty, Natalie Fromont, Etasha Golden, Oliver Stephenson, and Alan Wood.

Many thanks to Emma Crawford for processing and analysing the sediment samples. Beth McKinnel provided logistical support for the reconnaissance and the field survey.

Our thanks are extended to the local communities and iwi who share their knowledge of the sites and provide guidance for the surveys. Particular thanks go to Arvay Armstrong-Read (Te Waiariki, Ngāti Kororā, Ngāti Takapari Hapū Iwi Trust; Ngunguru Estuary) and to Hollie Kereopa and her team (Patuharakeke Te Iwi Trust Board; Marsden Bank) for supporting this kaupapa. Nick Bamford (Northland Regional Council) and Sheena Ross (Ngāti Korokoro Hapū) provided information and unpublished data for Hokianga Harbour.

Aerial imagery data were sourced from the LINZ Data Service. These data are licensed for reuse under the CC BY 4.0 licence.

The project was funded by Fisheries New Zealand, under project code AKI2024-01. We thank Dr Marine Pomarède (Fisheries New Zealand) for her guidance and review of this report.

8. REFERENCES

Anderson, M.J. (2008). Animal-sediment relationships re-visited: Characterising species' distributions along an environmental gradient using canonical analysis and quantile regression splines. *Journal of Experimental Marine Biology and Ecology 366 (1)*: 16–27.

Beentjes, M.P. (2021). Cockle (*Austrovenus stutchburyi*) survey of Otago Harbour in 2020. *New Zealand Fisheries Assessment Report 2021/02*. 49 p.

Berkenbusch, K.; Abraham, E.; Neubauer, P. (2015). Intertidal shellfish monitoring in the northern North Island region, 2013–14. *New Zealand Fisheries Assessment Report 2015/15*. https://fs.fish.govt.nz/Page.aspx?pk=113&dk=23774. 83 p.

Berkenbusch, K.; Hill-Moana, T. (2024). Intertidal shellfish monitoring in the northern North Island region, 2023–24. *New Zealand Fisheries Assessment Report 2024/35*. https://fs.fish.govt.nz/Page.aspx?pk=113&dk=25759. 110 p

Berkenbusch, K.; Hill-Moana, T. (2025). Intertidal shellfish monitoring in the northern North Island region, 2024–25. *New Zealand Fisheries Assessment Report 2025/27*. https://fs.fish.govt.nz/Page.aspx?pk=113&dk=25997. 111 p

Berkenbusch, K.; Hill-Moana, T.; Neubauer, P. (2022). Intertidal shellfish monitoring in the northern North Island region, 2021–22. *New Zealand Fisheries Assessment Report 2022/57*. https://fs.fish.govt.nz/Page.aspx?pk=113&dk=25318. 142 p.

Berkenbusch, K.; Neubauer, P. (2015). Intertidal shellfish monitoring in the northern North Island region, 2014–15. *New Zealand Fisheries Assessment Report 2015/59*. https://fs.fish.govt.nz/Doc/23960/FAR_2015_59_2933_AKI%202014-01.pdf.ashx. 110 p.

Berkenbusch, K.; Neubauer, P. (2016). Intertidal shellfish monitoring in the northern North Island region, 2015–16. *New Zealand Fisheries Assessment Report 2016/49*. https://fs.fish.govt.nz/Page.aspx?pk=113&dk=24186. 108 p.

Berkenbusch, K.; Neubauer, P. (2017). Intertidal shellfish monitoring in the northern North Island region, 2016–17. *New Zealand Fisheries Assessment Report 2017/51*. https://fs.fish.govt.nz/Page.aspx?pk=113&dk=24505. 103 p.

Berkenbusch, K.; Neubauer, P. (2020). Intertidal shellfish monitoring in the northern North Island region, 2019–20. *New Zealand Fisheries Assessment Report 2020/38*. https://fs.fish.govt.nz/Page.aspx?pk=113&dk=24836. 103 p.

Department of Internal Affairs (1994). Fisheries (Eastern Beach Shellfish Closed Season) Notice (Notice No. 1994-go363). *New Zealand Gazette* 13 January 1994 *(1994-go363)*: 50.

Department of Internal Affairs (1995). Fisheries (Eastern Beach Shellfish Closed Season) Notice (Notice No. 1995-go8326). *New Zealand Gazette* 14 December 1995 *(1995-go8326)*: 4773.

Department of Internal Affairs (2015). Fisheries (Whangateau Harbour Cockle and Pipi Harvest Closure) Notice 2015 (Notice No. MPI 567). *New Zealand Gazette* 10 December 2015 *(2015-go-7264)*: 1.

Department of Internal Affairs (2022). Fisheries (Marsden Bank and Mair Bank Temporary Closure) Notice 2022 (MPI 1498). *New Zealand Gazette* 27 June 2022 *(2022-sl2567)*: 1.

Department of Internal Affairs (2024a). Fisheries (Rehuotane Ki Tai Temporary Closure and Method Prohibition) Notice 2024 (MPI 1709). *New Zealand Gazette* 10 January 2024 *(2024-go14)*: 1.

Department of Internal Affairs (2024b). Fisheries (Umupuia Beach Temporary Closure) Notice 2024 (Notice No. MPI 1854). *New Zealand Gazette* 5 August 2024.

Eleftheriou, A.; McIntyre, A. (2005). *Methods for the study of marine benthos*. Blackwell Science, Oxford, United Kingdom. 418 p.

Fenton, K.F.; Salmond, N.H.; Foreman, S.E.; Curtis, J.S.; Jowett, T.; Savage, C.; Wing, S.R. (2024). High densities of large tuaki, the New Zealand cockle *Austrovenus stutchburyi*, provide a post-settlement predation refuge for conspecific juveniles. *Marine Ecology Progress Series 726*: 85–98.

Francis, R.I.C.C. (2006). Optimum allocation of stations to strata in trawl surveys. *New Zealand Fisheries Assessment Report 2006/23*. 51 p.

Grant, C.M.; Hay, B.E. (2003). A review of issues related to depletion of populations of selected infaunal bivalve species in the Hauraki Gulf Marine Park. A report prepared for the Hauraki Gulf Marine Park Forum by AquaBio Consultants Limited. (Unpublished report held by Auckland Regional Council, Auckland.)

Hartill, B.; Morrison, M.A.; Cryer, M. (2005). Estimates of biomass, sustainable yield and harvest: Neither necessary nor sufficient for the management of amateur intertidal fisheries. *Fisheries Research 71*: 209–222.

Heinemann, A.; Gray, A. (2024). National panel survey of marine recreational fishers 2012–23. *New Zealand Fisheries Assessment Report 2024/51*. 116 p.

Hewitt, J.E.; Cummings, V.J. (2013). Context-dependent success of restoration of a key species, biodiversity and community composition. *Marine Ecology Progress Series 479*: 63–73.

Hewitt, J.; Hatton, S.; Safi, K.; Craggs, R. (2001). Effects of suspended sediment levels on suspension-feeding shellfish in the Whitford embayment. *Auckland Regional Council, Technical Publication No. 159*.

Hooker, S.H. (1995). Life history and demography of the pipi - *Paphies australis* (Bivalvia: Mesodesmatidae) in northeastern New Zealand. (Doctoral dissertation). University of Auckland, Auckland, New Zealand.

Hooker, S.H.; Creese, R.G. (1995). The reproductive biology of pipi, *Paphies australis* (Gmelin, 1790)(Bivalvia: Mesodesmatidae). I. Temporal patterns of the reproductive cycle. *Journal of Shellfish Research 14 (1)*: 7–15.

Howells, J.; Maria, L.; Shirkey, T.; Carrington, A.; Lane, H.S. (2024). Testing a health baseline during a bivalve mollusc mortality event: An investigation into die-offs of pipi *Paphies australis* from Aotearoa New Zealand. *Journal of Invertebrate Pathology*: 108110.

Kainamu-Murchie, A.A.; Marsden, I.D.; Tau, R.T.M.; Gaw, S.; Pirker, J. (2018). Indigenous and local peoples' values of estuarine shellfisheries: Moving towards holistic-based catchment management. *New Zealand Journal of Marine and Freshwater Research 52 (4)*: 526–541.

Kettle, T. (2021). *Mātauranga Māori to inform understanding of population dynamics and health of pipi in Waihī Estuary, Bay of Plenty*. Retrieved April 30, 2026, from https://researchcommons.waikato.ac.nz/server/api/core/bitstreams/1525843a-dda5-481d-bbb1-8802a1363e8a/content

Larcombe, M.F. (1971). Ecology, population dynamics, and energetics of some soft shore molluscs. (Doctoral dissertation). University of Auckland, Auckland, New Zealand.

Lohrer, A.M.; Townsend, M.; Rodil, Y.F.; Hewitt, J.E.; Thrush, S.F. (2012). Detecting shifts in ecosystem functioning: The decoupling of fundamental relationships with increased pollutant stress on sandflats. *Marine Pollution Bulletin 64 (12)*: 2761–2769.

Morrison, M.A.; Pawley, M.D.M.; Browne, G.N. (1999). Intertidal surveys of shellfish populations in the Auckland region, 1997–98, and associated yield estimates. New Zealand Fisheries Assessment Research Document 1999/25. 25 p.

Morton, J.E.; Miller, M.C. (1973). *The New Zealand sea shore*. Collins, London. 653 p.

Neubauer, P.; Abraham, E.R.; Berkenbusch, K. (2015). Predictability of cockle (*Austrovenus stutchburyi*) population trends in New Zealand's northern North Island. *PeerJ PrePrints 3*: e1772. https://peerj.com/preprints/1422/

Neubauer, P.; Damodaran, D.; Berkenbusch, K. (2021). Bivalve abundance in relation to sediment properties across northern North Island. *New Zealand Fisheries Assessment Report 2021/49*. https://fs.fish.govt.nz/Page.aspx?pk=113&dk=24951. 21 p.

Patuharakeke Te Iwi Trust Board (2025a). Health investigation of kōkota/pipi, *Paphies australis*, from Whangārei, New Zealand. Unpublished report prepared by Patuharakeke Te Iwi Trust Board. 11 p.

Patuharakeke Te Iwi Trust Board (2025b). Patuharakeke annual kōkota survey 2025. Presentation prepared by Patuharakeke Te Iwi Trust Board.

Pawley, M.D.M. (2011). The distribution and abundance of pipis and cockles in the Northland , Auckland, and Bay of Plenty regions, 2010. *New Zealand Fisheries Assessment Report 2011/24*. 60 p.

Pawley, M.D.M.; Ford, R. (2007). Report for AKI2006/01. Final Research Report for Ministry of Fisheries Project AKl2006/01 (unpublished report held by Fisheries New Zealand, Wellington). 75 p.

Shirkey, T. (2024). Pipi monitoring programme final project report 2016–2020. Unpublished report prepared by Patuharakeke Te Iwi Trust Board.

Thrush, S.; Hewitt, J.E.; Herman, P.M.J.; Ysebaert, T. (2005). Multi-scale analysis of species-environment relationships. *Marine Ecology Progress Series 302*: 13–26.

Tremblay-Boyer, L.; Neubauer, P.; Berkenbusch, K.; Damodaran, D. (2021). Geostatistical estimates for intertidal shellfish monitoring in the northern North Island region, 2019–20. *New Zealand Fisheries Assessment Report 2021/77*. https://fs.fish.govt.nz/Page.aspx?pk=113&dk=25014. 70 p.

Tricklebank, K.A.; Grace, R.V.; Pilditch, C.A. (2021). Decadal population dynamics of an intertidal bivalve (*Austrovenus stutchburyi*) bed: Pre- and post-a mass mortality event. *New Zealand Journal of Marine and Freshwater Research 55 (2)*: 352–374.

APPENDIX A: Sampling dates and extent of northern North Island bivalve surveys

Table A-1: Sampling years (coloured blue) for sites included in the northern North Island bivalve surveys since 1999–2000. Fishing years are referred to by the latter year (e.g., 1999–2000 is shown as 2000).

Survey site	2000	2001	2002	2003	2004	2005	2006	2007	2010	2011	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Aotea Harbour							■		■				■		■		■		■		■			
Bowentown Beach			■							■	■			■		■		■		■		■		■
Cheltenham Beach														■										
Clarks Beach						■																		
Cockle Bay									■	■	■	■		■		■		■		■	■		■	
Cornwallis Wharf			■																					
Eastern Beach			■										■		■			■			■			■
Grahams Beach								■		■	■	■			■			■			■			■
Hokianga Harbour																	■				■			■
Howick Beach							■																	
Kawakawa Bay						■		■					■		■		■		■		■		■	
Little Waihi Estuary		■		■	■	■		■	■		■	■		■		■		■		■		■		■
Mangawhai Harbour	■	■	■	■	■					■			■		■		■			■		■		■
Marokopa Estuary							■			■				■										
Marsden Bank									■		■	■				■				■		■		■
Mill Bay	■	■	■		■	■	■		■				■			■	■			■			■	
Ngunguru Estuary					■	■				■			■		■		■			■		■		■
Ōhiwa Harbour			■				■	■	■		■			■			■		■		■		■	
Ōkahu Bay																							■	
Okoromai Bay	■		■	■	■	■		■	■		■	■		■		■			■		■		■	
Otūmoetai		■		■			■	■	■				■		■		■		■		■		■	
Papamoa Beach	■																							
Pataua Estuary				■	■		■					■		■		■		■		■	■		■	
Raglan Harbour	■	■		■	■				■		■		■			■		■		■		■		
Ruakākā Estuary								■		■			■		■		■			■		■		
Tairua Harbour	■	■	■	■			■	■		■		■		■		■		■		■		■		
Te Haruhi		■																						
Te Haumi Beach	■	■	■	■				■	■		■		■		■		■			■		■		
Te Mata Bay																			■	■		■		
Umupuia Beach	■	■	■	■	■	■	■	■	■	■	■	■		■		■		■		■		■		■
Waikawau Beach	■	■				■	■					■												
Waiotahe Estuary				■	■	■	■		■			■			■			■			■		■	
Whangamatā Harbour	■	■	■	■	■	■		■		■			■		■		■		■		■			■
Whangapoua Harbour				■	■	■	■			■			■		■		■		■		■		■	
Whangateau Harbour			■		■	■		■	■	■	■	■		■		■		■		■		■		■
Whitianga Harbour											■			■		■		■		■			■	

Table A-2: Sampling dates and size of the sampling extent for sites included in the northern North Island bivalve surveys since 1999–2000, including the present survey in 2025–26. Surveys are ordered by site and year.

Survey site	Year	Sampling dates	Sampling extent (ha)	Project
Aotea Harbour	2005–06	17 Jan–18 Jan	9.60	AKI2005-01
	2009–10	26 Mar–13 Jul	28.10	AKI2009-01
	2014–15	19 Feb	19.46	AKI2014-01
	2016–17	9 Feb	19.46	AKI2016-01
	2018–19	3 Feb	19.46	AKI2018-01
	2020–21	26 Feb	19.40	AKI2018-01
	2022–23	6 Feb	19.40	AKI2021-01
Bowentown Beach	2001–02	26 Apr–25 May	1.58	AKI2001-01
	2010–11	18 Mar	1.58	AKI2010-01
	2012–13	8 Feb	1.58	AKI2012-01
	2015–16	20 Jan	1.50	AKI2015-01
	2017–18	22 Feb	1.50	AKI2017-01
	2019–20	25 Feb	1.50	AKI2018-01
	2021–22	21 Feb–22 Feb	1.50	AKI2021-01
	2023–24	26 Feb	1.50	AKI2021-01
	2025–26	17 Feb	1.50	AKI2024-01
Cheltenham Beach	2015–16	14 Jan	31.92	AKI2015-01
Clarks Beach	2004–05	3 Feb–24 Feb	144.71	AKI2004-01
Cockle Bay	2009–10	16 Feb	16.00	AKI2009-01
	2010–11	5 May	16.00	AKI2010-01
	2012–13	31 Jan	16.00	AKI2012-01
	2013–14	29 Mar	15.77	AKI2013-01
	2015–16	18 Jan	15.77	AKI2015-01
	2017–18	27 Jan–28 Jan	15.77	AKI2017-01
	2019–20	15 Feb	15.77	AKI2018-01
	2021–22	17 Feb	15.59	AKI2021-01
	2022–23	11 Feb	15.77	AKI2021-01
	2024–25	3 Feb	15.77	AKI2024-01
Cornwallis Wharf	2001–02	26 Mar–20 Apr	2.65	AKI2001-01
Eastern Beach	2001–02	14 Mar–16 Apr	43.38	AKI2001-01
	2014–15	27 Jan–18 Feb	41.42	AKI2014-01
	2016–17	16 Feb	22.58	AKI2016-01
	2019–20	10 Feb	22.58	AKI2018-01
	2022–23	9 Mar	22.39	AKI2021-01
	2025–26	16 Feb	22.49	AKI2024-01
Grahams Beach	2006–07	20 Apr	24.75	AKI2006-01
	2010–11	17 May	25.15	AKI2010-01
	2012–13	11 Mar	20.06	AKI2012-01
	2013–14	28 Mar	26.76	AKI2013-01
	2016–17	10 Feb–28 Feb	26.78	AKI2016-01
	2019–20	9 Feb	26.78	AKI2018-01
	2022–23	8 Mar	26.46	AKI2021-01
	2025–26	31 Jan	26.75	AKI2024-01
Hokianga Harbour	2018–19	20 Feb	10.07	AKI2018-01
	2022–23	10 Feb–11 Feb	10.07	AKI2021-01
	2025–26	3 Feb	10.07	AKI2024-01
Howick Beach	2005–06	23 Dec–24 Jan	6.90	AKI2005-01
Kawakawa Bay	2004–05	5 Feb–8 Apr	60.37	AKI2004-01
	2006–07	19 Apr	62.94	AKI2006-01
	2014–15	17 Feb–25 Feb	60.90	AKI2014-01
	2016–17	27 Feb	60.89	AKI2016-01
	2018–19	4 Feb–25 Feb	60.89	AKI2018-01

Continued on next page

Table A-2 – *Continued from previous page*

Survey site	Year	Sampling dates	Sampling extent (ha)	Project
	2020–21	10 Feb	60.89	AKI2018-01
	2022–23	10 Mar	60.89	AKI2021-01
	2024–25	12 Feb	60.91	AKI2024-01
Little Waihi Estuary	2000–01	21 Mar–31 Mar	3.00	AKI2000-01
	2002–03	30 Jan–1 Feb	3.00	AKI2002-01
	2003–04	7 Jan–19 Jan	3.12	AKI2003-01
	2004–05	14 Jan–15 Jan	3.75	AKI2004-01
	2006–07	15 Jun–28 Jun	3.16	AKI2006-01
	2009–10	2 Mar	13.92	AKI2009-01
	2012–13	10 Feb	15.42	AKI2012-01
	2013–14	19 Mar–20 Mar	17.09	AKI2013-01
	2015–16	8 Feb–11 Feb	18.38	AKI2015-01
	2017–18	23 Feb–24 Feb	18.38	AKI2017-01
	2019–20	28 Feb–29 Feb	16.76	AKI2018-01
	2021–22	19 Feb–20 Feb	16.63	AKI2021-01
	2023–24	27 Feb–28 Feb	16.63	AKI2021-01
	2025–26	18 Feb–19 Feb	16.59	AKI2024-01
Mangawhai Harbour	1999–00	23 Mar–30 Jun	9.40	AKI1999-01
	2000–01	29 Jan–31 Jan	8.40	AKI2000-01
	2001–02	15 Mar–14 Apr	8.40	AKI2001-01
	2002–03	1 Jan–31 Jan	8.40	AKI2002-01
	2003–04	1 Jan–31 Jan	8.40	AKI2003-01
	2010–11	24 Mar–15 Apr	9.00	AKI2010-01
	2014–15	21 Jan–22 Jan	8.55	AKI2014-01
	2016–17	11 Feb–16 Feb	8.59	AKI2016-01
	2018–19	18 Jan–19 Jan	7.23	AKI2018-01
	2021–22	1 Feb–2 Feb	7.17	AKI2018-01
	2023–24	10 Feb–16 Feb	7.17	AKI2021-01
	2025–26	1 Feb–5 Feb	7.17	AKI2024-01
Marokopa Estuary	2005–06	18 Feb–20 Feb	2.35	AKI2005-01
	2010–11	16 May	2.35	AKI2010-01
	2015–16	12 Feb–13 Feb	2.58	AKI2015-01
Marsden Bank	2009–10	13 Nov	11.51	IPA2009-12
	2012–13	12 Dec	6.31	AKI2012-01
	2013–14	2 Feb	15.43	AKI2013-01
	2017–18	4 Feb–5 Feb	0.85	AKI2017-01
	2021–22	5 Feb	0.87	AKI2021-01
	2023–24	14 Feb	0.37	AKI2021-01
	2025–26	4 Feb	0.47	AKI2024-01
Mill Bay	1999–00	4 May–30 Jun	4.60	AKI1999-01
	2000–01	20 Feb–23 Feb	4.80	AKI2000-01
	2001–02	20 Mar–22 Apr	4.50	AKI2001-01
	2003–04	26 Jan–28 Jan	4.50	AKI2003-01
	2004–05	24 Dec–24 Jan	4.50	AKI2004-01
	2005–06	20 Dec–24 Dec	4.50	AKI2005-01
	2009–10	13 May	4.95	AKI2009-01
	2014–15	26 Feb	4.88	AKI2014-01
	2017–18	30 Jan–31 Jan	4.86	AKI2017-01
	2018–19	26 Jan	4.86	AKI2018-01
	2021–22	16 Feb	4.84	AKI2021-01
	2024–25	29 Jan	4.88	AKI2024-01
Ngunguru Estuary	2003–04	6 Mar–7 Mar	1.70	AKI2003-01
	2004–05	6 Feb–7 Feb	1.80	AKI2004-01
	2010–11	23 Mar	1.80	AKI2010-01

Continued on next page

Table A-2 – *Continued from previous page*

Survey site	Year	Sampling dates	Sampling extent (ha)	Project
	2014–15	23 Jan–24 Jan	5.46	AKI2014-01
	2016–17	13 Feb–15 Feb	6.28	AKI2016-01
	2018–19	22 Feb	6.47	AKI2018-01
	2021–22	3 Feb	6.35	AKI2018-01
	2023–24	11 Feb–14 Feb	6.01	AKI2021-01
	2025–26	2 Feb–5 Feb	5.74	AKI2024-01
Ōhiwa Harbour	2001–02	9 Apr–11 Apr	2.25	AKI2001-01
	2005–06	25 Feb–26 Feb	2.70	AKI2005-01
	2006–07	13 Jun–29 Jun	5.70	AKI2006-01
	2009–10	3 Mar	2.10	AKI2009-01
	2012–13	9 Feb–15 Mar	2.63	AKI2012-01
	2015–16	9 Feb–10 Feb	4.58	AKI2015-01
	2018–19	1 Feb–2 Feb	2.54	AKI2018-01
	2020–21	16 Feb–19 Feb	2.65	AKI2018-01
	2022–23	15 Mar–16 Mar	1.87	AKI2021-01
	2024–25	8 Feb–10 Feb	2.18	AKI2024-01
Ōkahu Bay	2024–25	2 Feb	6.01	AKI2024-01
Okoromai Bay	1999–00	19 Apr–24 Apr	20.00	AKI1999-01
	2001–02	8 Apr–12 Apr	24.00	AKI2001-01
	2002–03	26 Dec–29 Dec	20.00	AKI2002-01
	2003–04	17 Mar–20 Mar	20.00	AKI2003-01
	2004–05	15 Jan–16 Jan	20.00	AKI2004-01
	2006–07	20 Mar	20.00	AKI2006-01
	2009–10	17 Feb	20.00	AKI2009-01
	2012–13	30 Jan	20.00	AKI2012-01
	2013–14	31 Mar	19.84	AKI2013-01
	2015–16	11 Jan	19.84	AKI2015-01
	2017–18	6 Feb	19.83	AKI2017-01
	2020–21	27 Feb	19.83	AKI2018-01
	2022–23	7 Feb	19.83	AKI2021-01
	2024–25	30 Jan	19.84	AKI2024-01
Otūmoetai (Tauranga Harbour)	2000–01	27 Mar–2 Apr	5.60	AKI2000-01
	2002–03	3 Mar–5 Mar	5.60	AKI2002-01
	2005–06	15 Feb–28 Feb	4.60	AKI2005-01
	2006–07	13 Jun–14 Jun	4.60	AKI2006-01
	2009–10	1 Mar–17 Mar	5.60	AKI2009-01
	2014–15	31 Jan–1 Feb	7.67	AKI2014-01
	2016–17	20 Feb–21 Feb	8.09	AKI2016-01
	2018–19	30 Jan–31 Jan	8.06	AKI2018-01
	2020–21	17 Feb	6.52	AKI2018-01
	2022–23	14 Mar	4.44	AKI2021-01
	2024–25	7 Feb–11 Feb	4.48	AKI2024-01
Papamoa Beach	1999–00	1 May–3 May	2.00	AKI1999-01
Pataua Estuary	2002–03	4 Mar–28 Mar	10.65	AKI2002-01
	2003–04	14 Feb–16 Feb	10.45	AKI2003-01
	2005–06	14 Feb–16 Feb	10.45	AKI2005-01
	2013–14	3 Feb–6 Feb	26.30	AKI2013-01
	2015–16	12 Jan–13 Jan	27.78	AKI2015-01
	2017–18	3 Feb–4 Feb	27.71	AKI2017-01
	2019–20	13 Feb	27.92	AKI2018-01
	2021–22	6 Feb–7 Feb	27.88	AKI2021-01
	2022–23	8 Feb–9 Feb	28.18	AKI2021-01
	2024–25	31 Jan–1 Feb	28.34	AKI2024-01
Raglan Harbour	1999–00	26 May–30 Jun	10.10	AKI1999-01

Continued on next page

Table A-2 – *Continued from previous page*

Survey site	Year	Sampling dates	Sampling extent (ha)	Project
	2000–01	13 Feb–10 Mar	10.04	AKI2000-01
	2002–03	13 Jan–16 Jan	8.24	AKI2002-01
	2003–04	14 Jan–16 Jan	8.24	AKI2003-01
	2009–10	26 Apr	9.20	AKI2009-01
	2012–13	11 Jan	8.24	AKI2012-01
	2014–15	20 Feb–23 Feb	7.24	AKI2014-01
	2017–18	29 Jan	7.24	AKI2017-01
	2019–20	8 Feb	7.38	AKI2018-01
	2021–22	30 Jan	7.32	AKI2021-01
	2023–24	22 Feb	7.47	AKI2021-01
Ruakākā Estuary	2006–07	21 Mar	7.00	AKI2006-01
	2010–11	22 Mar	11.01	AKI2010-01
	2014–15	25 Jan–26 Jan	6.51	AKI2014-01
	2016–17	14 Feb	5.61	AKI2016-01
	2018–19	23 Feb	3.93	AKI2018-01
	2021–22	5 Feb–6 Feb	4.09	AKI2018-01
	2023–24	13 Feb	2.07	AKI2021-01
Tairua Harbour	1999–00	1 Apr–1 May	3.70	AKI1999-01
	2000–01	15 Feb–16 Feb	3.90	AKI2000-01
	2001–02	23 May–24 May	3.90	AKI2001-01
	2002–03	23 Feb–28 Mar	3.90	AKI2002-01
	2005–06	14 Jan–15 Jan	3.90	AKI2005-01
	2006–07	3 May–1 Aug	4.80	AKI2006-01
	2010–11	20 Apr	5.80	AKI2010-01
	2013–14	13 Mar–22 Mar	9.38	AKI2013-01
	2015–16	6 Feb–7 Feb	8.17	AKI2015-01
	2017–18	20 Feb–22 Feb	6.48	AKI2017-01
	2019–20	23 Feb	6.12	AKI2018-01
	2021–22	23 Feb	5.95	AKI2021-01
	2023–24	25 Feb	5.45	AKI2021-01
Te Haumi Beach	1999–00	7 Mar–30 Mar	10.00	AKI1999-01
	2000–01	15 Jan–26 Jan	9.90	AKI2000-01
	2001–02	15 Mar–15 Apr	9.90	AKI2001-01
	2002–03	21 Jan–22 Apr	9.90	AKI2002-01
	2006–07	22 Mar	9.81	AKI2006-01
	2009–10	18 Feb	12.06	AKI2009-01
	2012–13	13 Dec	12.06	AKI2012-01
	2014–15	24 Jan–26 Jan	12.78	AKI2014-01
	2016–17	12 Feb	12.77	AKI2016-01
	2018–19	21 Feb–24 Feb	11.91	AKI2018-01
	2021–22	4 Feb	10.64	AKI2018-01
	2023–24	12 Feb	10.04	AKI2021-01
Te Haruhi	2000–01	12 Mar	13.53	AKI2000-01
Te Mata Bay	2020–21	14 Feb–20 Feb	0.97	AKI2018-01
	2021–22	24 Feb–26 Feb	0.68	AKI2021-01
	2023–24	23 Feb–24 Feb	0.73	AKI2021-01
Umupuia Beach	1999–00	1 Apr–12 Apr	25.00	AKI1999-01
	2000–01	15 Feb–16 Feb	36.00	AKI2000-01
	2001–02	28 Mar–12 Apr	36.00	AKI2001-01
	2002–03	28 Dec–2 Jan	36.00	AKI2002-01
	2003–04	25 Mar–28 Mar	36.00	AKI2003-01
	2004–05	22 Jan–23 Jan	36.00	AKI2004-01
	2005–06	28 Jan–29 Jan	36.00	AKI2005-01
	2006–07	18 Apr	36.00	AKI2006-01

Continued on next page

Table A-2 – *Continued from previous page*

Survey site	Year	Sampling dates	Sampling extent (ha)	Project
	2009–10	15 Feb	36.00	AKI2009-01
	2010–11	4 May	36.00	AKI2010-01
	2012–13	13 Mar	36.00	AKI2012-01
	2013–14	30 Mar–1 Apr	33.86	AKI2013-01
	2015–16	18 Jan–19 Jan	33.90	AKI2015-01
	2017–18	28 Jan	33.43	AKI2017-01
	2019–20	14 Feb	33.43	AKI2018-01
	2021–22	18 Feb	32.72	AKI2021-01
	2023–24	9 Feb	33.90	AKI2021-01
	2025–26	21 Feb	33.87	AKI2024-01
Waikawau Beach	1999–00	20 May–30 Jun	2.90	AKI1999-01
	2000–01	24 Feb–15 May	2.70	AKI2000-01
	2004–05	18 Jan–10 Mar	3.10	AKI2004-01
	2005–06	15 Feb–27 Feb	3.10	AKI2005-01
	2013–14	21 Mar		AKI2013-01
Waiotahe Estuary	2002–03	7 Feb–10 Feb	8.50	AKI2002-01
	2003–04	21 Jan–24 Jan	8.50	AKI2003-01
	2004–05	21 Jan–25 Jan	9.50	AKI2004-01
	2005–06	10 Feb–12 Feb	9.50	AKI2005-01
	2009–10	4 Mar	9.50	AKI2009-01
	2013–14	17 Mar–20 Mar	11.23	AKI2013-01
	2016–17	22 Feb	11.98	AKI2016-01
	2019–20	26 Feb–27 Feb	11.98	AKI2018-01
	2022–23	16 Mar–17 Mar	11.98	AKI2021-01
	2024–25	9 Feb–10 Feb	11.75	AKI2024-01
Whangamatā Harbour	1999–00	20 May–29 May	5.48	AKI1999-01
	2000–01	15 Feb–16 Feb	5.48	AKI2000-01
	2001–02	9 May–26 May	5.48	AKI2001-01
	2002–03	9 Mar–28 Mar	5.48	AKI2002-01
	2003–04	1 Jan–31 Jan	5.48	AKI2003-01
	2004–05	6 Feb–8 Feb	5.48	AKI2004-01
	2006–07	2 May–2 Aug	24.61	AKI2006-01
	2010–11	19 Apr	5.89	AKI2010-01
	2014–15	28 Jan–30 Jan	7.62	AKI2014-01
	2016–17	24 Feb–26 Feb	7.71	AKI2016-01
	2018–19	29 Jan–30 Jan	7.55	AKI2018-01
	2020–21	11 Feb	8.18	AKI2018-01
	2022–23	11 Mar	8.09	AKI2021-01
	2025–26	20 Feb	8.20	AKI2024-01
Whangapoua Harbour	2002–03	30 Mar–6 Apr	1.66	AKI2002-01
	2003–04	1 Feb–3 Feb	5.20	AKI2003-01
	2004–05	8 Mar–10 Mar	5.20	AKI2004-01
	2005–06	8 Mar–10 Mar	5.20	AKI2005-01
	2010–11	21 Apr	5.20	AKI2010-01
	2014–15	24 Feb–25 Feb	6.32	AKI2014-01
	2016–17	25 Feb–26 Feb	6.32	AKI2016-01
	2018–19	27 Jan–28 Jan	5.28	AKI2018-01
	2020–21	12 Feb–13 Feb	5.27	AKI2018-01
	2022–23	12 Mar–13 Mar	5.07	AKI2021-01
	2024–25	4 Feb–5 Feb	5.31	AKI2024-01
Whangateau Harbour	2001–02	7 Apr–22 May	64.19	AKI2001-01
	2003–04	17 Dec–2 Mar	64.15	AKI2003-01
	2004–05	2 Feb–26 Mar	64.15	AKI2004-01
	2006–07	19 Mar–2 May	64.15	AKI2006-01

Continued on next page

Table A-2 – *Continued from previous page*

Survey site	Year	Sampling dates	Sampling extent (ha)	Project
	2009–10	18 Mar–14 Jul	64.51	AKI2009-01
	2010–11	19 May–20 May	64.15	AKI2010-01
	2012–13	14 Dec–17 Dec	64.20	AKI2012-01
	2013–14	29 Jan–6 Feb	110.91	AKI2013-01
	2015–16	15 Jan–17 Jan	110.71	AKI2015-01
	2017–18	1 Feb–2 Feb	110.91	AKI2017-01
	2019–20	11 Feb	110.88	AKI2018-01
	2021–22	31 Jan–1 Feb	111.20	AKI2021-01
	2023–24	15 Feb–16 Feb	111.32	AKI2021-01
	2025–26	6 Feb–7 Feb	110.89	AKI2024-01
Whitianga Harbour	2012–13	7 Feb	7.08	AKI2012-01
	2015–16	5 Feb	6.10	AKI2015-01
	2017–18	19 Feb–21 Feb	5.81	AKI2017-01
	2019–20	24 Feb	5.44	AKI2018-01
	2021–22	22 Feb–24 Feb	5.43	AKI2021-01
	2024–25	6 Feb	4.95	AKI2024-01

APPENDIX B: Sediment properties

Table B-1: Sediment organic content and sediment grain size distributions at sites surveyed in 2025–26 as part of the northern North Island bivalve surveys. Position of the sampling points is indicated in decimal degrees (World Geodetic System 1984). Sediment grain size fractions are defined as fines (silt and clay) ≤63 µm, very fine sand (VFS) >63 µm, fine sand (FS) >125 µm, medium sand (MS) >250 µm, coarse sand (CS) >500 µm, and gravel >2000 µm.

						Sediment grain size fraction (%)					
Survey site	Stratum	Sample	Latitude	Longitude	Organic content (%)	Fines	VFS	FS	MS	CS	Gravel
Bowentown Beach	A	1	-37.45741	175.97394	2.4	7.4	3.5	23.8	47.1	18.2	0.0
	A	2	-37.45693	175.97334	2.8	6.4	6.6	37.2	40.1	9.7	0.0
	A	3	-37.45683	175.97331	3.2	6.1	5.7	34.7	42.4	11.1	0.0
	A	4	-37.45681	175.97338	3.5	9.9	11.4	56.2	19.0	3.4	0.0
	A	5	-37.45675	175.97321	1.8	2.7	6.1	37.4	42.9	11.0	0.0
	A	6	-37.45668	175.97321	1.8	6.2	4.5	27.8	48.2	13.3	0.0
	A	7	-37.45646	175.97313	2.2	5.1	8.7	46.4	33.4	6.2	0.2
	A	8	-37.45645	175.97307	2.0	6.4	5.5	33.8	42.5	11.6	0.3
	B	1	-37.45672	175.97211	3.5	5.4	11.7	36.2	38.5	8.2	0.0
	B	2	-37.45672	175.97208	2.2	3.9	15.8	44.0	31.3	5.0	0.0
	B	3	-37.45666	175.97205	2.0	6.4	14.2	41.0	32.7	5.6	0.0
	B	4	-37.45664	175.97186	3.7	10.3	13.7	42.0	27.8	6.3	0.0
	B	5	-37.45650	175.97157	2.5	4.8	13.2	40.2	34.7	7.1	0.1
	B	6	-37.45645	175.97174	2.3	6.2	12.9	51.1	25.9	4.0	0.0
	B	7	-37.45627	175.97126	1.2	1.4	7.4	41.8	42.2	7.1	0.1
	B	8	-37.45622	175.97121	2.5	3.8	12.5	48.1	31.3	4.3	0.0
	C	1	-37.45574	175.97092	3.1	9.8	13.4	48.8	23.2	4.8	0.0
	C	2	-37.45572	175.97135	1.5	2.1	13.8	43.8	34.2	6.1	0.0
	C	3	-37.45569	175.97158	1.3	2.5	11.2	45.3	35.2	5.9	0.0
	C	4	-37.45563	175.97213	2.0	3.0	5.0	48.4	39.5	4.2	0.0
	C	5	-37.45553	175.97229	1.4	3.1	3.0	33.4	49.1	11.4	0.0
	C	6	-37.45545	175.97205	1.9	2.8	5.1	53.2	34.3	4.7	0.0
	C	7	-37.45523	175.97243	1.9	9.1	10.6	50.1	24.9	5.3	0.0
	C	8	-37.45523	175.97262	1.3	3.1	5.9	49.7	36.6	4.7	0.0

Continued on next page

Table B-1 – *Continued from previous page*

Survey site	Stratum	Sample	Latitude	Longitude	Organic matter (%)	Sediment grain size fraction (%)					
						Fines	VFS	FS	MS	CS	Gravel
Eastern Beach	A	1	-36.87588	174.91962	1.0	0.7	7.2	91.3	0.7	0.0	0.0
	A	2	-36.87518	174.91837	1.1	0.4	14.0	84.8	0.7	0.1	0.0
	A	3	-36.87471	174.91810	1.2	2.2	21.3	76.2	0.3	0.0	0.0
	A	4	-36.87423	174.91773	1.0	1.3	11.7	86.6	0.4	0.0	0.0
	A	5	-36.87383	174.91771	1.1	0.9	10.4	88.5	0.1	0.1	0.0
	A	6	-36.86994	174.91225	2.1	1.4	37.5	57.9	3.2	0.0	0.0
	A	7	-36.86973	174.91231	2.0	1.7	34.3	62.0	2.0	0.1	0.0
	A	8	-36.86945	174.91235	1.5	0.9	28.0	70.8	0.3	0.1	0.0
	A	9	-36.86926	174.91214	1.8	1.5	32.7	64.9	0.7	0.2	0.0
	A	10	-36.86924	174.91225	1.4	1.0	25.2	73.4	0.3	0.0	0.0
	A	11	-36.86872	174.91227	1.2	0.5	14.4	84.8	0.2	0.0	0.0
	A	12	-36.86852	174.91292	0.9	0.3	8.6	90.7	0.3	0.1	0.0
	B	1	-36.87742	174.91971	1.7	1.0	9.1	12.9	25.8	49.9	1.3
	B	2	-36.87708	174.91888	2.1	2.2	31.2	62.7	3.9	0.1	0.0
	B	3	-36.87706	174.91935	1.3	2.2	34.5	59.5	2.4	1.4	0.0
	B	4	-36.87699	174.92041	1.1	0.9	9.6	88.8	0.5	0.2	0.0
	B	5	-36.87621	174.91943	1.3	1.7	17.3	77.9	2.9	0.1	0.0
	B	6	-36.87476	174.91785	1.1	0.6	15.8	82.0	1.4	0.1	0.0
	B	7	-36.87454	174.91686	1.2	0.2	13.8	84.7	1.3	0.0	0.0
	B	8	-36.87364	174.91648	1.2	1.1	23.3	75.5	0.1	0.0	0.0
	B	9	-36.87272	174.91570	1.1	2.0	19.8	77.9	0.3	0.0	0.0
	B	10	-36.87220	174.91566	1.1	2.1	10.3	86.7	0.6	0.3	0.0
	B	11	-36.87165	174.91448	1.1	0.0	22.7	76.8	0.5	0.0	0.0
	B	12	-36.87034	174.91262	1.8	1.2	29.9	64.8	3.9	0.1	0.0
Grahams Beach	A	1	-37.05690	174.66803	1.2	1.6	1.7	35.3	33.8	24.4	3.3
	A	2	-37.05682	174.66697	0.9	1.3	0.3	5.8	57.5	34.7	0.4
	A	3	-37.05348	174.66619	3.1	8.9	2.5	22.4	51.2	14.7	0.3
	A	4	-37.05277	174.66527	1.0	0.4	0.5	10.7	76.4	11.1	0.9

Continued on next page

Table B-1 – *Continued from previous page*

						Sediment grain size fraction (%)					
Survey site	Stratum	Sample	Latitude	Longitude	Organic matter (%)	Fines	VFS	FS	MS	CS	Gravel
	A	5	-37.05013	174.66297	0.7	0.3	0.4	12.6	56.5	29.6	0.6
	A	6	-37.04918	174.66257	1.0	0.7	0.9	22.6	65.4	9.2	1.2
	A	7	-37.04865	174.66181	1.1	0.0	0.4	17.9	71.7	10.0	0.0
	A	8	-37.04653	174.66072	0.8	0.0	0.1	20.7	65.9	13.2	0.0
	B	1	-37.05729	174.66771	0.8	0.3	0.1	3.5	39.1	56.7	0.2
	B	2	-37.05712	174.66759	0.9	1.1	0.3	11.2	48.1	38.1	1.2
	B	3	-37.05210	174.66471	0.8	1.2	1.9	15.2	70.5	10.9	0.2
	B	4	-37.05198	174.66496	1.3	1.3	1.3	18.0	76.5	2.8	0.2
	B	5	-37.05179	174.66442	0.9	0.3	2.1	19.2	69.0	9.4	0.0
	B	6	-37.05087	174.66447	2.3	3.3	3.0	45.1	40.4	7.7	0.5
	B	7	-37.04638	174.66101	1.3	1.2	0.5	45.1	47.7	5.4	0.1
	B	8	-37.04616	174.66087	1.1	0.8	1.3	43.9	47.4	6.5	0.0
	C	1	-37.05628	174.66814	1.2	1.7	2.1	47.3	30.9	14.2	3.8
	C	2	-37.05340	174.66718	1.2	1.2	1.1	31.1	49.0	17.5	0.1
	C	3	-37.05266	174.66701	1.5	2.6	1.4	32.1	45.7	17.8	0.6
	C	4	-37.05213	174.66601	1.3	1.1	2.3	38.6	45.1	12.9	0.1
	C	5	-37.05184	174.66607	1.3	1.3	1.9	47.2	38.5	11.2	0.0
	C	6	-37.04907	174.66400	1.3	1.4	1.8	50.5	42.5	3.8	0.0
	C	7	-37.04864	174.66356	1.3	1.3	1.9	46.6	42.4	7.1	0.7
	C	8	-37.04853	174.66279	1.1	0.8	1.9	45.6	48.7	3.0	0.0
Hokianga Harbour	B	1	-35.49579	173.40260	2.0	2.2	3.0	31.9	29.0	8.7	25.2
	B	2	-35.49578	173.40281	4.6	5.6	2.6	18.2	31.6	10.9	31.1
	B	3	-35.49575	173.40253	3.8	13.4	7.3	34.3	16.9	10.6	17.6
	B	4	-35.49574	173.40271	2.5	2.4	3.7	25.1	15.8	8.8	44.3
	B	5	-35.49566	173.40254	1.7	4.6	2.4	21.2	31.8	13.5	26.5
	B	6	-35.49565	173.40240	2.8	4.0	5.1	37.0	23.9	10.8	19.3
	B	7	-35.49564	173.40282	1.8	3.6	3.2	24.7	38.4	12.8	17.4
	B	8	-35.49564	173.40238	2.2	4.3	2.8	18.4	13.1	11.0	50.4

Continued on next page

Table B-1 – *Continued from previous page*

Survey site	Stratum	Sample	Latitude	Longitude	Organic matter (%)	Sediment grain size fraction (%)					
						Fines	VFS	FS	MS	CS	Gravel
	B	9	-35.49563	173.40260	1.6	3.0	2.9	28.4	31.6	9.8	24.4
	B	10	-35.49561	173.40245	2.2	4.3	5.5	50.7	25.0	8.7	5.8
	B	11	-35.49560	173.40272	1.7	2.4	3.0	27.9	37.4	8.0	21.4
	B	12	-35.49560	173.40240	2.4	4.5	4.2	42.3	33.0	7.6	8.4
	B	13	-35.49559	173.40266	1.7	3.5	3.4	33.8	31.2	10.4	17.6
	B	14	-35.49558	173.40281	1.8	6.7	3.7	24.0	41.0	10.5	14.1
	B	15	-35.49557	173.40255	1.6	2.3	3.0	29.2	37.2	14.3	14.0
	B	16	-35.49555	173.40285	1.5	3.0	1.8	20.2	43.1	11.0	20.9
	B	17	-35.49552	173.40266	1.5	3.8	2.4	31.4	44.7	7.1	10.6
	B	18	-35.49551	173.40260	2.2	2.1	2.3	22.6	36.4	13.3	23.4
	B	19	-35.49549	173.40242	4.4	8.4	4.0	24.6	26.2	11.2	25.6
	B	20	-35.49548	173.40244	1.8	5.0	3.3	28.0	35.1	10.4	18.1
	B	21	-35.49544	173.40271	1.6	3.7	2.0	25.4	54.8	6.9	7.2
	B	22	-35.49543	173.40251	1.6	4.6	3.0	32.4	44.4	8.2	7.5
	B	23	-35.49540	173.40260	1.6	4.5	2.6	36.2	37.3	8.2	11.2
	B	24	-35.49536	173.40248	1.9	3.2	3.8	31.1	35.4	13.9	12.6
Little Waihi Estuary	A	1	-37.76344	176.48037	2.5	1.1	1.2	53.3	38.1	6.2	0.1
	A	2	-37.76319	176.48139	1.3	1.5	1.2	40.1	39.2	16.9	1.3
	A	3	-37.76254	176.48195	1.6	2.3	3.6	68.8	21.7	3.6	0.0
	A	4	-37.76206	176.48235	2.6	4.5	5.6	60.4	25.3	4.2	0.0
	A	5	-37.76106	176.48266	2.1	1.4	3.4	69.0	22.4	3.8	0.1
	A	6	-37.76105	176.48301	5.4	5.2	7.4	30.8	14.7	33.4	8.6
	A	7	-37.76094	176.48251	2.4	0.8	2.9	59.4	27.9	8.8	0.2
	A	8	-37.76063	176.48297	2.7	4.7	9.2	71.8	7.7	2.4	4.2
	A	9	-37.76060	176.48245	4.0	4.4	3.3	40.8	28.4	20.7	2.4
	A	10	-37.75994	176.48037	1.5	1.3	1.5	63.5	28.5	5.2	0.0
	A	11	-37.75992	176.48100	0.8	1.5	0.6	39.9	50.4	7.6	0.0
	A	12	-37.75957	176.48106	1.2	0.3	2.4	57.9	30.5	6.3	2.5

Continued on next page

Table B-1 – *Continued from previous page*

Survey site	Stratum	Sample	Latitude	Longitude	Organic matter (%)	Sediment grain size fraction (%)					
						Fines	VFS	FS	MS	CS	Gravel
	B	1	-37.75969	176.47934	1.2	5.0	4.6	54.4	22.1	8.2	5.7
	B	2	-37.75955	176.47969	1.4	0.6	0.5	48.2	44.2	6.5	0.0
	B	3	-37.75906	176.47974	0.9	0.0	0.9	48.9	41.1	8.5	0.6
	B	4	-37.75902	176.47898	1.3	2.1	0.7	38.7	50.8	6.7	1.1
	B	5	-37.75874	176.47997	1.9	2.8	3.5	67.5	21.1	5.1	0.0
	B	6	-37.75842	176.47900	1.6	0.3	1.1	59.4	36.9	2.3	0.0
	B	7	-37.75824	176.47945	1.4	0.0	0.5	47.7	46.5	5.3	0.0
	B	8	-37.75801	176.47895	1.3	0.7	1.2	59.5	34.9	3.6	0.1
	B	9	-37.75779	176.47860	1.7	2.0	2.2	37.2	42.7	15.9	0.0
	B	10	-37.75766	176.47865	1.0	0.3	0.6	41.5	44.2	12.0	1.3
	B	11	-37.75698	176.47819	1.3	1.2	1.6	61.6	30.9	4.7	0.0
	B	12	-37.75690	176.47805	1.3	0.7	0.4	24.0	40.6	26.4	7.9
Mangawhai Harbour	A	1	-36.08550	174.59095	0.8	0.0	1.7	67.6	28.9	1.8	0.0
	A	2	-36.08529	174.59068	0.8	0.0	2.1	64.0	32.8	1.1	0.0
	A	3	-36.08512	174.59046	0.9	0.4	1.0	54.3	42.2	2.0	0.0
	A	4	-36.08475	174.59059	0.8	0.0	0.9	38.6	56.1	4.4	0.0
	A	5	-36.08388	174.59089	0.8	1.1	1.4	46.0	48.1	3.3	0.1
	A	6	-36.08341	174.59173	1.1	0.5	3.6	65.6	28.8	1.6	0.0
	B	1	-36.08695	174.59023	1.0	0.8	1.2	60.8	36.8	0.4	0.0
	B	2	-36.08685	174.59048	1.1	0.7	1.1	50.2	42.0	5.4	0.5
	B	3	-36.08674	174.59020	0.7	0.0	0.9	68.6	30.0	0.4	0.0
	B	4	-36.08619	174.59059	0.9	0.2	2.4	75.3	21.2	0.9	0.0
	B	5	-36.08607	174.59088	1.1	0.9	2.4	66.3	28.9	1.5	0.0
	B	6	-36.08586	174.59091	0.7	0.0	1.2	76.5	21.1	1.2	0.0
	C	1	-36.08918	174.59017	0.6	0.0	1.1	47.5	50.7	0.7	0.0
	C	2	-36.08873	174.59014	0.7	0.4	0.7	43.0	55.0	1.0	0.0
	C	3	-36.08859	174.59016	0.6	0.2	0.7	45.0	53.3	0.9	0.0
	C	4	-36.08833	174.59011	0.5	0.0	1.1	62.5	36.2	0.3	0.0

Continued on next page

Table B-1 – *Continued from previous page*

Survey site	Stratum	Sample	Latitude	Longitude	Organic matter (%)	Sediment grain size fraction (%)					
						Fines	VFS	FS	MS	CS	Gravel
	C	5	-36.08817	174.59017	0.6	1.5	1.6	50.2	45.7	1.1	0.0
	C	6	-36.08809	174.59030	0.7	0.0	0.7	49.4	48.8	1.2	0.0
	D	1	-36.09878	174.59266	1.4	1.1	1.8	62.9	33.0	1.1	0.0
	D	2	-36.09814	174.59175	0.8	0.6	1.8	63.9	32.6	1.1	0.0
	D	3	-36.09743	174.59181	0.8	0.9	1.2	72.4	25.1	0.4	0.0
	D	4	-36.09726	174.59207	0.6	0.0	1.0	64.8	33.9	0.2	0.0
	D	5	-36.09699	174.59172	0.8	0.7	1.6	77.4	20.0	0.3	0.0
	D	6	-36.09658	174.59225	1.2	2.1	2.0	71.7	24.1	0.2	0.0
Ngunguru Estuary	A	1	-35.63487	174.50081	1.6	0.6	10.4	61.4	14.8	11.8	1.1
	A	2	-35.63420	174.50138	2.1	3.2	6.3	76.8	11.6	2.1	0.0
	A	3	-35.63326	174.50203	1.7	0.5	6.7	51.0	25.2	16.1	0.6
	A	4	-35.63278	174.50238	1.9	0.0	4.5	34.1	23.5	33.5	4.4
	A	5	-35.63266	174.50239	1.9	0.3	5.3	35.0	30.3	27.6	1.5
	A	6	-35.63260	174.50253	1.9	0.0	16.1	49.5	10.7	19.5	4.2
	A	7	-35.63243	174.50267	1.5	0.7	8.1	46.7	16.9	22.6	5.1
	B	1	-35.63774	174.50416	1.2	0.7	5.4	68.0	19.5	6.3	0.1
	B	2	-35.63752	174.50425	1.2	0.3	5.0	72.2	17.3	4.6	0.5
	B	3	-35.63745	174.50430	1.1	0.0	5.6	72.8	16.5	4.8	0.3
	B	4	-35.63691	174.50446	1.2	1.1	6.6	74.9	16.2	1.2	0.0
	B	5	-35.63675	174.50223	2.5	4.5	15.4	77.9	1.2	0.9	0.0
	B	6	-35.63631	174.50472	1.0	0.9	7.2	79.3	10.9	1.7	0.0
	B	7	-35.63575	174.50483	1.2	1.1	5.4	71.6	17.4	4.6	0.0
	B	8	-35.63565	174.50487	1.6	0.2	6.4	84.4	7.7	1.3	0.0
	C	1	-35.63689	174.50161	1.8	1.4	12.5	80.2	3.5	2.5	0.0
	C	2	-35.63671	174.50182	2.0	3.2	13.8	78.2	2.7	2.0	0.0
	C	3	-35.63608	174.50171	1.4	1.1	15.2	76.8	4.5	2.5	0.0
	C	4	-35.63581	174.50226	2.9	6.2	26.1	66.2	1.2	0.3	0.0
	C	5	-35.63576	174.50199	2.0	4.4	15.7	78.6	0.9	0.4	0.0

Continued on next page

Table B-1 – *Continued from previous page*

Survey site	Stratum	Sample	Latitude	Longitude	Organic matter (%)	Sediment grain size fraction (%)					
						Fines	VFS	FS	MS	CS	Gravel
	C	6	-35.63570	174.50478	1.3	0.4	5.2	67.2	15.0	9.5	2.8
	C	7	-35.63559	174.50256	3.0	7.0	14.5	76.2	1.9	0.4	0.0
	C	8	-35.63491	174.50099	2.1	2.7	12.7	70.4	11.2	3.0	0.0
	C	9	-35.63485	174.50226	1.6	0.6	6.0	78.8	13.4	1.2	0.0
Umupuia Beach	A	1	-36.90437	175.07382	2.0	5.0	2.7	5.7	17.0	41.4	28.3
	A	2	-36.90421	175.07261	5.4	51.3	15.1	22.7	5.5	3.4	2.0
	A	3	-36.90399	175.07191	8.1	72.2	13.4	9.7	4.3	0.4	0.0
	A	4	-36.90313	175.07358	1.5	5.7	37.2	51.5	3.8	1.1	0.7
	A	5	-36.90301	175.07318	1.4	3.6	41.1	53.7	1.4	0.1	0.0
	A	6	-36.90299	175.06794	2.2	5.0	10.1	31.5	31.0	15.9	6.5
	A	7	-36.90243	175.07013	1.5	3.3	61.6	34.8	0.3	0.0	0.0
	A	8	-36.90228	175.07126	1.7	4.8	37.0	49.1	6.5	2.5	0.0
	A	9	-36.90175	175.07087	1.1	2.7	29.8	61.6	4.9	0.9	0.0
	A	10	-36.90126	175.06776	1.7	4.9	45.2	42.7	6.7	0.5	0.0
	A	11	-36.90116	175.06712	1.8	4.7	37.8	38.3	18.2	1.1	0.0
	A	12	-36.89941	175.06572	1.5	2.4	25.8	68.3	3.5	0.1	0.0
	B	1	-36.90272	175.07487	1.1	1.5	26.5	68.5	3.3	0.1	0.0
	B	2	-36.90217	175.07237	1.5	4.9	32.6	58.6	2.2	1.7	0.0
	B	3	-36.90207	175.07402	1.2	1.4	19.2	77.5	1.8	0.2	0.0
	B	4	-36.90206	175.07466	1.1	2.1	26.5	69.3	2.0	0.0	0.0
	B	5	-36.90181	175.07194	1.2	4.3	40.8	53.1	1.6	0.1	0.0
	B	6	-36.90015	175.06514	4.4	42.1	16.2	28.5	12.0	1.2	0.0
	B	7	-36.89958	175.06482	4.6	23.6	39.1	12.6	6.7	11.6	6.5
	B	8	-36.89945	175.06753	1.4	4.4	30.5	61.1	3.4	0.4	0.1
	B	9	-36.89930	175.06741	1.8	5.6	25.2	65.2	3.5	0.4	0.0
	B	10	-36.89830	175.06698	1.2	1.9	20.4	71.6	6.0	0.1	0.0
	B	11	-36.89774	175.06516	1.5	4.7	22.3	68.7	4.1	0.3	0.0
	B	12	-36.89754	175.06488	1.7	0.9	26.1	68.6	4.1	0.3	0.0

Continued on next page

Table B-1 – *Continued from previous page*

Survey site	Stratum	Sample	Latitude	Longitude	Organic matter (%)	Sediment grain size fraction (%)					
						Fines	VFS	FS	MS	CS	Gravel
Whangamatā Harbour	A	1	-37.19692	175.87398	3.1	6.1	7.8	67.7	16.5	1.8	0.2
	A	2	-37.19687	175.87500	2.2	4.1	4.9	64.8	22.2	4.0	0.0
	A	3	-37.19669	175.87484	2.3	3.8	5.2	66.5	18.8	4.7	0.9
	A	4	-37.19641	175.87312	2.5	4.0	4.0	57.4	29.4	5.2	0.0
	A	5	-37.19635	175.87419	2.0	2.5	3.5	73.5	18.2	2.3	0.0
	A	6	-37.19626	175.87251	2.2	4.0	4.3	65.0	23.6	2.9	0.3
	A	7	-37.19622	175.87292	2.2	4.7	5.0	60.9	26.9	2.4	0.0
	A	8	-37.19590	175.87217	1.7	3.2	2.5	38.0	35.2	17.8	3.4
	A	9	-37.19402	175.87143	3.4	5.3	9.4	74.6	9.5	1.1	0.0
	A	10	-37.19384	175.87237	2.0	0.8	2.6	80.9	14.8	0.8	0.0
	A	11	-37.19352	175.87081	2.8	6.6	11.6	60.3	12.2	7.5	1.9
	A	12	-37.19327	175.87014	6.0	21.1	18.9	53.6	4.8	1.5	0.0
	A	13	-37.19310	175.87084	3.2	1.8	3.7	26.8	28.1	37.0	2.5
	A	14	-37.19273	175.87010	2.8	1.1	8.2	50.3	15.8	22.8	1.8
	A	15	-37.19258	175.86973	2.8	7.2	8.5	45.0	13.9	23.6	1.7
	B	1	-37.19565	175.87422	2.3	0.4	2.8	70.9	21.6	4.3	0.0
	B	2	-37.19563	175.87392	2.7	0.4	1.0	39.3	43.1	14.8	1.3
	B	3	-37.19551	175.87427	2.6	0.7	2.2	76.2	20.5	0.5	0.0
	B	4	-37.19538	175.87371	2.4	1.7	1.3	51.2	41.6	4.0	0.2
	B	5	-37.19412	175.87304	2.1	0.5	2.7	73.0	23.3	0.4	0.0
	B	6	-37.19411	175.87334	2.7	2.5	2.0	72.9	22.3	0.3	0.0
	B	7	-37.19389	175.87294	2.6	0.8	3.9	82.9	11.6	0.8	0.0
	B	8	-37.19385	175.87286	2.1	0.3	2.2	77.5	19.8	0.3	0.0
	B	9	-37.19366	175.87294	2.1	0.7	3.3	75.1	11.4	9.1	0.4
Whangateau Harbour	A	1	-36.33710	174.76387	2.6	2.7	7.9	71.6	17.5	0.3	0.0
	A	2	-36.33394	174.76357	1.6	2.0	3.5	63.7	29.3	1.5	0.0
	A	3	-36.33261	174.76431	1.1	1.4	3.8	84.1	9.6	1.1	0.0
	A	4	-36.32967	174.76451	0.8	0.2	6.8	87.8	4.9	0.2	0.0

Continued on next page

Table B-1 – *Continued from previous page*

Survey site	Stratum	Sample	Latitude	Longitude	Organic matter (%)	Sediment grain size fraction (%)					
						Fines	VFS	FS	MS	CS	Gravel
	A	5	-36.32965	174.76650	1.2	2.0	2.7	83.9	11.0	0.4	0.0
	A	6	-36.32899	174.76658	0.9	0.4	2.4	80.2	14.6	2.3	0.0
	A	7	-36.32830	174.76824	1.3	1.2	2.5	74.9	17.6	3.8	0.0
	A	8	-36.32811	174.76790	1.0	1.4	3.8	81.9	11.7	1.2	0.0
	A	9	-36.32689	174.77005	1.2	0.7	3.7	70.3	19.0	6.3	0.0
	A	10	-36.32639	174.77278	0.8	0.0	0.3	69.5	29.0	1.1	0.0
	A	11	-36.32589	174.77101	0.9	0.0	2.5	84.1	12.8	0.6	0.0
	A	12	-36.32496	174.77328	0.8	0.2	0.5	66.4	32.5	0.3	0.0
	B	1	-36.31750	174.77730	1.0	0.3	0.3	31.5	52.5	14.1	1.3
	C	1	-36.31694	174.77555	0.8	0.5	0.5	37.6	54.8	6.4	0.2
	C	2	-36.31588	174.77619	1.3	0.7	0.8	34.4	47.6	16.1	0.4
	C	3	-36.31474	174.77834	0.8	0.3	0.4	45.3	49.4	4.4	0.2
	C	4	-36.31459	174.78376	1.1	3.2	8.0	72.2	12.9	3.6	0.1
	C	5	-36.31436	174.78201	1.3	3.5	3.9	44.7	45.7	2.1	0.2
	D	1	-36.31494	174.77938	0.9	1.4	1.1	48.2	43.2	5.6	0.3
	D	2	-36.31465	174.77344	1.0	1.3	2.0	71.1	23.6	1.8	0.1
	D	3	-36.31360	174.78063	2.3	8.9	13.4	55.1	19.5	2.6	0.6
	D	4	-36.31205	174.77879	1.1	2.2	3.0	45.3	37.3	8.7	3.5
	D	5	-36.31180	174.77731	1.4	3.2	5.6	54.9	29.3	4.9	2.1
	D	6	-36.31130	174.77871	2.3	11.0	25.4	51.4	10.9	1.1	0.2

APPENDIX C: Geostatistical model predictions

C.1 Bowentown Beach

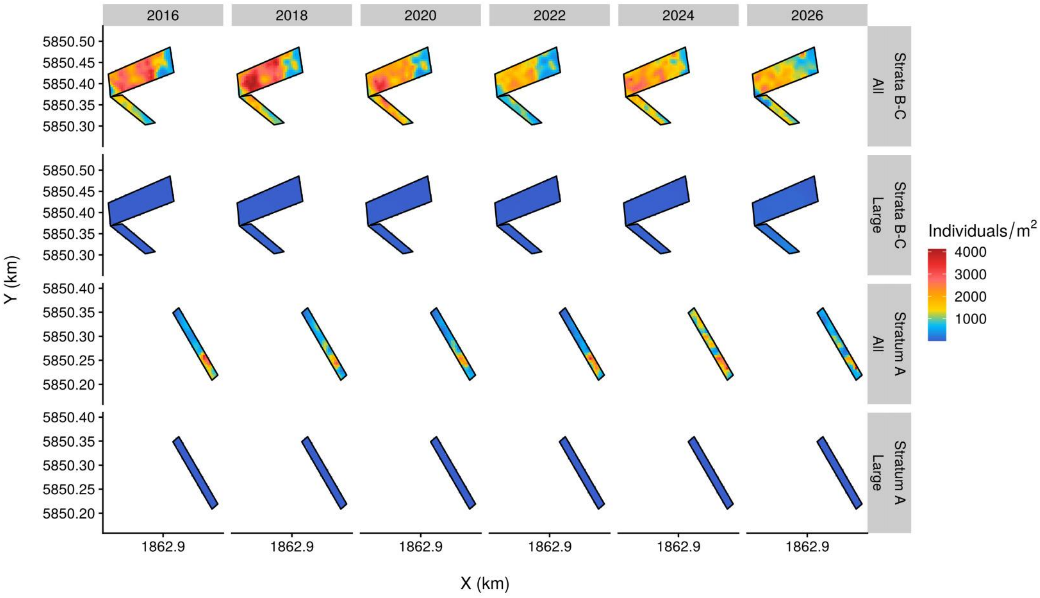

Figure C-1: Predicted cockle densities from the spatio-temporal model for Bowentown Beach. Predictions are shown for all and for large cockles (≥30 mm shell length) for each year the site was surveyed (since 2013–14, when high-resolution spatial data became available). Fishing years are indicated by the end year, e.g., 2026 refers to the 2025–26 fishing year.

C.2 Eastern Beach

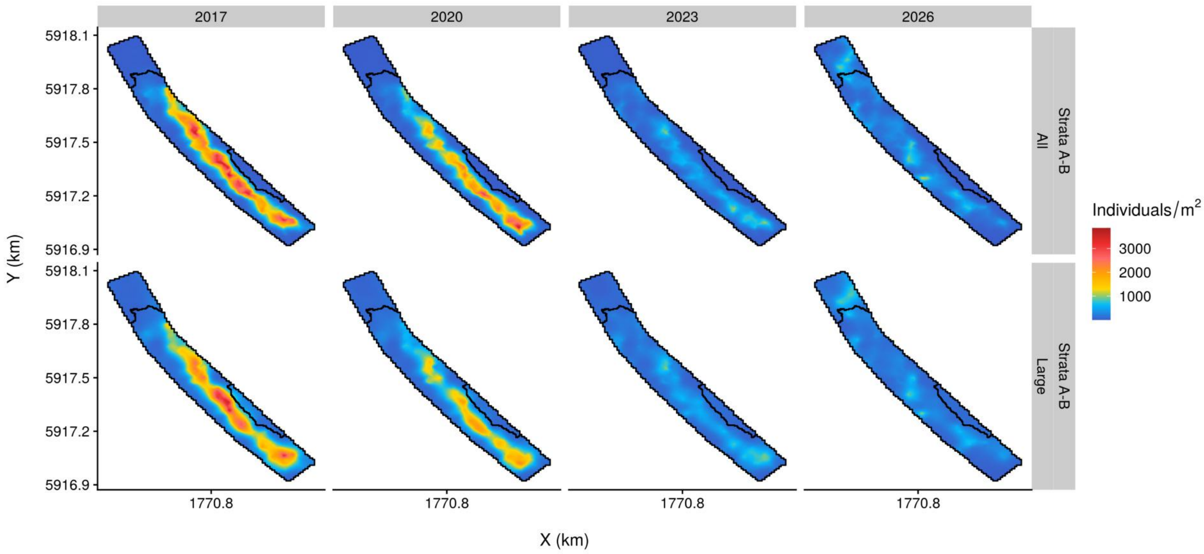

Figure C-2: Predicted cockle densities from the spatio-temporal model for Eastern Beach. Predictions are shown for all and for large cockles (≥30 mm shell length) for each year the site was surveyed (since 2013–14, when high-resolution spatial data became available). Fishing years are indicated by the end year, e.g., 2026 refers to the 2025–26 fishing year.

C.3 Grahams Beach

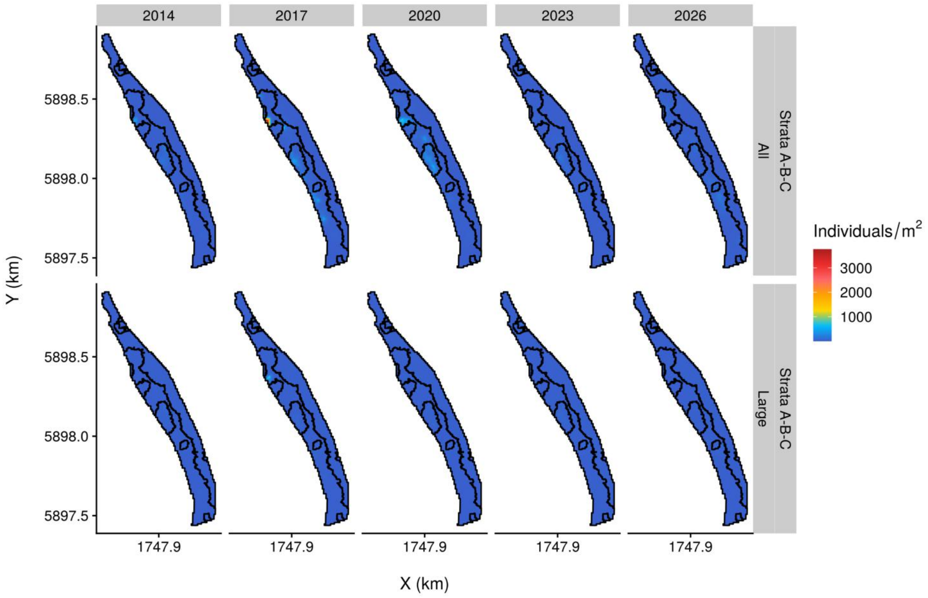

Figure C-3: Predicted cockle densities from the spatio-temporal model for Grahams Beach. Predictions are shown for all and for large cockles (≥30 mm shell length) for each year the site was surveyed (since 2013–14, when high-resolution spatial data became available). Fishing years are indicated by the end year, e.g., 2026 refers to the 2025–26 fishing year.

C.4 Hokianga Harbour

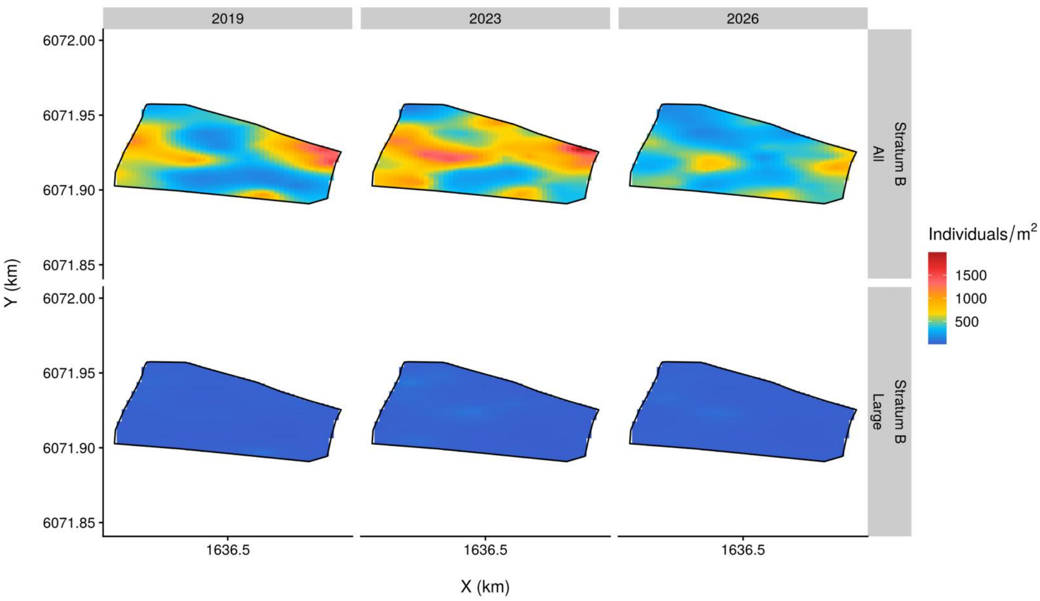

Figure C-4: Predicted cockle densities from the spatio-temporal model for Hokianga Harbour. Predictions are shown for all and for large cockles (≥30 mm shell length) for each year the site was surveyed (since 2013–14, when high-resolution spatial data became available). Fishing years are indicated by the end year, e.g., 2026 refers to the 2025–26 fishing year.

C.5 Little Waihi Estuary

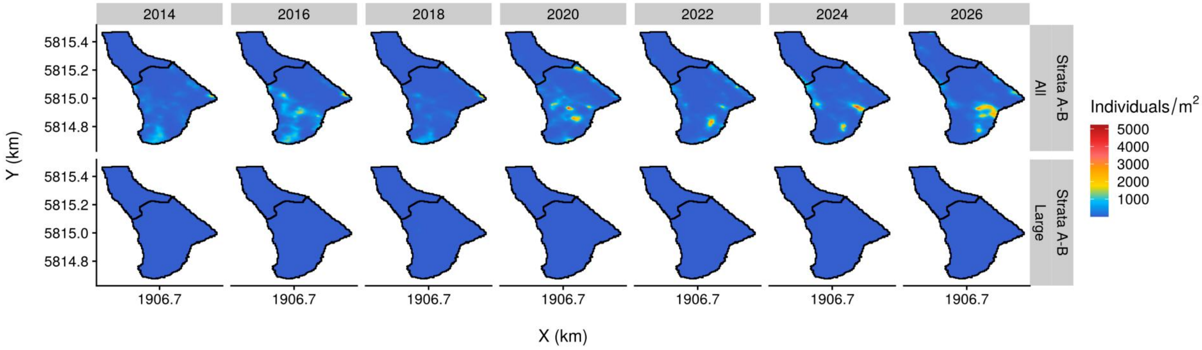

Figure C-5: Predicted cockle densities from the spatio-temporal model for Little Waihi Estuary. Predictions are shown for all and for large cockles (≥30 mm shell length) for each year the site was surveyed (since 2013–14, when high-resolution spatial data became available). Fishing years are indicated by the end year, e.g., 2026 refers to the 2025–26 fishing year.

C.6 Mangawhai Harbour

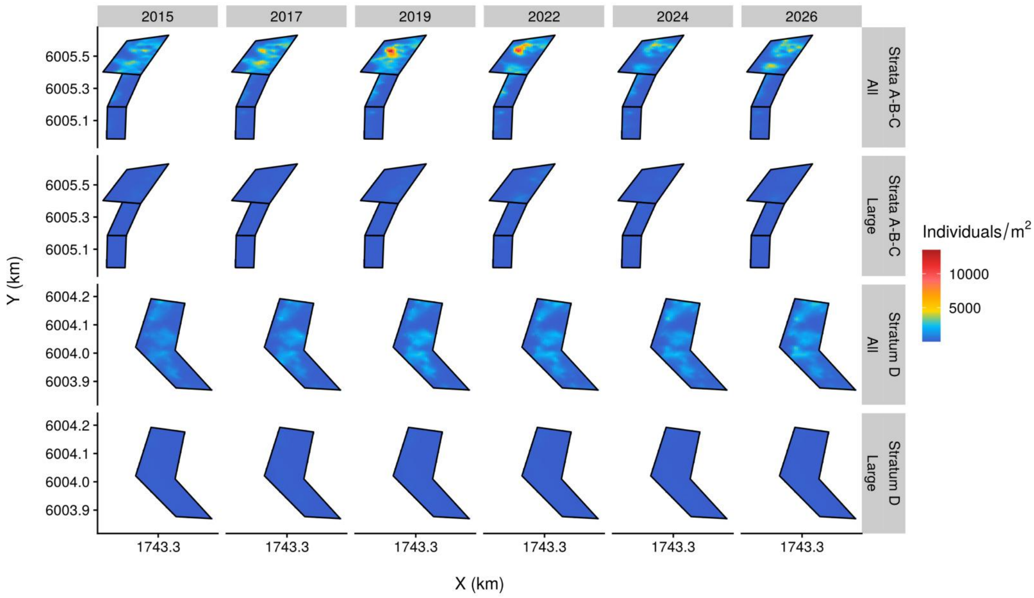

Figure C-6: Predicted cockle densities from the spatio-temporal model for Mangawhai Harbour. Predictions are shown for all and for large cockles (≥30 mm shell length) for each year the site was surveyed (since 2013–14, when high-resolution spatial data became available). Fishing years are indicated by the end year, e.g., 2026 refers to the 2025–26 fishing year.

C.7 Ngunguru Estuary

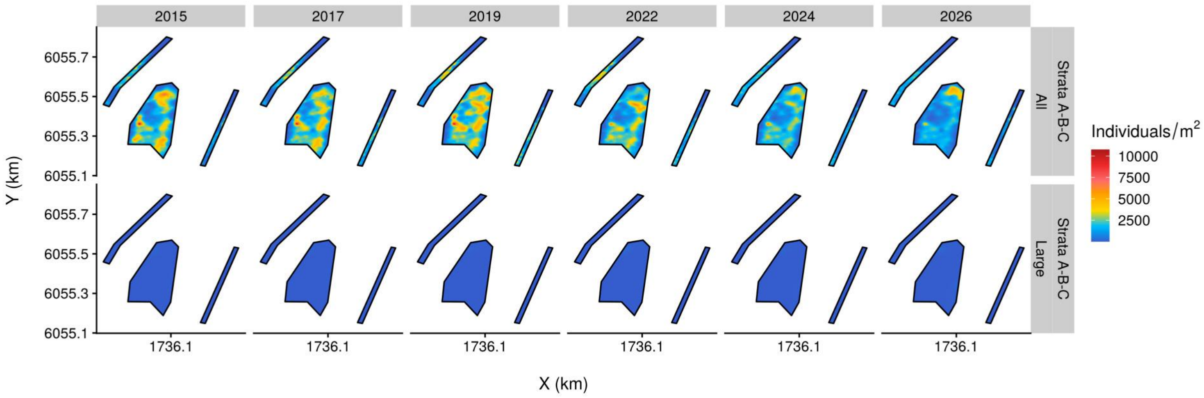

Figure C-7: Predicted cockle densities from the spatio-temporal model for Ngunguru Estuary. Predictions are shown for all and for large cockles (≥30 mm shell length) for each year the site was surveyed (since 2013–14, when high-resolution spatial data became available). Fishing years are indicated by the end year, e.g., 2026 refers to the 2025–26 fishing year.

C.8 Umupuia Beach

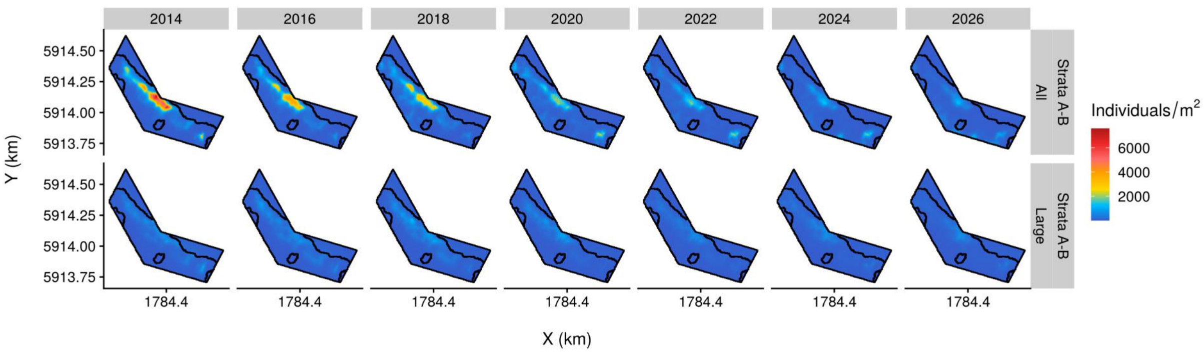

Figure C-8: Predicted cockle densities from the spatio-temporal model for Umupuia Beach. Predictions are shown for all and for large cockles (≥30 mm shell length) for each year the site was surveyed (since 2013–14, when high-resolution spatial data became available). Fishing years are indicated by the end year, e.g., 2026 refers to the 2025–26 fishing year.

C.9 Whangamatā Harbour

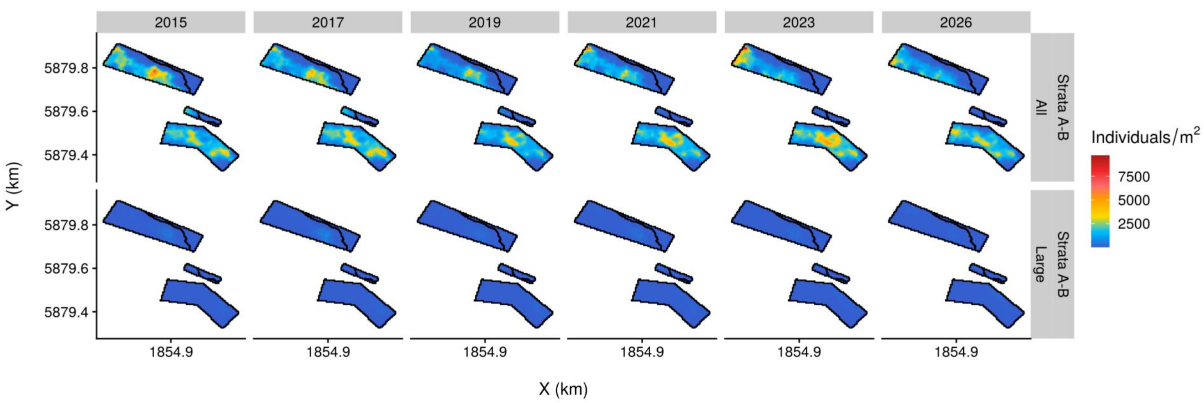

Figure C-9: Predicted cockle densities from the spatio-temporal model for Whangamatā Harbour. Predictions are shown for all and for large cockles (≥30 mm shell length) for each year the site was surveyed (since 2013–14, when high-resolution spatial data became available). Fishing years are indicated by the end year, e.g., 2026 refers to the 2025–26 fishing year.

C.10 Whangateau Harbour

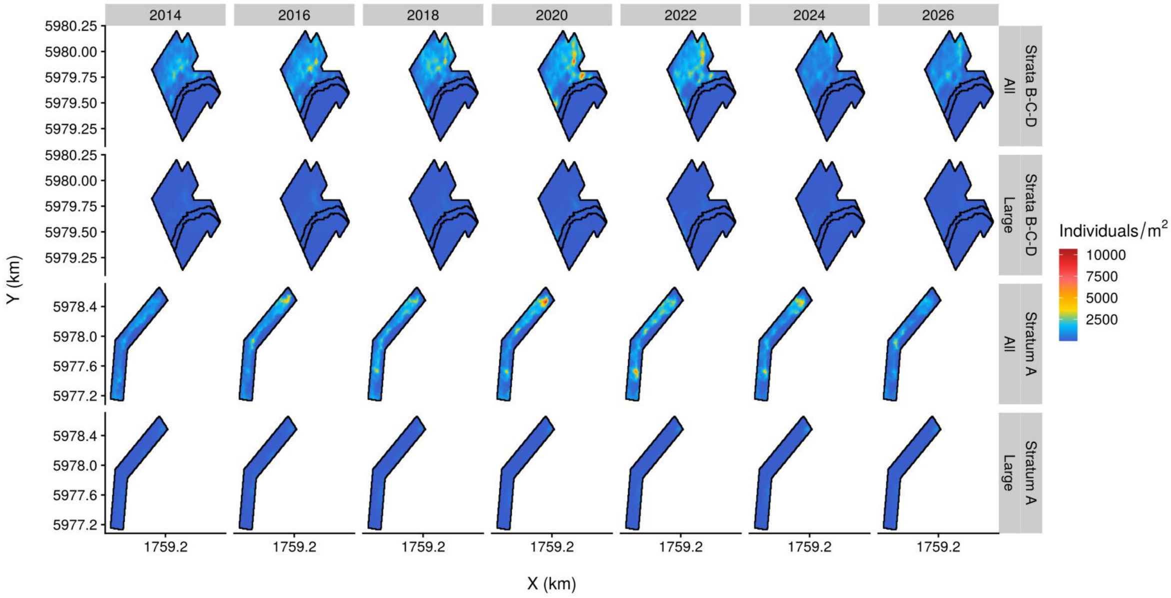

Figure C-10: Predicted cockle densities from the spatio-temporal model for Whangateau Harbour. Predictions are shown for all and for large cockles (≥30 mm shell length) for each year the site was surveyed (since 2013–14, when high-resolution spatial data became available). Fishing years are indicated by the end year, e.g., 2026 refers to the 2025–26 fishing year.

APPENDIX D: Geostatistical model applied to recruits

D.1 Example of separate geostatistical models for the cockle recruits size class

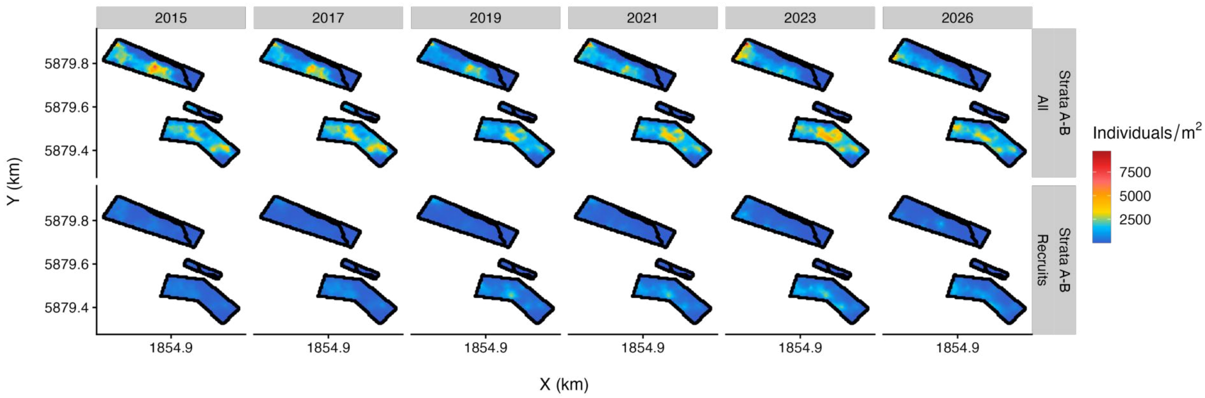

Figure D-1: Predicted cockle densities from the spatio-temporal model for Whangamatā Harbour. Predictions are shown for all cockles and for recruits (≤15 mm shell length) for each year the site was surveyed (since 2013–14, when high-resolution spatial data became available). Fishing years are indicated by the end year, e.g., 2026 refers to the 2025–26 fishing year.