

**Population and biomass survey of pipi (*Paphies australis*) on Mair Bank,  
Whangarei Harbour, 2016.**

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Image courtesy of Riaan Elliot

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## EXECUTIVE SUMMARY

### *Population and biomass survey of pipi (Paphies australis) on Mair Bank, Whangarei Harbour, 2016.*

DMP Statistical Solutions Ltd was commissioned by Refining NZ to survey the population and biomass of pipis (*Paphies australis*) on Mair Bank within Whangarei Harbour. Mair Bank is an important commercial and recreational shellfish collection area and provides a natural protection to the harbour entrance and Marsden Point. The survey was done in February 2016 and is the fourth pipi biomass estimate for Mair Bank that accounts for the subtidal population.

Following the 2005 (Williams et al. 2006), the 2010 (Pawley et al. 2013), and the 2014 (Pawley 2014) surveys, the Mair Bank sample extent encompassed an area defined approximately by the depth contour of 1.8 m. Within this area, we estimated the following (with 95% confidence):

- The absolute biomass (and 95% CI) of pipis is  $44.7 \pm 32.5$  tonnes.
  - The 2014 estimate of absolute biomass was  $73.5 \pm 44.6$  tonnes.
- The 2016 population of pipis at Mair Bank is  $5.3 \pm 4.4$  million.
  - The 2014 population of pipis at Mair Bank was  $4.95 \pm 3.52$  million.
- The number of 'harvestable pipis' (i.e. pipis larger than 50 mm) was  $1.04 \text{ million} \pm 0.9 \text{ million}$ .
  - The number of 'harvestable pipis' in 2014 was  $2.5 \text{ million} \pm 1.45 \text{ million}$ .
- The number of pipis recruited within the last 12 months (i.e. pipis smaller than 18 mm) was  $0.34 \pm 0.38$  million.
  - The number of recruits in 2014 was estimated to be  $0.48 \text{ million} \pm 0.82 \text{ million}$ .

The total abundance and biomass are both similar to the 2014 survey (in 2016 a total of only 45 pipis were found from 212 samples throughout the sample extent). However, both the 2016 and 2014 surveys are markedly lower than the 2010 survey.

The total population has declined from around 460 million in 2010 to around 5 million (2014) and has not changed significantly since the last survey. The 2016 estimate of absolute biomass, 44.7 t, is lower than the 2014 estimate of absolute biomass (73.5 t) and remains a small fraction of the 2010 estimate (4,450 t).

The subtidal extent contains very few pipis – a single pipi was found in the 2 samples taken from this area.

## 1. INTRODUCTION

### 1.1 Overview

This report summarises fishery and research information for pipi (*Paphies australis*) on Mair Bank, Whangarei Harbour. The report provides a description and results of the full biomass survey of pipi done on Mair Bank between 12 February and 14th February 2016.

This project was funded by Refining NZ.

#### 1.1.1 Overall objective

1. To assess the total population of pipis (*Paphies australis*) on Mair Bank, Whangarei Harbour.
2. To estimate the size structure and absolute biomass of pipis on Mair Bank in February 2016.
3. To compare the results of (1) and (2) with previous studies.

#### Physical character of Mair Bank

Mair Bank is an intertidal sand and shell ebb-tidal delta located at the southern side of the entrance to the Whangarei Harbour, north-eastern New Zealand. The bank extends offshore from Marsden Point, and is separated from the Bream Bay coast by a narrow channel that expands westward into the harbour. Mair Bank is fully submerged at high tide, but at low tide has a subaerial component of tightly-packed shell that extends approximately 1.1 km along its southern edge (Haddon, 1989).

#### Pipi

Pipis (*Paphies australis*) are moderately large, infaunal bivalves that can reach sizes of up to 90 mm in shell length. They have a thick, solid, white shell covered with a periostracum (skin-like organic coating). They position themselves within the top few centimetres of the substrate with their posterior end protruding slightly and feed by extending a short siphon from the substrate into the water column to extract food (Dickie, 1986). Pipis inhabit sandy deposits in areas of moderate wave energy (e.g. sandbanks and harbour entrances), and can occur in dense aggregations ('pipi beds') (up to 10000 m<sup>-1</sup> has been found on Marsden Bank). They may be found on the shore in the intertidal zone down to subtidal depths of at least 7 m (Dickie, 1986; Hooker, 1995).

#### The Mair Bank commercial fishery

Most commercial landings of pipi in New Zealand (over 99% ) have been harvested from Mair Bank. Commercial harvesting had typically been focused on the southern margins of the bank where shell cover is less dense, with the central area being avoided by commercial fishers. All commercial harvesting were conducted by hand, and fishers typically used a mask and snorkel. There is no minimum legal size (MLS) for pipi, but larger organisms were generally targeted over smaller individuals. Commercial pipi harvesting occurred year-around, so there was little seasonality in harvesting pressure. Current catch landings over the past decade have consistently been below the TACC (Table 1) with little commercial fishing taking place since 2012.

**Table 1: The greenweight (t) commercial landings of pipi (from Licensed Fish Receiver Returns: LFRR) in Whangarei Harbour between 1986-87 to 2012-13 fishing years. [Source: Report from the Fisheries Assessment Plenary, May 2014].**

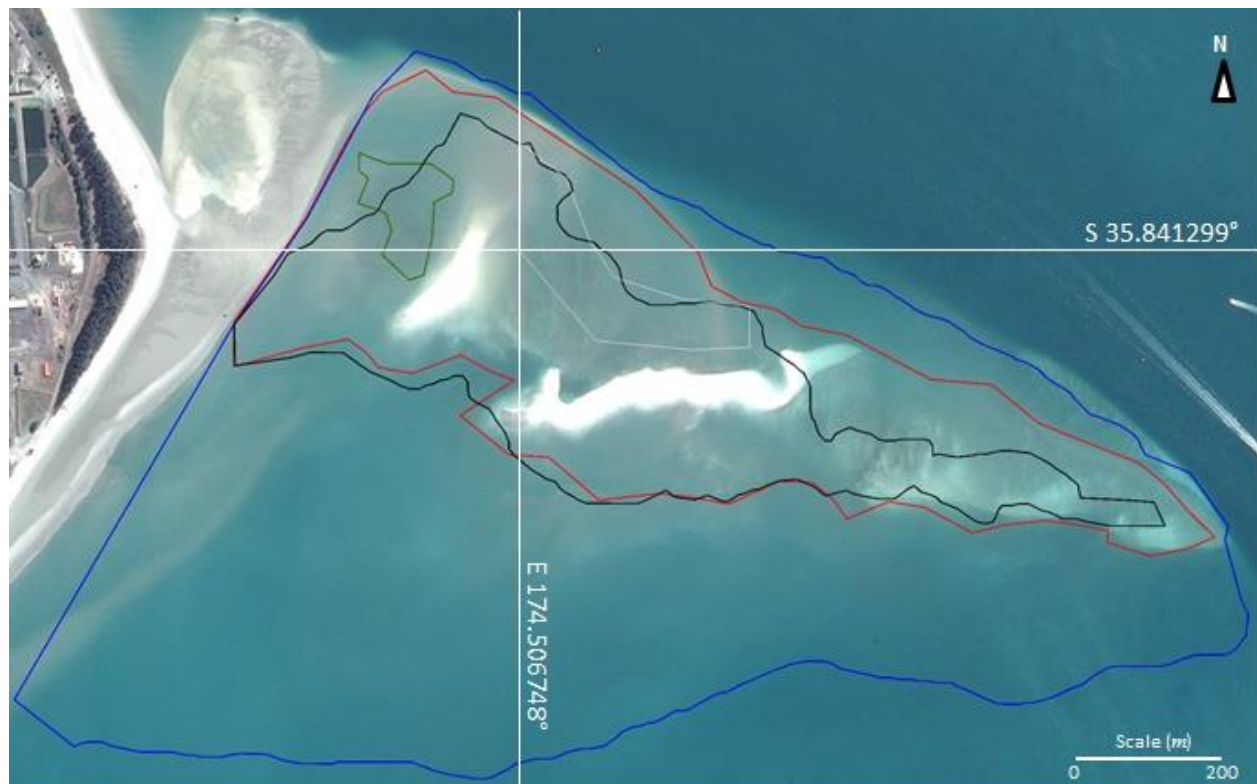
Year	Reported landings (t)	Limit (t)	Year	Reported landings (t)	Limit (t)
1986 - 87	131	657	2000 - 01	184	657
1987 - 88	133	657	2001 - 02	191	657
1988 - 89	134	657	2002 - 03	191	657
1989 - 90	222	657	2003 - 04	266	657
1990 - 91	285	657	2004 - 05	206	200
1991 - 92	326	657	2005 - 06	136.7	200
1992 - 93	184	657	2006 - 07	134.7	200
1993 - 94	258	657	2007 - 08	141.6	200
1994 - 95	172	657	2008 - 09	131.1	200
1995 - 96	135	657	2009 - 10	136	200
1996 - 97	146	657	2010 - 11	87	200
1997 - 98	122	657	2011 - 12	55	200
1998 - 99	130	657	2012 - 13	0	200
1999 - 00	143	657			

## 2. METHODS

### 2.1 Sample extent

#### 2.1.1 Mair Bank

The sample extent for Mair Bank was based on limits defined by Williams et al (2006), i.e. pipi were sampled within the area defined by the 1.8 m below chart datum (CD) contour. The sample extent was split into an intertidal area (defined by 0.5 m above CD) and subtidal area (the remaining area) (see Figure 1).



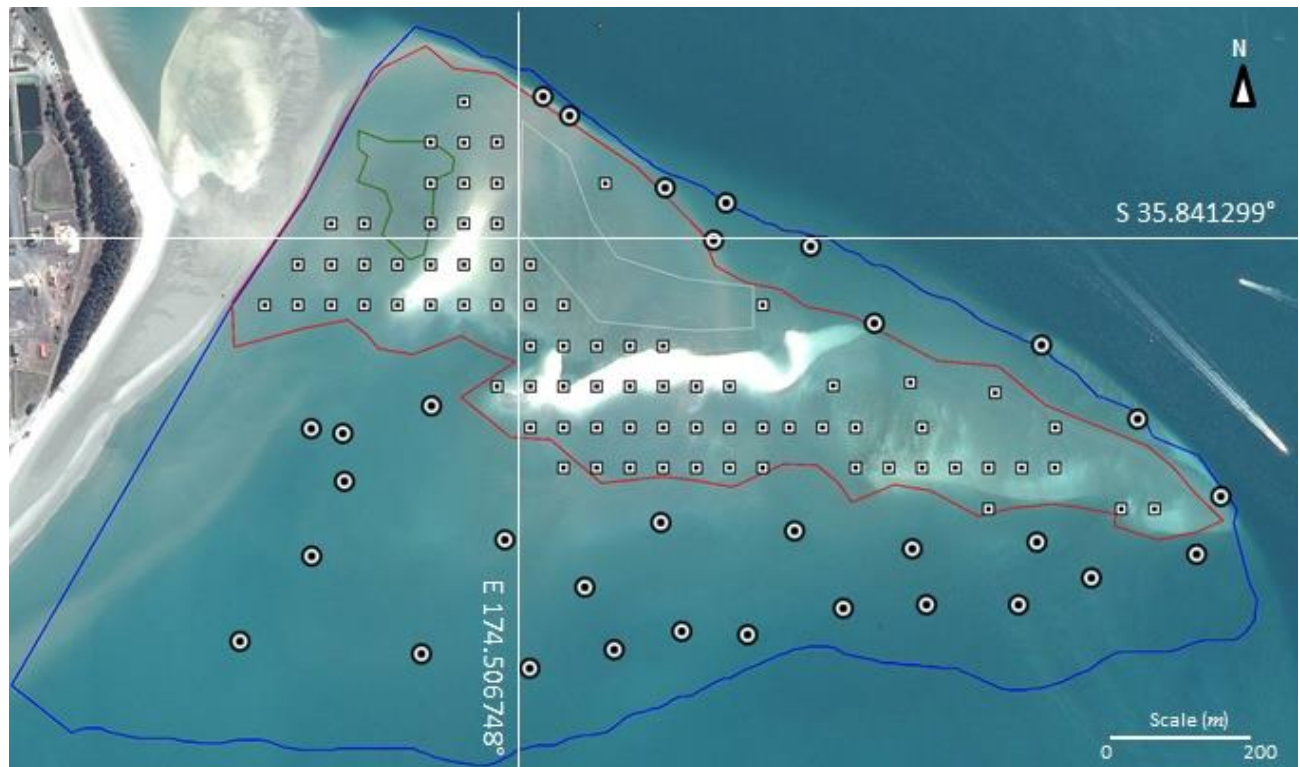
**Figure 1: The Mair Bank surveys since 2010 have divided the bank into intertidal and subtidal strata.** Intertidal and subtidal sample extents for the 2016 survey are shown by the red and blue contours respectively. The black contour shows the intertidal extent from the 2014 survey. The green polygon shows the extent of the mussel bed, and the white polygon shows the 'previous pipi bed' location (Image: Google Earth).

#### *Changes in Mair Bank structure*

The bathymetry of Mair Bank appears to have changed since the 2010 and 2014 surveys (see Figure 1). Mair Bank is no longer separated from neighbouring Marsden Bank by a channel, and the northern edge now extends further (compared to 2014). The extent of our samples changed to incorporate this additional area.

The intertidal area was haphazardly sampled, and two specific regions on the bank were sampled with greater resolution:

1. An area based on the reported previous position of the pipi bed was more densely sampled. Patuharakeke identified the approximate area where they had previously found a pipi bed (Figure 2 – white polygon).
2. NZ Refining noted that a green-lipped mussel bed (*Perna canalicula*) has recently appeared since the 2014 survey. DMP Stats were asked to survey its sample extent and estimate the mussel density (Figure 2 – green polygon shows the mussel bed extent).



**Figure 2: 2016 sample locations on Mair Bank.** White squares indicate intertidal sample positions, white circles subtidal sample positions. The 'previous pipi bed' (white polygon) was haphazardly sampled ( $n = 20$ ), and eight transects were run through the mussel bed (green polygon,  $n=89$ ) (Image: Google Earth).



## 2.1 Sampling methods

### 2.1.1. Sampling Pipis

The intertidal and subtidal samples were collected by taking a sample unit consisting of two adjacent, circular cores (with a 15 cm diameter) pushed into the substrate to a depth of 15 cm. The contents from the two cores were aggregated (so each sample unit covered a cross sectional area of 0.0353 m<sup>2</sup>) and passed through a 5 mm aperture sieve. All individuals of the target species retained on the sieve were identified, counted and measured across their widest axis to the nearest millimetre. The intertidal and subtidal sample extents were haphazardly sampled based on a random start systematic design (see Figure 2).

The total biomass for Mair Bank was calculated by calculating the average biomass (per m<sup>2</sup>) for each stratum, and then reweighting this value by the stratum area (see equation 1).

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

where  $W_i$  is the stratum area (m<sup>2</sup>), and

$\bar{x}_i$  is the average density or biomass (per m<sup>2</sup>) in stratum  $i$ .

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

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

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  $i$ .

### 2.1.2 Sampling Mussels

A large proportion of the mussel bed was under water at low tide making it difficult to count individual mussels—so the percentage coverage of mussels was estimated instead of absolute abundance.

The mussel bed extent was initially mapped out using GPS. Within the mussel extent, 8 parallel transects were positioned systematically through the bed. Along each transect, 0.25 m<sup>2</sup> square quadrats were placed at every 10 m. Each quadrat contained a grid with 25 points, and the percentage cover was assessed by counting the proportion of grid points over mussels.

The estimated average percentage coverage,  $\hat{p}$ , and its standard error ( $se[\hat{p}]$ ) was estimated using a generalized linear model with binomial error distribution and logit link function.

## 2.2 Biomass estimation

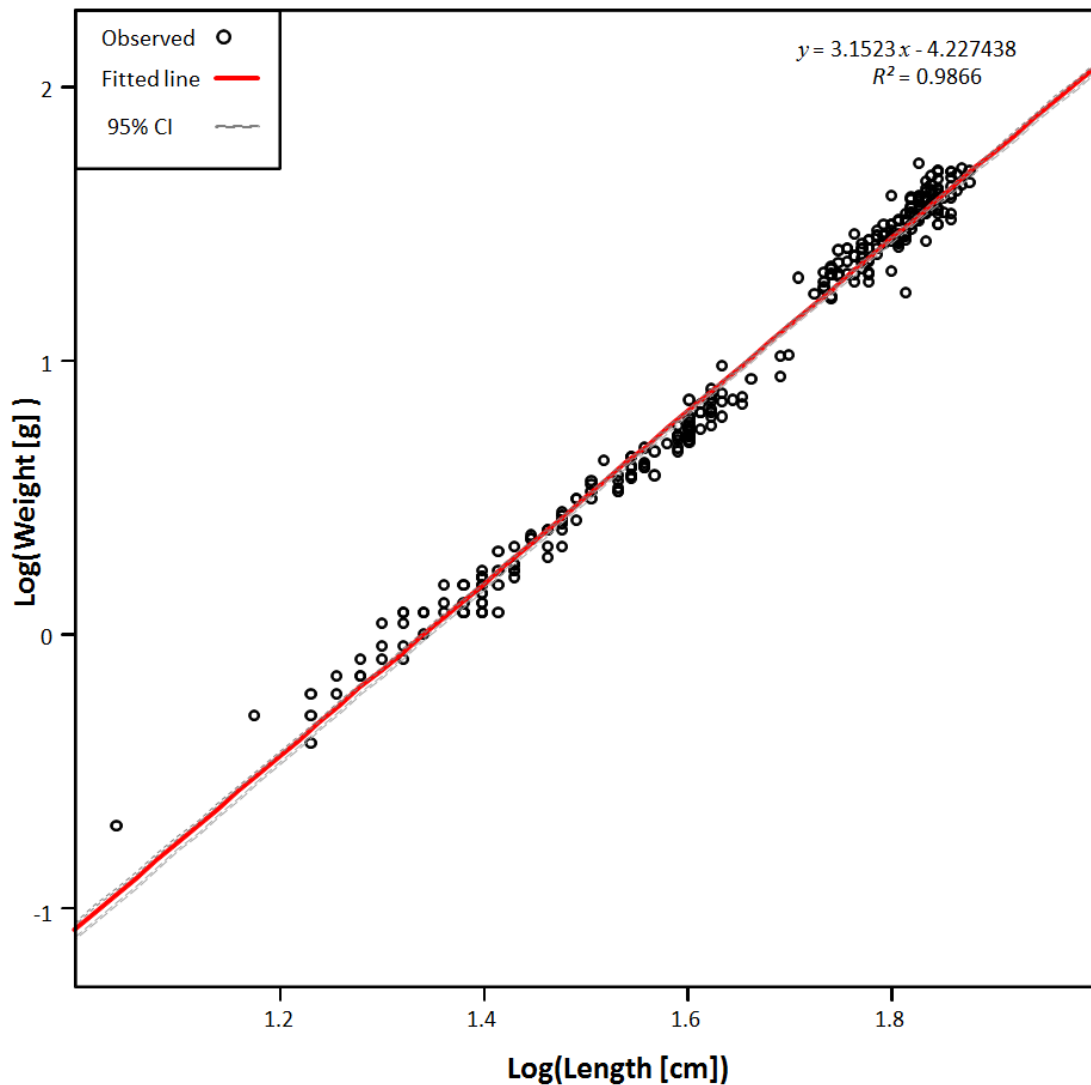
### 2.2.1 Length-Weight relationship

The relationship between length and weight of pipis derived by Pawley et al. (2013) was used to estimate biomass (see Table 2).

**Table 2: Pipi length-weight relationship estimates.** The relationship was determined from data with sample size ( $n$ ) used to estimate the model coefficients,  $a$  and  $b$ , from the equation:  $\text{Weight} = a \times \text{Length}^b$ . The proportion of total variability explained by the model ( $R^2$ ) is also shown in the table.

$A$	$b$	$n$	$R^2$	Reference
$5.861 \times 10^{-5}$	3.1523	300	0.987	Pawley et al. (2013)

The modelled relationship between length and weight is shown in Figure 3. Although the model fits individuals above 25 mm well, it appears to consistently underestimate smaller individuals.



**Figure 3: The relationship between the length and weight of pipis** (from Pawley et al., 2013).



### 3. RESULTS

#### 3.1 Total Population

In the 2016 survey, a total of 45 pipis (including 2 subtidal pipis) were found from 212 samples. The total number of pipis found is similar to the numbers found in the 2014 survey (63 pipis were found) and there is no evidence of a change in the population total since 2014 ( $p=0.6$ , 95% CI: -19.6 million [i.e. a decrease], 108.9 million pipis [increase]).

In contrast, the 2010 survey found 2,028 pipis (from 93 samples [the same sample unit type was used in both surveys]).

**Table 3: Pipi densities found within each stratum.**

Stratum	Sample size ( <i>n</i> )	Pipi density (per m <sup>2</sup> )	Stratum Area (m <sup>2</sup> )	Total (millions)
Intertidal	76	15.26	323 830	4.61
Mussel Bed	89	0	12 794	0
‘Previous Pipi Bed’	20	4.24	8 870	0
Subtidal	27	1.05	653 725	0.685

- We estimate that the 2016 population of pipis at Mair Bank is 5.33 million  $\pm$  4.5 million (95% confidence interval).
- We estimate that the number of ‘harvestable pipis’ (i.e. pipis larger than 50 mm) was 1.03 million  $\pm$  0.9 million.
- We estimate that the number of pipis recruited within the last year (i.e. pipis smaller than 18 mm) was 0.34 million  $\pm$  0.38 million.
- Only one pipi was found in the subtidal stratum.

#### 3.2 Biomass

We estimate the absolute biomass of pipis in the entire Mair Bank sample extent is 44.7  $\pm$  32.2 tonnes (95% confidence interval) (see Table 4).

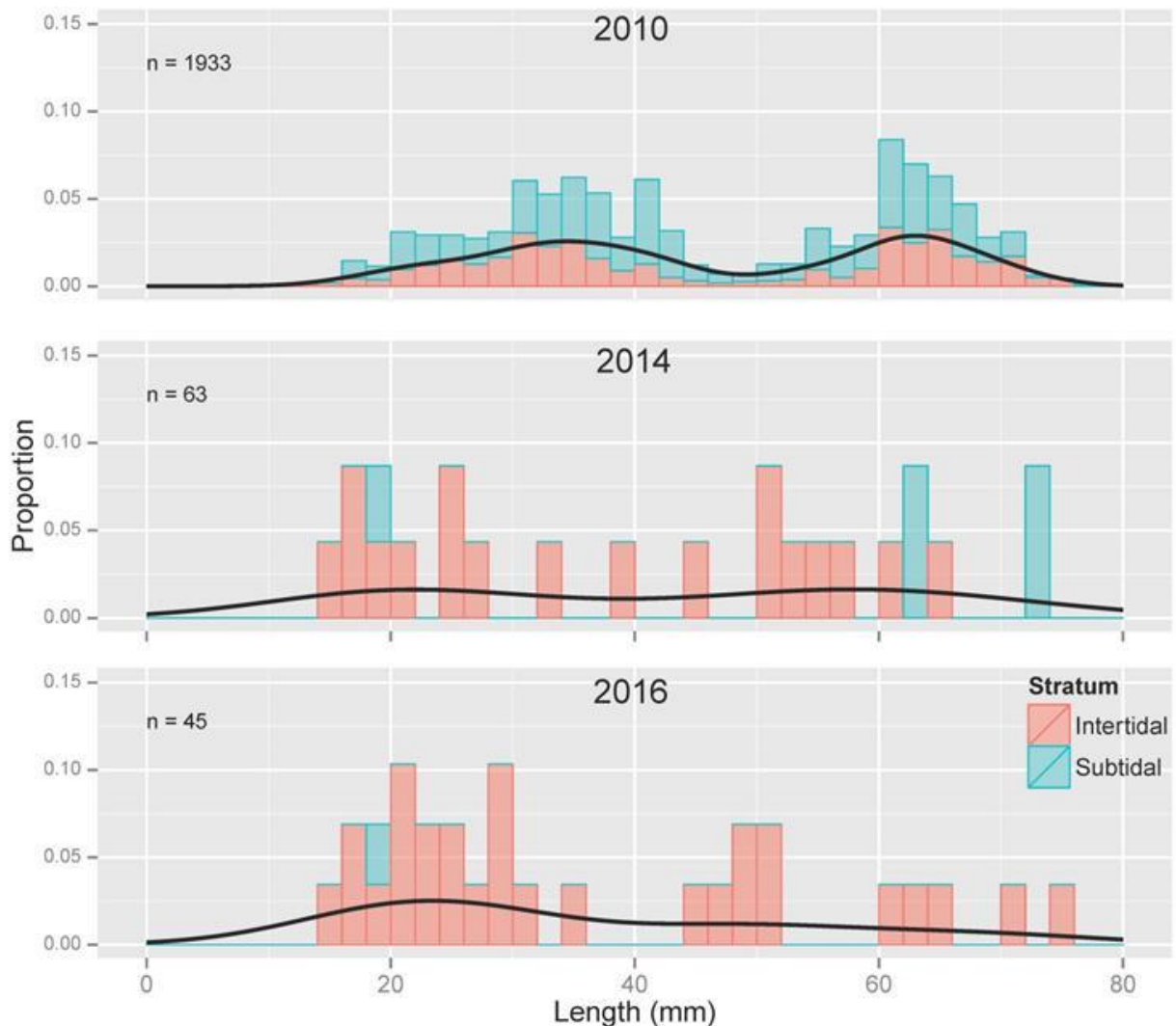
**Table 4: Absolute biomass estimates (1 mm recruited shell length) of pipis on Mair Bank.**

	Intertidal stratum		Subtidal stratum		<b>Mair Bank Total</b>	
Year	<i>Biomass</i> ( <i>t</i> )	<i>c.v.</i> (%)	<i>Biomass</i> ( <i>t</i> )	<i>c.v.</i> (%)	<i>Biomass</i> ( <i>t</i> )	<i>c.v.</i> (%)
2010	2 233	17.4	2 218	33.0	<b>4 452</b>	<b>15.2</b>
2014	46.1	50.8	27.5	25.9	<b>73.5</b>	<b>30.8</b>
2016	39.0	40.0	5.7	100.0	<b>44.7</b>	<b>72.7</b>

There has been no evidence of a decrease in the total (absolute) biomass of pipis at Mair Bank since the previous (2014) survey ( $p = 0.31$ ).

### 3.2 Length Frequency Distribution

The length frequency distributions are shown for the Mair Bank intertidal, and subtidal population for the 2010, 2014 and 2016 studies (Figure 4).<sup>1</sup>



**Figure 4: The weighted length frequency distribution of Mair Bank pipis in 2010, 2014 and 2016.** The black line is a smoothed estimate of the length frequency histogram.

The Mair Bank distribution of pipi length in 2010 was bimodal in both intertidal and subtidal areas - with modes around 30 mm and 62 mm. Since 2010, there have not been enough pipis to accurately estimate the length frequency distribution of the population. In the 2014 survey, sampled pipis were relatively uniformly distributed between around 14 and 70 mm. In the 2016 survey, there appears to be a small mode around 20 mm.

<sup>1</sup> The length frequency distributions shown in Figure 4 are standardized by the sample size, and account for different non-proportional sampling across the different strata.

### 3.3 Mussels

The mussel bed covered an area of approximately 12,800 m<sup>2</sup> on the north-western side of Mair Bank (near Marsden Bank) (see Figure 1 and Figure 2).

Within the mussel bed, the average coverage of mussels was 38.3% (95% CI 34.9% – 42.1%).

## 4. Discussion

The 2016 survey is the fourth pipi biomass estimate of Mair Bank that accounts for the subtidal population. In this survey, a total of 44 pipis were found from 212 samples throughout the sample extent.

### *Comparison with 2014*

The pipi population appears to be relatively unchanged since the 2014 survey. Intertidal pipi density for the intertidal and ‘previous pipi bed’ strata, at 15.3 and 4.2 pipis per m<sup>2</sup> respectively, was similar to the intertidal density found in 2014 (17.1 pipis m<sup>2</sup>). The subtidal pipi density remains very sparse (only a single pipi was found in the subtidal stratum in 2016). The biomass has also remained relatively unchanged since 2014.

### *Comparisons with earlier studies*

Both the total abundance and biomass have plummeted since the 2010 survey. The total population has declined from around 460 million (2010) to around 4.95 million, and the 2016 estimate of absolute biomass, 44.7 t, is around only 1% of the 2010 estimate (4,450 t) and less than 1% of the 2005 estimate (10,542 t).

### *Mussels*

This is the 1<sup>st</sup> description of mussels on Mair Bank. At the time of sampling, the mussel bed covered an area of approximately 13,000 m<sup>2</sup> on the north-western side of Mair Bank (near Marsden Bank). The bed covered, on average, around 40% of the substrate with green lipped mussels.

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