Port Taranaki Limited Maintenance Dredging Monitoring Report 2009 – 2014

Technical Report 2014-113

ISSN: 1178-1467 (Online)
Document: 1476713 (Word)
Document: 1500172 (Pdf)

Taranaki Regional Council
Private Bag 713
STRATFORD

June 2015

Executive summary

Port Taranaki Limited (the Company) is the commercial operator of the port located on Breakwater Road, New Plymouth. Port Taranaki is an artificially created harbour which is contained by two breakwaters enclosing 94 hectares of sheltered water. The Company undertakes regular dredging to maintain navigable channels within the port. Sand accumulates in large quantities around the tip of the main breakwater and this has to be removed on a regular basis in order to maintain the required depth in the entrance channel. Due to this accumulation of sand around the breakwater, the city beaches to the north east of the port have previously been starved of sand.

The Company holds resource consent 5886-1 that allows the Company to deposit the fine sands that accumulate around the end of the main breakwater in a nearshore dispersal site, in an attempt to introduce this sand back into the natural littoral drift and help replenish the city's beaches.

This report for the period July 2009-June 2014 describes the monitoring programme implemented by the Taranaki Regional Council (the Council) to assess the Company's environmental performance during the period under review, and the results and environmental effects of the Company's activities.

The Company holds three resource consents related to this report, which include a total of 28 conditions setting out the requirements that the Company must satisfy. The Company holds one consent to dredge accumulated sediments within Port Taranaki and two consents that allow them to discharge sediment into the inshore and offshore spoil disposal areas in the Tasman Sea.

During the monitoring period, Port Taranaki Limited demonstrated an overall high level of environmental performance.

The Council's monitoring programme for the period under review included two intertidal surveys at four sites, and two kaimoana surveys at five sites.

The results of intertidal surveys did not indicate that the disposal of dredged material was having a significant impact on the abundance or diversity of intertidal species. Natural sand movement was likely to have a greater impact than from the disposal of sand from dredging.

Surveys at five locally important kaimoana beds showed that paua and kina counts over the last two surveys were lower than surveys undertaken between 2004 and 2009, being more comparable to pre-dredge counts. There was no significant evidence to indicate that the drop in counts were related to dredging activities as no major build up of sand on the reefs has been noted in association with the dredging campaigns by the Company.

During the period, the Company demonstrated a high level of environmental and administrative performance and compliance with the resource consents. During the period under review there were no unauthorised incidents associated with dredging undertaken by the Company.

This report includes recommendations for the 2014-2016 period.

Table of contents

List of tables

List of figures

List of photographs

1. Introduction

1.1 Compliance monitoring programme reports and the Resource Management Act 1991

1.1.1 Introduction

Port Taranaki Limited (the Company) operates the port situated at New Plymouth, and holds resource consents allowing the dredging of sediments within Port Taranaki and the discharge of these sediments to the Tasman Sea. As part of the consent conditions, Taranaki Regional Council (the Council) implemented a compliance monitoring programme to ensure that the Company comply with their consent conditions. This monitoring report has been produced by the Council for the period July 2009 to June 2014 to describe the monitoring programme and associated results. This is the third monitoring report to be prepared by the Council to cover the Company's sediment discharges and their effects on the receiving environment.

1.1.2 Structure of this report

Section 1 of this report is a background section. It sets out general information about compliance monitoring under the *Resource Management Act 1991* (RMA) and the Council's obligations and general approach to monitoring sites through annual programmes, the resource consents held by the Company for the port, the nature of the monitoring programme in place for the period under review, and a description of the dredging activities and operations conducted in and around the port.

Section 2 presents the results of monitoring during the period under review, including scientific and technical data.

Section 3 discusses and interprets the results and their significance for the environment.

Section 4 presents recommendations to be implemented in the 2014-2016 monitoring period.

A glossary of common abbreviations and scientific terms, and a bibliography, are presented together with the appendecies at the end of the report.

1.1.3 The Resource Management Act (1991) and monitoring

The RMA primarily addresses environmental 'effects' which are defined as positive or adverse, temporary or permanent, past, present or future, or cumulative. Effects may arise in relation to:

(a) the neighbourhood or the wider community around a discharger, and may include cultural and socio-economic effects;
(b) physical effects on the locality, including landscape, amenity and visual effects;
(c) ecosystems, including effects on plants, animals, or habitats, whether aquatic or terrestrial;
(d) natural and physical resources having special significance (for example, recreational, cultural, or aesthetic); and
(e) risks to the neighbourhood or environment.

In drafting and reviewing conditions on discharge permits, and in implementing monitoring programmes, the Council is recognising the comprehensive meaning of 'effects' inasmuch as is appropriate for each activity. Monitoring programmes are not only based on existing permit conditions, but also on the obligations of the RMA to assess the effects of the exercise of consents. In accordance with section 35 of the RMA, the Council undertakes compliance monitoring for consents and rules in regional plans, and maintains an overview of the performance of resource users and consent holders. Compliance monitoring, including both activity and impact monitoring, enables the Council to continually re-evaluate its approach and that of consent holders to resource management and, ultimately, through the refinement of methods and considered responsible resource utilisation, to move closer to achieving sustainable development of the region's resources.

1.1.4 Evaluation of environmental performance

Besides discussing the various details of the performance and extent of compliance by the consent holder during the period under review, this report also assigns a rating as to the Company's environmental and administrative performance.

Environmental performance is concerned with actual or likely effects on the receiving environment from the activities during the monitoring period. **Administrative performance** is concerned with the Company's approach to demonstrating consent compliance in site operations and management including the timely provision of information to Council (such as contingency plans and water take data) in accordance with consent conditions.

Events that were beyond the control of the consent holder and unforeseeable (that is a defence under the provisions of the RMA can be established) may be excluded with regard to the performance rating applied. For example loss of data due to a flood destroying deployed field equipment.

The categories used by the Council for this monitoring period, and their interpretation, are as follows:

Environmental Performance

- **High** No or inconsequential (short-term duration, less than minor in severity) breaches of consent or regional plan parameters resulting from the activity; no adverse effects of significance noted or likely in the receiving environment .The Council did not record any verified unauthorised incidents involving significant environmental impacts and was not obliged to issue any abatement notices or infringement notices in relation to such impacts.

- **Good** Likely or actual adverse effects of activities on the receiving environment were negligible or minor at most. There were some such issues noted during monitoring, from self reports, or in response to unauthorised incident reports, but these items were not critical, and follow-up inspections showed they have been dealt with. These minor issues were resolved positively, co-operatively, and quickly. The Council was not obliged to issue any abatement notices or infringement notices in relation to the minor non-compliant effects; however abatement notices may have been issued to mitigate an identified potential for an environmental effect to occur.

For example:

- High suspended solid values recorded in discharge samples, however the discharge was to land or to receiving waters that were in high flow at the time;
- Strong odour beyond boundary but no residential properties or other recipient nearby.

- **Improvement required** Likely or actual adverse effects of activities on the receiving environment were more than minor, but not substantial. There were some issues noted during monitoring, from self reports, or in response to unauthorised incident reports. Cumulative adverse effects of a persistent minor non-compliant activity could elevate a minor issue to this level. Abatement notices and infringement notices may have been issued in respect of effects.

- **Poor** Likely or actual adverse effects of activities on the receiving environment were significant. There were some items noted during monitoring, from self reports, or in response to unauthorised incident reports. Cumulative adverse effects of a persistent moderate non-compliant activity could elevate an 'improvement required' issue to this level. Typically there were grounds for either a prosecution or an infringement notice in respect of effects.

Administrative performance

- **High** The administrative requirements of the resource consents were met, or any failure to do this had trivial consequences and were addressed promptly and co-operatively.

- **Good** Perhaps some administrative requirements of the resource consents were not met at a particular time, however this was addressed without repeated interventions from the Council staff. Alternatively adequate reason was provided for matters such as the no or late provision of information, interpretation of 'best practical option' for avoiding potential effects, etc.

- **Improvement required** Repeated interventions to meet the administrative requirements of the resource consents were made by Council staff. These matters took some time to resolve, or remained unresolved at the end of the period under review. The Council may have issued an abatement notice to attain compliance.

- **Poor** Material failings to meet the administrative requirements of the resource consents. Significant intervention by the Council was required. Typically there were grounds for an infringement notice.

For reference, in the 2012-2013 year, 35% of consent holders in Taranaki monitored through tailored compliance monitoring programmes achieved a high level of environmental performance and compliance with their consents, while another 59% demonstrated a good level of environmental performance and compliance with their consents. In the 2013-2014 year, 60% of consent holders achieved a high level of environmental performance and compliance with their consents, while another 29% demonstrated a good level of environmental performance and compliance.

1.2 Process description

1.2.1 General

Port Taranaki is an artificially created harbour which lies between a group of offshore islands to the west and Kawaroa Reef which is a large volcanic breccia reef that extends out to the 20 m contour line sub-tidally to the east.

The port is enclosed by two breakwaters, the Main breakwater and the Lee breakwater, which were created to provide additional shelter to the port and the ships that visit. These breakwaters enclose 94 hectares of sheltered water (Figure 1). Since the main breakwater at Port Taranaki was constructed, noticeable effects along the shoreline of New Plymouth have been observed.

A strong net littoral drift of sand occurs in a north-easterly direction along this area of coast. This drift is driven by the high-energy wave climate, which is dominated from the west north west quarter, and causes sand to accumulate in large quantities around the tip of the main breakwater. Two problems occur as a result of the accumulated sand around the breakwater; firstly there are issues in maintaining the required depth in the shipping channel, secondly erosion of the city beaches to the east of the port has been largely attributed to the port breakwaters interrupting the natural sand transport along the coast.

The accumulated sand needs to be removed on a regular basis. Dredging takes place approximately every two years at Port Taranaki to ensure that ships with a large draft can enter the port safely. Historically the disposal of the dredge spoil has occurred 1000 m due north of the tip of the main breakwater in water depths of 15 to 20 m. Once the spoil has been deposited at these depths it is no longer available to contribute to the littoral drift east of the port.

Figure 1 Port Taranaki showing the Main Breakwater on the left and the Lee Breakwater on the right

1.2.2 Port Taranaki dredging history

Port Taranaki has been regularly dredged over the last 115 years, with the dredged material being placed in an offshore location. It has been estimated that since 1986 approximately 180,000 – 210,000 m^3 of sediment is removed during each dredging campaign. It has been shown in a number of previous reports that most of the accretion of sediment occurs around the tip of the main breakwater area.

Since the harbour was first constructed there has been an increase in the coastal erosion north east of the port and along the city's foreshore and beaches. As a result of this, the Company applied for consent 5886 to introduce this sand back into the natural littoral drift of sand north east of the port.

As discussed above, the sediments were previously deposited offshore approximately 1000 m due north of the port. In 1998 a trial inshore site was used following investigations over several years by the University of Waikato (Black & McComb, 2000), where 47,000 m^3 of sediment was placed and monitored to see the dispersion patterns of sediment within this inshore site. The trial resulted in the discovery that any placed sediments will disperse in suspension rather than in bedload and that 12 months after the trial 40% of the deposited sand had moved from the deposition area.

The results from this trial led to the positioning of the new inshore dispersal site that is exercised under consent 5886 (Figure 2). This new site is located in front of the city's foreshore, where it ranges in depth from 6-15 m. The area is 1,290 m long and 580 m wide, which equates to an area of approximately 70 hectares. Initially the site was rectangular in shape, but following further investigation it was adjusted slightly due to the location of a kelp forest bordering on the boundary of the site. Restrictions associated with the dredging vessel's draft and sediment movement were taken into account when choosing this site, to ensure that the sediments do not move offshore, as that would defeat the purpose of the consent.

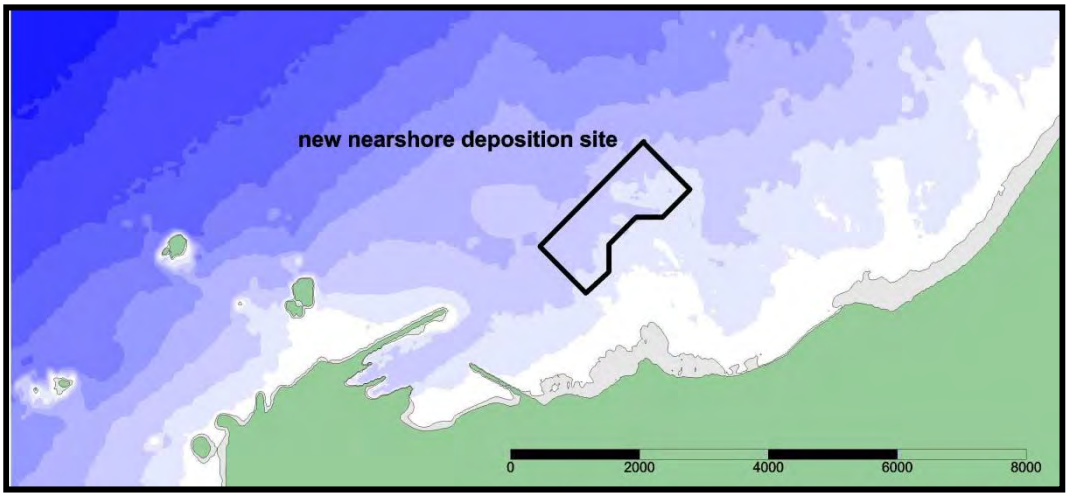


Figure 2 The inshore deposition site for clean sand dredged from Port Taranaki

The trailer suction dredge, the *Pelican* (Photograph 1), is equipped with GPS navigation systems and lateral thrusters, which allow precise positioning of the vessel (Atkinson *et al*., 2001). This navigation system also allows the vessel's location to be measured continuously, producing a map of its track at all times. An example of the continual monitoring of the *Pelican's* tracks is shown in Figure 3. Tracks of the vessel

show where each dredged load came from, and into what area it was dispersed within the spoil site (Figure 2). The vessel is a split hopper dredge with a hopper capacity of 965 m^3. Once the vessel is full and on site ready to dispose the spoil, the entire hull opens in half where it pivots about its longitudinal centreline on hinges just above deck level (Atkinson *et al*., 2001). The Pelican operates 24 hours a day for 6.5 days per week, with the remaining half day used for maintenance purposes.

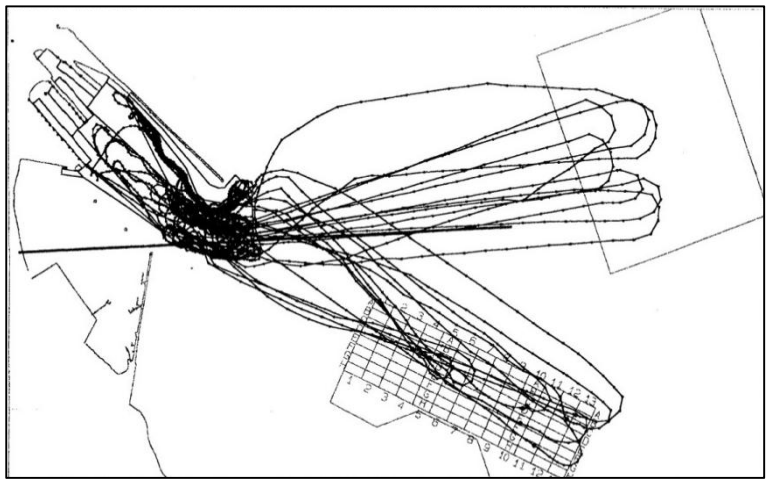


Figure 3 Dredging track of the *Pelican* to both the inshore (gridded box) and offshore (empty box) disposal sites.

Photograph 1 The *Pelican* used for dredging at Port Taranaki

1.3 Resource consents

Section 12 of the RMA restricts activities relating to the foreshore and seabed that have, or are likely to have, adverse effects, unless the activity is expressly allowed for by a resource consent or a rule in a regional coastal plan. A brief summary of the details and associated conditions of the three coastal permits associated with the dredging activities is provided below, with copies of the full permits attached to this report in Appendix I.

1.3.1 Coastal permit 3982-2

Port Taranaki Limited holds coastal permit **3982-2** to cover the dredging of accumulated sediments at Port Taranaki. This permit was issued by the Council on 28 January 2002 as a resource consent under Section 87(c) of the RMA. It is due to expire on 1 June 2029. Condition requirements of this permit are as follows:

- Condition 1 requires the consent holder to notify the Council 15 days prior to undertaking any dredging activities.
- Condition 2 allows for dredging of loose sediments accumulated within Port Taranaki and the main shipping channel only.
- Conditions 3 and 4 state that activity shall be conducted in accordance with the information submitted with the application, and the consent holder shall adopt the best practicable option to prevent or minimise any environmental effects.
- Condition 5 requires that the exercise of the consent does not affect the recreational use of Ngamotu Beach.
- Condition 6 requires the consent holder to keep and maintain records of all dredging activities.
- Condition 7 requires the consent holder to take representative samples of seabed sediments for chemical analysis.
- Condition 8 relates to the review of the permit.

1.3.2 Coastal permit 3374-2

Port Taranaki Limited holds coastal permit **3374-2** to cover the deposition of 570,000 m^3 in any one dredging campaign, and up to 1,045,000 m^3 in any three successive dredging campaigns of accumulated sediments dredged from Port Taranaki in an offshore spoil disposal area. This permit was issued by the Council on 28 January 2002 as a resource consent under Section 87(c) of the RMA. It is due to expire on 1 June 2029. Condition requirements of this permit are as follows:

- Condition 1 requires the consent holder to notify the Council 15 days prior to undertaking any dredging activities.
- Condition 2 defines types of dredging and area allowed.
- Condition 3 requires that every endeavour shall be made to ensure that clean sand be deposited at the inshore disposal site.
- Condition 4 states that this consent only be exercised where it is impractical to exercise permit 5886-1 due to sediment quality or operational necessity.
- Condition 5 requires the consent holder to keep and maintain records of all activities under this consent, including dates, volumes and origins of dredged material and a hydrographic survey of seabed depths following each campaign.
- Condition 6 states that the exercise of this consent shall be conducted in accordance with the information submitted in support of the application.
- Condition 7 requires the consent holder to adopt the best practicable option to prevent or minimise any adverse effects on the environment.
- Condition 8 relates to review of the permit.

1.3.3 Coastal permit 5886-1

Port Taranaki Limited holds coastal permit **5886-1** to cover the deposition of 400,000 m^3 in any one dredging campaign, and up to 730,000 m^3 in any three successive dredging campaigns of accumulated sands dredged from Port Taranaki within an inshore disposal area on the western flank of Kawaroa Reef. This permit was issued by the Minister of Conservation under Section 119 of the RMA on 9 April 2002, as the activity is a restricted coastal activity under the Regional Coastal Plan. The permit is due to expire on 1 June 2029. Condition requirements of this permit are as follows:

- Condition 1 requires the consent holder to notify the Council 15 days prior to undertaking any dredging activities.
- Condition 2 requires that the activity is undertaken in accordance with the information submitted in support of the application.
- Condition 3 states that the sand to be used for the inshore disposal shall be restricted to clean sand dredged from the outer harbour deposits.
- Condition 4 states that following the initial dredging campaign the annual volume of sand disposed is limited to 400,000 m^3 minus the estimated volume of sand remaining in the inshore disposal area from the last campaign.
- Condition 5 requires the consent holder to keep and maintain records of the inshore disposal of clean sands, including samples of deposited materials, dates, and volumes, with this information forwarded to the Council upon completion of each dredging campaign.
- Condition 6 requires the consent holder to undertake all practicable measures to ensure water discolouration from the disposal is kept to a minimum.
- Condition 7 states that the exercise of the consent shall not give rise to any significant sand inundation on the subtidal area of Kawaroa Reef outside of the inshore disposal area.
- Condition 8 states that there shall be no significant adverse ecological effects outside of the area specified as the inshore disposal area.
- Condition 9 requires there shall be no adverse effects on Kaimoana on the New Plymouth coast between the Lee Breakwater and the mouth of the Te Henui Stream.
- Condition 10 states that should there be a breach of conditions 7, 8 or 9 then the consent holder shall cease immediately of any sediment disposal authorised by this consent.
- Condition 11 requires that all monitoring undertaken in association with the consent is made publicly available at least three months prior to a review period.
- Condition 12 relates to review of the permit.

1.4 Monitoring programme

1.4.1 Introduction

Section 35 of the RMA sets out an obligation for the Council to gather information, monitor, and conduct research on the exercise of resource consents, and the effects arising, within the Taranaki region.

The Council may therefore make and record measurements of physical and chemical parameters, take samples for analysis, carry out surveys and inspections, conduct investigations, and seek information from consent holders.

The monitoring programme for the July 2009 to June 2014 period consisted of four primary components. Each component has a number of different methodologies and included surveys of marine ecology and kaimoana and reviews of the dredging data, programme liaison and management. The actions taken as part of these requirements are summarised below, with detailed results discussed in Section 2 and Appedicies II to IV of this report.

1.4.2 Programme liaison and management

There is generally a significant investment of time and resources by the Council in:

- ongoing liaison with resource consent holders over consent conditions and their interpretation and application;
- in discussion over monitoring requirements;
- preparation for any reviews;
- renewals;
- new consents;
- advice on the Council's environmental management strategies and content of regional plans and;
- consultation on associated matters.

1.4.3 Review of dredge data

As required by all three consents, following the dredging campaigns, the consent holder forwarded the records relating to the inshore disposal area. Special condition 3 in consent 5886 requires that the sand to be used for the inshore disposal area shall be restricted to clean sand dredged from the outer harbour deposits. To ensure this, the consent holder produced records of the dates, volumes, and positions of clean sand deposited, as well as samples from the deposited material.

1.4.4 Inter-tidal ecology

Intertidal surveys were conducted at two sites on Kawaroa Reef, one site on Arakaitai Reef and a control site at Greenwood Road during spring 2010 and 2012 to determine whether the disposal of sand has had a detrimental effect on the intertidal communities.

1.4.5 Kaimoana

Surveys to estimate the relative abundance of kaimoana species were undertaken at three sites on Kawaroa Reef, one site on Arakaitai Reef and one site off the Lee Breakwater during summer/autumn (March-April) 2011 and 2014. The surveys were conducted to determine whether the disposal of sand has had a detrimental effect on kaimoana species.

Photograph 2 A Council officer and Iwi representative undertaking a kaimoana survey

2. Results

2.1 Dredging

2.1.1 Dredged volumes

Dredging was undertaken on two occasions during the period July 2009 to June 2014. The first dredging and disposal operation commenced on 18 March 2011 and finished on 12 May 2011. A total of 262 loads with a total hopper volume of 174,192 m^3 were disposed of at the inshore dump ground over 26 days. This equated to an *in-situ* volume of 156,086 m^3 removed from the main breakwater sandbank (at a bulking factor of 1.116). In addition, 463 loads with an *in-situ* volume of 129,573 m^3 were dumped at the offshore dump ground.

Dredging in 2013 began on 19 January and was completed on 13 March. A total of 311 loads with a total hopper volume of 211,679 m^3 were disposed of at the inshore dump site over 23 days. This equated to an *in-situ* volume of 189,677 m^3 removed from the main breakwater sandbank. In addition, an *in-situ* volume of 82,657 m^3 was taken to the offshore dump ground.

Since commencement of the dumping of sand in the inshore dump ground (12 January 2004), a total of 1,167,133 m^3 *in situ* has been dumped (Table 1).

Table 1 Volume of sand dumped for each dredging campaign

Dredging Campaign	Date	Consent 5886-1: Inshore dump area		Consent 3374-2: Offshore dump area	
		In-situ sand volume (m^3)	Cumulative volume: three campaigns (m^3)	*In-situ* sand volume (m^3)	Cumulative volume: three campaigns (m^3)
First	12 Jan 2004 to 23 Mar 2004	253,633	253,633	90,239*	90,239
Second	13 May 2005 to 5 July 2005	199,101	452,734	114,094	204,333
Third	29 Nov 2006 to 19 Feb 2007	173,475	626,209	134,294*	338,627
Emergency	5 Aug 2008 to 18 Aug 2008	29,166	401,742	26,595*	274,983
Fourth	3 Jan 2009 to 4 April 2009	165,995	368,636	73,755*	234,644
Fifth	18 Mar 2011 to 12 May 2011	156,086	351,247	129,573	229,923
Sixth	19 Jan 2013 to 13 Mar 2013	189,677	511,758	82,657	285,985
Consent Limit (m^3)		400,000	730,000	570,00	1,045,000

**Volume calculations based on an average production rate of 180 m^3/h*

2.2 Intertidal ecology

Intertidal ecological monitoring was undertaken at four sites to ascertain whether there have been any adverse effects on the intertidal reefs as a result of the nearshore sand displacement. The sites surveyed were Arakaitai Reef, Kawaroa Reef 1.2 km north east of Lee Breakwater (Kawaroa 1.2 km), Kawaroa Reef 750 m north east of Lee Breakwater (Kawaroa 750 m), and one control site at Greenwood Road, approximately 20 km south west of the disposal site
(Figure 4).

The two survey reports, including statistical analysis of results and further discussion of the findings, are included in Appendix II. This section summarises the main findings of these survey reports.

It is expected that detectable adverse effects of the dredging activities on the intertidal communities would have been evident as a significant decline in species richness and diversity at the potential impact sites relative to the control site. No such adverse effects were evident during the 2009-2014 monitoring period. During both the 2010 and 2012 surveys, number of species per quadrat and Shannon-Weiner Index per quadrat were either higher or comparable at the potential impact sites relative to the control site (Figure 5 and 6, see Appendix II for details).

Figure 4 Site locations used for intertidal monitoring

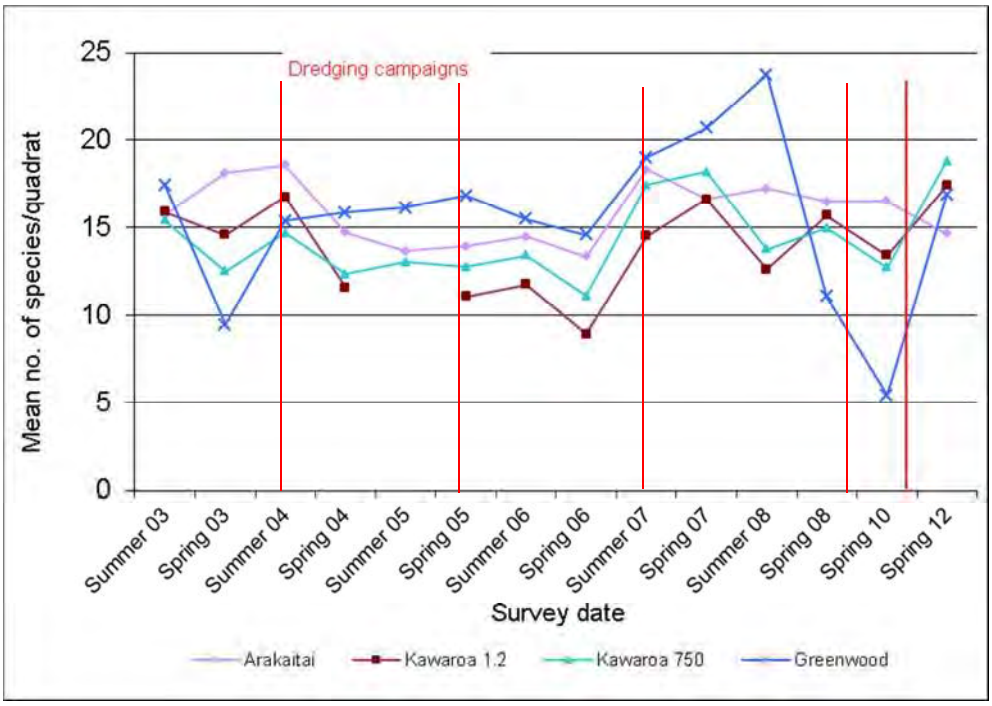


Figure 5 Summary for number of species per quadrat both pre and post dispersal

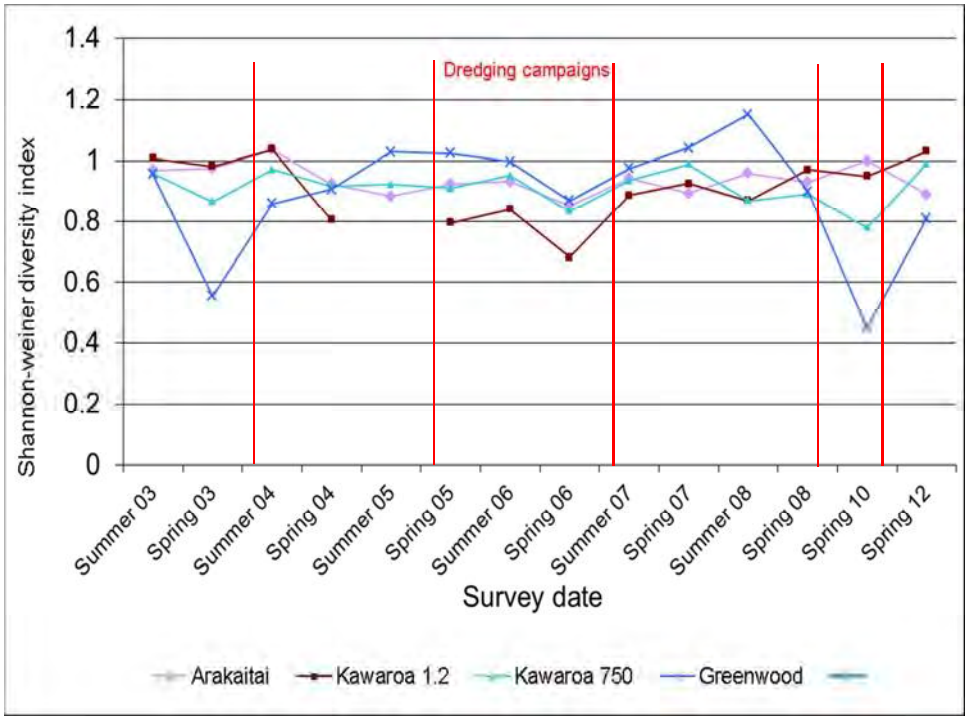


Figure 6 Shannon-Weiner diversity index per quadrat both pre and post dispersal

One of the main concerns of submitters to the inshore disposal proposal was the likelihood for sand inundation on the reefs around New Plymouth. It has been shown from previous investigation by the Council that a decrease in the number of species richness and diversity is likely to occur once the sand levels approach 30% sand coverage per quadrat.

Sand cover at the three potential impact sites remained low to moderate in spring 2010 and spring 2012 surveys (Figure 7). Sand cover at the Kawaroa 750 m site has been moderate on occasions, with sand often trapped in the turf which occurs in abundance across the lahar platform that makes up the majority of this site. Low levels of sand cover are typically present at Arakaitai, with only two surveys showing sand cover of greater than 5%. Pockets of sand are occasionally present towards the top of the shore at this reef (Photograph 3). The Kawaroa 1.2 km site had moderate levels of sand in initial, pre-dredging surveys, however sand at this site has remained low in all post-dredging surveys with the exception of the 2010 survey, during which moderate sand cover was recorded.

The control site at Greenwood Road has on occasions been susceptible to heavy sand inundation. During the 2003, 2008 and 2010 surveys, sand/silt cover at this site was 41%, 62% and 76% respectively. Sand deposistion at this site is due to natural oceanographic processes.

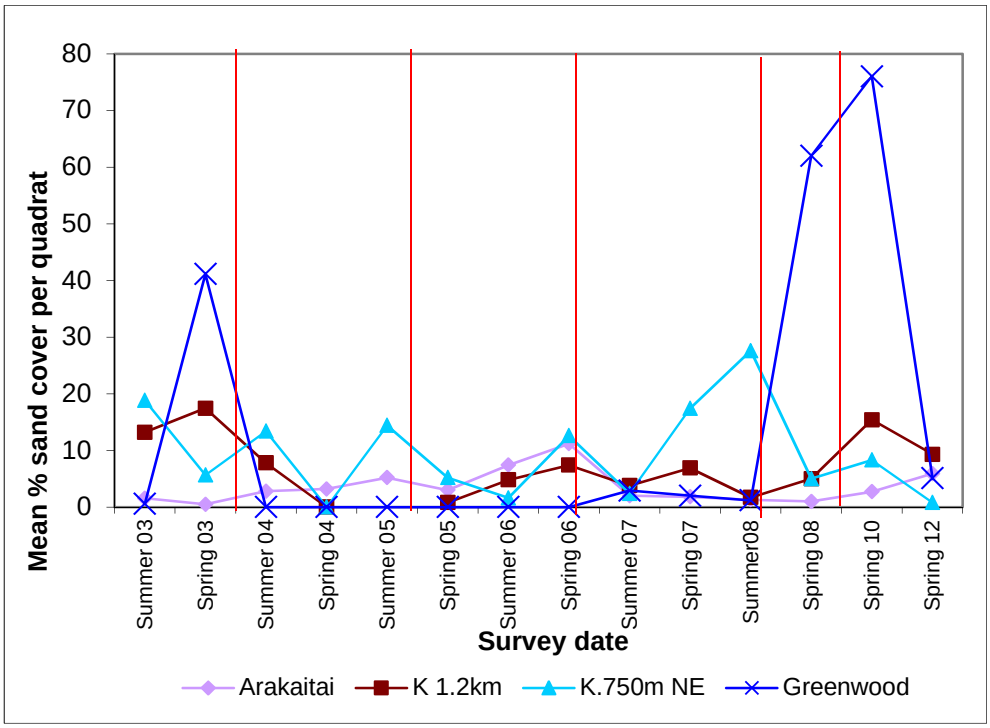


Figure 7 Mean percentage sand cover at the survey sites

Photograph 3 Sand accumulation on the high-shore at Arakaitai Reef, March 2010

Additional inspections of Kawaroa Reef and Arakaitai Reef were undertaken in March 2010, August 2011, November 2013 and May 2014 in order to assess the extent of sand accumulation on the reefs (Appendix III). In all inspections the reefs remained relatively sand free with the exception of occasional sand build up on the high shore at Arakaitai Reef at the top of the groyn along the base of the rock wall (Photograph 3, Appendix III).

2.3 Kaimoana

Kaimoana inspections were undertaken at five locally important kaimoana beds on Kawaroa Reef and Arakaitai Reef as identified by Ngati Te Whiti (Figure 8). The inspections included the low intertidal to shallow subtidal, which is not specifically surveyed as part of the intertidal monitoring, but is recognised as being abundant in kaimoana species. The surveys were undertaken to gather information on kaimoana abundance, as well as gaining information on the size frequency of paua.

The two survey reports (2011 and 2014), including analysis of results and further discussion of the findings, are included in Appendix IV. This section summarises the main findings of these survey reports.

A 'rapid visual technique' was used in the survey which provides semi-quantitative count data (see Appendix IV for further details). For each site, all available rocky crevice and under rock habitat was searched for 60 minutes. Within this time interval all paua encountered (*Haliotis iris, Haliotis australis* and *Haliotis virginea*) were measured and counted. Other kaimoana species (kina *Evechinus chloroticus* and cooks turban shell *Cookia sulcata*) were also counted, but not measured.

It is expected that detectable adverse effects of the dredging activities on the kaimoana species would have been evident as a significant decline in paua and kina counts in post-dredging surveys relative to pre-dreding surveys, in addition to a major build up of sand on the reefs in association with the dredging activities.

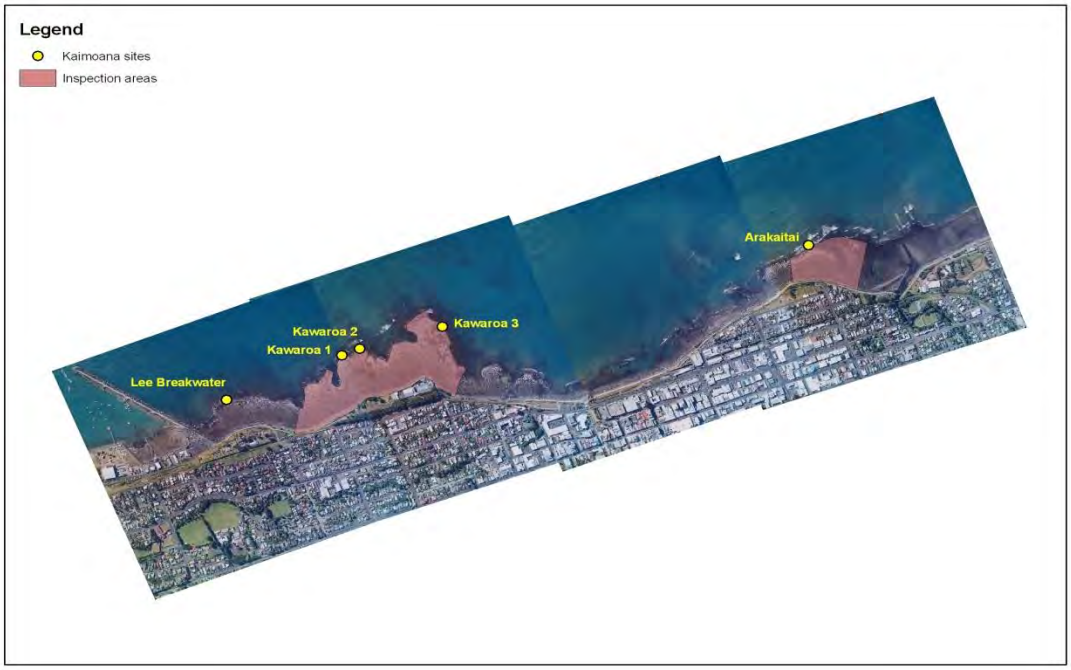


Figure 8 Kaimoana survey sites

Table 2 Summary paua count data for all surveys (post- and pre-dredging)

	Arakaitai	Lee Breakwater	Kawaroa 1	Kawaroa 2	Kawaroa 3
Mean count per minute (all surveys)	5.5	4.1	3.3	3.2	5.8
Pre-dredge (3 surveys)	2.6	4.0	2.2	2.6	5.1
Post-dredge (12 surveys*)	6.2	4.1	3.6	3.3	6.0
Min (mm)	5	7	10	4	10
Max (mm)	95	100	100	105	100
Mean	45.7	42.5	44.0	52.5	49.2

* There have been ten post-dredge surveys at Lee Breakwater and eleven at Kawaroa 1 and Arakaitai.

Since the kaimoana surveys began in 2003, Kawaroa 3 has had the highest average count of paua per minute, followed by Arakaitai, Lee Breakwater, Kawaroa 1 and Kawaroa 2. All sites have shown a higher mean count per minute in post-dredge surveys when compared with pre-dredge surveys (Table 2).

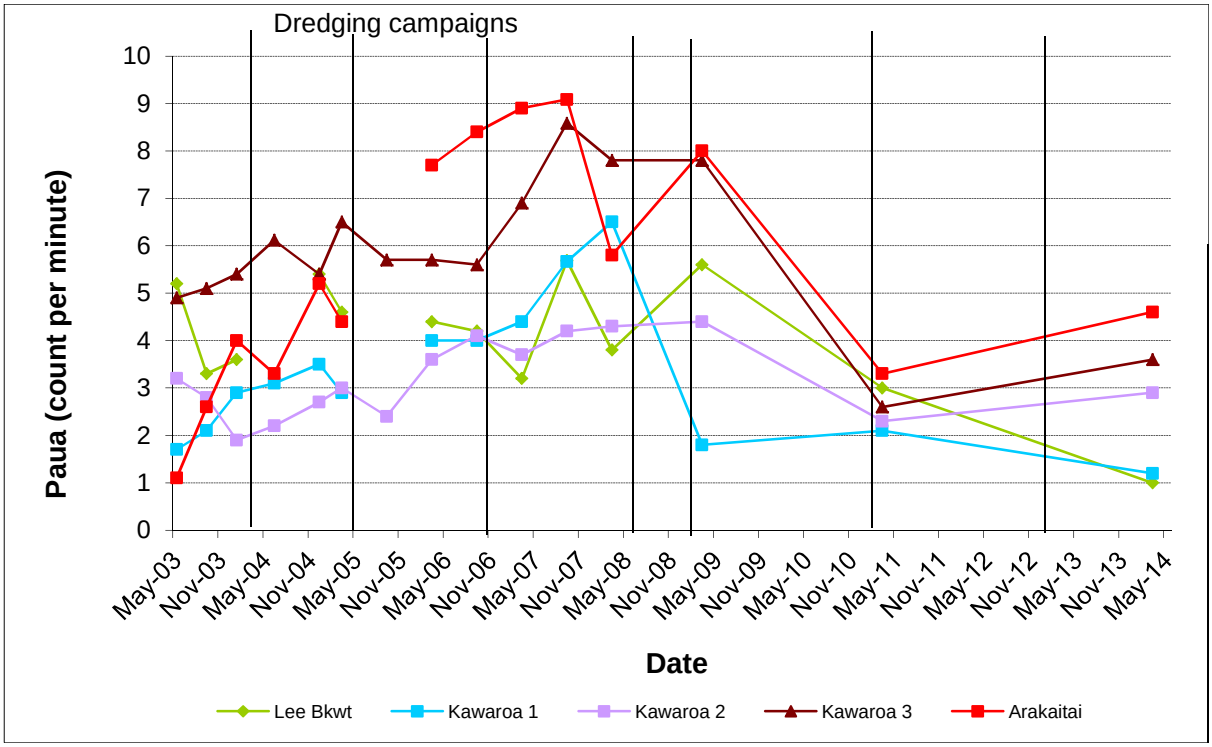


Figure 9 Number of paua found per minute searched at the five kaimoana reef sites

In general, the number of paua per minute showed a general increased at all sites from 2003 to 2007 (Figure 9). Lower numbers of paua per minute were recorded during the 2011 and 2014 surveys. The possible reasons for this decrease in paua counts are discussed further in Appendix IV 2014 Report and below.

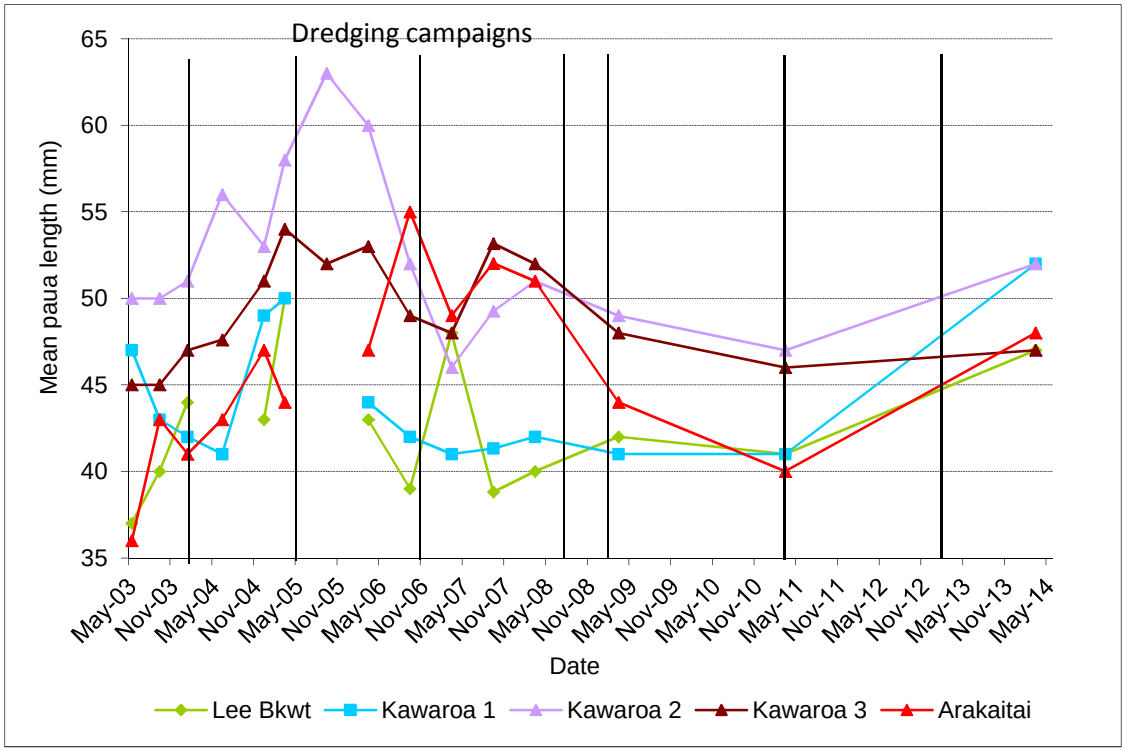


Figure 10 Mean length of paua at the five kaimoana reef sites

No obvious trends in paua length are evident in conjunction with dredging activities (Figure 10). In general, paua mean length has remained between 40 mm to 55 mm at the majority of sites with the exception of a few records >55 mm recorded at Kawaroa 2 between 2004 and 2006.

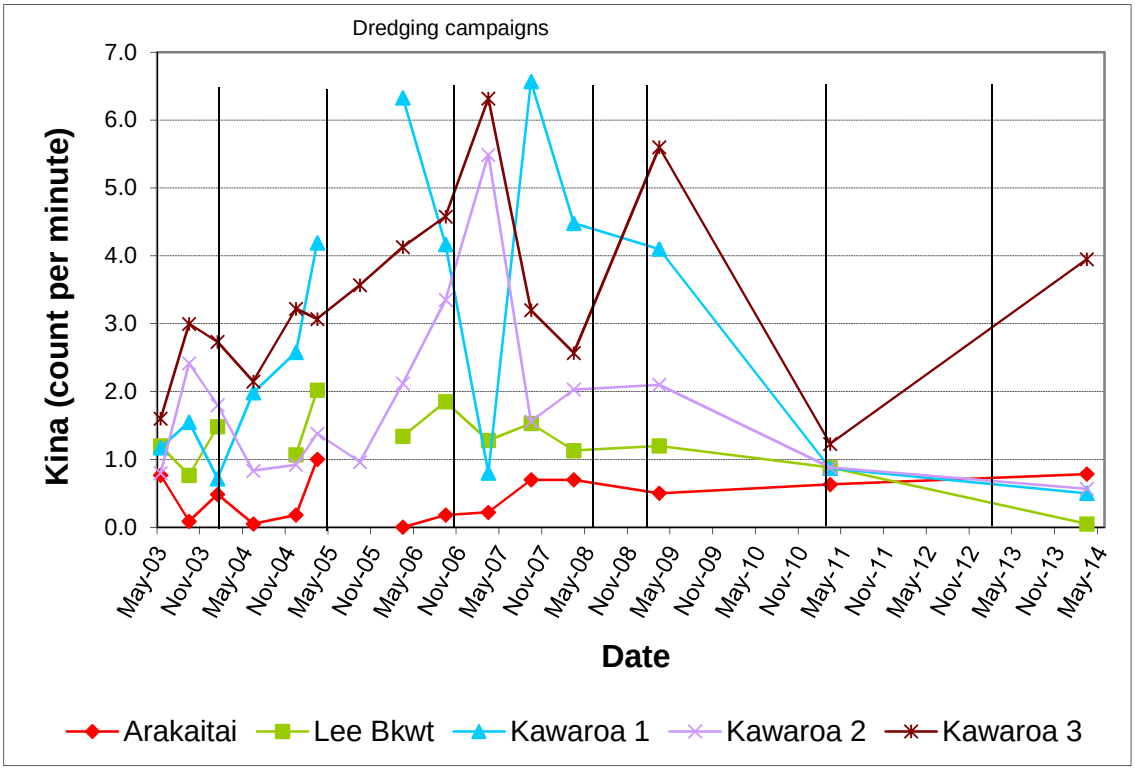


Figure 11 Number of kina found per minute searched at the five kaimoana reef sites

Figure 11 shows the number of kina (count per minute) for all surveys to date. The Arakaitai Reef and Lee Breakwater sites have shown the least amount of variation since monitoring began, largely due to fewer kina being observed during the surveys. Counts at the three Kawaroa reef sites have been highly variable since the surveys began.

In general, both paua and kina counts over the last two surveys (2011 and 2014) were lower than surveys undertaken between 2004 and 2009, being more comparable to pre-dredge counts (Figures 9 and 11).There are a number of factors which could potentially influence paua and kina counts on the reefs including natural variation in environmental conditions, increased kaimoana harvesting, dredging activities and a change in personnel undertaking the kaimoana surveys (see Appendix IV 2014 Report for further discussion). Determining how these factors have influenced paua and kina counts is not straight forward, however, no major build up of sand on the reefs has been noted in association with the dredging activities by the Company.

2.4 Investigations, interventions, and incidents

The monitoring programme for the period under review was based on what was considered to be an appropriate level of monitoring, review of data, and liaison with the consent holder. During the year matters may arise which require additional activity by the Council for example provision of advice and information, or investigation of potential or actual causes of non-compliance or failure to maintain

good practices. A pro-active approach that in the first instance avoids issues occurring is favoured.

The Council operates and maintains a register of all complaints or reported and discovered excursions from acceptable limits and practices, including non-compliance with consents, which may damage the environment. The Incident Register includes events where the company concerned has itself notified the Council. The register contains details of any investigation and corrective action taken.

Complaints may be alleged to be associated with a particular site. If there is potentially an issue of legal liability, the Council must be able to prove by investigation that the identified company is indeed the source of the incident (or that the allegation cannot be proven).

During 2009-2014 monitoring period there were no incidents recorded by the Council that were associated with the Company in relation to the inshore dredging campaigns.

3. Discussion

3.1 Environmental effects of exercise of consents

Dredging was undertaken on two occasions during the period July 2009 to June 2014. Since commencement of the dumping of sand in the inshore dump ground (12 January 2004), a total of 1,167,133 m^3 *in situ* has been dumped (Table 1).

During the consent process there was a reasonable amount of public interest in the application due to concerns that the introduced sand could have a significant ecological effect on the two locally important reefs, Kawaroa Reef and Arakaitai Reef. A compliance monitoring programme was designed around these concerns, where the submitters agreed that the monitoring proposed would show if any adverse effects to the reef occurred as a result of the sand dispersal to the inshore site.

The results of intertidal surveys at three potential impact sites and one control site did not indicate that the disposal of dredged material was having a significant impact on the abundance or diversity of intertidal species. Natural sand movement was likely to have a greater impact than from the disposal of sand from dredging.

Surveys at five locally important kaimoana beds did not show any obvious impacts of dredging on kaimoana species, with numbers of both paua and kina similar to pre-dredging values. No major build up of sand on the reefs has been noted in association with the dredging activities by the Company.

3.2 Evaluation of performance

A summary of the Company's compliance record for the period under review is set out in Tables 3 - 5.

Table 3 Summary of performance for Consent 3374-2 to deposit dredged sand within an offshore Spoil Disposal Area

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Written notice prior to undertaking activities under consent	Notice received as required	Yes
2. Dredging from within Port Taranaki and main shipping channel covered		N/A
3. Clean sand deposited at the inshore disposal site	Sand samples provided	Yes
4. Consent only exercised when impractical to exercise 5886		Yes
5. Consent holder to keep and maintain records of dates, volumes etc.	Records forwarded to Council	Yes
6. Exercise of permit in accordance with information submitted in application	Records forwarded to Council	Yes
7. Best practical option		Yes
8. Option for review of consent	Next scheduled in June 2017 if required	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		High
Overall assessment of administrative performance in respect of this consent		High

N/A = not applicable

Table 4 Summary of performance for Consent 3982-2 to dredge accumulated sediments from Port Taranaki

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Written notice prior to dredging	Notice received as required	Yes
2. Dredging of loose sediments only, not bedrock	Compliant	Yes
3. Exercise of consent in accordance with application	Information provided by consent holder	Yes
4. BPO to minimise environmental effects		Yes
5. Exercise of consent not to effect the recreational use of Ngamotu Beach	No complaints received	Yes
6. Consent holder to keep and maintain records of dredging activities	Samples, track and volume data provided	Yes
7. Consent holder to undertake a representative sample of seabed sediments	Sample collected	Yes
8. Option for review of consent	Next scheduled for review in June 2017 if required	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		High
Overall assessment of administrative performance in respect of this consent		High

Table 5 Summary of performance for Consent 5886-1 to deposit dredge sands at an inshore disposal site

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Written notice prior to undertaking activities under consent	Notification received	Yes
2. Exercise of permit in accordance with information submitted in application	Data supplied by company	Yes
3. Sand dumped at inshore site restricted to clean sand from outer harbour	Data supplied by company	Yes
4. Sand disposal limited to 400,000 m^3 minus estimated volume remaining in disposal area	Data supplied by company (although some clerical errors occurred with calculating disposal volumes this did not result in a breach of consent: *in situ* volume 189,677 m^3)	Yes
5. Consent holder to maintain records of disposal, including samples	Data and samples supplied by company	Yes
6. Water discolouration kept to a minimum	Compliant	Yes
7. No significant sand inundation on the subtidal area of Kawaroa Reef	Side scan surveys	Yes
8. No significant adverse ecological effects outside disposal area	Intertidal and kaimoana surveys	Yes
9. No significant adverse ecological effects on kaimoana	Kaimoana surveys	Yes
10. Disposal to cease if breach of conditions 7, 8, or 9	Conditions 7, 8 and 9 not considered to have been breached	N/A
11. Results of all monitoring made publicly available prior to review	Monitoring reports	Yes
12. Review of consent	Next scheduled review June 2017, if required	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		High
Overall assessment of administrative performance in respect of this consent		High

During the year, the Company demonstrated overall a high level of environmental and high level of administrative performance with the resource consents defined in Section 1.1.4. During the period under review there were no unauthorised incidents associated with dredging undertaken by the Company.

3.3 Recommendations from the 2005-2009 Monitoring Report

In the 2005-2009 Monitoring Report, it was recommended:

1. THAT the monitoring of inshore disposal of dredged material from Port Taranaki Limited is changed to a biennial programme.

2. THAT the requirements for the provision of a record of dredged volumes, and hydrographic surveys of the inshore dispersal ground post dumping, remain unchanged.

3. THAT intertidal ecological sampling is reduced from twice per year, to spring every second year.

4. THAT kaimoana surveys are reduced from twice per year to summer every second year.

5. THAT the provision for subtidal monitoring is discontinued.

6. THAT the Council confirm the decision not to review consents 3374-2, 3982-2, and 5886-1 in June 2009.

These recommendations were implemented.

3.4 Alterations to monitoring programmes for 2014-2016

In designing and implementing the monitoring programmes for discharges in the region, the Council has taken into account the extent of information made available by previous authorities, its relevance under the Act, the obligations of the Act in terms of monitoring discharges and effects, and subsequently reporting to the regional community, the scope of assessments required at the time of renewal of permits, and the need to maintain a sound understanding of industrial processes within Taranaki discharging to the environment.

A reduced monitoring programme was implemented during the 2009-2014 monitoring period and suggested no adverse environmental effects arose from the dredging operations. Therefore, it is proposed that for 2013-2015, the monitoring programme remains unchanged. A recommendation to this effect is included within Section 4.

3.5 Exercise of optional review of consent

Resource consents 3374-2, 3982-2 and 5886-1 provided for an optional review of consent in June 2013. Conditions attached to the consents allowed the Council to review the consents to ensure that the conditions are adequate to deal with any adverse effects on the environment.

Based on the results of the monitoring period under review, and in previous years as set out in an earlier compliance monitoring report, it was considered that there were no grounds that required a review to be pursued.

4. Recommendations

1. THAT the monitoring of inshore disposal of dredged material from Port Taranaki Limited continues as a biennial programme.

2. THAT the Company provide a record of dredged volumes, and hydrographic surveys of the inshore dispersal ground post dumping.

3. THAT intertidal ecological sampling is undertaken in spring every second year.

4. THAT kaimoana surveys are undertaken each summer every second year.

5. THAT the Council confirm the decision not to review consents 3374-2, 3982-2, and 5886-1 in June 2013.

Glossary of common terms and abbreviations

The following abbreviations and terms are used within this report:

Agglomerate	A rock type made of a cemented mixture.
ANZECC	Australia and New Zealand Environment and Conservation Council.
Bathymetric	Measurement of depth in the sea which is used to produce charts and maps of areas of the seafloor.
Biomonitoring	Assessing the health of the environment using aquatic organisms.
Breccia	Rock of angular stones cemented by finer mixture.
Conglomerate	A rock consisting of pebbles and gravel cemented togeather.
Corraline Pavement	Seabed encrusted with flat coralline seaweeds.
Ecology	Relationship between organisms and their environment.
Gastropod	A snail.
Hydrographic	Physical features of the oceans.
In situ	In the original position.
Interstitial	The spaces in between.
Intertidal	Between the low water and high water marks.
Invertebrates	An animal that lacks a back bone or spinal column.
Kaimoana	Seafood.
Lahar	Volcanic rock.
Littoral drift	Movement of sediments within the nearshore coastal zone.
Mixing zone	The zone below a discharge point where the discharge is not fully mixed with the receiving environment. For a stream, conventionally taken as a length equivalent to 7 times the width of the stream at the discharge point.
Photosynthetic	Algae use the energy of sunlight to synthesise organic compounds from carbon dioxide and water.
Quadrat	A square metal frame of a known area used to quantify the abundance of organisms within this area.
Qualitative	Relates to the quality or character of what is being surveyed.
Quantitative	Capable of being measured or expressed in numerical terms.
Revetment wall	Rock boulder wall along the city's foreshore.
RMA	Resource Management Act 1991 and subsequent amendments.
SCUBA	Self contained underwater breathing apparatus.
Side Scan sonar	A "fish" is towed behind a boat which sends a signal to the sea floor which is reflected back and recorded. The stronger the echo the harder the substrate is e.g. rock.
Spring low tide	Occurs when the gravitational pull of the moon and sun are combined. Results in very high and very low tides.
Subtidal	The area below the low tide mark.

Transect	Tape run along the shoreline where the random quadrats are taken from.
IR	Incident Register entry- an event recorded by the Council on the basis that it had potential or actual environmental consequences that may represent a breach of a consent or provision in a Regional Plan.

Bibliography and references

Atkinson, P.N., Black, K.P., Cole, R.G., Dunlop, R. & McComb, P.J., 2001. Port Taranaki Maintenance dredging consent renewal. Report 5: Assessment of environmental effects.

ANZECC, 2000. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand.

Black, K.P. & McComb, P.J., 2000. Port Taranaki maintenance dredging consent renewal studies. Report 2: Site selection, effects and outcomes. Department of Earth Sciences, University of Waikato.

Howse, B.P.S., Black, K.P., Cole, R.G., & McComb, P.J., 2000. Port Taranaki Dredging consent renewal studies. Report 3: The relationship of sediment flux to abundance and sizes of paua and kina on New Plymouth reefs. Department of earth sciences, University of Auckland.

Kelly, S., 2007. Marine Receiving Environment Stormwater Contaminants: Status Report 2007. Auckland Regional Council Technical Publication Number 333.

McComb, P.J. & Black, K.P., 2000. Port Taranaki Maintenance dredging consent renewal studies. Report 1: Field measurements. Volume 1 – Text. 102p

McComb, P., 2008. Port Taranaki Nearshore Sand Deposition: monitoring of sand dispersal form the dump site. Report prepared for Port Taranaki Limited by MetOcean Solutions.

Taranaki Regional Council, 1999. Westgate Transport Ltd TRK985186 Sand deposition trial monitoring programme report. Technical Report 99-21.

Taranaki Regional Council, 2006. Port Taranaki Limited Monitoring Programme Monitoring Report 2002-2005. Technical Report 2005-71.

Taranaki Regional Council, 2009. Port Taranaki Limited Monitoring Programme Monitoring Report 2002-2005. Technical Report 2009-24.

Appendix I

Coastal permits held by Port Taranaki Limited

Consent 3982-2

TARANAKI REGIONAL COUNCIL

CHIEF EXECUTIVE
PRIVATE BAG 713
47 CLOTEN ROAD
STRATFORD
NEW ZEALAND
PHONE: 06-765 7127
FAX: 06-765 5097
www.trc.govt.nz

Please quote our file number on all correspondence

Coastal Permit

Pursuant to the Resource Management Act 1991 a resource consent is hereby granted by the Taranaki Regional Council

Name of Consent Holder:	Port Taranaki Limited P O Box 348 NEW PLYMOUTH
Consent Granted Date:	28 January 2002

Conditions of Consent

Consent Granted:	To remove up to 570,000 cubic metres in any one dredging campaign, and up to 1,045,000 cubic metres in any three successive dredging campaigns [or any seven-year period, what ever comes first], of accumulated sediments from the bed of the coastal marine area of the area commonly known as Port Taranaki.... also GR: P19:995-381, P19:003-389, P19:006-384 at or about GR: P19:993-382
Expiry Date:	1 June 2029
Review Date(s):	June 2005, June 2009, June 2013, June 2017, June 2021, June 2025
Site Location:	Port Taranaki, New Plymouth
Legal Description:	
Catchment:	Tasman Sea

For General, Standard and Special conditions pertaining to this consent please see reverse side of this document

General conditions

a) On receipt of a requirement from the Chief Executive, Taranaki Regional Council the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.

b) Unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.

c) The consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:

i) the administration, monitoring and supervision of this consent; and
ii) charges authorised by regulations.

Special conditions

1. The consent holder shall provide written notice to the Chief Executive, Taranaki Regional Council at least 15 working days prior to undertaking any dredging activities under this consent.

2. The exercise of this consent provides for the maintenance dredging of loose sediments accumulated within the area commonly known as Port Taranaki and the main shipping channel and does not provide for capital [port deepening] dredging activities, associated with the removal of bedrock.

3. The exercise of this consent shall be conducted in accordance with the information submitted in support of the application and to ensure that the conditions of this consent are met at all times.

4. At all times the consent holder shall adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any actual or likely adverse effect on the environment associated with dredging activities.

5. The exercise of this consent shall not affect the recreational use of Ngamotu Beach.

6. The consent holder shall keep and maintain records of all dredging activities under this consent including samples of dredged material, dates, volumes and hydrographic surveys of seabed depths below chart datum before and after each campaign, and shall make these records available to the Chief Executive, Taranaki Regional Council, upon request.

7. The consent holder shall undertake a representative sample of seabed sediments for chemical analysis including heavy metal concentrations to the satisfaction of the Chief Executive, Taranaki Regional Council, and present the findings at least 6 months prior to provision of review of the consent in June 2009 as provided for in special condition 8 below.

8. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June 2005 and/or June 2009 and/or June 2013 and/or June 2017 and/or June 2021 and/or June 2025, for the purpose of ensuring that the conditions are adequate to deal with any adverse effects on the environment arising from the exercise of this resource consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Transferred at Stratford on 11 October 2005

For and on behalf of
Taranaki Regional Council

Director-Resource Management

Consent 3374-2

TARANAKI REGIONAL COUNCIL
CHIEF EXECUTIVE
PRIVATE BAG 713
47 CLOTEN ROAD
STRATFORD
NEW ZEALAND
PHONE: 06-765 7127
FAX: 06-765 5097
www.trc.govt.nz

Please quote our file number on all correspondence

Coastal Permit

Pursuant to the Resource Management Act 1991 a resource consent is hereby granted by the Taranaki Regional Council

Name of Consent Holder:	Port Taranaki Limited P O Box 348 NEW PLYMOUTH
Consent Granted Date:	28 January 2002

Conditions of Consent

Consent Granted:	To deposit up to 570,000 cubic metres in any one dredging campaign, and up to 1,045,000 cubic metres in any three successive dredging campaigns [or any seven-year period what ever comes first], of accumulated sediments removed from the bed of the coastal marine area of the area commonly known as Port Taranaki within an offshore Spoil Disposal Area defined by the Taranaki local circuit grid co-ordinates 283867E-710404N, 283875E-711896N, 285042E-711891N, and 285025E-710431N.... also GR: P19:003-413, P19:015-400, P19:015-413 at or about GR: P19:003-400
Expiry Date:	1 June 2029
Review Date(s):	June 2005, June 2009, June 2013, June 2017, June 2021, June 2025
Site Location:	Seabed, approximately 1 km north of Port Taranaki, New Plymouth
Legal Description:	
Catchment:	Tasman Sea

For General, Standard and Special conditions pertaining to this consent please see reverse side of this document

General conditions

a) On receipt of a requirement from the Chief Executive, Taranaki Regional Council the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.

b) Unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.

c) The consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:

   i) the administration, monitoring and supervision of this consent; and
   ii) charges authorised by regulations.

Special conditions

1. The consent holder shall provide written notice to the Chief Executive, Taranaki Regional Council at least 15 working days prior to undertaking any activities under this consent.

2. The exercise of this consent covers both maintenance and capital dredged material from within the confines of the area commonly known as Port Taranaki, and the main shipping channel.

3. Every endeavour shall be made to ensure that clean sand be deposited at the inshore disposal site in accordance with coastal permit 5886 in order to mitigate the effects of the Port and its dredging activities upon the adjacent shoreline.

4. This consent shall only be exercised where for reasons of sediment quality, or operational necessity, it is impractical to exercise coastal permit 5886.

5. The consent holder shall keep and maintain records of all activities under this consent including dates, volumes and origins of all dredged material deposited and a hydrographic survey of seabed depths below chart datum of the spoil disposal area following each dredging campaign, and shall make these records available to the Chief Executive, Taranaki Regional Council, upon request.

6. The exercise of this consent shall be conducted in accordance with the information submitted in support of the application and to ensure that the conditions of this consent are met at all times.

7. At all times the consent holder shall adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any actual or likely adverse effect on the environment associated with dredging activities.

8. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June 2005 and/or June 2009 and/or June 2013 and/or June 2017 and/or June 2021 and/or June 2025, for the purpose of ensuring that the conditions are adequate to deal with any adverse effects on the environment arising from the exercise of this resource consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Transferred at Stratford on 11 October 2005

For and on behalf of
Taranaki Regional Council

Director-Resource Management

Coastal Permit

Pursuant to the Resource Management Act 1991
a resource consent is hereby granted by the
Taranaki Regional Council

Name of Consent Holder:	Port Taranaki Limited P O Box 348 NEW PLYMOUTH	
Consent Granted Date:	9 April 2002	[by the Minister of Conservation]

Conditions of Consent

Consent Granted:	To deposit up to 400,000 cubic metres in any one dredging campaign, and up to 730,000 cubic metres in any three successive dredging campaigns [or any seven-year period whichever comes first], of accumulated sands removed from the bed of the coastal marine area from the area commonly known as Port Taranaki, within an inshore disposal area on the western flank of Kawaroa Reef defined by the Taranaki local circuit grid co-ordinates 285638E-710703N, 286045E-710297N, 285133E-709384N, 284726E-709791N, 285575E-710050N, 285816E-710050N, 285335E-709810N, and 285335E-709570N
Expiry Date:	1 June 2029
Review Date(s):	June 2005, June 2009, June 2013, June 2017, June 2021, June 2025
Site Location:	Seabed off Kawaroa Park, Tisch Avenue, New Plymouth
Legal Description:	n/a
Catchment:	Tasman Sea

For General, Standard and Special conditions
pertaining to this consent please see reverse side of this document

General conditions

a) On receipt of a requirement from the Chief Executive, Taranaki Regional Council the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.

b) Unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.

c) The consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:

   i) the administration, monitoring and supervision of this consent; and
   ii) charges authorised by regulations.

Special conditions

1) The consent holder shall provide written notification to the Taranaki Regional Council at least 15 working days prior to undertaking the activity licensed by this consent.

2) The activity licensed by this consent shall be undertaken in accordance with the information submitted in support of the application and to ensure that the conditions of this consent are met at all times.

3) Sand used for the inshore disposal area shall be restricted to clean sand dredged from the outer harbour deposits. No predominantly silty or muddy material dredged from inner harbour areas or from capital dredging shall be deposited.

4) Following the initial dredging campaign the annual volume of sand to be disposed shall be limited to 400,000 cubic metres minus the estimated volume of sand remaining in the inshore disposal area from the last campaign to ensure that there is no excessive long term build up of sand in the disposal area authorised by this consent.

5) The consent holder shall keep and maintain records of the inshore disposal of clean sands, including samples of deposited material, dates, volumes, and position of clean sands deposited, and forward these records to the Taranaki Regional Council upon the completion of each dredging campaign.

6) The consent holder shall undertake all practicable measures to ensure that water discoloration from the disposal is kept to an absolute minimum.

7) The exercise of this consent shall not give rise to any significant sand inundation on the subtidal [below Mean Low Water Spring] area of Kawaroa Reef outside of the inshore disposal area.

8) The exercise of this consent shall not give rise to any significant adverse ecological effects outside of the area specified as the inshore disposal area on the New Plymouth coast between the Lee Breakwater and the mouth of the Te Henui Stream.

9) The exercise of this consent shall not give rise to any significant adverse effects to kaimoana on the New Plymouth coast between the Lee Breakwater and the mouth of the Te Henui Stream.

10) Should there be a breach of conditions 7, 8 or 9 of this consent then the consent holder, shall at the direction of the Chief Executive of the Taranaki Regional Council, immediately cease any sediment disposal authorised by this consent and the consent holder shall not recommence that disposal until so authorised in writing by the Chief Executive of the Taranaki Regional Council.

11) The results of all monitoring undertaken in association with this consent shall be made publicly available at least three months prior to the provision of the review of the consent as provided for by special condition 12 below.

12) In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June 2005 and/or June 2009 and/or June 2013, and/or June 2017 and/or June 2021 and/or June 2025, for the purpose of ensuring that the conditions are adequate to deal with any adverse effects on the environment arising from the exercise of this resource consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Transferred at Stratford on 10 October 2005

For and on behalf of
Taranaki Regional Council

_____

Director-Resource Management

Appendix II

Intertidal ecological reports

Internal Memorandum

To: Science Manager – Hydrology/Biology, Regan Phipps
From: Scientific Officer, Emily Roberts and Technical Officer, Abbie Bates
File: #1438931
Date: 27 November 2014

Port Taranaki Limited Dredging Programme – Intertidal Ecological Survey Spring 2010

1. Introduction

Port Taranaki Limited holds resource consent 5886-1 to deposit up to 400,000 m^3 in any one dredging campaign, and up to 730,000 m^3 in any three successive dredging campaigns within an inshore disposal area on the western flank of Kawaroa Reef. This permit was granted on 7 March 2002 by the then Minister of Conservation, Sandra Lee. Special conditions of the consent require that the sand to be used for the inshore disposal area shall be restricted to clean sand dredged from the outer harbour deposits.

As part of the Port Taranaki Limited dredging monitoring programme, surveys are undertaken at Kawaroa Reef and Arakaitai Reef (important reefs for kaimoana gathering) in order to assess if there have been any adverse effects on intertidal communities as a result of dredging activities. Initially, surveys were undertaken twice annually in order to compare intertidal communities prior to and post dredging (Table 1 and 2). In the Port Taranaki Limited Maintenance Dredging Report 2005-2009 (TRC 2009-24), it was proposed that the monitoring programme be reduced given that, following seven years of monitoring, no significant adverse environmental effects had been detected as a result of disposal of dredged material at the nearshore dumpsite. Since 2008, intertidal surveys have been conducted biennially during spring.

Special condition 8 requires there to be no significant sand inundation on the subtidal area of the Kawaroa Reef outside of the inshore disposal area. Special condition 9 requires there to be no significant visual or ecological impacts outside of the area specified as the inshore disposal area on the New Plymouth coast between the Lee Breakwater and the mouth of the Te Henui Stream. Accordingly, intertidal surveys of the intertidal zone were carried out as part of the 2008-2010 monitoring programme. The surveys for the 2008-2010 monitoring period were conducted at four sites between 7 and 10 October 2010.

Special condition 10 requires there to be no significant adverse effects to kaimoana outside of the area specified as the inshore disposal area on the New Plymouth coast between the Lee Breakwater and the mouth of the Te Henui Stream. There is also a separate monitoring programme for the locally important kaimoana species, paua (*Haliotis iris*) and kina (*Evechinus chloroticus*) at Kawaroa Reef and Arakaitai Reef, with regards to any adverse effects from the sand disposal.

Table 1 Dredge history associated with coastal permit 5886

Disposal campaign	Date	Volume (m^3) dumped inshore
First	12-Jan-2004 to 23-Mar-2004	253,633
Second	13-May-2005 to 5-July-2005	199,101
Third	29-Nov-2006 to 19-Feb-2007	173,475
Fourth (emergency dredging)	5-Aug-2008 to 18-Aug-2008	35,549
Fifth	3-Jan-2009 to 4-April-2009	185,250
Sixth	18-March-2011 to 12-May-2011	174,192

**Emergency dredging was undertaken in August 2008 in response to a large storm*

Table 2 Summary of surveys undertaken in conjunction with monitoring of consent 5886

Survey Number	Date	Disposal Campaign (Table 1)
1	Summer 2003	Pre-disposal
2	Spring 2003	
3	Summer 2004	
4	Spring 2004	1
5	Summer 2005	
6	Spring 2005	2
7	Summer 2006	
8	Spring 2006	
9	Summer 2007	3
10	Spring 2007	
11	Summer 2008	
12	Spring 2008	4 (Emergency)
13	Spring 2010	5

2. Methods

2.1 Field Work

The surveys were conducted at three potential impact sites Arakaitai Reef (SEA 902045), Kawaroa Reef 750 m north east of Lee Breakwater (SEA902055), Kawaroa Reef 1.2 km north east of Lee Breakwater (SEA902053) and the control site Greenwood Road (SEA 903070), approximately 20 km south west of the disposal site.

At each site, a 50 m transect was used to establish five 5 m x 3 m blocks. Within each block, five random 0.25 m^2 quadrats were laid giving a total of 25 random quadrats. For each quadrat the percentage cover of algae and encrusting animal species was estimated using a grid. For all other animal species, individuals larger than 3 mm were counted. Under boulder biota was counted where rocks and cobbles were easily turned over.

Photo 1 Potential impact site Arakaitai Reef (SEA 902045), October 2010

Photo 2 Potential impact site Kawaroa Reef 750 m north east of Lee Breakwater (SEA902055), October 2010

Photo 3 Potential impact site Kawaroa Reef 1.2 km north east of Lee Breakwater (SEA902053), October 2010

Photo 4 Control site Greenwood Road (SEA 903070) inundated with sand, October 2010

3. Results

3.1 Summary statistics

Summary statistics, including the mean number of species per quadrat and the mean Shannon-Weiner indices, are shown in Table 3. Arakaitai Reef had the highest number of species, followed by Kawaroa 1.2 km NE, Kawaroa 750 m NE and Greenwood Road. Arakaitai Reef had the highest Shannon-Weiner index followed by the Kawaroa 1.2 km NE, Kawaroa 750 m NE and Greenwood Road sites.

Table 3 Summary statistics - spring 2010 survey

Site	No. of quadrats	Mean number of species per quadrat			Mean Shannon-Weiner indices per quadrat		
		Algae	Animals	Total Species	Algae	Animals	Total Species
Arakaitai Reef	25	3.64	12.88	16.52	0.44	0.88	1.00
Kawaroa Reef 1.2 km NE	25	3.85	9.55	13.40	0.48	0.76	0.95
Kawaroa Reef 750 m NE	25	3.88	8.84	12.72	0.359	0.65	0.78
Greenwood Road	25	1.52	3.88	5.40	0.21	0.38	0.46

3.2 Number of species per quadrat data

Figure 1 shows the total number of species per quadrat as a box and whisker plot. The notched area of the box represents the median plus and minus a 95% confidence interval for the median. This form of graphical representation allows a quick comparison to be made between sites. Generally, if the notched areas of the boxes for the different sites do not overlap, one would expect to obtain a significantly different result with ANOVA[1].

[1] Analysis of variance (ANOVA): a statistical test used to analyse differences between a number of means.

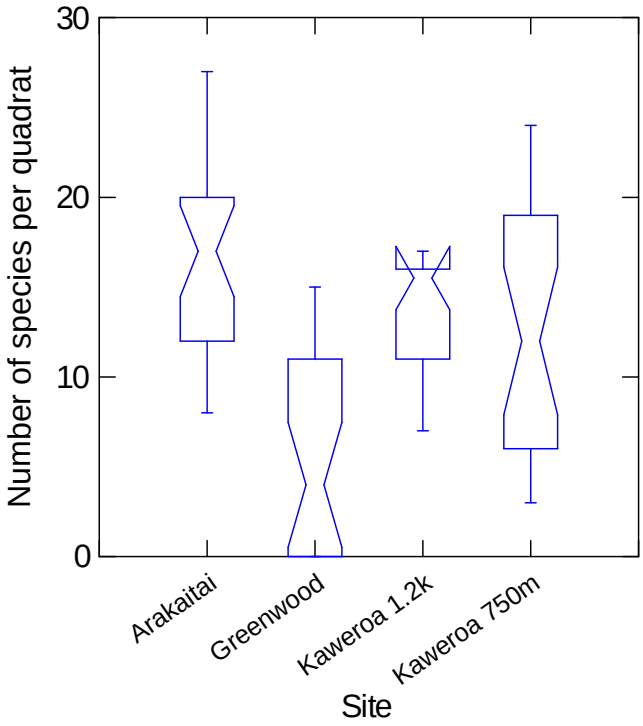


Figure 1 **Box and whisker plot of total number of species per quadrat**

The following sites showed a significant deviation from normal distribution at the 95% confidence level: Kaweroa 1.2km NE, Kaweroa 750m NE and Greenwood Road (Lilliefors test, n = 25, P = <0.05). There was a significant difference in mean number of species per quadrat between the sites (ANOVA, n = 25, F = 18.30, P < 0.001). Significant differences between sites were determined using Tukey's multiple comparison test (Table 4). At Greenwood Road the mean number of species per quadrat was significantly lower than that at all other sites.

Table 4 Tukey multiple comparison test of number of species per quadrat

Site	Arakaitai Reef	Greenwood Road	Kawaroa Reef 1.2km NE
Greenwood Road	SIG		
Kawaroa Reef 1.2km NE	NS	SIG	
Kawaroa Reef 750 m NE	NS	SIG	NS

Key: SIG = significant difference at 95% confidence level
NS = no significant difference

Comparison of the mean number of species per quadrat for all Port dredging surveys undertaken to date are shown in Figure 2. Number of species per quadrat showed interannual variability, with no obvious long term trends in diversity evident at the three potential impact sites over time. For the 2010 survey, number of species per quadrat at the three potential impact sites were well within the range of values previously recorded. The number of species per quadrat at the control site Greenwood

Road in 2010 was the lowest on record since the Port Taranaki Limited dredging programme started in 2003.The reasons behind these low number of species at Greenwood Road are discussed further in Section 4.

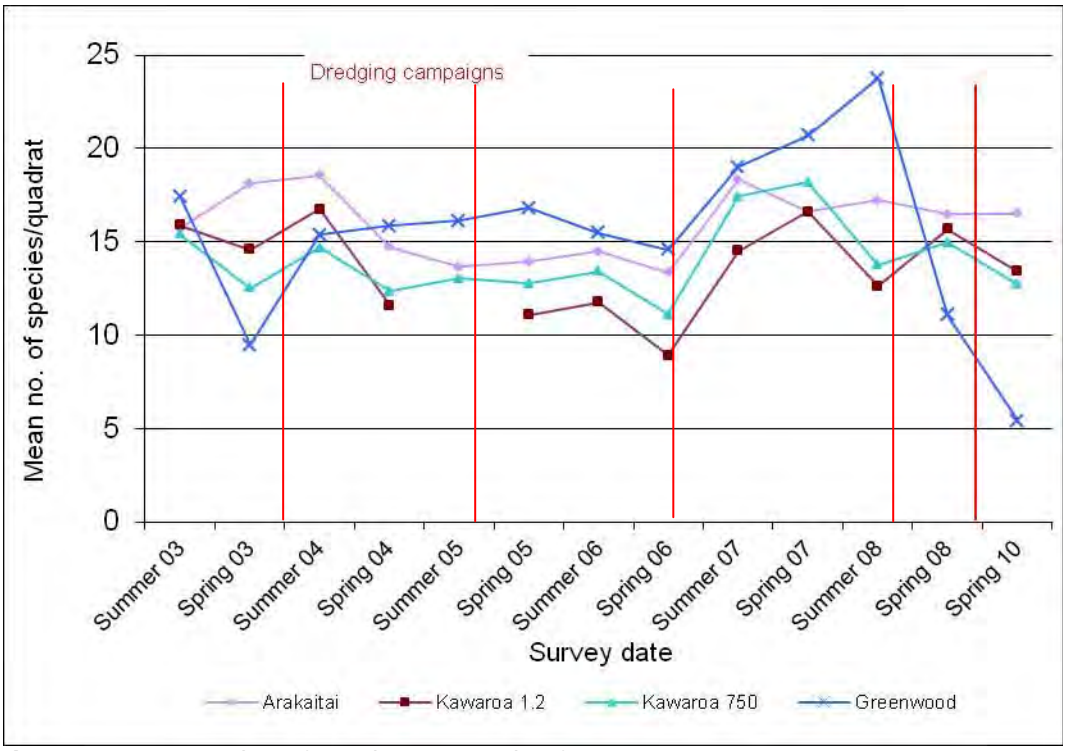


Figure 2 Mean number of species per quadrat from 2003 to 2010

3.2 Shannon-Weiner Diversity Index Data

Figure 3 shows the mean Shannon-Weiner index data at each site as a box and whisker plot.

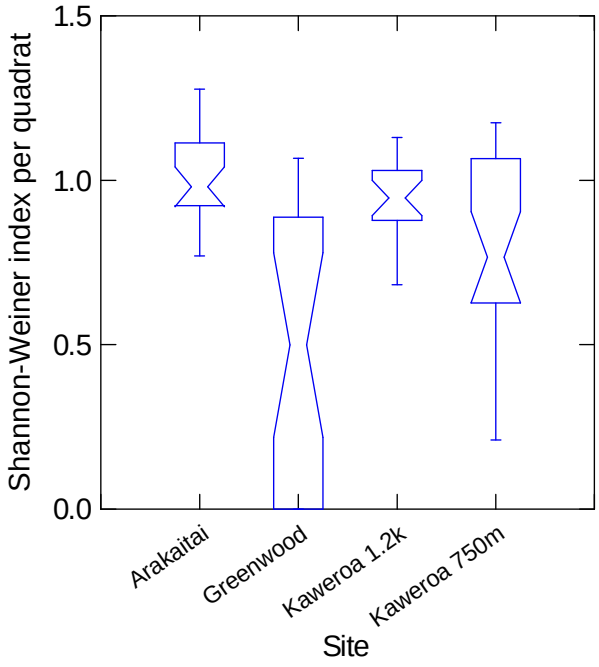


Figure 3 Box and whisker plots of Shannon-Weiner diversity indices

Only one site (Greenwood Road) showed a significant deviation form normal distribution at the 95% confidence level (Lilliefors test, n = 25, P = <0.001). There was a significant difference in mean Shannon Weiner index per quadrat between the sites (ANOVA, n = 25, F = 17.76, P < 0.001). Significant differences between sites were determined using Tukey's multiple comparison test (Table 5). At Greenwood Road the mean number of species per quadrat was significantly lower than that at all other sites. Mean Shannon Weiner index at Arakaitai Reef was significantly higher than that at Kaweroa Reef 750m NE.

Table 5 Tukey multiple comparison test of Shannon-Weiner index per quadrat

Site	Arakaitai Reef	Greenwood Road	Kawaroa Reef 1.2km NE
Greenwood Road	SIG		
Kawaroa Reef 1.2km NE	NS	SIG	
Kawaroa Reef 750m NE	SIG	SIG	NS

Key: SIG = significant difference at 95% confidence level
NS = no significant difference

Figure 4 shows mean Shannon-Weiner index per quadrat for all surveys undertaken for the Port Dredging programme. For the 2010 survey, mean Shannon-Weiner index per quadrat at the Arakaitai Reef and Kaweroa Reef 1.2 km NE sites were within the range of values previously recorded at these sites. The Shannon-Weiner index per quadrat at the potential impact site Kaweroa Reef 750 m NE and control site Greenwood Road in 2010 were the lowest site specific values on record since the Port Taranaki dredging programme started in 2003. The reasons behind these lower diversity indices at the Greenwood Road and Kaweroa 750 m NE sites are discussed further in Section 4.

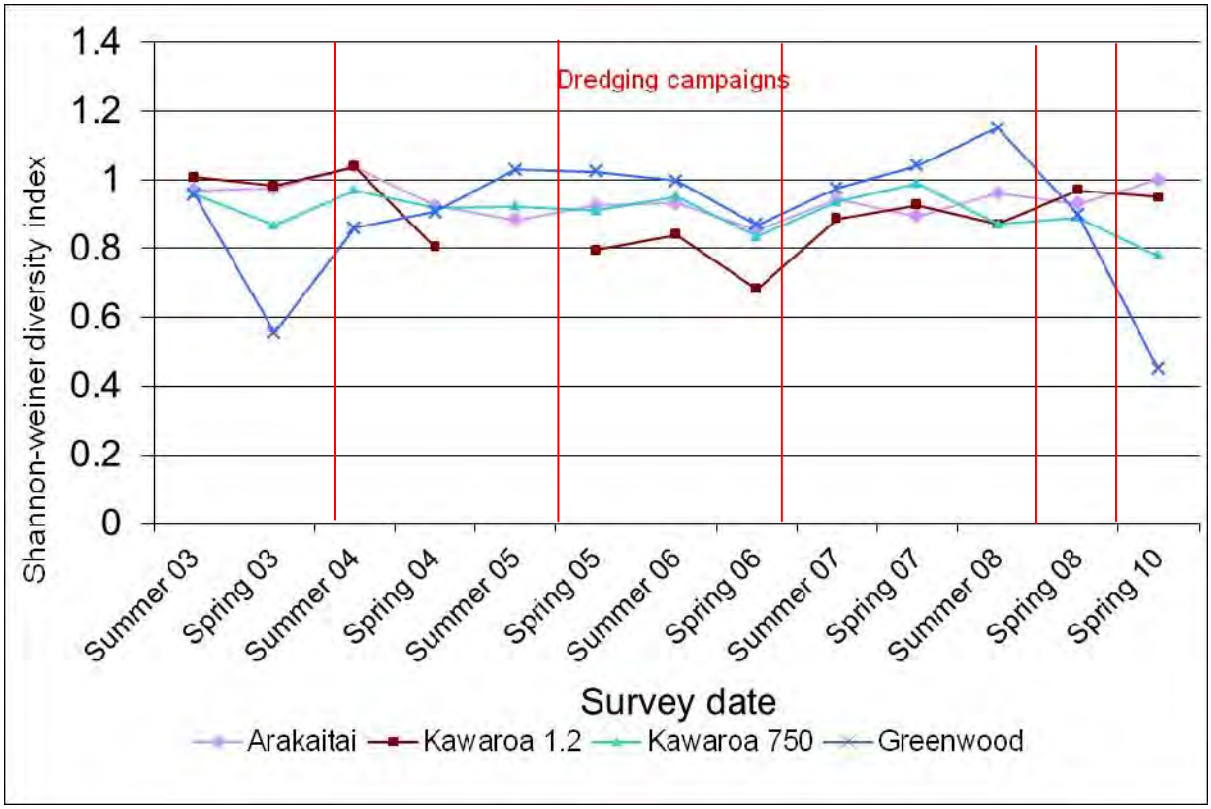


Figure 4 Mean Shannon-Weiner index per quadrat from 2003 to 2010

3.3 Sand Coverage

The level of sand cover was relatively low (≤15%) at all sites with the exception of Greenwood Road (76%, Table 5). Abundance and diversity of intertidal species/communities can be significantly impacted by sand cover of 30% and higher.

Table 5 Mean percent sand cover per quadrat

Site	Mean coverage of sand per quadrat (%)
Arakaitai Reef	3
Greenwood Road	76
Kawaroa Reef 1.2 km NE	15
Kawaroa Reef 750 m NE	8

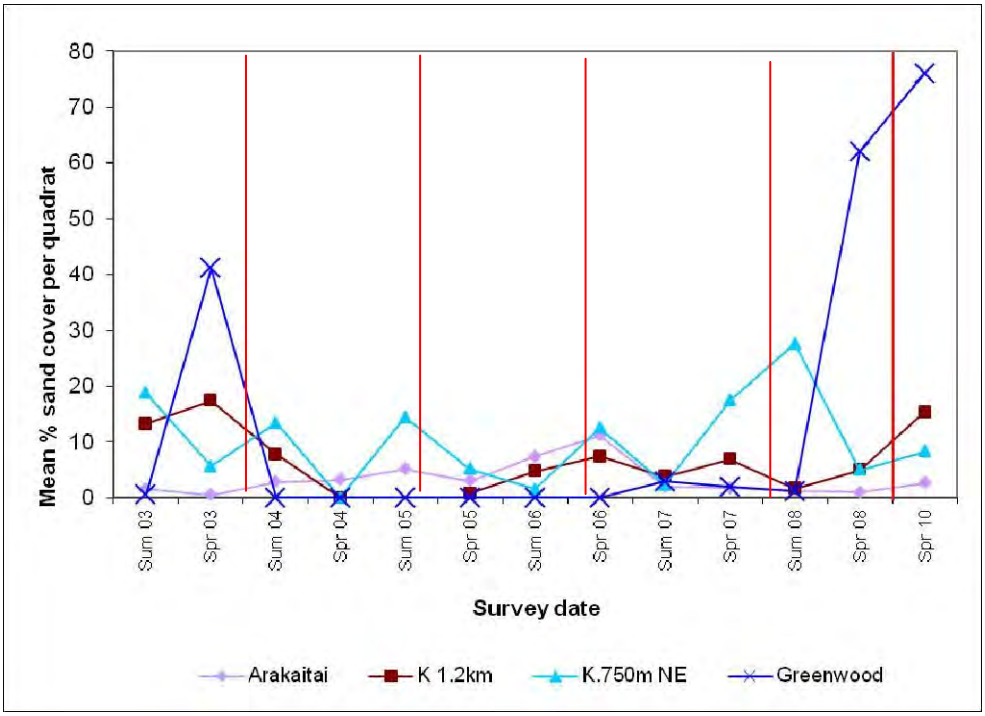


Figure 5 Mean percentage sand cover by site since 2003
Note: Value for Greenwood Road in spring 2008 also includes sand and silt

The Greenwood Road site has on occasions been susceptible to heavy sand inundation. During the 2003, 2008 and 2010 sand/silt cover at this site was 41%, 62% and 76% respectively. The impact of this high sand cover on intertidal communities is discussed further in Section 4.

Sand cover at the three potential impact sites has typically been low to moderate during surveys (Figure 5). Sand cover at the Kawaroa 750 m NE site has been moderate on occasions, with sand often trapped in the turf which is abundant across the lahar platform that makes up the majority of this site. Low levels of sand cover are typically present at Arakaitai, with only two surveys showing sand cover of greater than 5%. Pockets of sand are occasionally present towards the top of the shore at this reef (Photograph 1). The site at Kawaroa 1.2 km NE had moderate levels of sand in initial, pre-dredging surveys, however sand at this site has remained low in all post-dredging surveys with the exception of the 2010 survey, during which moderate sand cover was recorded.

Photograph 5 Sand build up on the high-shore at Arakaitai Reef 2010

4. Discussion

Given that no significant adverse environmental effects had been detected as a result of disposal of dredged material at the nearshore dumpsite during the first seven years of monitoring, the frequency of components of the monitoring programme were reduced in 2009. This memo covers the first surveys undertaken since changing the frequency of the intertidal surveys from biannual to biennial.

The results from the 2010 intertidal survey indicate that disposal of dredged material was not having detectable adverse effects on the intertidal reef communities at the New Plymouth sites surveyed. Both number of species and Shannon-Weiner index were significantly higher at all three potential impact sites compared to the control site. Mean number of species and Shannon-Weiner index at the Arakaitai Reef and Kaweroa Reef 1.2 km NE sites were within the range of values previously recorded at these sites. At Kaweroa Reef 1.2 km NE mean Shannon-Weiner index was lower than that recorded in previous years, however, this was not directly associated with elevated sand cover, with a mean percentage sand cover per quadrat of 8%.

The level of sand cover was relatively low (≤15%) at all sites with the exception of Greenwood Road (76%, Table 5). The Greenwood Road control site has periodically been susceptible to heavy sand inundation. The most evident factor impacting the intertidal communities at Greenwood Road was sand cover (76%, Table 5). Sand can cause smothering and scouring of intertidal communities and significant volumes of sand can be deposited as a result of seasonal oceanographic processes. Within Taranaki, sand deposition appears to be a dominant driver of species richness and diversity amongst intertidal reef communities. Long term monitoring of intertidal rocky reefs around the Taranaki coastline has revealed the abundance and diversity of these communities can be adversely affected when sand levels exceed 30% coverage. However, historical results from Greenwood Road (Figure 3 and 4) indicate that Taranaki intertidal communities can recover relatively rapidly (within the year) from heavy sand inundation providing that high sand deposition is not continuous.

5. Conclusion

In order to assess the effects of dredging on the nearby intertidal communities, ecological surveys were conducted between 7 and 10 October 2010 at four sites. These surveys included three potential impact sites adjacent to the inshore disposal area and one control site to the southwest. It is expected that adverse effects of dredging on the intertidal communities would have been evident as a significant decline in species richness and diversity at the potential impact sites relative to the control site.

Both number of species per quadrat and Shannon-Weiner diversity indices were higher at the potential impact sites relative to the control site, and results from sites close to the inshore disposal area had not declined notably in recent years. Therefore the results indicate that dredging activities were not having detectable adverse effects on the intertidal reef communities of New Plymouth. Natural environmental factors, including wave exposure, sand cover as a result of natural processes and substrate mobility appeared to be dominant drivers of species richness and diversity at the sites surveyed.

Emily Roberts
Marine Ecologist

Abbie Bates
Technical Officer

Internal Memorandum

To: Science Manager – Hydrology/Biology, Regan Phipps
From: Scientific Officer, Emily Roberts and Technical Officer, Abbie Bates
File: #1443770
Date: 10 December 2014

Port Taranaki Limited Dredging Programme – Intertidal Ecological Survey Spring 2012

1. Introduction

Port Taranaki Limited holds resource consent 5886-1 to deposit up to 400,000 m^3 in any one dredging campaign, and up to 730,000 m^3 in any three successive dredging campaigns within an inshore disposal area on the western flank of Kawaroa Reef. This permit was granted on 7 March 2002 by the then Minister of Conservation, Sandra Lee. Special conditions of the consent require that the sand to be used for the inshore disposal area shall be restricted to clean sand dredged from the outer harbour deposits.

As part of the Port Taranaki Limited dredging monitoring programme, surveys are undertaken at Kawaroa Reef and Arakaitai Reef (important reefs for kaimoana gathering) in order to assess if there have been any adverse effects on intertidal communities as a result of dredging activities. Initially, surveys were undertaken twice annually in order to compare intertidal communities prior to and post dredging (Table 1 and 2). In the Port Taranaki Limited Maintenance Dredging Report 2005-2009 (TRC 2009-24), it was proposed that the monitoring programme be reduced given that, following seven years of monitoring, no significant adverse environmental effects had been detected as a result of disposal of dredged material at the nearshore dumpsite. Since 2008, intertidal surveys have been conducted biennially during spring.

Special condition 8 requires there to be no significant sand inundation on the subtidal area of the Kawaroa Reef outside of the inshore disposal area. Special condition 9 requires there to be no significant visual or ecological impacts outside of the area specified as the inshore disposal area on the New Plymouth coast between the Lee Breakwater and the mouth of the Te Henui Stream. Accordingly, intertidal surveys of the intertidal zone were carried out as part of the 2010-2012 monitoring programme. The surveys for the 2010-2012 monitoring period were conducted at four sites between 21 September and 16 November 2012.

Special condition 10 requires there to be no significant adverse effects to kaimoana outside of the area specified as the inshore disposal area on the New Plymouth coast between the Lee Breakwater and the mouth of the Te Henui Stream. There is also a separate monitoring programme for the locally important kaimoana species, paua (*Haliotis iris*) and kina (*Evechinus chloroticus*) at Kawaroa Reef and Arakaitai Reef, with regards to any adverse effects from the sand disposal.

Table 1 Dredge history associated with coastal permit 5886

Disposal campaign	Date	Volume (m^3) dumped inshore
First	12-Jan-2004 to 23-Mar-2004	253,633
Second	13-May-2005 to 5-July-2005	199,101
Third	29-Nov-2006 to 19-Feb-2007	173,475
Fourth (emergency dredging)	5-Aug-2008 to 18-Aug-2008	35,549
Fifth	3-Jan-2009 to 4-April-2009	185,250
Sixth	18-March-2011 to 12-May-2011	174,192
Seventh	19-January-2013 to 13-March-2013	189,677

**Emergency dredging was undertaken in August 2008 in response to a large storm*

Table 2 Summary of surveys undertaken in conjunction with monitoring of consent 5886

Survey Number	Date	Disposal Campaign (Table 1)
1	Summer 2003	Pre-disposal
2	Spring 2003	
3	Summer 2004	
4	Spring 2004	1
5	Summer 2005	
6	Spring 2005	2
7	Summer 2006	
8	Spring 2006	
9	Summer 2007	3
10	Spring 2007	
11	Summer 2008	
12	Spring 2008	4 (Emergency)
13	Spring 2010	5
14	Spring 2012	6

2. Methods

2.1 Field Work

The surveys were conducted at three potential impact sites Arakaitai Reef (SEA 902045), Kawaroa Reef 750 m north east of Lee Breakwater (SEA902055), Kawaroa Reef 1.2 km north east of Lee Breakwater (SEA902053) and the control site Greenwood Road (SEA 903070), approximately 20 km south west of the disposal site.

At each site, a 50 m transect was used to establish five 5 m x 3 m blocks. Within each block, five random 0.25 m^2 quadrats were laid giving a total of 25 random quadrats. For each quadrat the percentage cover of algae and encrusting animal species was estimated using a grid. For all other animal species, individuals larger than 3 mm were counted. Under boulder biota was counted where rocks and cobbles were easily turned over.

Photo 1 Potential impact site Arakaitai Reef (SEA 902045), October 2010

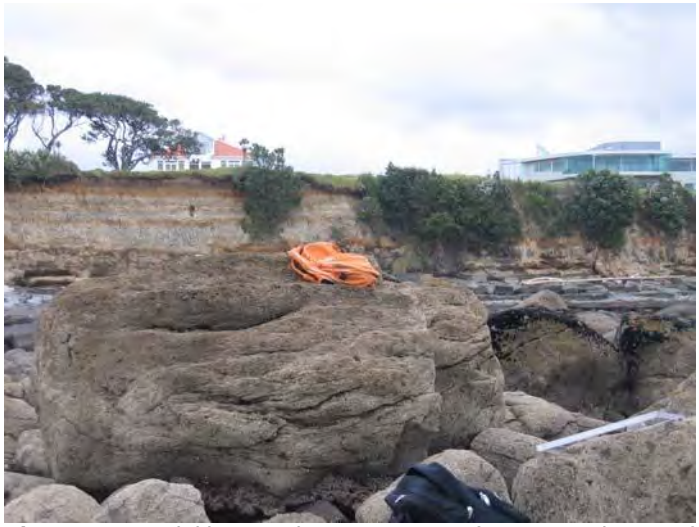


Photo 2 Potential impact site Kawaroa Reef 750 m north east of Lee Breakwater (SEA902055), October 2010

Photo 3 Potential impact site Kawaroa Reef 1.2 km north east of Lee Breakwater (SEA902053), October 2010

Photo 4 Control site Greenwood Road (SEA 903070) inundated with sand, October 2010

3. Results

3.1 Summary statistics

Summary statistics, including the mean number of species per quadrat and the mean Shannon-Weiner indices, are shown in Table 3. The Kawaroa 750 m NE site had the highest number of species, followed by the Kawaroa 1.2 km NE, Greenwood Road and Arakaitai Reef sites. The Kawaroa 1.2 km NE site had the highest Shannon-Weiner index followed by the Kawaroa 750 m NE, Arakaitai Reef and Greenwood Road sites.

Table 3 Summary statistics - spring 2012 survey

Site	No. of quadrats	Mean number of species per quadrat			Mean Shannon-Weiner indices per quadrat		
		Algae	Animals	Total Species	Algae	Animals	Total Species
Arakaitai Reef	25	5.24	9.40	14.64	0.58	0.71	0.89
Kawaroa Reef 1.2 km NE	25	5.75	11.68	17.40	0.61	0.90	1.03
Kawaroa Reef 750 m NE	25	6.36	12.44	18.80	0.61	0.82	0.99
Greenwood Road	25	7.20	9.72	16.92	0.69	0.61	0.81

3.2 Number of species per quadrat data

Figure 1 shows the total number of species per quadrat as a box and whisker plot. The notched area of the box represents the median plus and minus a 95% confidence interval for the median. This form of graphical representation allows a quick comparison to be made between sites. Generally, if the notched areas of the boxes

for the different sites do not overlap, one would expect to obtain a significantly different result with ANOVA[1].

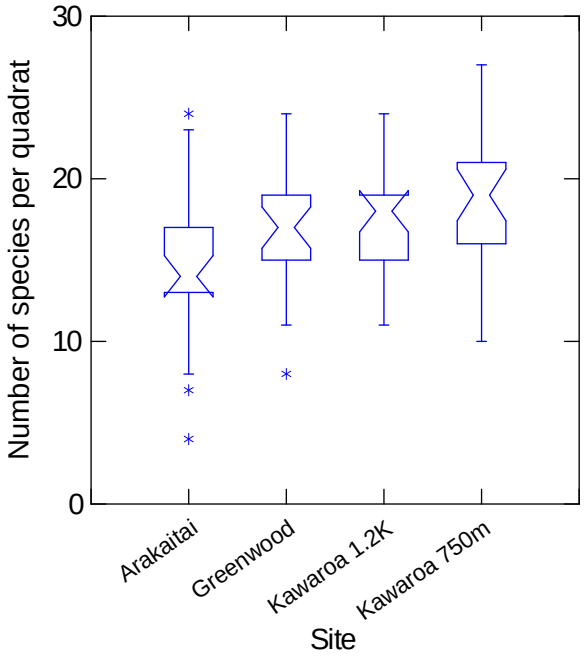


Figure 1 Box and whisker plot of total number of species per quadrat

Only one site (Arakaitai Reef) showed a significant deviation from normal distribution at the 95% confidence level (Lilliefors test, n = 25, P <0.003).
There was a significant difference in mean number of species per quadrat between the sites (ANOVA, n = 25, F = 4.865, P = <0.003).

Table 4 Tukey multiple comparison test of number of species per quadrat

Site	Arakaitai Reef	Greenwood Road	Kawaroa Reef 1.2 km NE
Greenwood Road	NS		
Kawaroa Reef 1.2 km NE	NS	NS	
Kawaroa Reef 750 m NE	SIG	NS	NS

Key: SIG = significant difference at 95% confidence level
NS = no significant difference

Significant differences between sites were determined using Tukey's multiple comparison test (Table 4). Mean number of species per quadrat was significantly higher at Kawaroa Reef 750 m NE than at Arakaitai Reef (Tukey's, n = 25, p <0.05).

[1] Analysis of variance (ANOVA): a statistical test used to analyse differences between a number of means.

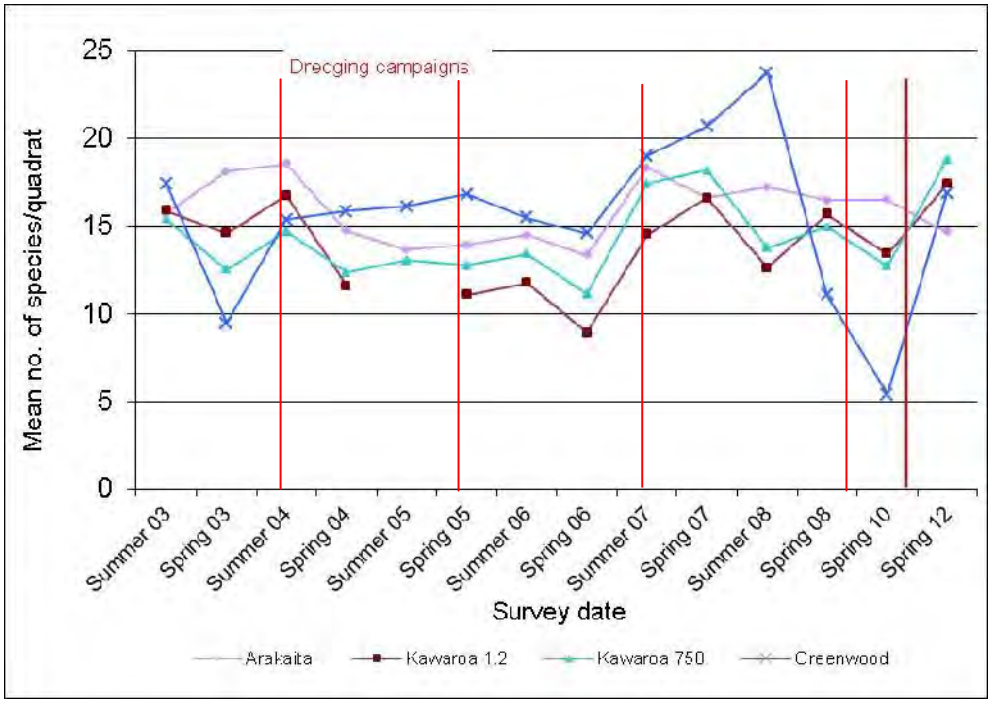


Figure 2 Mean number of species per quadrat from 2003 to 2012

Figure 2 shows mean number of species per quadrat for all surveys undertaken for the Port Dredging monitoring programme. For the 2012 survey, the mean number of species per quadrat at Greenwood Road and Arakaitai Reef was within the range of values previously recorded at these sites. At the two Kawaroa Reef sites mean number of species per quadrat was higher than previously recorded. The number of species per quadrat at Greenwood Road had increased substantially since 2010 and these results are discussed further in Section 4.

3.2 Shannon-Weiner Diversity Index Data

Figure 3 shows the mean Shannon-Weiner index data at each site as a box and whisker plot.

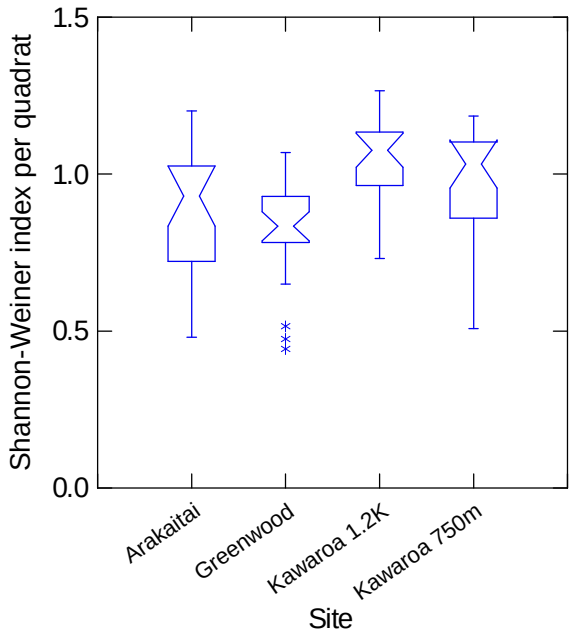


Figure 3 Box and whisker plots of Shannon-Weiner diversity indices

Two sites (Greenwood Road and Kawaroa Reef 1.2 km NE) showed a significant deviation from normal distribution at the 95% confidence level (Lilliefors test, n = 25, p <0.001). There was a significant difference in mean Shannon Weiner index per quadrat between the sites (ANOVA, n = 25, F = 9.187, p < 0.001).

Table 5 Tukey multiple comparison test of Shannon-Weiner index per quadrat

Site	Arakaitai Reef	Greenwood Road	Kawaroa Reef 1.2 km NE
Greenwood Road	NS		
Kawaroa Reef 1.2 km NE	SIG	SIG	
Kawaroa Reef 750 m NE	NS	SIG	NS

Key: SIG = significant difference at 95% confidence level
NS = no significant difference

Significant differences between sites were determined using Tukey's multiple comparison test (Table 5). At the Greenwood Road site the mean number of species per quadrat was significantly lower than that at the Kawaroa Reef 1.2 km NE and Kawaroa Reef 750 m NE sites. Mean Shannon Weiner index at thr Arakaitai Reef site was significantly lower than that at the Kawaroa Reef 1.2 km NE site.

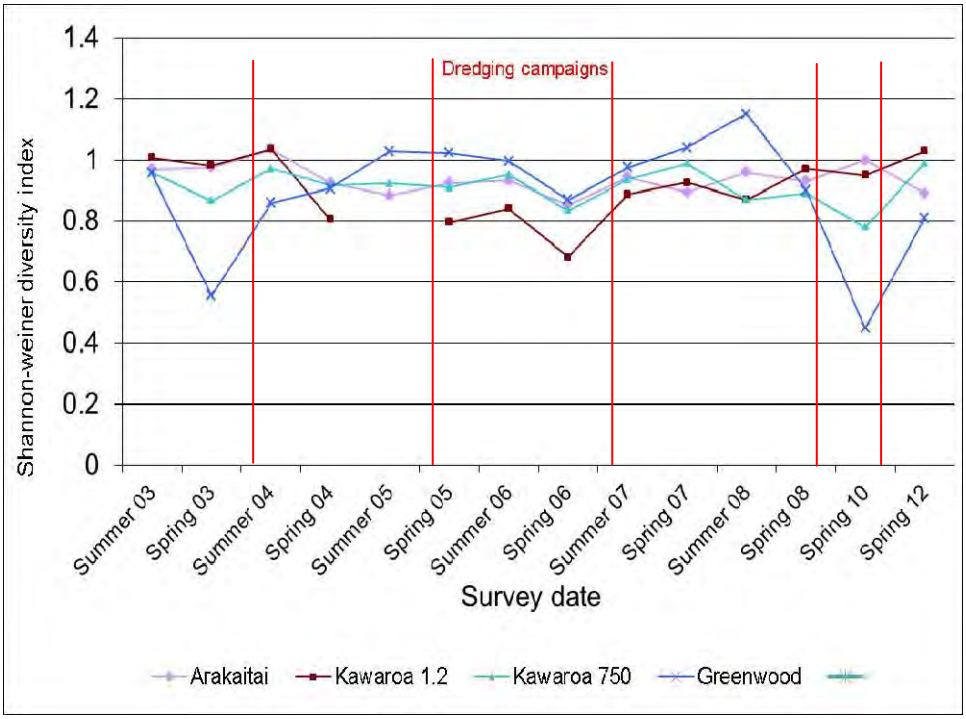


Figure 4 Mean Shannon-Weiner index per quadrat from 2003 to 2012

Figure 4 shows mean Shannon-Weiner index per quadrat for all surveys undertaken for the Port dredging monitoring programme. For the 2012 survey, the mean Shannon-Weiner index per quadrat at all sites was within the range of values previously recorded at these sites. The diversity index at Greenwood Road had increased since 2010 and these results are discussed further in Section 4.

3.3 Sand Cover

The level of sand cover was relatively low (≤10%) at all sites. Abundance and diversity of intertidal species/communities can be significantly impacted by sand cover of 30% and higher.

Table 5 Mean percent sand cover per quadrat (2012)

Site	Mean coverage of sand per quadrat (%)
Arakaitai Reef	6
Greenwood Road	5
Kawaroa Reef 1.2 km NE	1
Kawaroa Reef 750 m NE	9

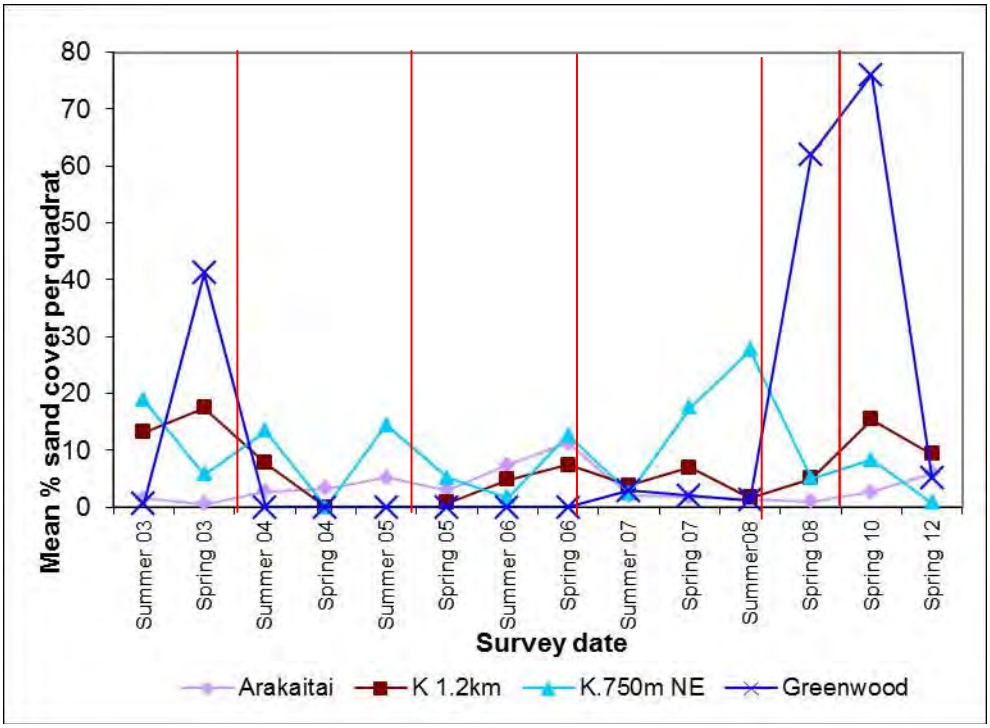


Figure 5 Mean percentage sand cover by site from 2003 to 2012
Note: Value for Greenwood Road in spring 2008 includes both sand and silt

The Greenwood Road site has on occasions been susceptible to heavy sand inundation. During the 2003, 2008 and 2010 surveys, sand/silt cover at this site was 41%, 62% and 76% respectively. The impact of this high sand cover on intertidal communities is discussed further in Section 4.

Sand cover at the three potential impact sites has typically been low to moderate during surveys (Figure 5). Sand cover at the Kawaroa 750 m site has been moderate on occasions, with sand often trapped in the turf which occurs in abundance across the lahar platform that makes up the majority of this site. Low levels of sand cover are typically present at Arakaitai, with only two surveys showing sand cover of greater than 5%. Pockets of sand are occasionally present towards the top of the shore at this reef (Photograph 5). The site at Kawaroa 1.2 km NE had moderate levels of sand in initial, pre-dredging surveys, however sand at this site has remained low in all post-dredging surveys with the exception of the 2010 survey, during which moderate sand cover was recorded.

Photograph 5 Sand accumulation observed on the high-shore at Arakaitai in 2010

4. Discussion

Given that no significant adverse environmental effects had been detected as a result of disposal of dredged material at the nearshore dumpsite during the first seven years of monitoring, the frequency of components of the monitoring programme were reduced in 2009. This memo covers the second group of surveys undertaken since changing the frequency of the intertidal surveys from biannual to biennial.

The results from the 2012 intertidal survey indicate that disposal of dredged material was not having detectable adverse effects on the intertidal reef communities at the New Plymouth sites surveyed. In particular, values of mean number of species per quadrat at the two Kawaroa sites were higher than previously recorded (Figure 2).

The level of sand cover was relatively low (≤10%) at all sites. Abundance and diversity of intertidal species/communities can be significantly impacted by sand cover of 30% and higher. The intertidal community at Greenwood Road were still recovering following previous heavy sand inundation. The level of sand cover at Greenwood Road was 76% in the 2010 survey and 5% in the 2012 survey.

5. Conclusions

In order to assess the effects of dredging on the nearby intertidal communities, ecological surveys were conducted between 21 September and 16 November 2012 at four sites. These surveys included three potential impact sites adjacent to the inshore disposal area and one control site to the southwest. It is expected that adverse effects of dredging on the intertidal communities would have been evident as a significant decline in species richness and diversity at the potential impact sites relative to the control site.

Both species richness and diversity were comparable or higher at the potential impact sites relative to the control site, and results from sites close to the inshore disposal area had not declined notably in recent years. Therefore the results indicate that dredging activities were not having detectable adverse effects on the intertidal

reef communities of New Plymouth. Natural environmental factors, including wave exposure, sand cover as a result of natural processes and substrate mobility appeared to be dominant drivers of species richness and diversity at the sites surveyed.

Emily Roberts
Marine Ecologist

Abbie Bates
Technical Officer

Appendix III

Intertidal sand inspections of New Plymouth reefs

Memorandum

To Environmental Monitoring Manager, Keith Brodie
From Scientific Officer, Kate Giles
File 694120
Date 1 December 2009

Reef inspections

An inspection of the Kawaroa intertidal reef was undertaken on 30 November 2009. Inspection commenced at approximately 14:20pm with low tide at Port Taranaki at 15:00pm (NZDT) at a height of 0.8 metres.

The inspection began at the eastern carpark. Photograph 1 shows the eastern intertidal reef to be predominantly rocky in nature.

As in previous inspections the rocky intertidal reefs on the eastern flank of Kawaroa were characterised by areas of breccia covered with turf (Photograph 2). Some minor sand was noted in patches of turf, but there were no major areas of sand present.

In front of the aquatic centre most areas were predominantly rocky with the exception of areas of breccia platforms covered with turf and/or *Hormosira banksii*.

Again some small patches of sand were present out from the western carpark. This is an area where, during previous inspections, sand patches have been observed. The mostly rocky surrounding areas were characterised by breccia platforms covered with turf and very minor sand deposits (Photographs 3 to 6).

Arakaitai Reef was also inspected. The area to the east of the groyne had the usual strip of sand around the base of the rock wall (Photograph 7). Sand was present around the groyne, up to the height of the groyne close to the rock wall (Photograph 8). There were also several patches of sand further to the west (Photographs 9 and 10). The usual strip of sand was present along the wall towards the wind wand (Photograph 11).

Kate Giles
Scientific Officer

Photograph 1

Photograph 2

Photograph 3

Photograph 4

Photograph 5

Photograph 6

Photograph 7

Photograph 8

Photograph 9

Photograph 10

Photograph 11

Memorandum

To Environmental Monitoring Manager, Keith Brodie
From Scientific Officer, Kate Giles
File #731895
Date 1 March 2010

Reef inspections

An inspection of the Kawaroa intertidal reef was undertaken on 1 March 2010. Inspection commenced at approximately 16:30 pm with low tide at Port Taranaki at 17:21pm (NZDT) at a height of 0.0 metres.

The inspection began at the eastern carpark (Photographs 1 and 2) show the eastern intertidal reef to be predominantly rocky in nature.

As in previous inspections the rocky intertidal reefs on the eastern flank of Kawaroa were characterised by areas of breccia covered with turf no major areas of sand present.

In front of the aquatic centre most areas were predominantly rocky with the exception of areas of breccia platforms covered with turf and/or *Hormosira banksii*. Very few patches of sand were observed (Photographs 3 to 6).

Arakaitai Reef was also inspected. The area to the east of the groyne had the usual strip of sand around the base of the rock wall (Photograph 7). Sand was present in moderate quantities around the groyne (Photograph 8). There were also several patches of sand further to the west (Photograph 9). There was the usual strip of sand along the seawall through towards the wind wand (Photograph 10).

Kate Giles
Scientific Officer

Photograph 1

Photograph 2

Photograph 3

Photograph 4

Photograph 5

Photograph 6

Photograph 7

Photograph 8

Photograph 9

Photograph 10

Memorandum

To Environmental Monitoring Manager, Keith Brodie
From Environmental Consultant, Dan Govier
File #1485181
Date 9 June 2014

Reef inspections

An inspection of the Kawaroa intertidal reef was undertaken on 29 August 2011. Inspection commenced at approximately 14:30 pm with low tide at Port Taranaki at 15:43 pm (NZDT) at a height of 0.2 metres.

The inspection began at the eastern carpark (Photographs 1 and 2) show the eastern intertidal reef to be predominantly rocky in nature.

As in previous inspections the rocky intertidal reefs on the eastern flank of Kawaroa were characterised by areas of breccia covered with turf no major areas of sand present.

In front of the aquatic centre most areas were predominantly rocky with the exception of areas of breccia platforms covered with turf and/or *Hormosira banksii*. Very few patches of sand were observed (Photographs 3 to 6).

Arakaitai Reef was also inspected. The area to the west of the groyne had a strip of sand around the base of the rock wall (Photograph 7). There was significantly less sand present around the groyne as has been observed in previous inspections (Photograph 8). There were also several patches of sand further to the west (Photograph 9) however these were all observed at the base of the rock wall. There was the usual strip of sand along the seawall through towards the wind wand (Photograph 10).

Dan Govier
Environmental Consultant

Photograph 1

Photograph 2

Photograph 3

Photograph 4

Photograph 5

Photograph 6

Photograph 7

Photograph 8

Photograph 9

Photograph 10

Memorandum

To Environmental Monitoring Manager, Keith Brodie
From Scientific Officer, Emily Roberts
File 1279658
Date 19 November 2013

Reef inspections

An intertidal inspection of the Kawaroa Reef was undertaken on 15 November 2013. Inspection commenced at approximately 14:40 (NZDT) with low tide (Port Taranaki) at 15:03 (NZDT) at a height of 0.6 m.

The inspection began at the eastern carpark. Photographs 1 and 2 show the eastern intertidal reef to be predominantly rocky in nature.

The rocky intertidal reefs on the eastern flank of Kawaroa were characterised by areas of breccia covered with *Corallina* turf. No major areas of sand were present (Photograph 2).

In front and to the west of the aquatic centre, most areas were predominantly rocky with the exception of breccia platforms covered with *Corallina* turf and/or *Hormosira banksii*. Very few patches of sand were observed (Photographs 3 to 6).

Arakaitai Reef was also inspected. Compared to previous inspections (for example 1 March 2010, Photograph 7) relatively little sand had accumulated in the area to the east of the groyne around the base of the rock wall (Photograph 7). Relatively little sand was present around the groyne (Photograph 8). No large patches of sand were observed further to the west (Photographs 9). The usual strip of sand was present along the wall towards the wind wand (Photograph 10).

Emily Roberts
Scientific Officer

Photograph 1

Photograph 2

Photograph 3

Photograph 4

Photograph 5

Photograph 6

Photograph 7

Photograph 8

Photograph 9

Photograph 10

Memorandum

To Environmental Monitoring Manager, Regan Phipps
From Scientific Officer, Emily Roberts
File 1346308
Date 12 May 2014

Reef inspections

An intertidal inspection of the Kawaroa Reef was undertaken on 9 May 2014. Inspection commenced at approximately 10:45 (NZDT) with low tide (Port Taranaki) at 11:31 (NZDT) at a height of 1.1 m. In general, sand cover and distribution on the reefs was similar to that observed in the November 2013 inspection with only a few minor changes.

The inspection began at the eastern carpark. Photographs 1 and 2 show the eastern intertidal reef to be predominantly rocky in nature.

The rocky intertidal reefs on the eastern flank of Kawaroa were characterised by areas of breccia covered with *Corallina* turf. No major areas of sand were present (Photograph 2).

In front and to the west of the aquatic centre, most areas were predominantly rocky with the exception of breccia platforms covered with *Corallina* turf and/or *Hormosira banksii*. Very few patches of sand were observed (Photographs 3 to 6).

Arakaitai Reef was also inspected. Compared to some previous inspections (e.g. 1 March 2010) relatively little sand had accumulated in the area to the east of the groyne around the base of the rock wall (Photograph 7), although there was more sand at the top of the shore compared to the previous survey (November 2013). More sand was present around the groyne (Photograph 8) than in November 2013, but not as much as in March 2010. No large patches of sand were observed further to the west (Photographs 9). Less sand was present along the wall towards the wind wand than usual, although a lower tide would have been useful to confirm the full extent of this (Photograph 10).

Emily Roberts
Scientific Officer

Photograph 1

Photograph 2

Photograph 3

Photograph 4

Photograph 5

Photograph 6

Photograph 7

Photograph 8

Photograph 9

Photograph 10

Appendix IV

Kaimoana reports

Memorandum

To Environmental Monitoring Manager, Regan Phipps
From Environmental Consultant, Dan Govier
File 1486324
Date 7 August, 2014

Port Taranaki Limited Dredging Programme – 14th Kaimoana Survey, Summer 2011

1. Introduction

Port Taranaki Limited (Port Taranaki), under coastal permit 5886-1 are permitted to deposit up to 400,00 cubic metres of sand in any one dredging campaign within an inshore disposal area on the western flank of Kawaroa Reef. This permit was granted on 9 April 2002 by the Minister of Conservation.

Special conditions of the consent require that the sand to be used for the inshore disposal area shall be restricted to clean sand dredged from the outer harbour deposits. As part of the environmental monitoring requirements for the Port Taranaki sand disposal, ecological monitoring of kaimoana is undertaken consisting of kaimoana and intertidal surveys. A kaimoana survey at the two locally important reefs for gathering kaimoana (Kawaroa Reef and Arakaitai Reef) is undertaken twice per year to obtain data pre and post disposal. The kaimoana considered most important to monitor are the paua (*Haliotis iris* and *Haliotis australis*); kina (*Evechinus chloroticus*), cook's turban (*Cookia sulcata*) and pupu or cat's eye (*Melagraphia aethiops* and *Turbo smaragdus*).

This is the 14th kaimoana survey to be carried out at five known kaimoana beds on Arakaitai and Kawaroa Reefs. The survey was conducted between 10 to 12 March 2011 as part of the 2010-2011 Port Taranaki compliance monitoring programme. The objective of the survey is to gather information on kaimoana abundance as well as gaining information on the size frequency of paua. This data will be an important component in assessing any effects from the sand disposal programme. This is the eleventh survey since the initial inshore disposal was undertaken during January to March 2004. Table 1 below describes a history of the dredging carried out.

Table 1 Dredge history connected with coastal permit 5886

Site	Date	Volume m^3 dumped inshore
Initial campaign	12-Jan-2004 to 23-Mar-2004	253,633
Second campaign	13-May-2005 to 5-July-2005	199,101
Third campaign	29-Nov-2006 to 19-Feb-2007	173,475
Emergency dredging	5-Aug-2008 to 18-Aug-2008	29,166
Fourth campaign	3-Jan-2009 to 2 April-2009	165,995
Fifth campaign	18-Mar-2011 to 19-April-2011	156,086

2. Methods

2.1 Field Work

The March 2011 survey was conducted at five kaimoana beds on Kawaroa and Arakaitai Reefs (Figure 1).

The inspections included the low intertidal to shallow subtidal zone between 0.1 m and 0.6 m above chart datum, which is not specifically surveyed as part of the intertidal monitoring but is recognised to be abundant in kaimoana species. The monitoring technique has to quantify kaimoana stocks or numbers in order to be able to detect any impact. Quantitative sampling using transects and quadrats, although typically preferable, are inadequate to estimate population numbers when the species are cryptic, in low average densities and aggregated in shallow, wave-swept habitats. Dr Russell Cole, from NIWA, suggested that time-count sampling; a rapid visual technique would be most beneficial after his initial pilot study. Although this technique is semi-quantitative it can provide information regarding the relative abundance and size frequency of paua. The "rapid visual technique" was used, however the difficulty with this technique is that quantitative estimates of abundance cannot be readily derived from the data collected.

For each site all available rocky crevice and under rock habitat is searched for 60 minutes. Within this time interval all paua encountered were measured and counted. All other kaimoana species are also counted as they are encountered, but not measured (Photograph 1).

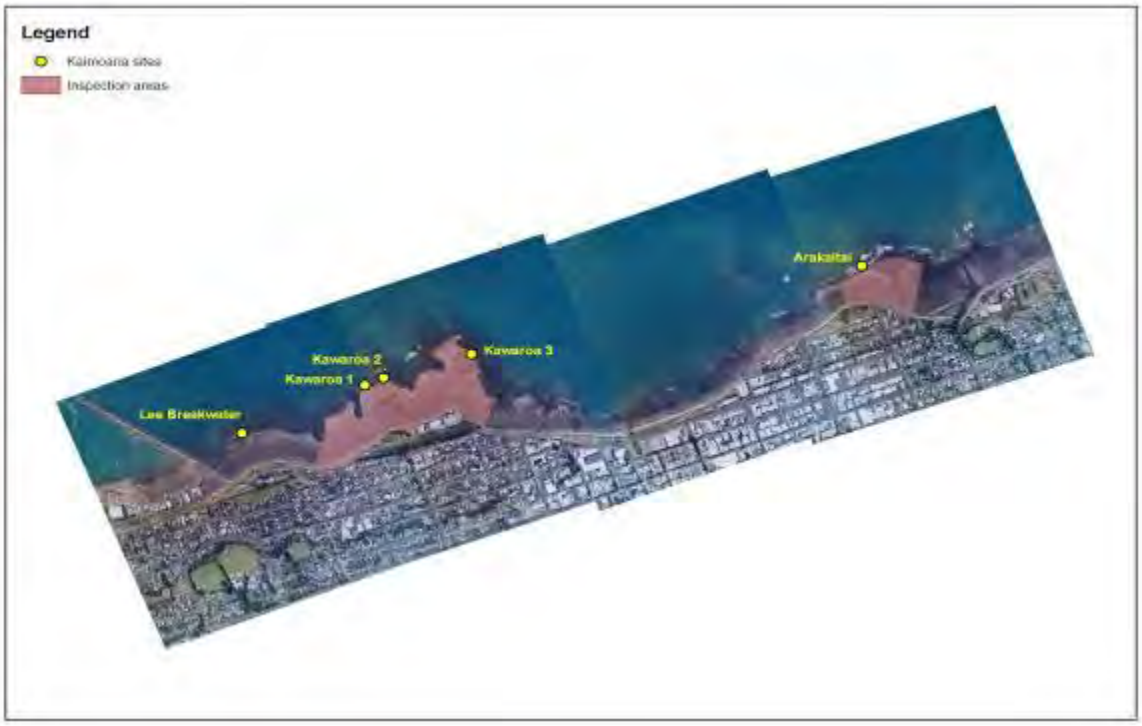


Figure 1 Intertidal kaimoana survey sites on Kawaroa and Arakaitai Reefs

2.2 Data Analysis

The rapid visual search technique is the most efficient way of locating the maximum number of paua in a given time. This method provides data for the number of paua per unit time searched, which can be compared over time for each bed.

Timed searches in appropriate habitat are used to find, measure, and count paua, collect information about paua aggregations and collect size frequency data. This method allows relative abundance of paua, expressed in terms of paua encountered per unit search time (number per minute), and size frequency distribution of paua for each site.

Graphical summaries of number, length, and count per minute are made, and the total length of paua at each site were also graphed using box and whisker plots. Assumptions of normality were tested using the Lilliefors test to determine which sites differ from a normal distribution at a 95% confidence level. One-way analysis of variance (ANOVA) tests were carried out on overall length of paua at each reef to determine if there was any significant difference between sites. A Tukey multiple comparison test was used to determine where differences occurred between sites when a significantly different result was obtained using the ANOVA test.

Eleven data sets have now been gathered for kaimoana, both pre and post-dispersal and these are plotted on graphs in the results section, which will help show any changes between sites over time.

Photograph 1 Council staff undertaking a kaimoana survey with an iwi representative

3. Results

3.1 Paua

Summary statistics for the paua counted during the March 2011 survey are presented in Table 2. The results have been standardised to the number of paua counted per minute to allow for comparison between sites and over time.

Table 2 Number of paua counted from the five locally important Kaimoana Reefs

	Arakaitai	Lee Breakwater	Kawaroa 1	Kawaroa 2	Kawaroa 3
Time (min)	60	60	60	60	60
Actual count	200	179	123	137	155
Min (mm)	12	7	12	4	19
Max (mm)	85	80	83	100	88
Mean (mm)	40	41	41	47	46
Count (paua/minute)	3.3	2.9	2	2.3	2.6

Table 2 and Figure 2 show that the highest numbers of paua were found at Arakaitai Reef, followed closely by Lee Breakwater. Kawaroa 3 was next followed by Kawaroa 2 and Kawaroa 1 with much less paua.

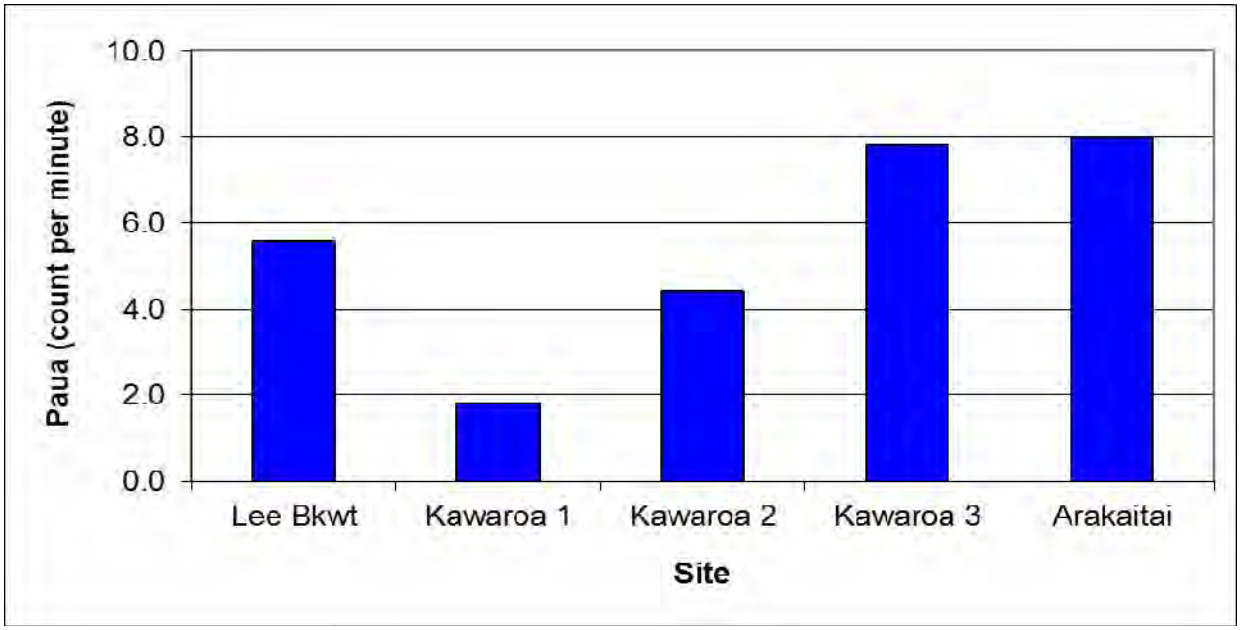


Figure 2 Paua count per minute for the summer 2011 survey

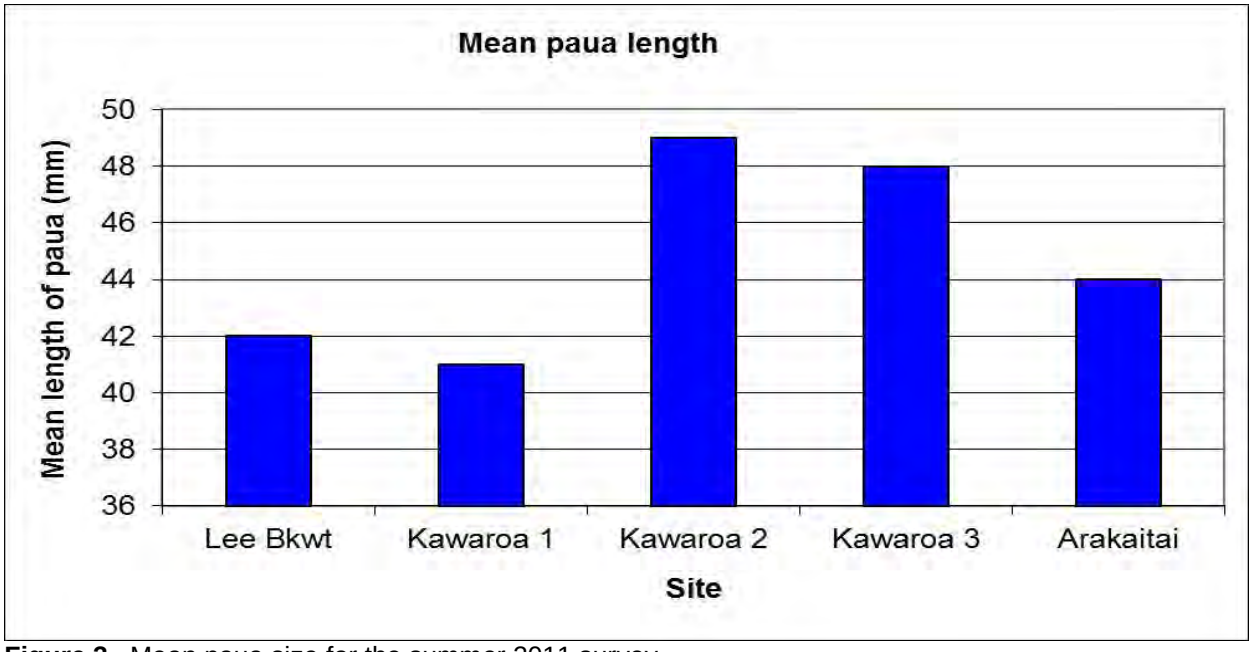


Figure 3 Mean paua size for the summer 2011 survey

The smallest and largest paua were both found at Kawaroa 2 and measured 4 mm and 100 mm respectively (Table 2). The mean size of paua measured ranged between 40 mm at Arakaitai and 47 mm at Kawaroa 2 (Figure 3).

Summaries of the overall length of paua at each site in 2011 are shown as box and whisker plots in Figure 4. This form of graphical representation allows a quick comparison to be made between sites.

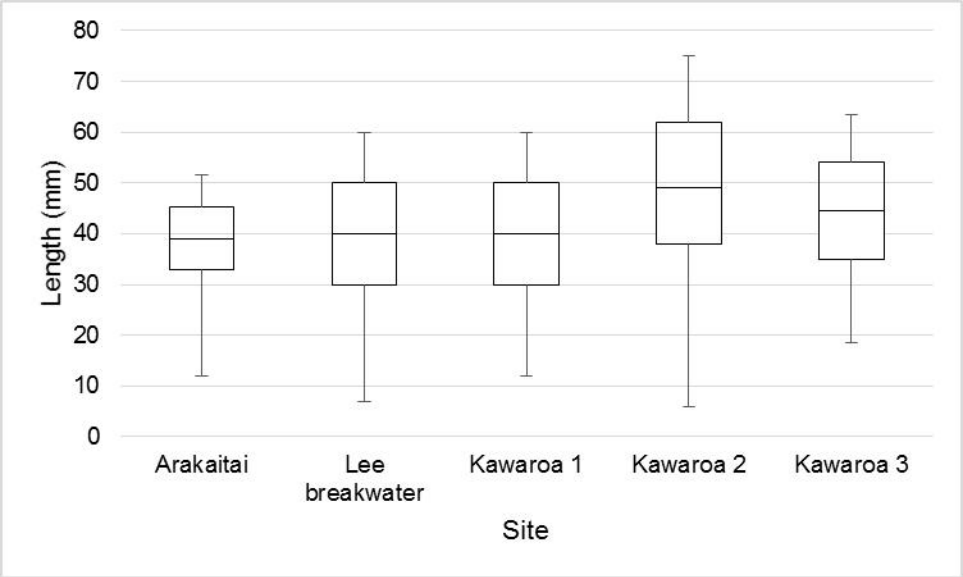
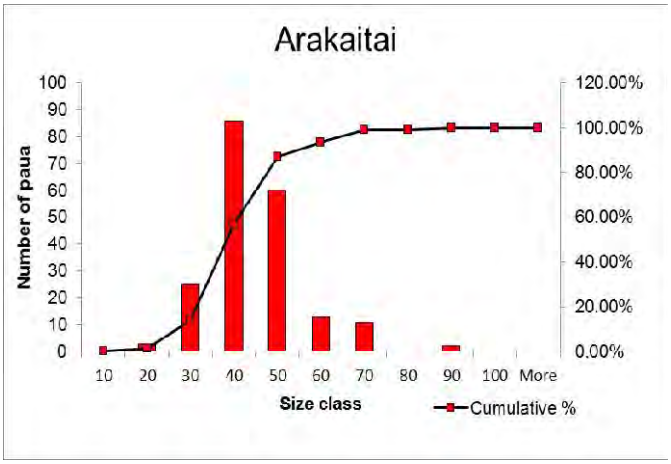


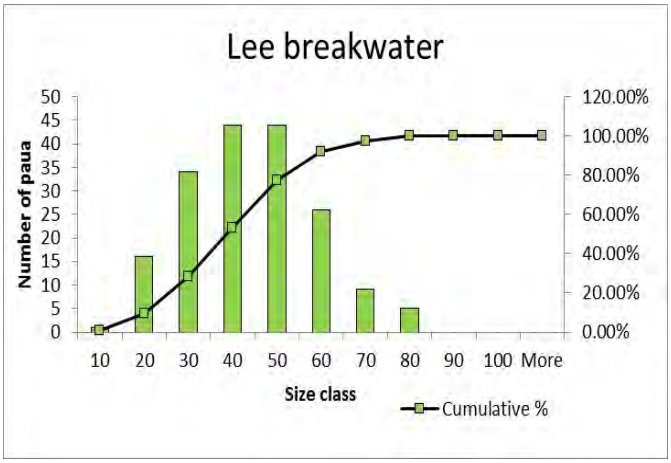
Figure 4 Box and whisker plot for total lengths of Paua at the five Kaimoana beds

Paua length is further investigated in Figures 5 – 8 by division into 10 mm size classes.



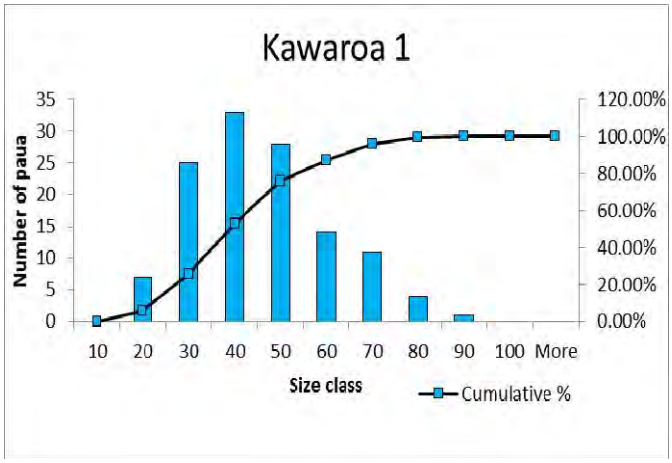
At Arakaitai reef, the highest number of paua were found in the 41 -50 mm size classes, with very few large paua found.

Figure 5 Size class of paua at Arakaitai Reef



At the Lee Breakwater site the most paua were found in the 41-60 size classes. Similar to Arakaitai, very few large paua were found.

Figure 6 Size class of paua at Lee Breakwater

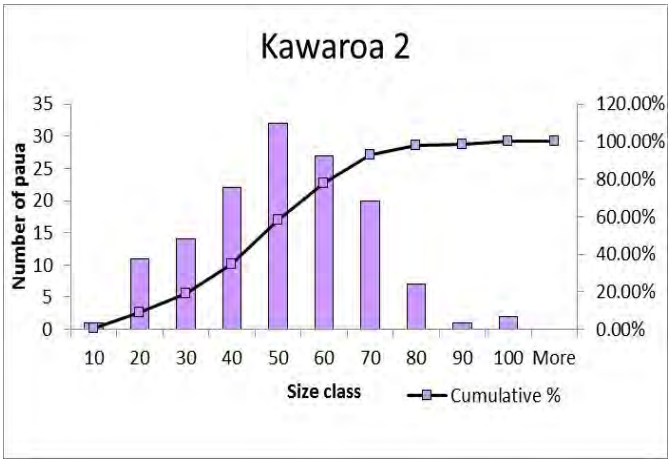


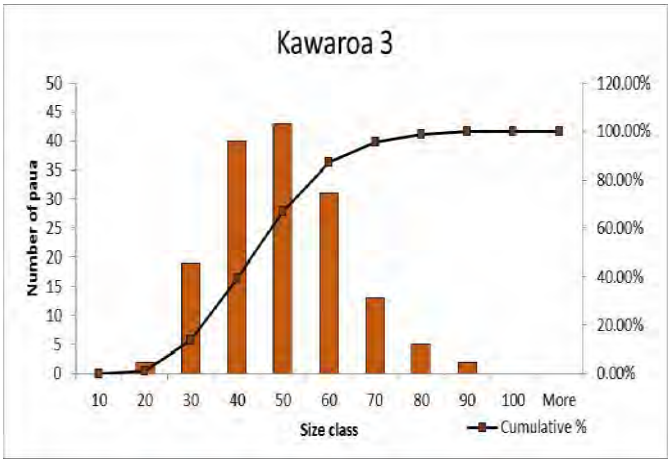
The most commonly found paua at Kawaroa 1 Reef were between 31 – 60 mm. Again, very few paua were found in the higher size classes at this site with much greater numbers in the smaller size classes.

Figure 7 Size class of paua at Kawaroa 1

The most paua were found in the 51 - 70 mm size classes at Kawaroa 2.

Figure 8 Size class of paua at Kawaroa 2





At Kawaroa 3 the highest number of paua were found between 31 – 60 mm. This site showed a bell-shaped curve around 51-60 mm, with paua in both the higher and lower size classes.

Figure 9 Size class of paua at Kawaroa 3

3.2 Other kaimoana species

Other kaimoana species present on the five reefs were only counted and not measured. However, the pupu (cats eyes) were not counted, given these are very common on the reefs around Taranaki. Table 4 presents the results of the other kaimoana species found.

Table 3 Numbers of other kaimoana species found on the five Kaimoana Reefs

	Arakaitai	Lee Breakwater	Kawaroa 1	Kawaroa 2	Kawaroa 3
Count duration (min)	60	60	60	60	60
Kina	38	53	52	53	74
Kina count per minute	0.6	0.9	0.9	0.9	1.2
Cooks Turban	1	3	0	3	2

The site at Kawaroa 3 had the most kina, followed by Kawaroa 1, Kawaroa 2 and Lee Breakwater. Fewer kina were present at the Arakaitai site.

Cooks turbans were fairly rare at all sites, while Cat's eyes were plentiful on the reefs, either common or abundant at all sites.

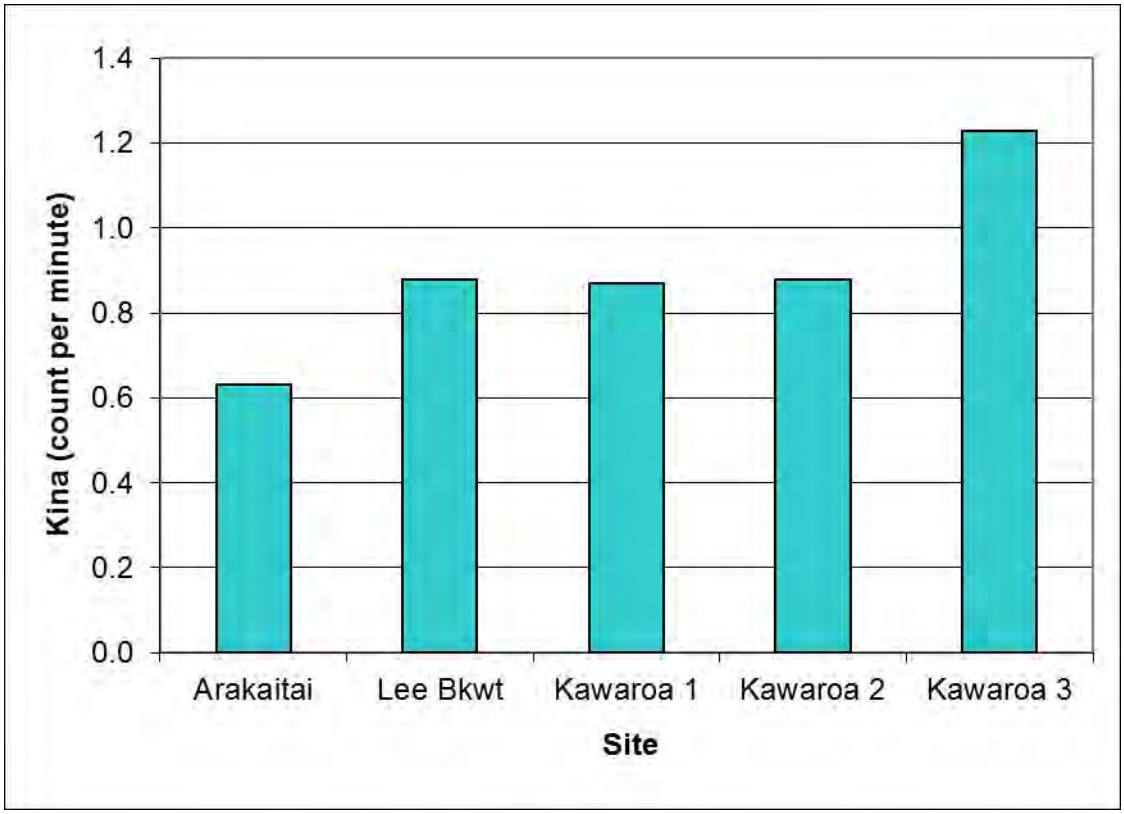


Figure 10 Number of kina counted (per minute searched) during the summer 2011 survey

3.3 Trends over time

3.3.1 Paua

A summary of data collected over all surveys to date is presented in Table 5 below.

Table 4 Average per minute, minimum, maximum and mean of paua counted at the five sites for all surveys

	Arakaitai	Lee Breakwater	Kawaroa 1	Kawaroa 2	Kawaroa 3
Average count per minute (all surveys)	5.5	4.3	3.4	3.2	6.0
Pre-dredge (3 surveys)	2.6	4.0	2.2	2.6	5.1
Post-dredge (11 surveys*)	6.4	4.4	3.8	3.4	6.2
Min (mm)	5	7	10	4	10
Max (mm)	95	90	100	105	100
Mean	45.5	42.2	43.4	52.5	49.3

* There have been nine post-dredge surveys at Lee Breakwater and ten at Kawaroa 1 and Arakaitai.

Since the kaimoana surveys began in 2003, Kawaroa 3 has had the highest average count of paua per minute, followed by Arakaitai, Lee Breakwater, Kawaroa 1 and Kawaroa 2. All sites have shown a higher mean count per minute in post-dredge surveys when compared with pre-dredge surveys. The smallest paua found to date has been at Kawaroa 2 and was 4 mm in length. Whereas the largest size of paua found has ranged from 90 mm at Lee Breakwater to 105 mm at Kawaroa 2. Kawaroa 2

also has the highest mean length of paua at 52.5 mm, while the Lee Breakwater site has the lowest mean length, at 42.2 mm.

As a result of a number of surveys being unable to be carried out for 60 minutes, the number of paua counted per minute searched provides a better comparison between the sites, and over time (Figure 11).

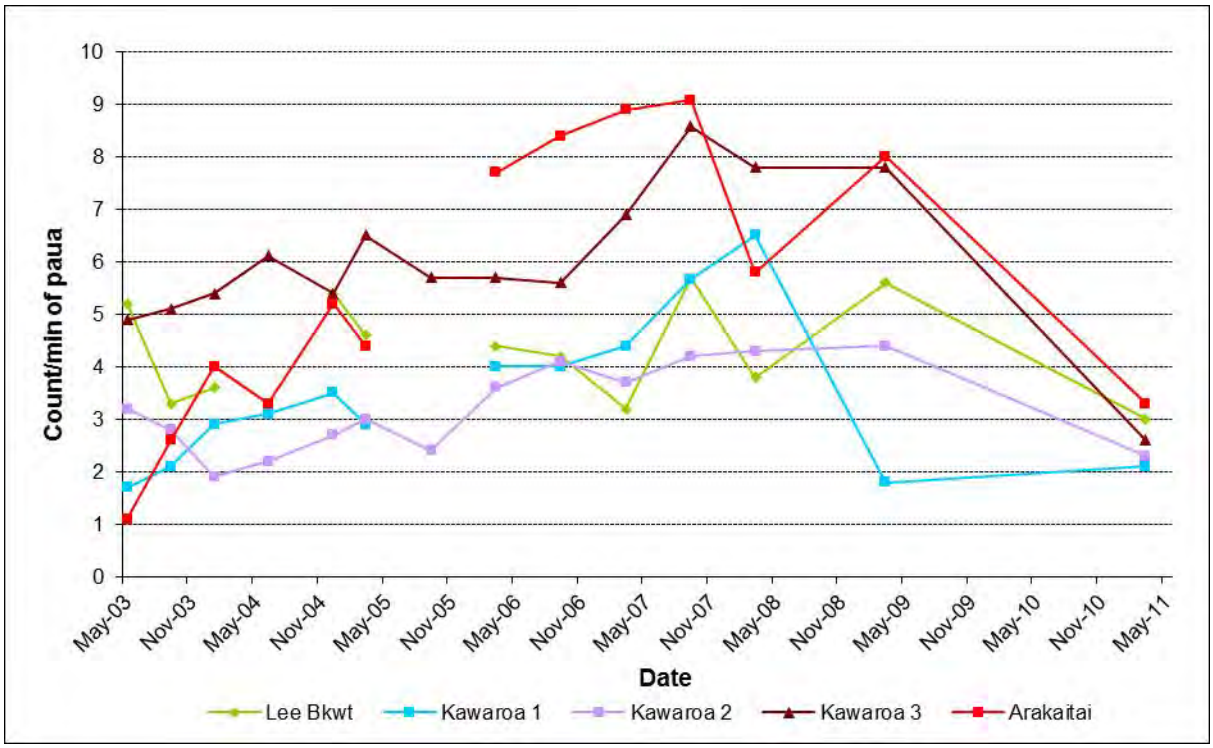


Figure 11 Number of paua counted per minute searched

The number of paua per minute found has varied from survey to survey since monitoring began in 2003. In general, most sites have remained relatively stable over time, or increased slightly from initial pre-disposal values. In the 2011 survey, all sites, except for Kawaroa 1 showed a decrease in the number of paua found per minute. This may be, in part, due to the fact that the weather was very inclement on the day the survey was undertaken and the wind was pushing the tide up the reef.

The site at Arakaitai has shown the most marked variations with an increase from between 1 and 4 paua per minute in the initial surveys, to over nine paua per minute in the spring 2007 survey and then back to 3 paua per minute in the 2011 survey. This most recent survey also revealed notably less variability between sites than in previous years.

Figure 12 below shows the mean length of paua per survey for all surveys to date.

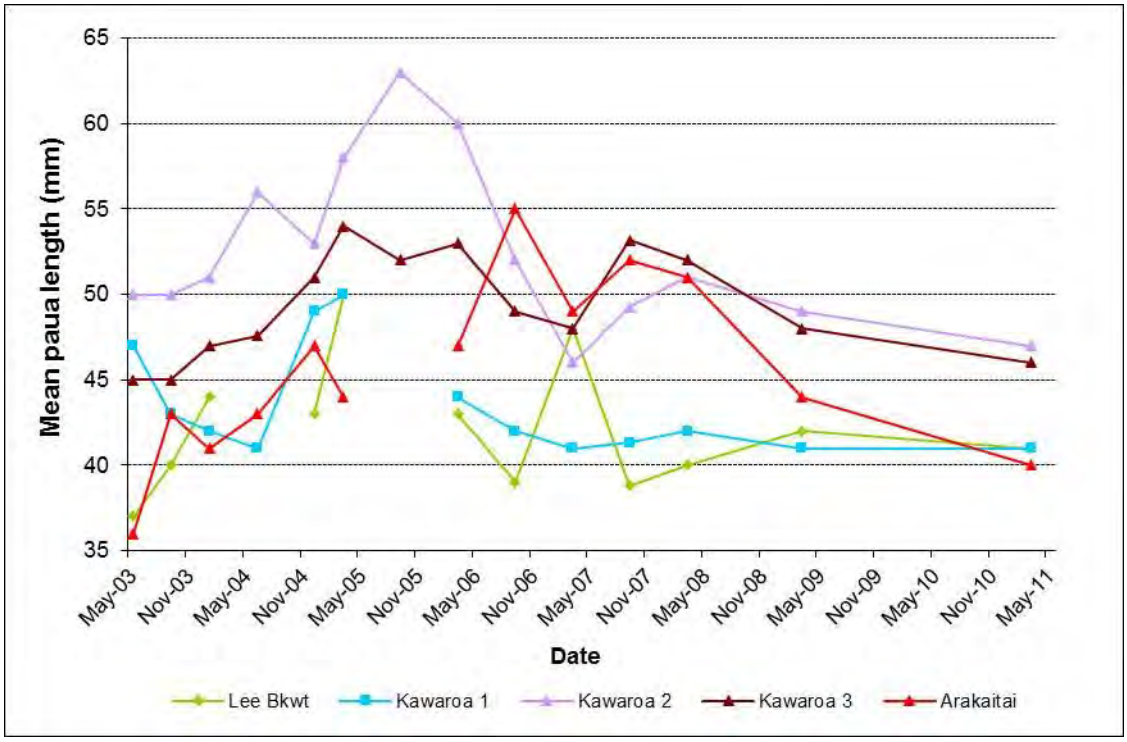


Figure 12 Mean length of paua at the five Kaimoana reefs

The mean length of paua at each site has also varied from survey to survey. Kawaroa 1 and Lee Breakwater have generally had the smallest paua found, while Kawaroa 2 and Kawaroa 3 generally had the biggest. Paua found at Arakaitai reef have been more variable in size, with the 2011 survey resulting in a decrease of mean length compared to recent surveys.

3.3.2 Kina

Figure 13 shows the number of kina (count per minute) for all surveys to date.

The Arakaitai Reef and Lee Breakwater sites have shown the least amount of variation since monitoring began, largely due to very few kina being observed during the surveys. There was an increase in kina numbers during September 2006 and March 2007 at Kawaroa 2; however, levels found during the 2011 survey are similar to those found pre-dredging. Numbers of kina counted at Kawaroa 3 increased steadily from pre-dredging levels to a peak in summer 2007, where numbers then decreased similar to pre-dredging values in the following two surveys, increasing again in 2009 only to drop lower than pre-dredge levels in the 2011 survey. Kina numbers at Kawaroa 1 have been variable over time, peaking in 2007, although since then there has been a significant decrease in kina found, with the 2011 results slightly below the pre-dredge levels.

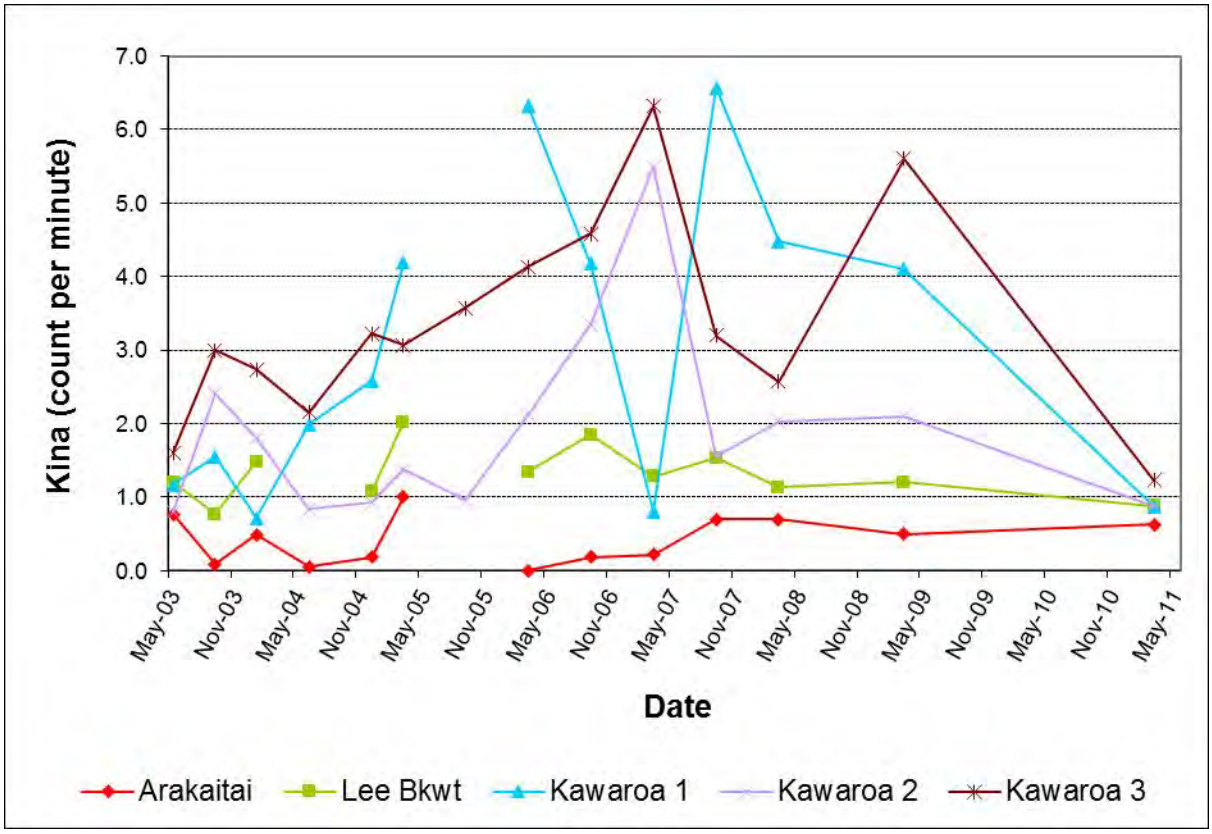


Figure 13 Count per minute of kina during each survey

4. Discussion

This is the fourteenth survey for the kaimoana monitoring programme for Port Taranaki, and the eleventh post dredging survey after clean sand was initially dispersed within the inshore disposal area on the western flank of Kawaroa Reef. The initial dispersal took place after the completion of all the kaimoana, subtidal and intertidal sampling in January 2004 (January 2004 -March 2004). There was concern by the general public and local Iwi that kaimoana gathering from the local reefs would be affected by sand inundation. There is now a large set of data available for both pre-dredging and post-dredging. Gathering this information on the locally important kaimoana species will help determine whether or not the dispersal of sand on the inshore site is having an effect on the reef.

In the initial pilot study undertaken by Russell Cole on kaimoana, he recommended that instead of using random quadrats, a time count method would be more beneficial. This is due to the distribution of paua being cryptic in habit, clumped together, present in low mean densities and in wave-swept environments. In the initial survey each kaimoana bed that was identified was searched for 30 minutes with the number and size of paua recorded. This resulted in a number of paua likely to be found per minute of searching, which can be compared between sites and over time. Given the natural variability and harvesting pressure upon paua it would be difficult to quantify any impact solely due to sand inundation. This is why the monitoring of kaimoana prior to the first dredging campaign (January 2004) was scheduled, to attempt to provide a measure (albeit somewhat limited) of the natural variability that can occur within populations.

The kaimoana surveys were altered after the initial survey, with time spent counting kaimoana increased from 30 minutes to 60 minutes. The aim was to count a higher number of paua, which would then result in an increase in the size frequency data set. There was no difference between the 30 or 60 minute counts in terms of the number counted per minute within the first survey (as compared with the second survey), which supports the fact that the first data set is still comparable.

During the 2011 survey, the most paua (as count per minute) were found at Arakaitai Reef, followed Lee Breakwater, Kawaroa 3, Kawaroa 2 and Kawaroa 1. Habitat is very important to the distribution of paua and kina, with both species having a higher frequency when suitable habitat is present. Higher counts were observed when there was a greater under boulder habitat available, and the macroalgal species *Carpophyllum* was present. When large boulders, breccia terraces, cemented boulders or sand are present, or in areas where kelp is reduced, the number of paua and kina counted is significantly lower.

At the Kawaroa 1 site in the shallow subtidal zone, the substrate mainly consists of large boulders with some smaller rocks. On the southern side of the rocky outcrop there is a bay containing a large number of *Carpophyllum*.

The Kawaroa 2 site has a large distribution of *Carpophyllum* present in the bays on either side of the outcrop, which resulted in noticeably larger paua being found on average. The rocks and boulders at this site are in general large, with many cemented into the reef. This results in more effort required by the searcher to find suitable rocks to turn, and may be a significant reason why less paua are found at this site.

The Kawaroa 3 site has suitable habitat for paua, with smaller rocks 500-600 mm long providing more under boulder habitat, and abundant *Carpophyllum.* The smaller rocks also make searching for paua quicker and easier. This site is on the north-eastern side of the main Kawaroa reef, which may be less exposed to the prevailing winds and sea, providing a more sheltered habitat.

The Lee Breakwater site has a mix of small rocks and large boulders and is also sheltered from the prevailing wind and sea conditions.

As with Kawaroa 3, the survey site at Arakaitai Reef is on the north-eastern side of the reef, which may provide some measure of shelter for the intertidal species. The large number of loose small rocks appears to provide excellent habitat for paua around the 40-60 mm size, with large numbers often found on one rock. The ease of turning these small rocks with the high concentrations of paua under just one rock makes counting paua at this site quick and easy, which in part accounts for the high numbers found here. From observations made during surveys, there also appears to be less kaimoana collection on this reef.

The smallest paua was found at Kawaroa 2 and measured 4 mm. The maximum size found at the five sites ranged between 80 mm at Lee Breakwater to 100 mm at Kawaroa 2. The mean size found ranged between 40 mm at Arakaitai to 47 mm at Kawaroa 2.

The Kawaroa 2 and 3 reef sites had the biggest paua and were not significantly different from one another in terms of paua length. Arakaitai, Kawaroa 1 and the Lee Breakwater sites were not significantly different from each other, and generally the smaller paua are found at these three sites.

This was illustrated further when the size class distributions were analysed. These varied from site to site with Kawaroa 2 and 3 containing the highest numbers of paua in the medium size classes, while Lee Breakwater and Kawaroa 1 had slightly more paua in the smaller size classes.

The highest numbers of kina were found at Kawaroa 3, followed by Kawaroa 1, Kawaroa 2 and Lee Breakwater. There were few kina found at the Arakaitai site. This result is consistent with Howse *et al.* (2000) who found that kina were smaller in areas with both high wave exposure and high-suspended sediment concentrations. Human grazing pressure on these easily accessed reefs may also account in part for this observation.

As weather and tidal conditions have occasionally resulted in surveys of less than 60 minutes, paua count per minute is used to identify trends over time at the five sites. The number of paua per minute searched varied from survey to survey with Kawaroa 3 having the highest average count per minute, followed by Arakaitai, Lee Breakwater and Kawaroa 1 and 2. The mean length of paua at each site has varied from survey to survey; however, the 2011 results are comparable to the pre-dredging results. Likewise, the count of paua per minute searched has fluctuated over time but the 2011 results were relatively consistent with pre-dredging results. Kawaroa 1 and Lee Breakwater tended to have the smallest paua, while Kawaroa 3 generally had the biggest.

Arakaitai Reef and Lee Breakwater have the least amount of variation in terms of kina numbers, with relatively few kina observed during any of the surveys. Kina found at Kawaroa 1, 2 and 3 monitoring sites has fluctuated over time; however in 2011 the numbers found were comparable to the pre-dredging survey results.

During all the surveys, large numbers of people gathering kaimoana have been observed over the entire Kawaroa Reef during the low spring tides. The numbers gathering seafood are not recorded, but it is occasionally noted that undersize paua (<85 mm) are being taken from the reef and in excess of the Ministry for Primary Industries daily limit of 10 per person.

In conclusion, the five sites surveyed appear to be in a healthy state, with the dispersal of clean sand on the inshore site having had no apparent adverse effect on the kaimoana species found on the surrounding reefs.

Dan Govier
Environmental Consultant

Memorandum

To Science Manager – Hydrology/Biology, Regan Phipps
From Scientific Officer – Marine Ecology, Emily Roberts
File 1487143
Date 23 March 2015

Port Taranaki Limited Dredging Programme – 15th Kaimoana Survey, Summer/Autumn 2014

1. Introduction

Port Taranaki Limited (Port Taranaki), under coastal permit 5886-1 are permitted to deposit up to 400,00 cubic metres of sand in any one dredging campaign within an inshore disposal area on the western flank of Kawaroa Reef. This permit was granted on 9 April 2002 by the Minister of Conservation.

Special conditions of the consent require that the sand to be used for the inshore disposal area shall be restricted to clean sand dredged from the outer harbour deposits. As part of the environmental monitoring requirements for the Port Taranaki sand disposal, ecological monitoring of kaimoana is undertaken consisting of kaimoana and intertidal surveys. A kaimoana survey at the two locally important reefs for gathering kaimoana (Kawaroa Reef and Arakaitai Reef) is undertaken twice per year to obtain data pre and post disposal. The kaimoana considered most important to monitor are the paua (*Haliotis iris, Haliotis australis and Haliotis virginea*); kina (*Evechinus chloroticus*), cook's turban (*Cookia sulcata*) and pupu or cat's eye (*Melagraphia aethiops* and *Turbo smaragdus*).

This is the 15th kaimoana survey to be carried out at five known kaimoana beds on Arakaitai and Kawaroa Reefs. The survey was conducted between 1 March and 30 April 2014 as part of the Port Taranaki Limited maintenance dredging monitoring programme. The objective of the survey is to gather information on kaimoana abundance as well as gaining information on the size frequency of paua. This data will be an important component in assessing any effects from the sand disposal programme. This is the 12th survey since the initial inshore disposal was carried out during January to March 2004. Table 1 below describes a history of the dredging carried out.

Table 1 Dredge history connected with coastal permit 5886

Site	Date	Volume m^3 dumped inshore
Initial campaign	12-Jan-2004 to 23-Mar-2004	253,633
Second campaign	13-May-2005 to 5-July-2005	199,101
Third campaign	29-Nov-2006 to 19-Feb-2007	173,475
Emergency dredging	5-Aug-2008 to 18-Aug-2008	29,166
Fourth campaign	3-Jan-2009 to 2 April-2009	165,995
Fifth campaign	18-Mar-2011 to 19-April-2011	156,086
Sixth campaign	19-Jan-2013 to 13-Mar-2013	189,677

2. Methods

2.1 Field Work

The March-April 2014 survey was conducted at five kaimoana beds on Kawaroa and Arakaitai Reefs (Figure 1).

The inspections included the low intertidal to shallow subtidal zone between 0.1 m and 0.6 m above chart datum, which is not specifically surveyed as part of the intertidal monitoring but is recognised to be abundant in kaimoana species. In order to detect any potential impact from dredging activities a monitoring technique that quantifies kaimoana stocks or numbers is required. Quantitative sampling using transects and quadrats, although typically preferable, are inadequate to estimate population numbers when the species are cryptic, in low average densities and aggregated in shallow, wave-swept habitats. Dr Russell Cole (NIWA) recommended that time-count sampling (a rapid visual technique) would be most beneficial based on results from a pilot study. Although this technique is semi-quantitative it can provide information regarding the relative abundance and size frequency of paua. The "rapid visual technique" was used, however, the difficulty with this technique is that quantitative estimates of abundance cannot be readily derived from the data collected.

For each site all available rocky crevice and under rock habitat is searched for 60 minutes. Within this time interval all paua (*Haliotis iris* Photograph 1, *Haliotis australis* and *Haliotis virginea* Photograph 2) encountered were measured and counted. Other kaimoana species (kina *Evechinus chloroticus* and cooks turban shell *Cookia sulcata*) are also counted as they are encountered, but not measured (Photograph 3).

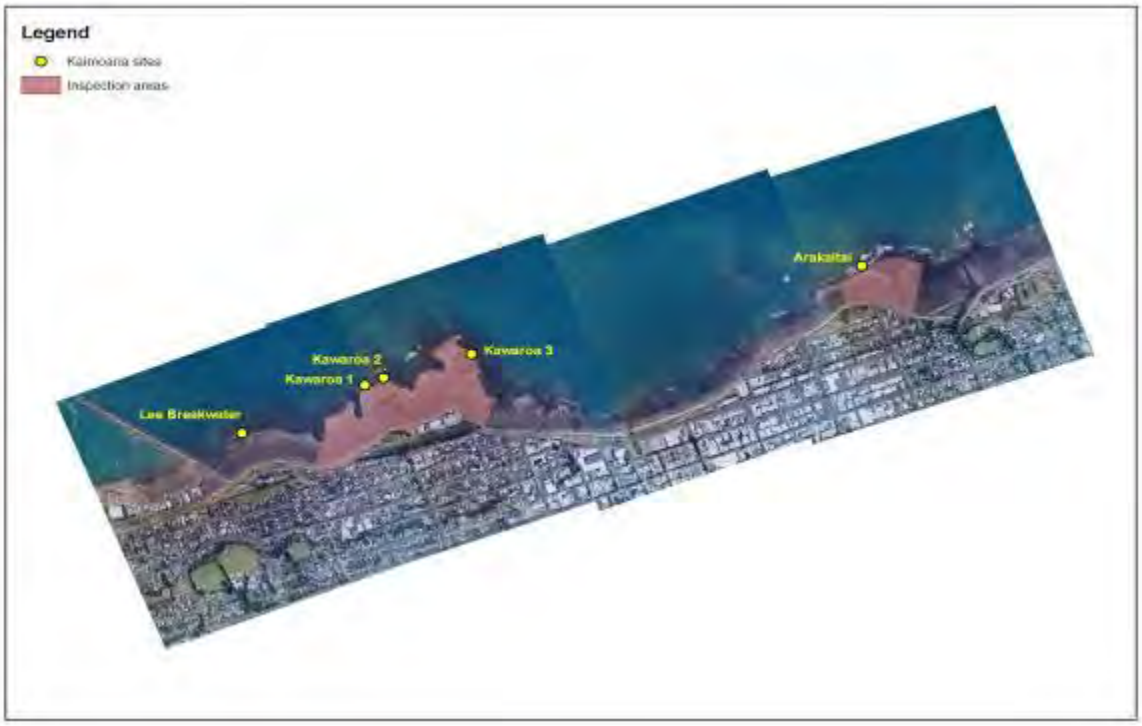


Figure 1 Intertidal kaimoana survey sites on Kawaroa and Arakaitai Reefs

Photograph 1 Black-foot paua, *Haliotis iris*, Kaweroa Reef (March 2014)

Photograph 2 Virgin paua, *Haliotis virginea*, Kaweroa Reef (March 2014)

Photograph 3 Council staff undertaking a kaimoana survey with an iwi representative (2005)

3. Results

3.1 Paua

Summary statistics for the paua counted during the March/April 2014 survey are presented in Table 2.

Table 2 Number of paua counted from five sites located on locally important kaimoana reefs

	Arakaitai	Lee Breakwater	Kawaroa 1	Kawaroa 2	Kawaroa 3
Time (min)	60	60	60	60	60
Actual count	275	61	74	171	217
Min (mm)	20	10	10	10	25
Max (mm)	70	100	90	80	75
Mean (mm)	48	47	52	52	47
Count (paua/minute)	4.6	1.0	1.2	2.9	3.6

For the 2014 survey the highest numbers of paua were found at Arakaitai Reef, followed by Kawaroa 3, Kawaroa 2, Kawaroa 1 and the Lee Breakwater respectively (Table 2, Figure 2). Both the smallest and largest paua were found at the Lee Breakwater site, measuring 10 mm and 100 mm respectively (Table 2). Paua mean length ranged from 47 mm (Lee Breakwater and Kawaroa 3) to 52 mm (Kawaroa 1 and 2) (Figure 3).

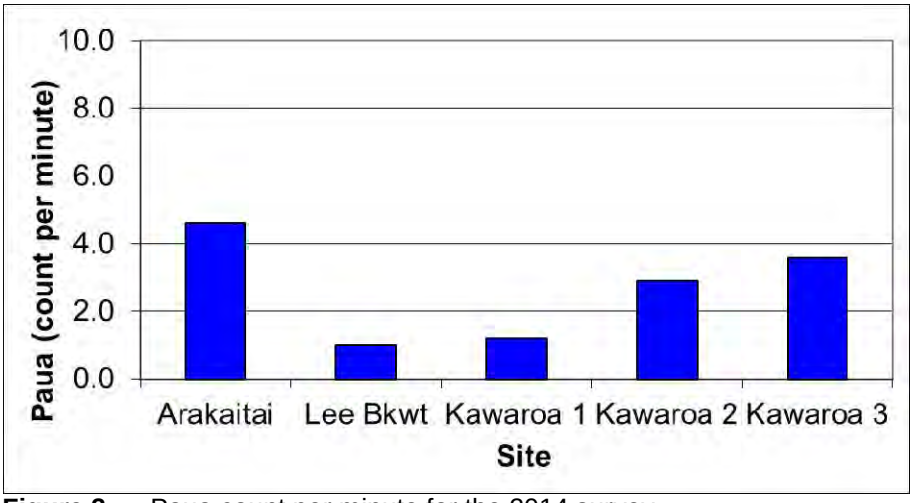


Figure 2 Paua count per minute for the 2014 survey

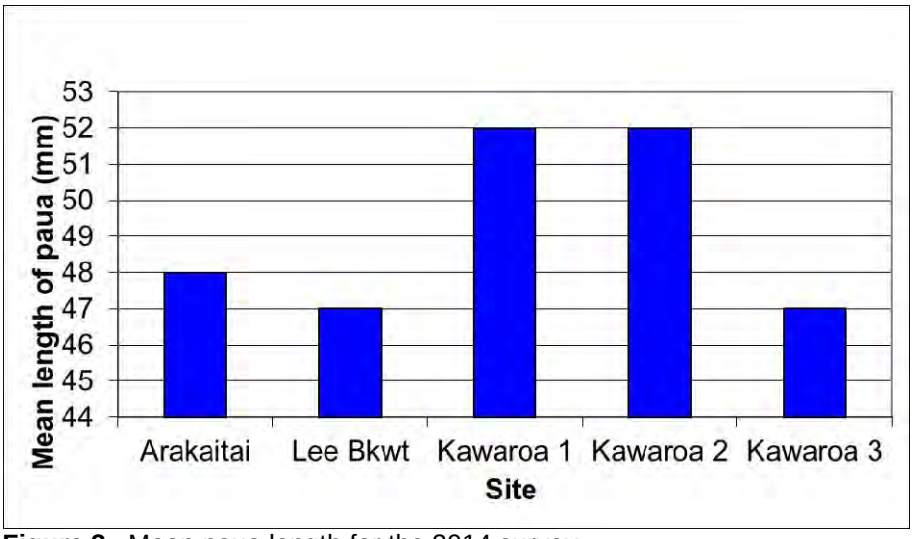
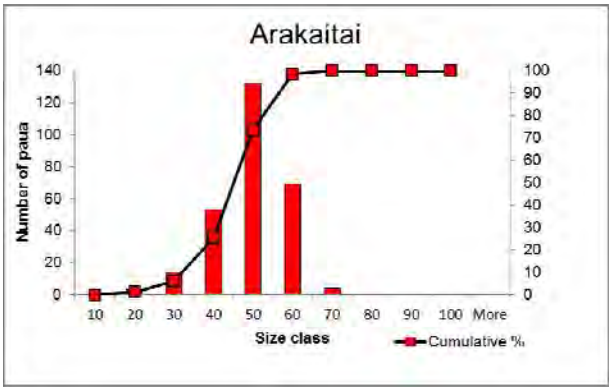
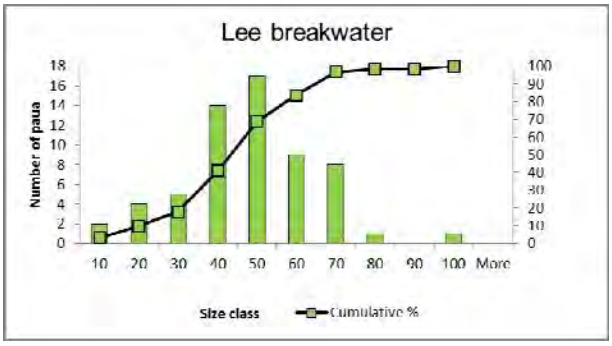


Figure 3 Mean paua length for the 2014 survey



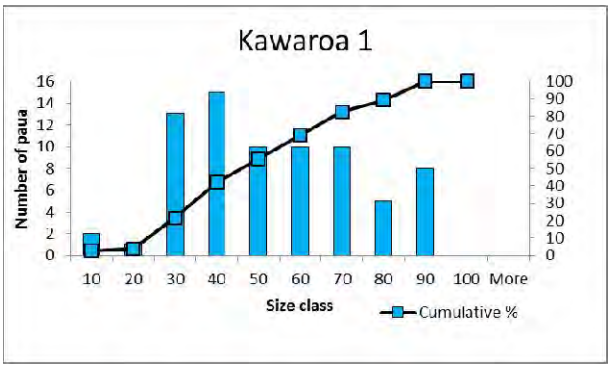
At Arakaitai Reef, the majority of paua (92%) were between the narrow size range of 31-60 mm, with very few large paua found.

Figure 4 Size class of paua at Arakaitai Reef



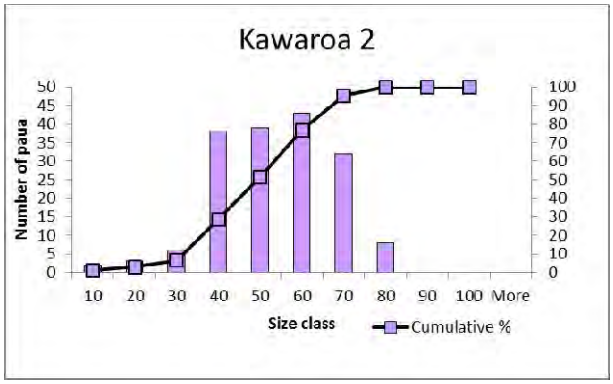
At the Lee Breakwater paua size was more evenly distributed that at Arakaitai. The most common size class was 41-50 mm which included 28% of the paua measured.

Figure 5 Size class of paua at Lee Breakwater



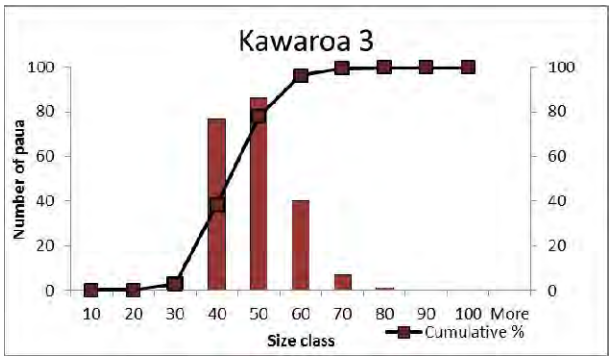
Paua at the Kawaroa 1 site showed a relatively even size distribution .

Figure 6 Size class of paua at Kawaroa 1



The most abundant size class of paua at Kaweroa 2 was 51-60 mm. Although size distribution at Kaweroa 2 was more skewed towards the larger size classes relative to the other sites, no legal sized paua (≥85 mm) were encountered.

Figure 7 Size class of paua at Kawaroa 2



In common with Arakaitai Reef, the majority of paua at Kawaroa 3 (94%) were between the narrow size range of 31-60 mm, with very few large paua found.

Figure 8 Size class of paua at Kawaroa 3

3.2 Other kaimoana species

Kina and cooks turban shells present on the five reef sites were only counted and not measured. Pupu (cats eyes) were not counted, given these are very common on the reefs around Taranaki and are better quantified using alternative methods. Table 3 presents the results of the other kaimoana species found.

Table 3 Numbers of other kaimoana species found on the five kaimoana reef sites

	Arakaitai	Lee Breakwater	Kawaroa 1	Kawaroa 2	Kawaroa 3
Count duration (min)	60	60	60	60	60
Kina	47	3	30	34	237
Kina count per minute	0.8	0.1	0.5	0.6	4.0
Cooks Turban	0	0	0	4	3

The site at Kawaroa 3 had the most kina, followed by Arakaitai, Kawaroa 2 and Kawaroa 1. Fewer kina were present at the Lee Breakwater. Cooks turbans were fairly rare at all sites, while Cat's eyes were plentiful on both reefs (either common or abundant at all sites).

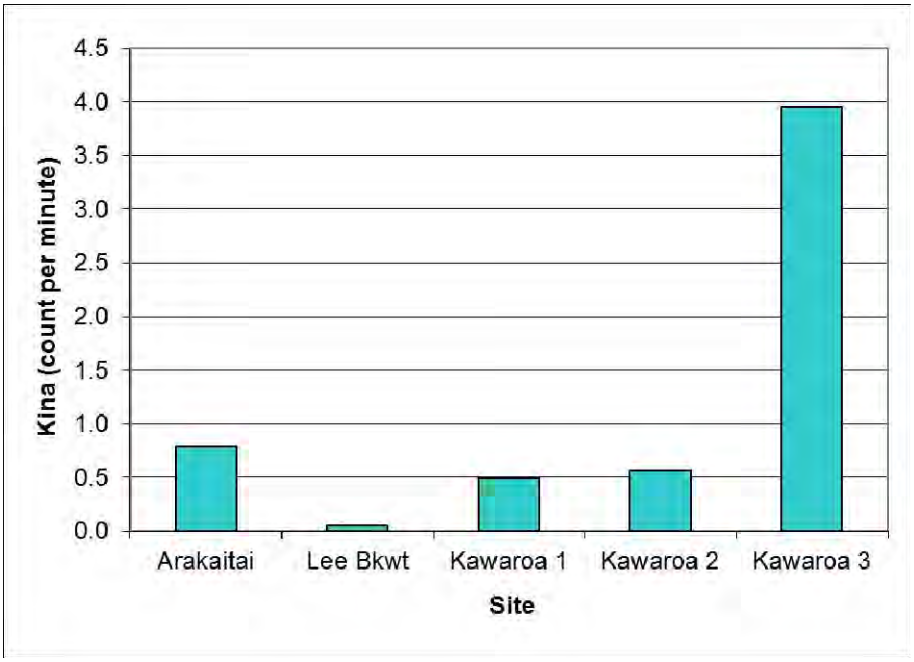


Figure 9 Number of kina counted (per minute searched) during the summer 2014 survey

3.3 Trends over time

3.3.1 Paua

A summary of paua count and length data collected over all surveys to date are presented in Table 4.

Table 4 Summary paua count data for all surveys (post- and pre-dredging)

	Arakaitai	Lee Breakwater	Kawaroa 1	Kawaroa 2	Kawaroa 3
Mean count per minute (all surveys)	5.5	4.1	3.3	3.2	5.8
Pre-dredge (3 surveys)	2.6	4.0	2.2	2.6	5.1
Post-dredge (12 surveys*)	6.2	4.1	3.6	3.3	6.0
Min (mm)	5	7	10	4	10
Max (mm)	95	100	100	105	100
Mean	45.7	42.5	44.0	52.5	49.2

* There have been ten post-dredge surveys at Lee Breakwater and eleven at Kawaroa 1 and Arakaitai.

Since the kaimoana surveys began in 2003, Kawaroa 3 has had the highest average count of paua per minute, followed by Arakaitai, Lee Breakwater, Kawaroa 1 and Kawaroa 2. All sites have shown a higher mean count per minute in post-dredge surveys when compared with pre-dredge surveys. The smallest paua to date was found at Kawaroa 2 and was 4 mm in length. The largest paua found was 105 mm at Kawaroa 2. Mean length of paua was also greatest at Kaweroa 2 (52.5 mm), while the Lee Breakwater site had the lowest mean length (42.5 mm).

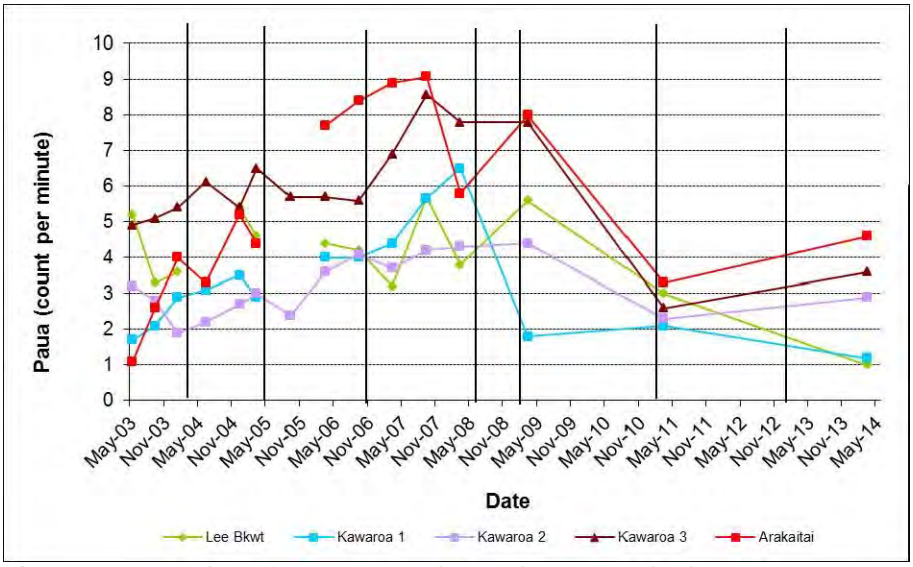


Figure 10 Number of paua counted per minute searched

In general, the number of paua per minute showed a general increased at all sites from 2003 to 2007 (Figure 10). Lower numbers of paua per minute were recorded during the 2011 and 2014 surveys. The possible reasons for this decrease in paua counts are discussed further in Section 4.

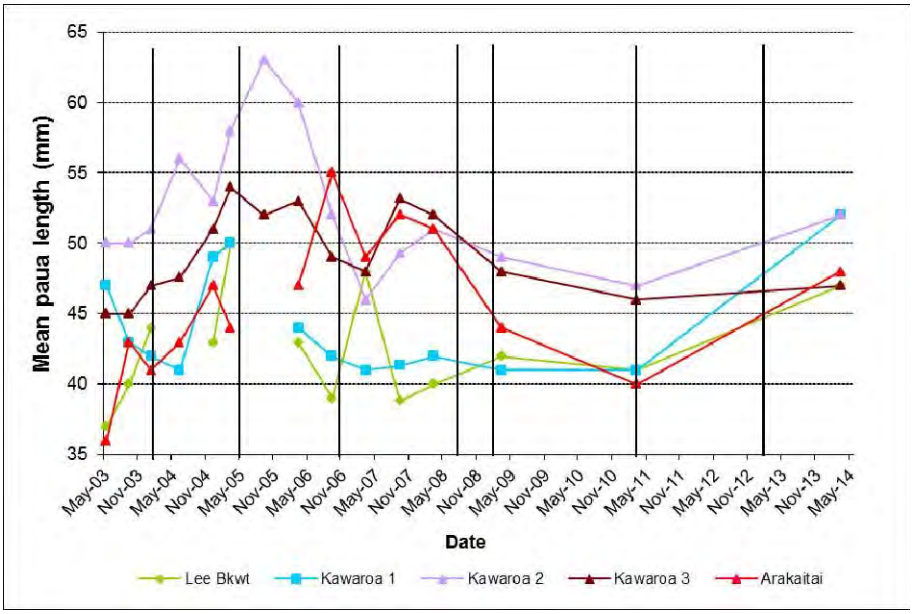


Figure 11 Mean length of paua at the five reef sites

No obvious trends in paua length are evident in conjunction with dredging activities (Figure 11). In general, paua mean length has remained between 40 mm to 55 mm at the majority of sites with the exception of a peaks (>55 mm) recorded at Kaweroa 2 between 2004 and 2006.

3.3.2 Kina

Figure 13 shows the number of kina (count per minute) for all surveys to date. The Arakaitai Reef and Lee Breakwater sites have shown the least amount of variation since

monitoring began, largely due to fewer kina being observed during the surveys. Counts at the three Kawaroa reef sites have been highly variable since the surveys began (Figure 13).

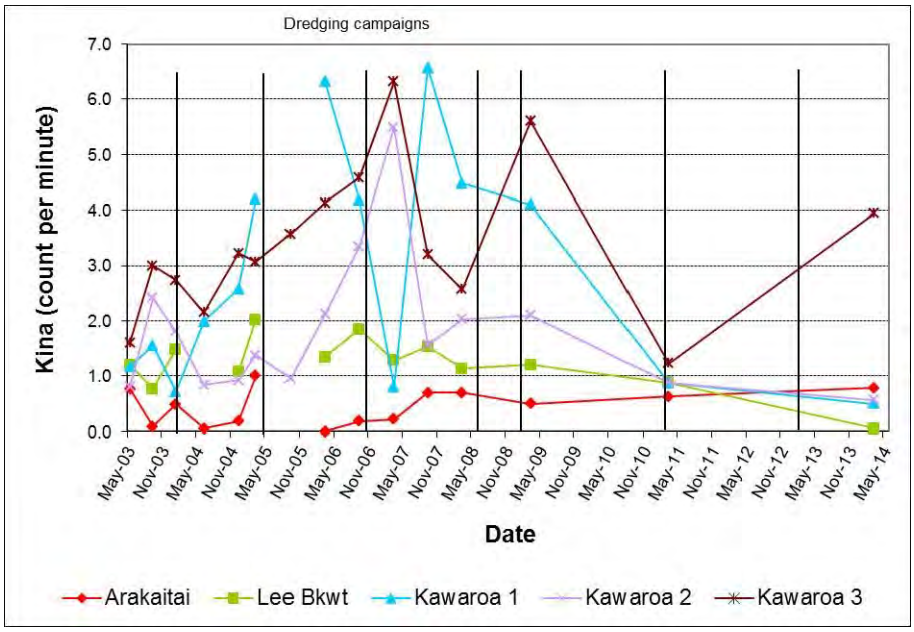


Figure 12 Kina count per minute since the surveys began

4. Discussion

This is the fifteenth survey for the kaimoana monitoring programme for Port Taranaki, and the twelfth post dredging survey after clean sand was initially dispersed within the inshore disposal area on the western flank of Kawaroa Reef. The initial dispersal took place after the completion of all the kaimoana, subtidal and intertidal sampling in January 2004 (January 2004 -March 2004). There was concern by the general public and local Iwi that kaimoana gathering from the local reefs would be affected by sand inundation. There is now a large set of data available for both pre-dredging and post-dredging. Gathering this information on the locally important kaimoana species will help determine whether or not the dispersal of sand on the inshore site is having an effect on the reef.

In the initial pilot study undertaken by Russell Cole on kaimoana, he recommended that instead of using random quadrats, a time count method would be more beneficial. This is due to the distribution of paua being cryptic in habit, clumped together, present in low mean densities and in wave-swept environments. In the initial survey each kaimoana bed that was identified was searched for 30 minutes with the number and size of paua recorded. This resulted in a number of paua likely to be found per minute of searching, which can be compared between sites and over time. Given the natural variability and harvesting pressure upon paua it would be difficult to quantify any impact solely due to sand inundation. This is why the monitoring of kaimoana prior to the first dredging campaign (January 2004) was scheduled, to attempt to provide a measure (albeit somewhat limited) of the natural variability that can occur within populations.

The kaimoana surveys were altered after the initial survey, with time spent counting kaimoana increased from 30 minutes to 60 minutes. The aim was to count a higher number of paua, which would then result in an increase in the size frequency data set. There was

no difference between the 30 or 60 minute counts in terms of the number counted per minute within the first survey (as compared with the second survey), which indicates that the first data set is still comparable.

During the 2014 survey, the most paua (as count per minute) were found at Arakaitai Reef, followed by Kawaroa 3, Kawaroa 2, Kawaroa 1 and the Lee Breakwater. Habitat is very important to the distribution of paua and kina, with both species having a higher frequency when suitable habitat is present. Higher counts were observed when there was a greater under boulder habitat available, and the macroalgal species *Carpophyllum* was present. When large boulders, breccia terraces, cemented boulders or sand are present, or in areas where mcroalgae is reduced, the number of paua and kina counted was lower.

At the Kawaroa 1 site in the shallow subtidal zone, the substrate mainly consists of large boulders with some smaller rocks. On the southern side of the rocky outcrop there is a bay containing an abundance of *Carpophyllum*.

The Kawaroa 2 site has dense populations of *Carpophyllum* in the bays on either side of the outcrop, which resulted in noticeably larger paua being found on average. The rocks and boulders at this site are in general large, with many cemented into the reef. This results in more effort required by the searcher to find suitable rocks to turn, and may be a reason why typically less paua are found at this site.

The Kawaroa 3 site has suitable habitat for paua, with smaller rocks 500-600 mm long providing more under boulder habitat, and abundant *Carpophyllum.* The smaller rocks also make searching for paua quicker and easier. This site is on the north-eastern side of the main Kawaroa reef, which may be less exposed to the prevailing winds and sea, providing a more sheltered habitat.

The Lee Breakwater site has a mix of small rocks and large boulders and is also sheltered from the prevailing wind and sea conditions.

As with Kawaroa 3, the survey site at Arakaitai Reef is on the north-eastern side of the reef, which may provide some measure of shelter for the intertidal species. The large number of loose small rocks appears to provide excellent habitat for paua around the 40-60 mm size, with large numbers often found underneath a single rock. The ease of turning these small rocks with the high concentrations of paua under just one rock makes counting paua at this site quick and easy, which in part accounts for the high numbers found here. From observations made during surveys, there also appears to be less kaimoana collection on this reef.

The highest numbers of kina were found at Kawaroa 3. There were fewer kina found at the Arakaitai site. This result is consistent with Howse *et al.* (2000) who found that kina were less abundant in areas with both high wave exposure and high-suspended sediment concentrations.

In general, both paua and kina counts over the last two surveys (2011 and 2014) were lower than surveys undertaken between 2004 and 2009, being more comparable to pre-dredge counts. There are a number of potential factors that could have influenced the drop in counts observed, including:

- Natural variation in environmental conditions (increased sand deposition and wave exposure);

- Human impact from increased harvesting of kaimoana species on the reefs;
- Sand smothering from dredging activities by Port Taranaki Limited; and/or
- A change of personnel undertaking the survey (NB the 'rapid visual technique' used is only semi-quantitative, potentially subject to user variability/bias).

Determining how the above factors have influenced paua and kina counts is not straightforward, however, no major build up of sand on the reefs has been noted in association with dredging activities. During all the surveys, large numbers of people gathering kaimoana have been observed over the entire Kawaroa Reef during the low spring tides. The numbers gathering seafood are not recorded, but it is occasionally noted that undersize paua (<85 mm) are being taken from the reef and in excess of the Ministry for Primary Industries daily limit of 10 per person.

4.1 Conclusion

Both paua and kina counts over the last two surveys (2011 and 2014) were lower than surveys undertaken between 2004 and 2009, being more comparable to pre-dredge counts. There are a number of factors which could potentially influence paua and kina counts on the reefs including natural variation in environmental conditions, increased kaimoana harvesting, dredging activities and a change in personnel undertaking the kaimoana surveys. Determining how these factors have influenced paua and kina counts is not straight forward, however, no major build up of sand on the reefs has been noted in association with the dredging activities by Port Taranaki Limited.

Emily Roberts
Scientific Officer