Population and Biomass Survey of Cockles (*Austrovenus stutchburyi*) in Whangārei Harbour 2014

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Executive Summary

In January 2014 Northland Regional Council (council) undertook a population and biomass survey of cockles (*Austrovenus stutchburyi*) at two potential donor sites (Snake Bank and McDonald Bank) and at a proposed transplant site (Takahiwai). The intention was to undertake a transplant of up to 500kg of cockles from Snake Bank and McDonald Bank to Takahiwai if survey results showed that the population could support it.

The population of cockles at Snake Bank was estimated to be 355.9 million ± 95.6 million and the absolute biomass to be 1794.5 ± 516.9 tonnes. This biomass estimate is within the range (1405-3486 tonnes) from previous surveys between 1982 and 2009. The population of cockles at McDonald Bank was estimated to be 360.7 million ± 67.8 million and the absolute biomass to be 1528.2 ± 299.7 tonnes. This is lower than the last biomass estimate of 2548 in 2002, although the 2002 survey covered a slightly larger area and was undertaken in July. The 250kg of cockles represents approximately 0.01% of the total population at Snake Bank and 0.02% of the population at McDonald Bank. The results of the survey from the two proposed donor sites show that there are sufficient populations of cockles on these beds to support a loss of 250kg of cockles to a potential donor site.

At Takahiwai very low densities of cockles were found in areas with seagrass vegetation and on areas of bare ground cockle densities and average biomass per m^2 are lower than at Snake Bank and McDonald Bank. The relatively low densities of cockles on bare inter-tidal areas at Takahiwai suggests that these sites may benefit from translocation of cockles.

However, historical aerial photographs of Takahiwai from 2003-2011 show that there has been a rapid increase in the extent of seagrass and field observations during the survey found that only a narrow band of bare sand remains close to the shoreline and mangrove forest. It is possible that seagrass will soon cover the entire intertidal flats at Takahiwai. As seagrass habitat does not appear to be a suitable habitat for cockles at Takahiwai it is recommended that the proposed cockle transplant does not take place.

1 Introduction

In 2002, the Northland Regional Council (council), in conjunction with the Whāngārei Harbour Kaitiaki Rōpū and NorthPort, initiated a project to restore shellfish populations in the Whāngārei Harbour. Research began in 2002/3 to trial methods to restore shellfish populations. This research involved surveys and small scale experimental trials to determine the best methods to successfully enhance cockle (*Austrovenus stutchburyi*) populations in the Harbour. The findings of this research have been described in a number of reports to council (Cummings & Hatton 2003, Cummings *et al*. 2004, 2005, 2007, 2008). The key recommendation from this body of work has been to undertake transplanting in May to avoid heat stress during summer months; to transplant adult cockles; to transplant cockles into medium sized patches (60cm x 60cm) at densities around 500m^2; and that plots should be arranged in a patchy manner on the sandflat.

Council subsequently applied to the Ministry of Primary industries for a special permit to undertake shellfish transplants in the Whāngārei Harbour, on the instruction of both Kaitiaki Rōpū and NorthPort. The permit includes the following conditions:

- No more than 500kg of cockle and 250kg of pipi may be translocated in any 12 month period.
- No more than 250kg of cockle may be translocated from Snake Bank in any 12 month period commencing February 2014.
- No more than 125kg of pipi may be translocated from Mair Bank in any 12 month period commencing February 2014.

In January 2014 council undertook a survey of two potential donor beds at Snake Bank and McDonald Bank and a proposed transplant site at Takahiwai, with the intention to undertake a large scale transplant. The intention was to transplant 250kg of cockles from both Snake Bank and McDonald Bank to Takahiwai. A transplant would only proceed if survey results indicated that the populations of cockles at donor sites were sufficient and if a suitable donor site was identified.

2 Methods

2.1 Sampling locations

Snake Bank

Six transects each 100m apart running from south to north were sampled with stations located 100m along each transect (Figure 1). The extent of the cockle bed was determined with reference to the cockle count data from this survey, the extent of available intertidal habitat and previous surveys of the bed (Williams *et al.* 2009).

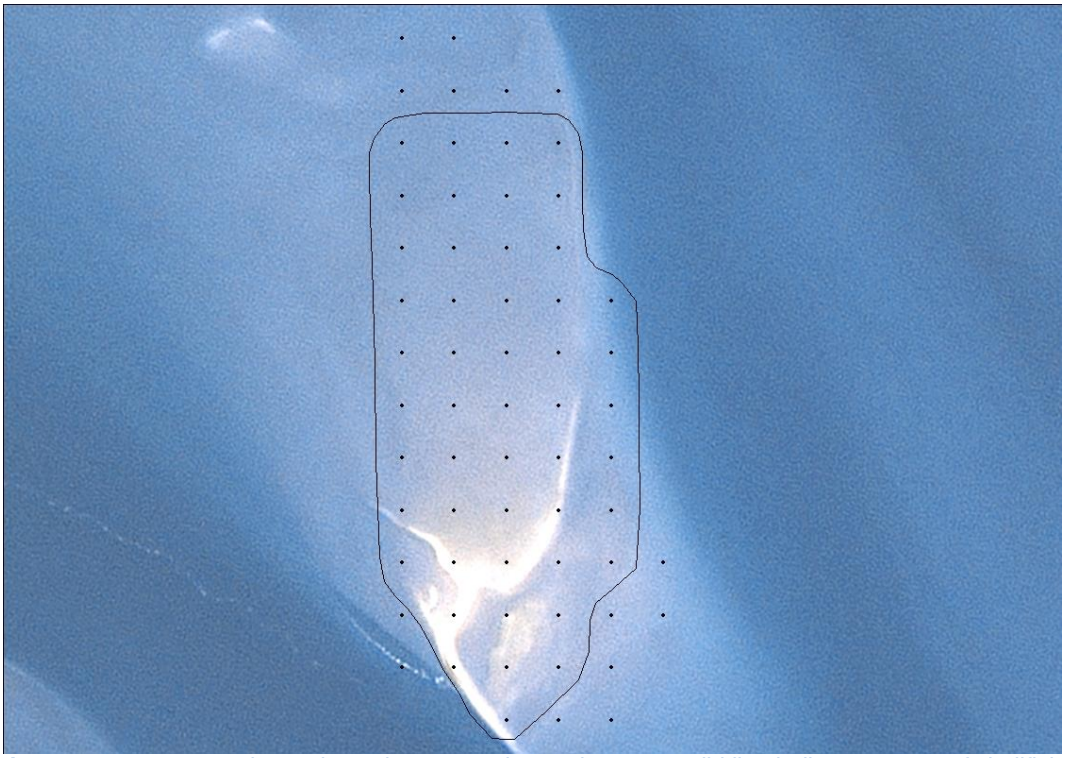


Figure 1: Transects and sample stations at Snake Bank, 2014. Solid line indicates extent of shellfish bed.

McDonald Bank

Five transects each 100m apart running from south to north were sampled with stations located 100m along each transect (Figure 2). The extent of the cockle bed was determined with reference to the cockle counts, the extent of available intertidal habitat and previous surveys of the bed (Cryer *et al.* 2003).

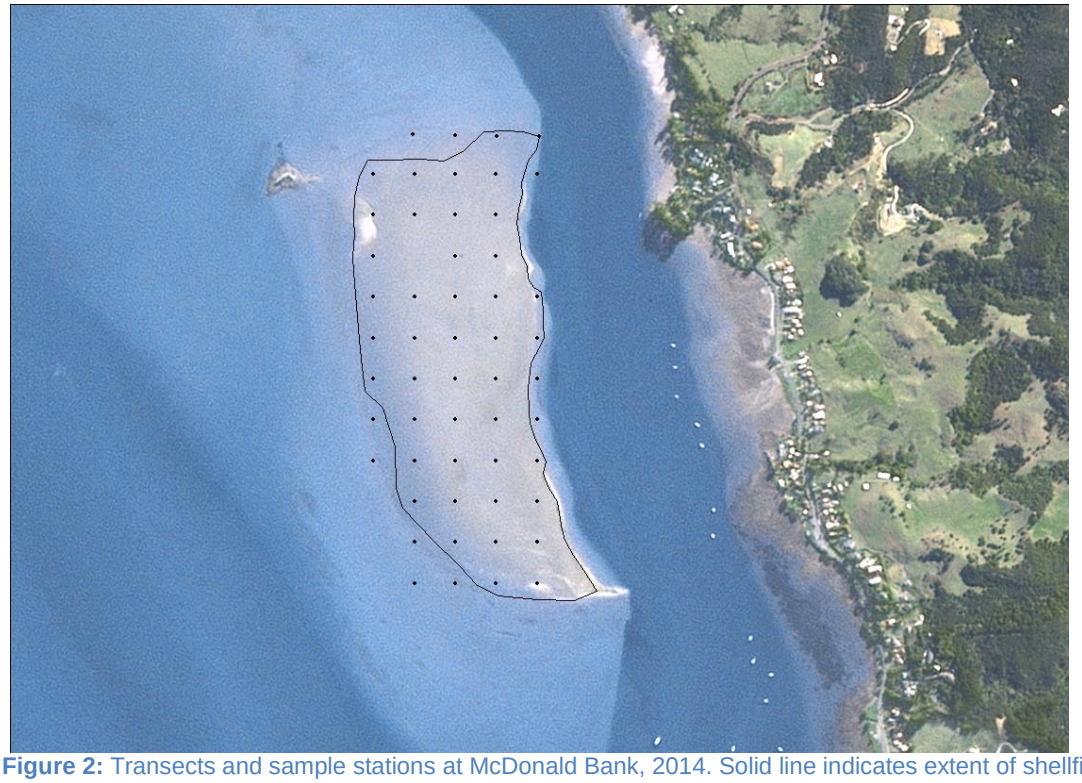


Figure 2: Transects and sample stations at McDonald Bank, 2014. Solid line indicates extent of shellfish bed.

Takahiwai

Because of the size of the intertidal sand flats at Takahiwai the original plan had been to sample five transects perpendicular to the shoreline each approximately 700m apart (Figure 3). Stations were to be located 100 metres apart on each transect. During the survey it was quickly observed that very few cockles were present in areas covered by seagrass. On transect A for example, 11 cockles were observed at the first station nearest the shore on bare sandy substrate but no further cockles were found at stations A2-A7 where seagrass was present.

As the majority of the inter-tidal flats at Takahiwai are now covered with seagrass (Figure 5 and Figure 9) except for a narrow band towards the mangrove forest and shoreline, the sampling plan was altered. Sampling of the original transects was undertaken until seagrass was encountered. Once the seagrass bed was reached on any given transect only two more stations were sampled. In addition two new transects approximately 100m apart, but running parallel to the shoreline, were sampled. On these new transects stations were located approximately 250 metres apart (Figure 4). The cockle count data was subsequently used to divide the intertidal flats into four stratums Takahiwai A, B, C and D (Figure 4).

Figure 3: Planned transects and sample stations at Takahiwai 2014.

Figure 4: Actual transects and sample stations at Takahiwai 2014. Solid lines indicate extent of stratums.

Figure 5: Seagrass at Takahiwai 2014.

2.2 Sampling methods

The samples were collected by taking a sample unit consisting of two adjacent, circular cores (with a 15cm diameter) pushed into the substrate to a depth of 15cm. The contents from the two cores were aggregated (so each sample unit covered a cross sectional area of 0.0353m^2) and passed through a 5mm aperture sieve. All individuals of the target species (cockles) retained on the sieve were counted and at least 30 individuals at each site were measured across their widest axis to the nearest millimetre. The sample extents were sampled using a random start systematic design (see Figure 1, 2, and 4).

2.3 Biomass estimates

For the purpose of this survey Snake Bank and McDonald Bank were treated as one stratum. The total biomass for Snake Bank and McDonald Bank was calculated by calculating the average biomass (per m^2) and then multiplying this by the area of the shellfish bed. Takahiwai was separated into four stratums and the biomass was determined by calculating the average biomass (per m^2) for each stratum, and then reweighting this value by the stratum area (see equation 1).

$$Total\ biomass(X) = \sum_{i=1} W_i \bar{x}_i \qquad \textbf{[1]}$$

where W_i is the stratum area (m^2), and
$\bar{x}_i$ is the average density or biomass (per m^2) in stratum *i*.

The variance for the total biomass was then estimated using equation 2:

$$\mathrm{var}(X) = \sum_{i=1} \frac{W_i^2 s_i^2}{n_i} \qquad \textbf{[2]}$$

where s_i^2 is the sampling variance of the site density biomass estimates in stratum *i*, and
n_i is the number of samples within stratum *i*.

2.4 Length-weight relationship

The following relationship, derived by (Williams *et al*. 2009) between the length and weight of cockles was used to calculate biomass estimates:

$$\textbf{Weight} = 0.00014 \times (\textbf{shell length})^{3.29}$$

The weight of each cockle was determined and this was then used to calculate a biomass per m^2 for each station.

2.5 Timing of sampling

McDonald Bank was surveyed on 28 January 2014 and 29 January 2014; Snake Bank was surveyed on 29 January 2014; and Takahiwai was surveyed on 30 January 2014.

3 Results

3.1 Snake Bank

The extent of the cockle bed was determined to be 0.493km^2. The 2014 population of cockles on Snake Bank was calculated to be 355.9 million ± 95.6 million (95% confidence interval) (Table 1). The highest densities were found towards the south west edge of the Bank and in the middle north area of the Bank (Figure 6).

Table 1: Cockle density and population found within Snake Bank

Sample size (*n*)	Cockle density (per m^2) (SE)	Stratum Area (m^2)	Total (millions)
49	721.5 (96.5)	493253.67	355.9

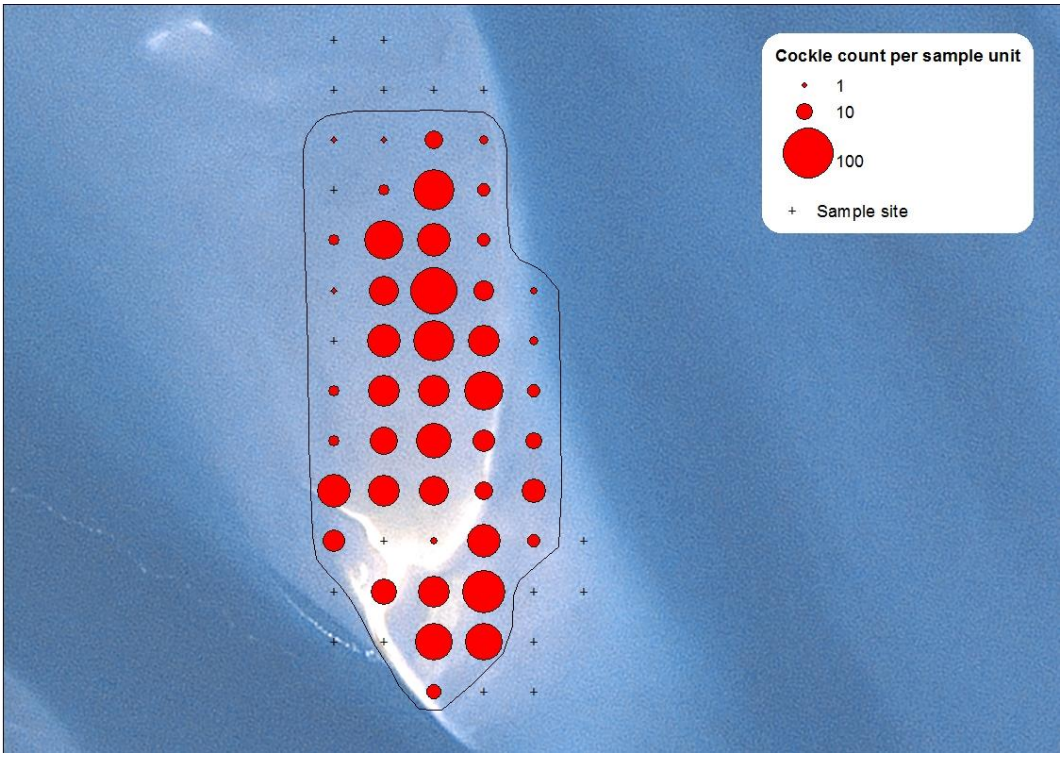


Figure 6: Cockle counts at Snake Bank in 2014.

The absolute biomass of cockles on Snake Bank was estimated to be 1794.5 ± 516.9 tonnes (95% confidence interval) (see Table 2).

Table 2: Biomass estimate of cockles on Snake Bank

Sample size (*n*)	Area (m^2)	Mean biomass (per m2)	Biomass (tonnes)	c.v. (%)
49	493253.67	3638.1g	1794.5	0.14

3.2 McDonald Bank

The 2014 population of cockles at McDonald Bank is estimated to be 360.7 million ± 67.8 million (95% confidence interval) (Table 3). The highest cockle densities were found towards the south and west of the bank (Figure 7).

Table 3: Cockle densities found within McDonald Bank

Sample size (*n*)	Cockle density (per m^2) (SE)	Stratum Area (m^2)	Total (millions)
43	853.2 (79.6)	422787	360.7

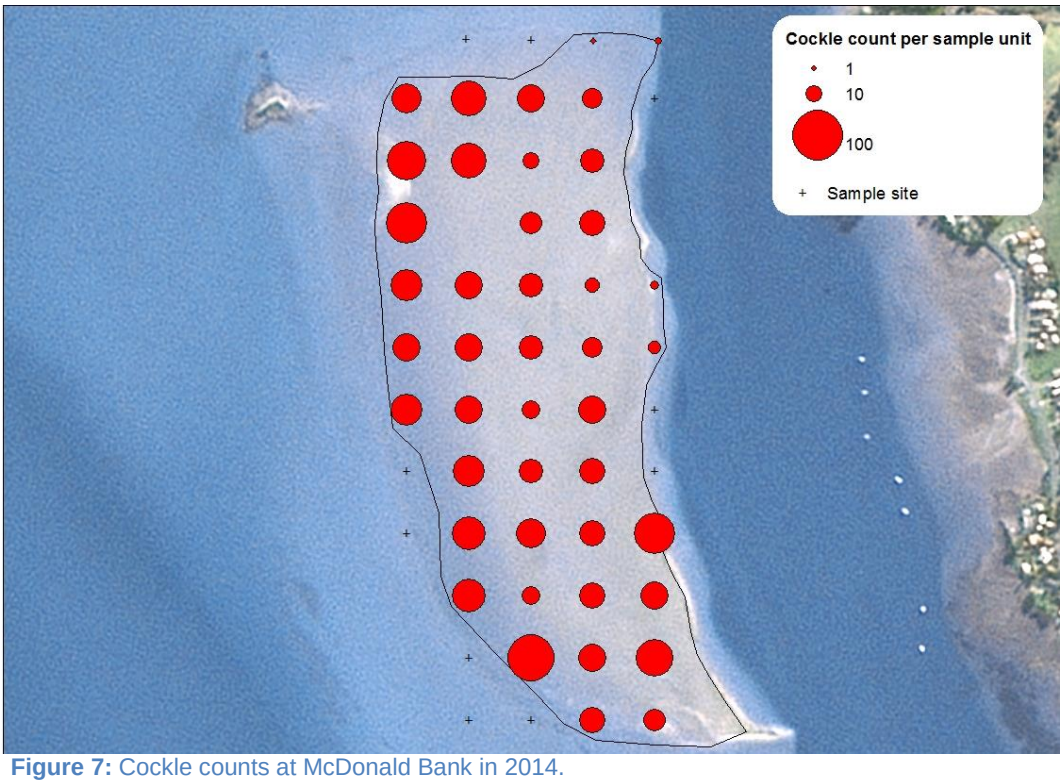


Figure 7: Cockle counts at McDonald Bank in 2014.

The absolute biomass of cockles at McDonald Bank sample extent is estimated to be 1528.2 ± 299.7 tonnes (95% confidence interval) (Table 4).

Table 4: Biomass estimates of cockles on McDonald Bank

Sample size (*n*)	Area (m^2)	Mean biomass (per m2)	Biomass (tonnes)	c.v. (%)
43	422787	3614.5g	1528.2	0.097

3.3 Takahiwai

A total of 54 stations were sampled in Takahiwai but only 25 sites were used for density and biomass estimates. Very low densities of cockles were found at sites vegetated with seagrass. Of the 27 stations where seagrass was observed, cockles were found at just five sites and the densities at these five sites was very low (28 per m^2 to 169 per m^2). Consequently areas covered with seagrass were not included in the extent of cockle beds at Takahiwai and not used in calculations of population or biomass. The extent of the cockle beds at Takahiwai was limited to areas of bare sandy substrate. The extent of the cockle bed was determined to be 0.473 km^2. On bare sandy substrate, the mean density of cockles at Takahiwai (498 per m^2) was much lower than at Snake Bank (722 per m^2) and McDonald Bank (853 per m^2). The highest densities were found at Takahiwai B and Takahiwai C (Table 5 and Figure 8). The 2014 population of cockles at Takahiwai is estimated to be 235.2 million ± 116.2 million (95% confidence interval) (Table 5).

Table 5: Cockle densities found within Takahiwai

	Sample size (*n*)	Cockle density (per m^2) (SE)	Stratum Area (m^2)	Total (millions)
Takahiwai A	7	493.7 (77.7)	195041	96.3
Takahiwai B	6	505.2 (217.4)	49763	25.14
Takahiwai C	8	524.1 (81.4)	139169	72.9
Takahiwai D	4	460.3 (160.4)	88604	40.8
All	25	497.6 (119.3)	472578	235.2

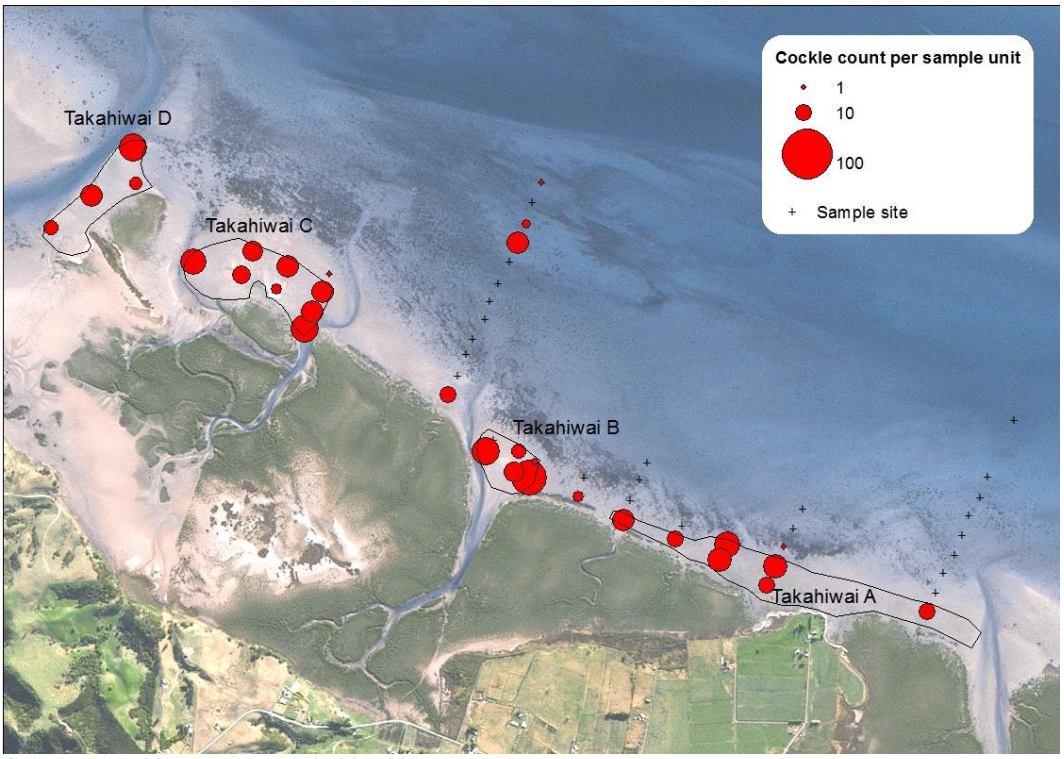


Figure 8: Cockle counts at Takahiwai in 2014.

The absolute biomass of cockles at the four stratums in Takahiwai is estimated to be 697.1 tonnes ± 362.6 tonnes (95% confidence interval) (Table 6). This total is much lower than the total biomass estimates for Snake Bank (1794.5 tonnes) and McDonald Bank (1528.2 tonnes) even though the total areas used for the estimates are similar in size.

Table 6: Biomass estimates of cockles on Takahiwai

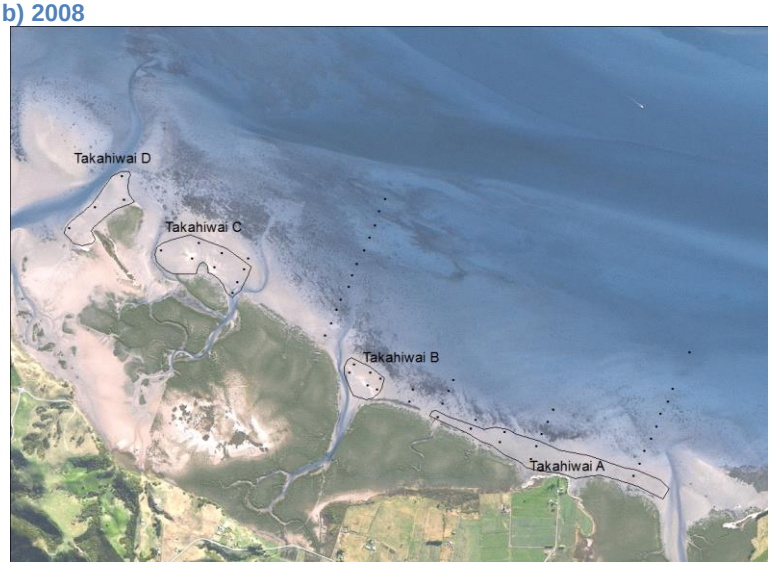
	Sample size (*n*)	Area (m^2)	Mean biomass (per m2)	Biomass (tonnes)	c.v. (%)
Takahiwai A	7	195041	1713.8	334.3	
Takahiwai B	6	49763	1059.3	52.7	
Takahiwai C	8	139168	1371.3	190.8	
Takahiwai D	4	88604	1346.0	119.3	
Total	25	472578	1475.1	697.1	0.256

Seagrass Extent

Historical aerial images show that there has been a large increase in the seagrass extent at Takahiwai (Figure 9). GIS Analysis of aerial images show that in 2003 seagrass covered 0.011km^2 but this had increased to 0.722km^2. In 2011 seagrass extent was 2.704km^2.

a) 2003

b) 2008



c) 2011

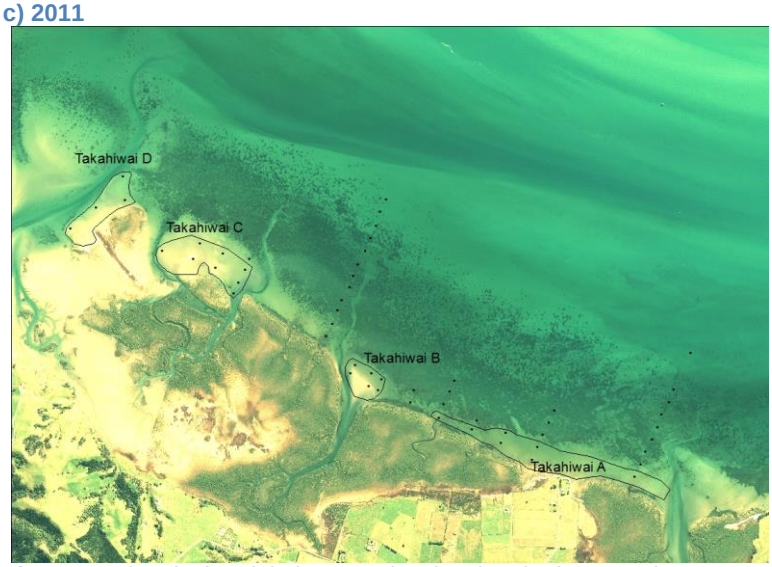


Figure 9: Historical aerial photographs showing the increase in seagrass extent at Takahiwai from 2003 – 2011.

4 Discussion

The 2014 population of cockles at Snake Bank was estimated to be 355.9 million ± 95.6 million and the total biomass 1794.5 ± 516.9 tonnes. The 2014 biomass estimate for Snake Bank was within the range of estimates from previous surveys (1405 – 3486 tonnes) undertaken between 1982 and 2009 and similar to the estimate of 1686 tonnes in 2009 (Williams *et al*. 2009).

At McDonald Bank the population was estimated to be 360.7 million ± 67.8 million with a total biomass of 1528.2 ± 299.7 tonnes. The biomass estimate at McDonald Bank was lower than the last estimate in 2002 of 2548 tonnes although the area surveyed in 2002 was slightly larger (0.563km^2 in 2002 compared to 0.423km^2 in current survey) and it was conducted in July - August compared to January for the current survey.

250kg of cockles represents approximately 0.01% of the total population at Snake Bank and 0.02% of the population at McDonald Bank. The results of the surveys from the two potential donor sites shows that there are sufficient populations of cockles on both beds to support a loss of 250kg of cockles to a potential donor site.

At Takahiwai very low densities of cockles were found at stations covered with seagrass compared to stations with no seagrass cover. Of the 27 stations where seagrass was observed, cockles were found at just five sites and the densities at these five sites was very low (28 per m^2 to 169 per m^2). This supports the findings of an ecological survey of the harbour by council in 2012 which also found very low densities of cockles at three sites located within the seagrass bed at Takahiwai (Griffiths 2012). On bare sandy substrate at Takahiwai the cockle densities (460 – 524 per m^2) are also lower than at Snake Bank (722 per m^2) and McDonald Bank (853 per m^2), which supports anecdotal evidence from the Kaitiakia Rōpū. The average biomass per m^2 at Takahiwai (1059.3 – 1713.8g) is also lower than Snake Bank (3638.1g) and McDonald Bank (3614.5g). The absolute biomass of cockles at the four stratums in Takahiwai is estimated to be 697.1 tonnes ± 362.6 tonnes (95% confidence interval). This is lower than Snake Bank and McDonald Bank even though the total areas used for the estimates are similar in size. 500kg of cockles represents approximately 0.07% of the total population at Takahiwai.

The low density of cockles in areas covered by seagrass indicates that these areas are not suitable for a large scale transplant. The relatively low densities of cockles on bare inter-tidal areas of Takahiwai suggests that these sites may benefit from translocation of cockles. However, the relatively rapid expansion of seagrass at Takahiwai raises the question whether it would be prudent to translocate cockles to an area that may soon become covered with seagrass. Seagrass coverage at Takahiwai has increased markedly from the early 2000's when there was almost no seagrass (Figure 9) to the present day when the majority of the intertidal flats are now covered in seagrass. Field observation during this survey found that there is now just a narrow band of firm sandy habitat fringing the mangrove forest and shoreline and that in places seagrass extends right up to the mangrove forest.

Recommendations

- There are sufficient cockle populations at both Snake Bank and McDonald Bank to support the transplant of 250kg of cockles from each bed to a transplant site.
- There are areas of bare sand intertidal flats at Takahiwai with lower densities of cockles which may benefit from the transplant of cockles
- These areas may soon be covered by seagrass which appears to be a less suitable habitat for cockles.

- Cockles should not currently be transplanted from either Snake Bank or McDonald Bank to Takahiwai.

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