Port Taranaki Ltd
Maintenance Dredging
Monitoring Programme
Biennial Report
2016-2018

Technical Report 2018-65

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Executive summary

Port Taranaki Ltd (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.

This report for the period July 2016 to June 2018 describes the monitoring programme implemented by the Taranaki Regional Council (the Council) to assess the Company's environmental and consent compliance performance relating to the dredge campaign during the period under review and the results and environmental effects of the campaign.

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 Ltd demonstrated an overall good level of environmental performance.

The Council's monitoring programme for the 2016-2018 period included reviewing the dredge campaign information, four intertidal sand inspections along the New Plymouth foreshore, one intertidal survey at four sites and one kaimoana survey at five sites.

Following a review of the data from the 2017 dredge campaign, the Company were found to have exceeded the maximum allowable final volume for the inshore dump ground. At the time of report writing, the Company have been sent a 14 day letter requesting a formal explanation for this non-compliance. A decision will be made regarding further enforcement action following the Company's response.

The results of intertidal surveys, kaimoana survey and sand inspections did not indicate that the disposal of dredged material was having a significant impact on the abundance or diversity of intertidal species, including key kaimoana species. However, there has been an apparent decrease in the abundance of paua and kina on these reefs in recent years, as well as a uniform decrease in average paua length across all sites since 2016. There are a number of factors that could have potentially influenced these results, including natural variation in environmental conditions, increased (and illegal) kaimoana harvesting, dredging activities and changes in personnel undertaking the surveys. Accordingly, it is recommended that the kaimoana survey method and analytical process is refined prior the next round of monitoring, in order to better differentiate the factors potentially influencing the kaimoana communities at Kawaroa and Arakaitai Reefs.

During the period, the Company demonstrated a good level of environmental performance and compliance and a high level of administrative performance and compliance with the resource consents. One non-compliance was recorded in relation to the 2017 dredging campaign as noted above.

For reference, in the 2017-2018 year, consent holders were found to achieve a high level of environmental performance and compliance for 76% of the consents monitored through the Taranaki tailored monitoring programmes, while for another 20% of the consents, a good level of environmental performance and compliance was achieved.

In terms of overall environmental and compliance performance by the consent holder over the last several years, this report shows that the consent holder's performance was slightly lower in the period under review than in previous years.

This report includes recommendations for the 2018-2020 period.

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1 Introduction

1.1 Compliance monitoring programme reports and the Resource Management Act 1991

1.1.1 Introduction

This report is for the period July 2016 to June 2018 by the Council describing the monitoring programme associated with resource consents held by Port Taranaki Ltd (the Company).

This report covers the results and findings of the monitoring programme implemented by the Council in respect of the consents held by the Company that relate to the dredging of sediments within Port Taranaki and the discharge of these sediments to the Tasman Sea. This is the fourth report to be prepared by the Council to cover the Company's dredging activities and their effects.

1.1.2 Structure of this report

Section 1 of this report is a background section. It sets out general information about:

- consent compliance monitoring under the RMA and the Council's obligations;
- the Council's approach to monitoring sites though annual programmes;
- the resource consents held by the Company;
- the nature of the monitoring programme in place for the period under review; and
- a description of the activities and operations conducted by the Company.

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

Section 3 discusses the results, their interpretations, and their significance for the environment.

Section 4 presents recommendations to be implemented in the 2018-2020 monitoring period.

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

1.1.3 The Resource Management Act (1991) and monitoring

The *Resource Management Act 1991* (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 an activity, and may include cultural and social-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 Company, this report also assigns them a rating for their environmental and administrative performance during the period under review.

Environmental performance is concerned with actual or likely effects on the receiving environment from the activities during the monitoring year. 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 2016-2017 year, consent holders were found to achieve a high level of environmental performance and compliance for 74% of the consents monitored through the Taranaki tailored monitoring programmes, while for another 21% of the consents, a good level of environmental performance and compliance was achieved. In the 2017-2018 year, consent holders were found to achieve a high level of environmental performance and compliance for 76% of the consents monitored through the Taranaki tailored monitoring programmes, while for another 20% of the consents, a good level of environmental performance and compliance was achieved.

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 ha 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 1,000 m due north of the tip of the main breakwater in water depths of 15 to 20 m. However, once the spoil has been deposited at these depths it is no longer available to contribute to the littoral drift east of the port.

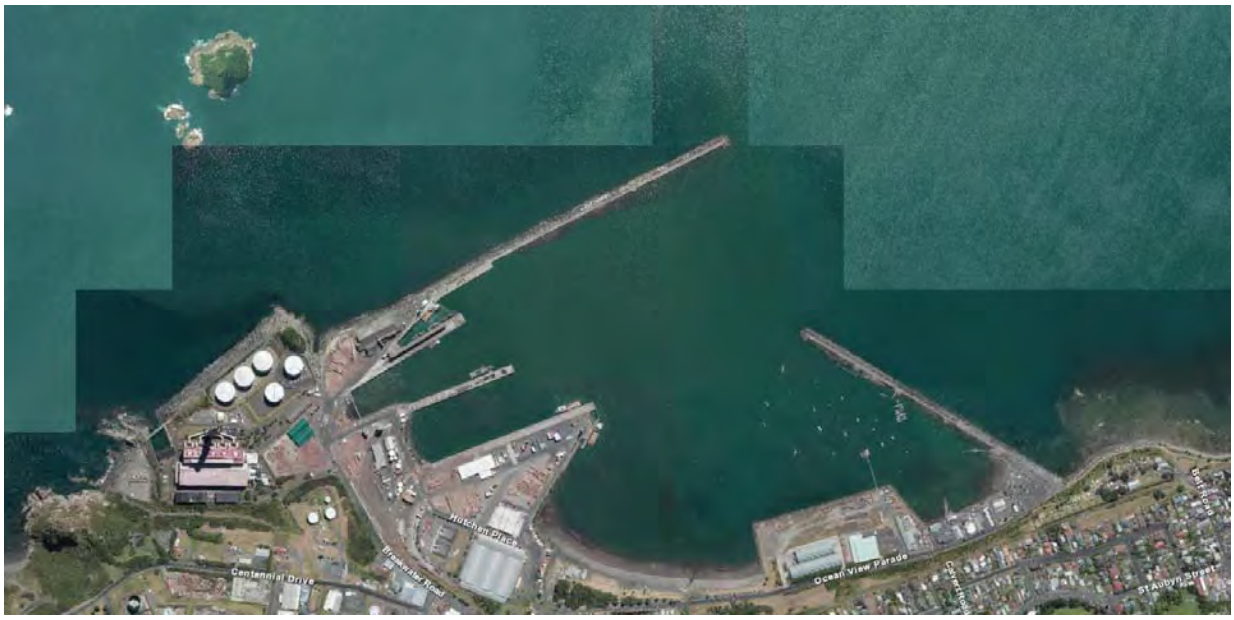

Figure 1 Port Taranaki showing the Main Breakwater on the left and the Lee Breakwater on the right

1.2.2 Port Taranaki dredging history

Port Taranaki requires regular dredging. Since 1986 approximately 180,000–210,000 m^3 of sediment has been removed during each dredging campaign. It has been shown that accretion occurs along a bank on the inside of the breakwater. This creates the breakwater bank and it is this feature that gives rise to the majority of the dredging volume.

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.

Previously, the sediments were deposited offshore approximately 1,000 m due north of the port. In 1998 a trial inshore site was used following research by the University of Waikato (Black & McComb, 2000), where 47,000 m^3 of sediment was placed and monitored to investigate the dispersion patterns of sediment within this inshore site. The trial found that placed sediments dispersed in suspension rather than in bedload and that 12 months after the trial 40% of the deposited sand had moved from the deposition area, with some sand moving back towards the port entrance.

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, ranging 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 ha. Initially the site was rectangular in shape, but following further investigation it was adjusted 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.

The trailer suction dredge, the *Pelican* (Photo 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.

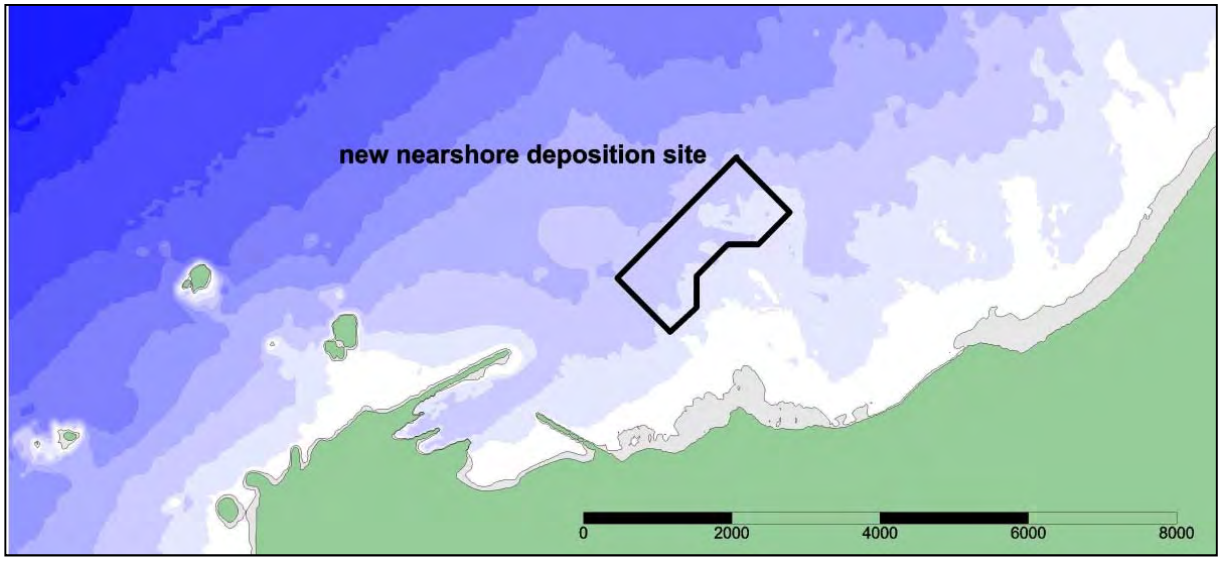

Figure 2 The inshore deposition site for clean sand dredged from Port Taranaki

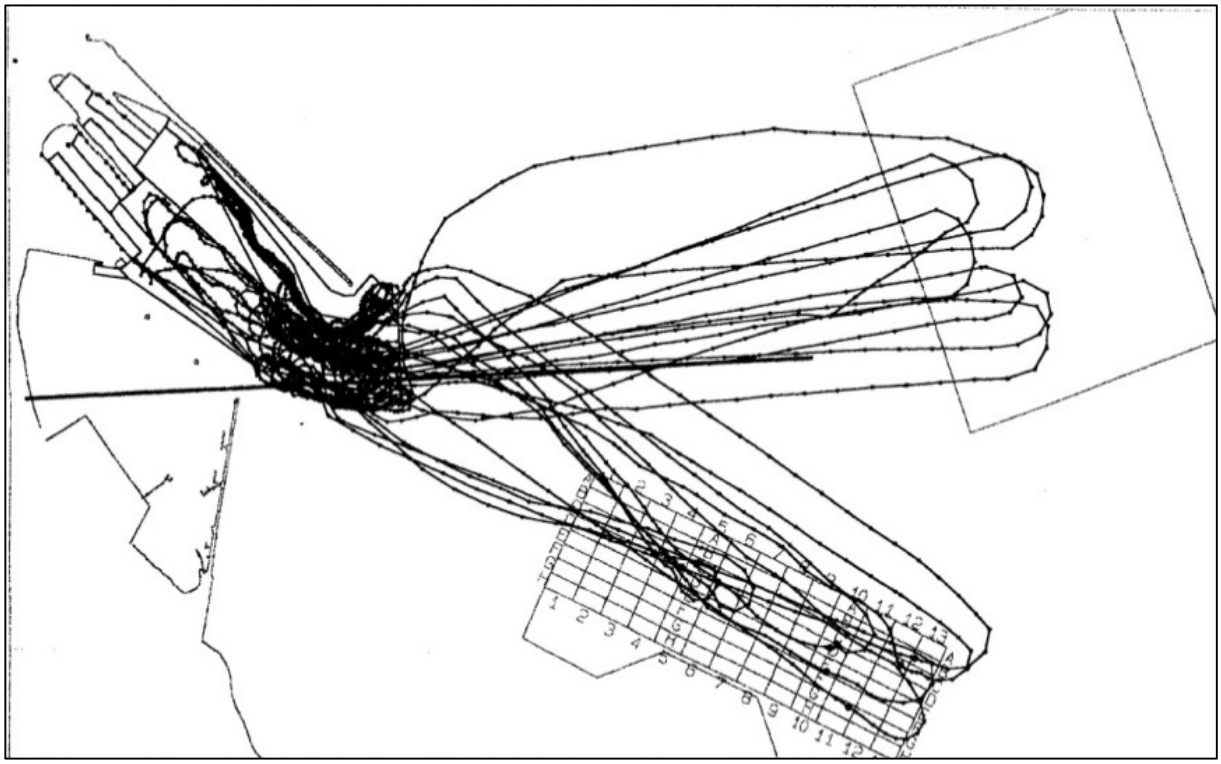

Figure 3 Dredging track of the *Pelican* to both the inshore (gridded box) and offshore (empty box) disposal sites.

Photo 1 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.

The Company holds three resource consents in relation to the maintenance dredging operation; the details of which are summarised in the table below and outlined in sections 1.3.1 to 1.3.3.

Table 1 Summary of Port Taranaki's resource consents in relation to the maintenance dredging operation

Consent number	Purpose	Granted	Review	Expires
3982-2.1	To remove up to 570,000 m^3 in any one dredging campaign, and up to 1,045,000 m^3 in any three successive dredging campaigns (or any seven-year period, whatever comes first), of accumulated sediments from the bed of the coastal marine area of the area commonly known as Port Taranaki	18 Mar 2015	Jun 2021	1 Jun 2029
3374-2	To deposit up to 570,000 m^3 in any one dredging campaign, and up to 1,045,000 m^3 in any three successive dredging campaigns (or any seven-year period, whatever 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	28 Jan 2002	Jun 2021	1 Jun 2029

Consent number	Purpose	Granted	Review	Expires
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 (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	9 Apr 2002	Jun 2021	1 Jun 2029

1.3.1 Coastal permit 3982-2

Port Taranaki Ltd holds coastal permit **3982-2.1** 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.

On 18 March 2015, the consent was changed in order to increase the extent of the seabed which could be dredged during maintenance campaigns.

1.3.2 Coastal permit 3374-2

Port Taranaki Ltd 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 Ltd 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.

This summary of consent conditions may not reflect the full requirements of each condition. The consent conditions in full can be found in the resource consents which are appended to this report.

1.4 Monitoring programme

1.4.1 Introduction

Section 35 of the RMA sets obligations upon the Council to gather information, monitor and conduct research on the exercise of resource consents within the Taranaki region. The Council is also required to assess the effects arising from the exercising of these consents and report upon them.

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 Port Taranaki's January 2017 dredging campaign consisted of five primary components.

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 consent reviews, renewals or new consent applications;
- 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 campaign, 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 Reef inspections

Intertidal reef inspections were carried out before (6 January 2017), during (17 February 2017) and after (10 April 2017) the dredge campaign as well as one the following year when no dredging had occurred (28 March 2018), to assess intertidal sand accretion on Kawaroa and Arakaitai Reefs. The aim of inspecting the reefs on these dates was to identify potential effects of the campaign and to differentiate from those of natural processes.

1.4.5 Intertidal 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 2017 (September-October) to determine whether the disposal of sand had adversely affected the intertidal communities.

1.4.6 Kaimoana

Surveys were undertaken at three sites on Kawaroa Reef, one site on Arakaitai Reef and one site off the Lee Breakwater between summer and autumn in 2018 (January-April) to estimate the relative abundance of particular kaimoana species (Photo 2). The surveys were conducted to determine whether the disposal of sand had adversely affected low shore kaimoana species.

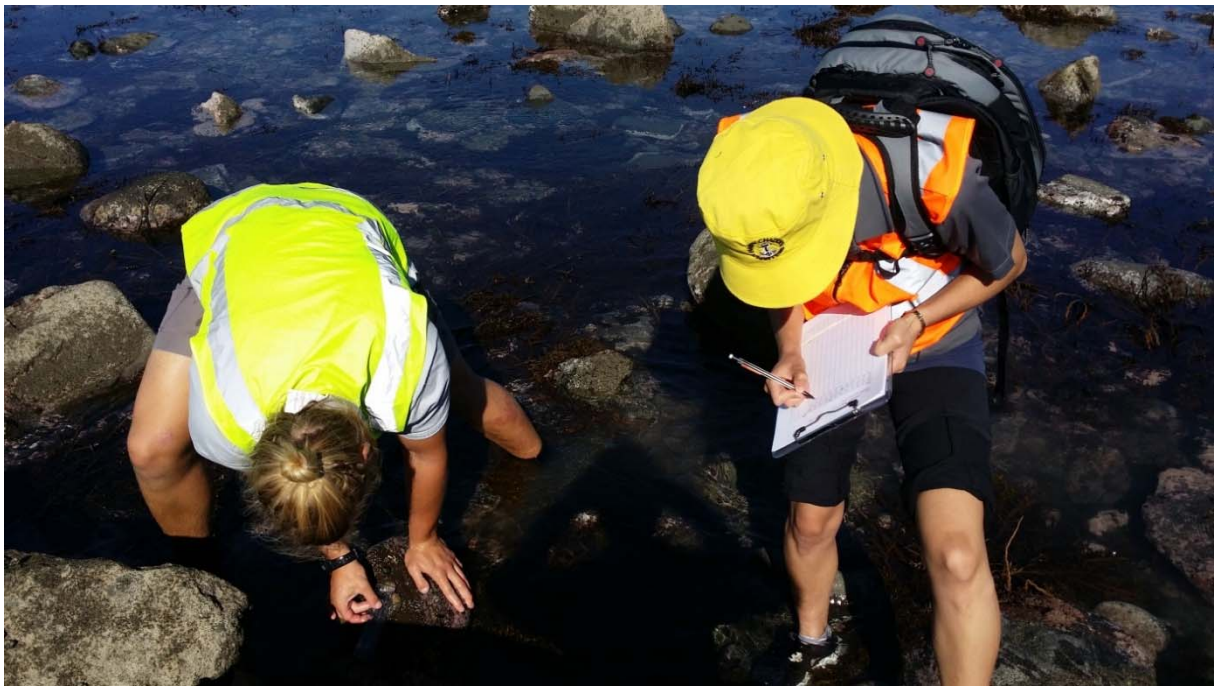

Photo 2 Council officers undertaking a kaimoana survey

2 Results

2.1 Dredge campaign

Dredging was undertaken on one occasion during the period July 2016 to June 2018. The dredging and disposal operation commenced on 8 January 2017 and finished on 12 March 2017. A total of 501 loads with a total hopper volume of 326,610 m^3 were disposed of at the inshore dump ground. This equated to an *in-situ* volume of 292,661 m^3 removed from the main breakwater sandbank (at a bulking factor of 1.116). In addition, an *in-situ* volume of 116,434 m^3 was dumped at the offshore dump ground.

Since commencement of the dumping of sand in the inshore dump ground (12 January 2004), a total of 1,459,794 m^3 *in situ* has been dumped (Table 1).

The maximum inshore deposition volume stipulated in the purpose of consent 5886-1 is conditional on the final volume of sand at the inshore dump ground being no greater than 400,000 m^3; i.e. a maximum volume of 400,000 m^3 may be deposited at the inshore dump ground provided the final volume of sand is no greater than 400,000 m^3. As such, a hydrographic survey is undertaken prior to and at the completion of each dredge campaign. Survey results have revealed that the capacity of the inshore dump ground has decreased over time, yet the deposited volumes have not been reduced accordingly (Table 2). At the completion of the 2017 dredge campaign, the sand volume at the inshore dump ground was 517,660 m^3.

Table 2 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 deposited (m^3)**	**Cumulative volume: deposited over three campaigns (m^3)**	**Final sand volume in dump ground (m^3)**	***In-situ* sand volume deposited (m^3)**	**Cumulative volume: deposited over three campaigns (m^3)**
First	12 Jan 2004 - 23 Mar 2004	253,633	253,633	-	90,239*	90,239
Second	13 May 2005 - 5 July 2005	199,101	452,734	328,493	114,094	204,333
Third	29 Nov 2006 - 19 Feb 2007	173,475	626,209	400,294	134,294*	338,627
Fourth (Emergency)	5 Aug 2008 - 18 Aug 2008	29,166	401,742	309,531	26,595*	274,983
Fifth	3 Jan 2009 - 4 April 2009	165,995	368,636	389,213	73,755*	234,644
Sixth	18 Mar 2011- 12 May 2011	156,086	351,247	361,858	129,573	229,923
Seventh	19 Jan 2013 - 13 Mar 2013	189,677	511,758	437,576	82,657	285,985
Eighth	19 Jan 2015 - 23 Mar 2015	196,277	542,040	475,245	14,007	226,237
Ninth	8 Jan 2017 - 12 Mar 2017	292,661	678,615	517,660	116,434	213,098
Consent Limit (m^3)		**400,000**	**730,000**	**400,000**	**570,000**	**1,045,000**

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

2.2 Reef inspections

Intertidal reef inspections were carried out before (6 January 2017), during (17 February 2017) and after (10 April 2017) the dredge campaign as well as one the following year when no dredging had occurred (28 March 2018), to assess intertidal sand accretion on Kawaroa and Arakaitai Reefs. The aim of inspecting the reefs on these dates was to identify potential effects of the campaign and to differentiate from those of natural processes.

The intertidal zone of Kawaroa Reef appeared largely sand free following the dredging campaign. Relatively thin and localised patches of sand were found associated with Hormosira cover at mid to low shore heights. No significant deposits of sand were observed higher up the shore. At Arakaitai Reef, significant depositions of sand were discovered high up the shore following the dredge campaign, though further evidence suggests that this was likely due to natural processes (Photo 3). The complete reef inspection report is included in Appendix II.

Overall, the 2017 dredge campaign did not appear to result in significant volumes of sand inundating either Kawaroa or Arakaitai Reefs in the period under review.

Photo 3 Sand accumulation on the high-shore at Arakaitai Reef; pre (6 Jan 2017), during (17 Feb 2017), and post (10 Apr 2017) dredging campaign and the following year (28 Mar 2018)

2.3 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 complete survey report, including statistical analysis of results and further discussion of the findings, are included in Appendix III. 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 2016-2018 monitoring period.

During the spring 2017 survey, the 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 III for details).

Figure 4 Site locations used for intertidal monitoring

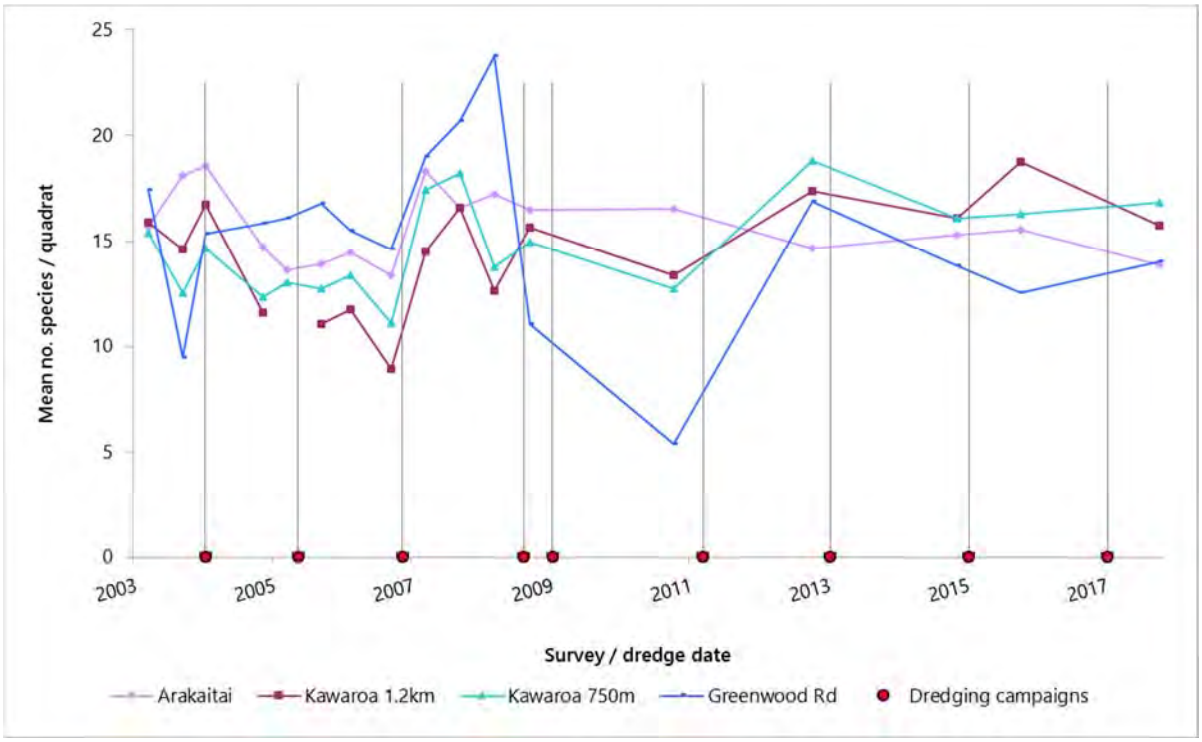

Figure 5 Summary for number of species per quadrat both pre and post dispersal

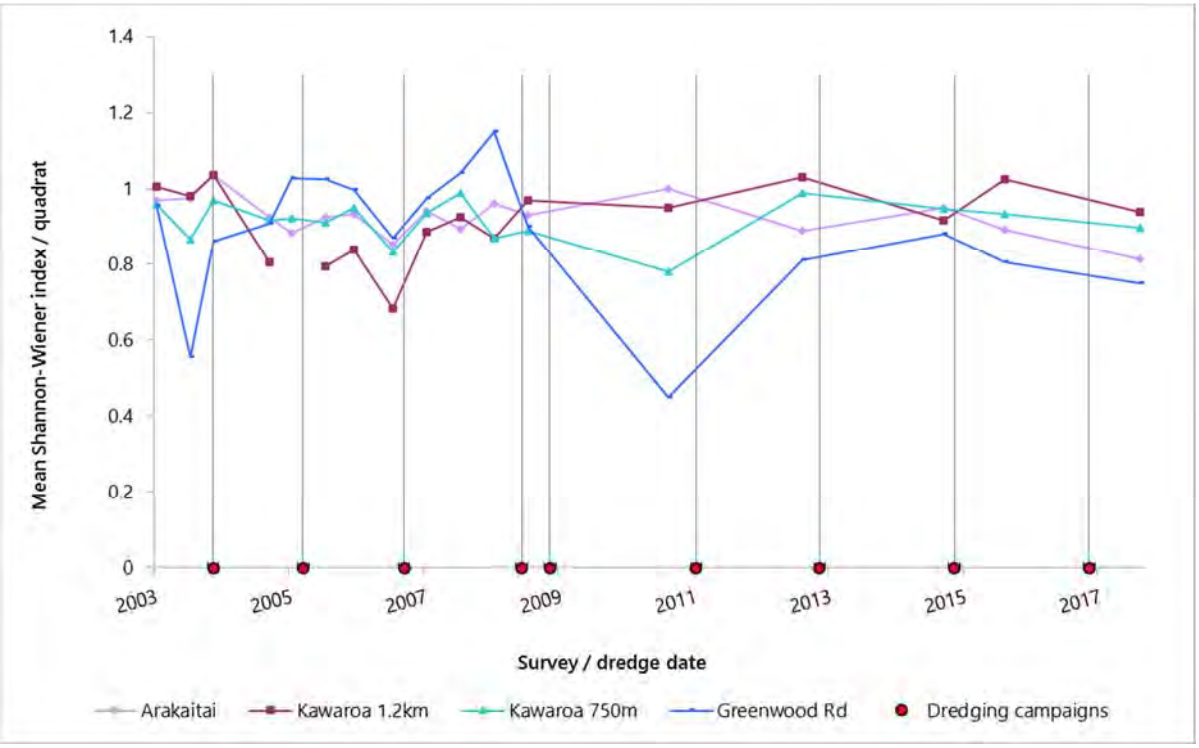

Figure 6 Shannon-Weiner diversity index per quadrat both pre and post dispersal

One of the main concerns of submitters to the inshore disposal proposal was the likelihood of 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 estimates at the three potential impact sites remained low in the spring intertidal surveys (Figure 7). Historically, sand cover at the two Kawaroa sites has been moderate on occasions, with sand often trapped in the coralline turf algae which occurs in abundance across the lahar platform that makes up the majority of these sites. 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, as discovered during the reef inspections (Section 2.2).

The control site at Greenwood Road has on occasion been susceptible to heavy sand inundation. During the 2003, 2008, 2010 and 2014 surveys, sand/silt cover at this site was 41%, 62%, 76% and 35% respectively. Sand deposition at this site is attributed to natural geological and oceanographic processes.

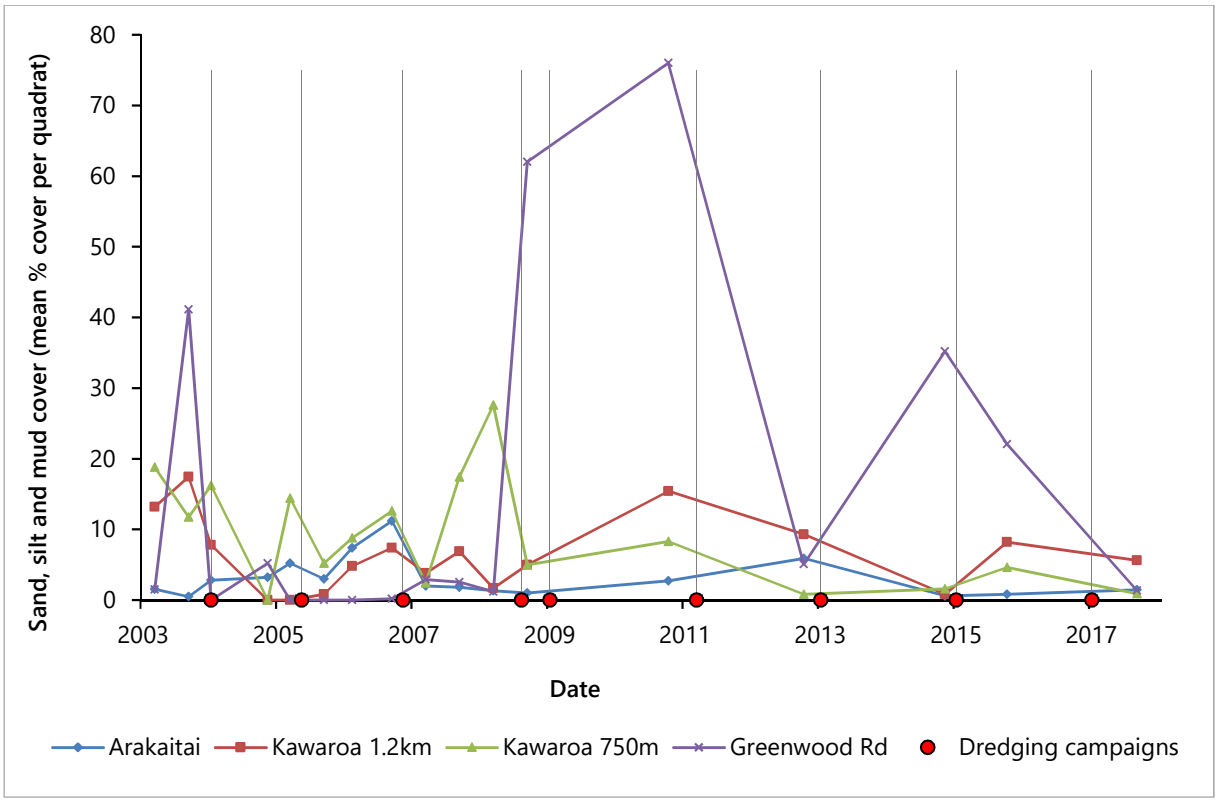

Figure 7 Mean percentage sand cover at the survey sites

2.4 Kaimoana

A kaimoana inspection was 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 survey report, including analysis of results and further discussion of the findings, is included in Appendix IV. This section summarises the main findings.

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-dredging surveys, in addition to a major build-up of sand on the reefs in association with the dredging activities.

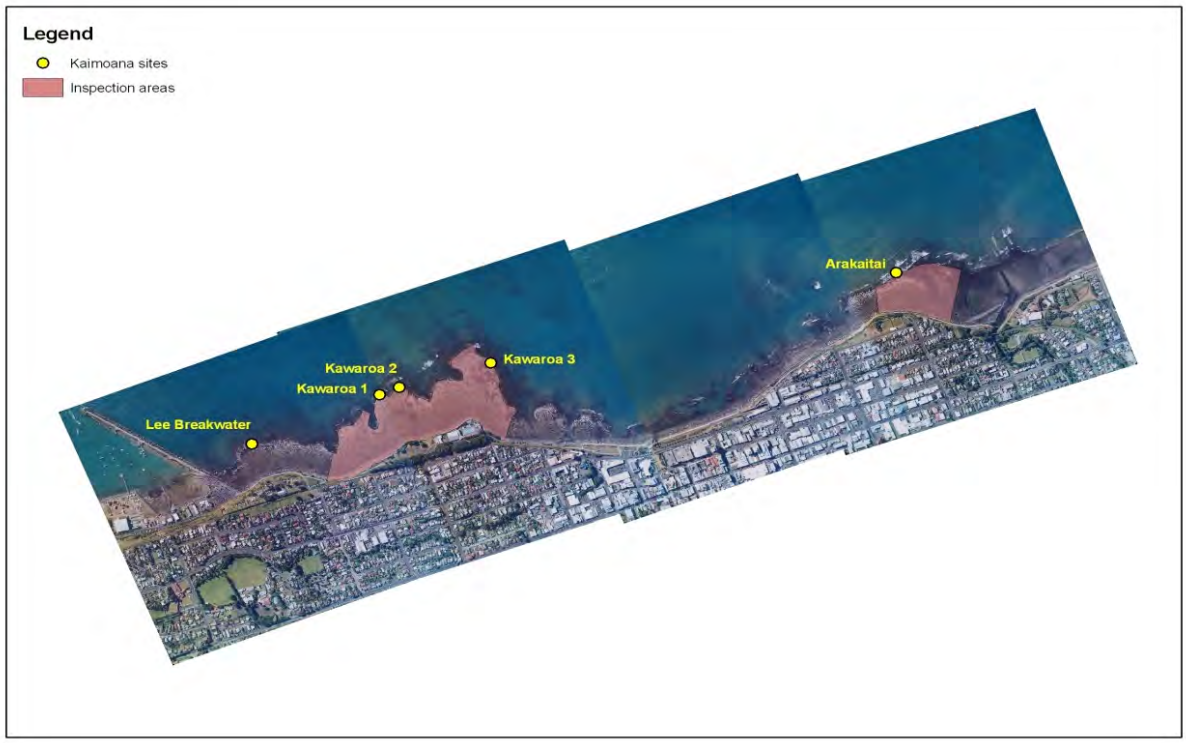

Figure 8 Kaimoana survey sites

Table 3 Summary paua count data for all surveys (post- and pre-dredging)

	Arakaitai	Lee Breakwater	Kawaroa 1	Kawaroa 2	Kawaroa 3
Mean count per minute (pre-dredge) (3 surveys)	2.57	4.03	2.23	2.63	5.13
Mean count per minute (post-dredge) (14 surveys)	5.92	3.75	3.29	2.99	5.67
Mean count per minute (all surveys)	5.29	3.81	3.10	2.92	5.57
Minimum size (mm) (all surveys)	5	5	10	4	10
Maximum size (mm) (all surveys)	95	100	110	105	100
Mean size (all surveys)	46.46	42.75	44.71	51.94	49.54

* There have been thirteen post-dredge surveys at Lee Breakwater and fourteen 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, the Lee Breakwater, Kawaroa 1 and Kawaroa 2. Most sites have shown a higher mean count per minute in post-dredge surveys when compared with pre-dredge surveys. However, there has been a 7% decrease in the mean count per minute recorded at the Lee Breakwater since dredging was introduced.

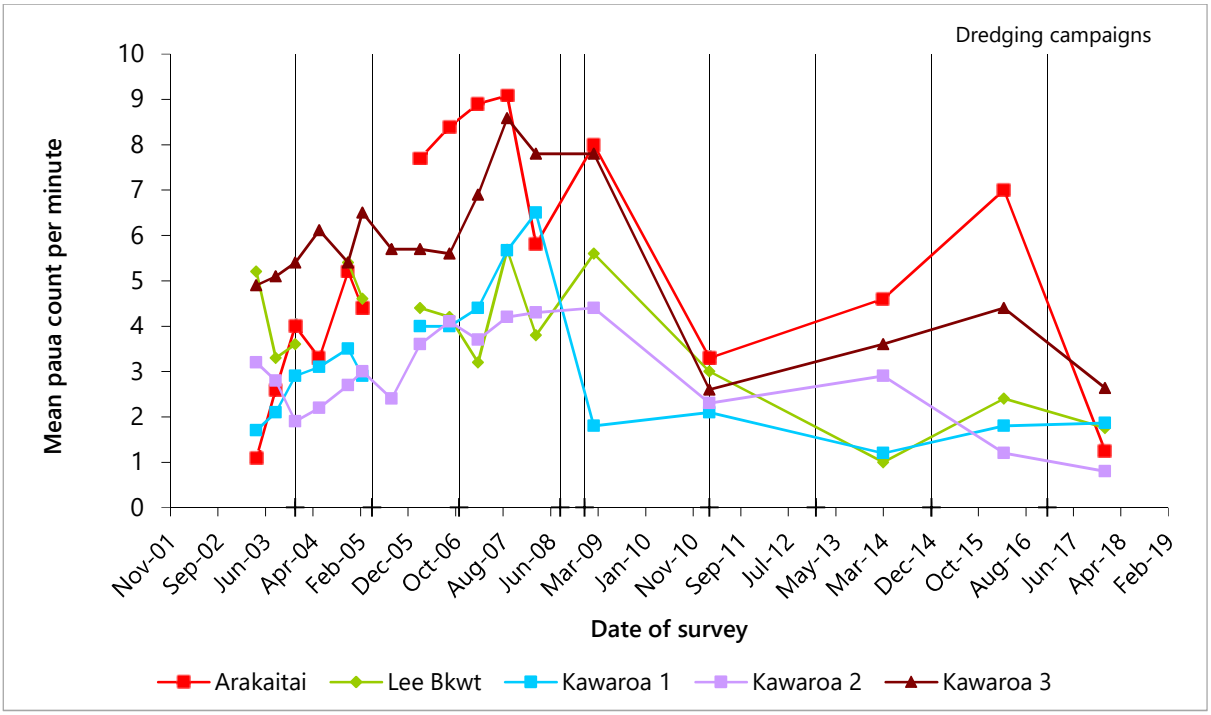

Figure 9 Number of paua found per minute searched at the five kaimoana reef sites

The number of paua per minute showed a general increase at all sites from 2003 to 2007 (Figure 7). Lower numbers of paua per minute were recorded during the 2011 and 2014 surveys, with numbers increasing again during the 2016 survey. Similar or lower counts were recorded in 2018, when compared with the previous survey. In particular, there was a considerable decrease in the number of paua counted per minute at Arakaitai. The possible reasons for these changes in paua counts are discussed further in Appendix IV and below.

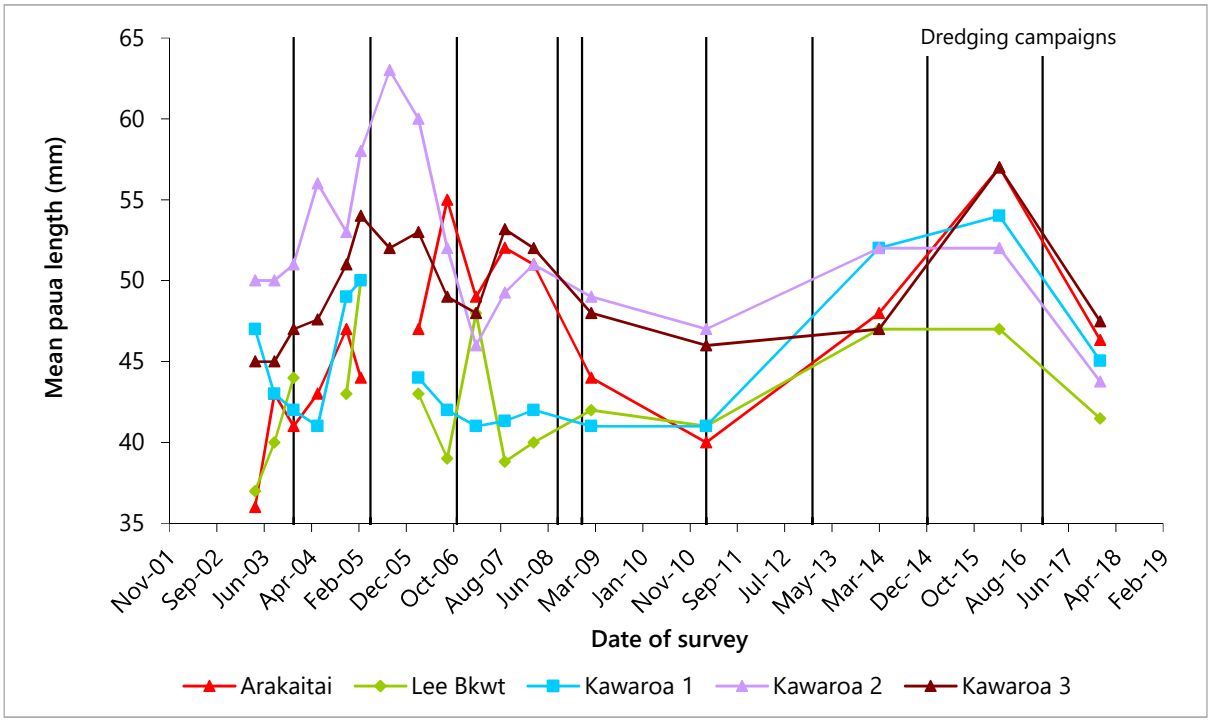

Figure 10 Mean length of paua at the five kaimoana reef sites

Mean paua length has typically remained between 40-55 mm at the majority of sites, with the exception of peaks greater than 55 mm recorded at Kawaroa 2 between 2004 and 2006, and at Kawaroa 3 and Arakaitai in 2016. There was an almost uniform decrease in mean paua length at all sites in 2018, compared with 2016.

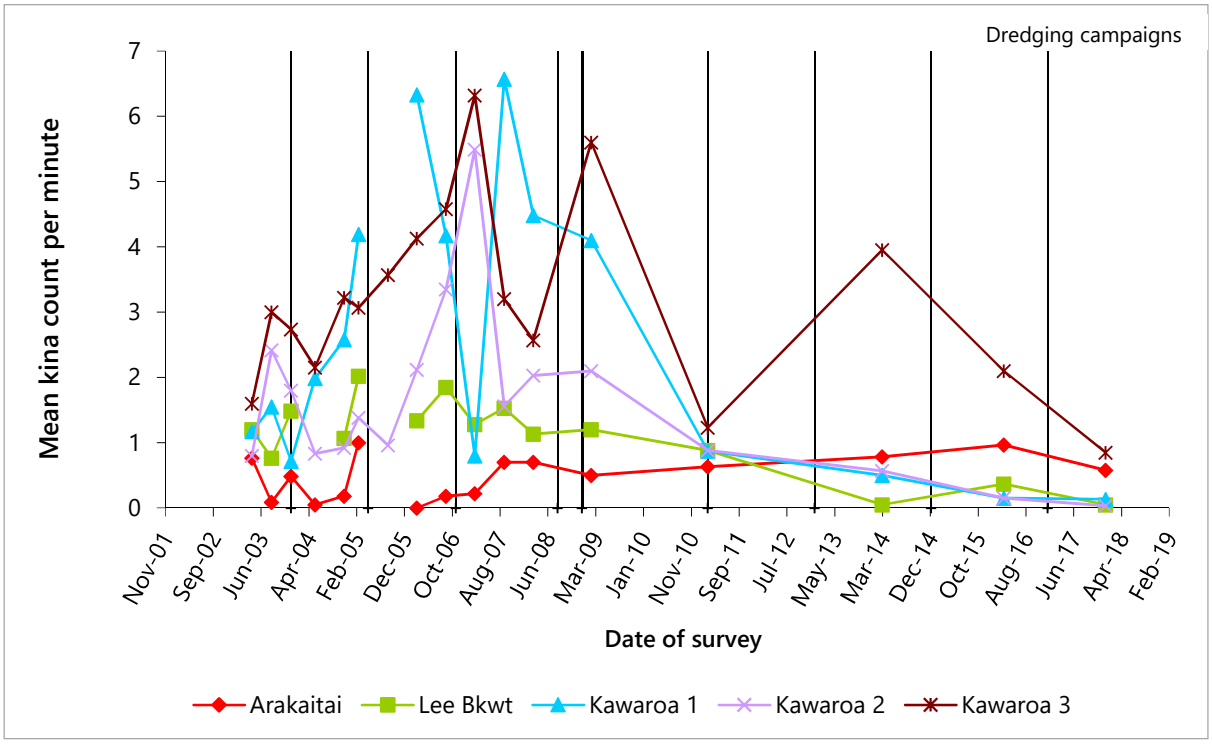

Figure 11 Number of kina found per minute searched at the five kaimoana reef sites

The Arakaitai Reef and Lee Breakwater sites have shown the least amount of variation in mean kina count per minute 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. Mean kina counts per minute have been particularly low at all five sites since 2009, with the exceptions of the higher counts recorded at Kawaroa 3 in 2014 and 2016. Although Kawaroa 3 still maintains the highest counts of the sites, kina counts have been steadily decreasing here since 2014.

There has been an apparent decrease in the abundance of paua and kina on these reefs in recent years, as well as a uniform decrease in average paua length across all sites since 2016. There are a number of factors that could have potentially influenced these results, including natural variation in environmental conditions, increased (and illegal) kaimoana harvesting, dredging activities and changes in personnel undertaking the surveys. Determining how these factors have influenced paua and kina counts and sizes is not straightforward; however, there was no major build-up of sand on the reefs noted in association with the 2017 dredge campaign. Therefore, there is no causal evidence to indicate that the inshore dredge disposal was a significant factor behind the changes observed in kaimoana communities.

The results of this survey highlight the importance of using complimentary survey techniques (i.e. sand inspections, intertidal surveys and kaimoana surveys) to monitor potential effects from activities such as dredge disposal. It is recommended that the kaimoana survey method and analytical process is refined for the next round of monitoring, in order to better differentiate the factors potentially influencing the kaimoana communities at Kawaroa and Arakaitai Reefs. Such refinements could include:

- Visual estimates of shallow subtidal sand cover during the kaimoana survey to detect subtle changes in habitat availability and further contextualize survey results; and

- Long term comparisons of the size distribution data to identify peaks and troughs in recruitment which may be useful for interpreting changes in paua abundance and average size over time.

2.5 Investigations, interventions, and incidents

The monitoring programme for the year 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).

In the 2016-2018 period, the Council was required to record an incident, in association with one of the Company's resource consents.

Review of data supplied by the Company found that condition four, of resource consent 5886-1, had been breached during the 2017 dredge campaign. In summary, the final volume of sand at the dump ground is to be no greater than 400,000 m^3, however, the volume at the end of the 2017 campaign was 517,660 m^3.

This non-compliance was initially discussed in a meeting with the Company, with regards to the upcoming 2019 dredge campaign to ensure this exceedance was not repeated. A 14 day letter has also been issued to the Company seeking a formal explanation of the non-compliance. The need for further enforcement action will be assessed based on the Company's response.

3 Discussion

3.1 Discussion of dredge campaign

Dredging was undertaken on one occasion during the period July 2016 to June 2018. The dredging and disposal operation commenced on 8 January 2017 and finished on 12 March 2017.

The volume of dredge material deposited at the offshore dump site was well below the maximum consented limits for the individual campaign and cumulatively over the past three.

Although the volume deposited at the inshore dump ground was less than that stated in the purpose of the consent, the final volume of sand at the dump ground was considerably greater than the maximum limit stipulated in condition four. As identified by the hydrographic survey prior to the campaign, the volume of sand at the dump ground has increased since the sand was first deposited at the site (Figure 12). That is, natural processes have not been transporting the sand from the dump ground at a rate previously anticipated, resulting in a gradual accumulation of sand in the site.

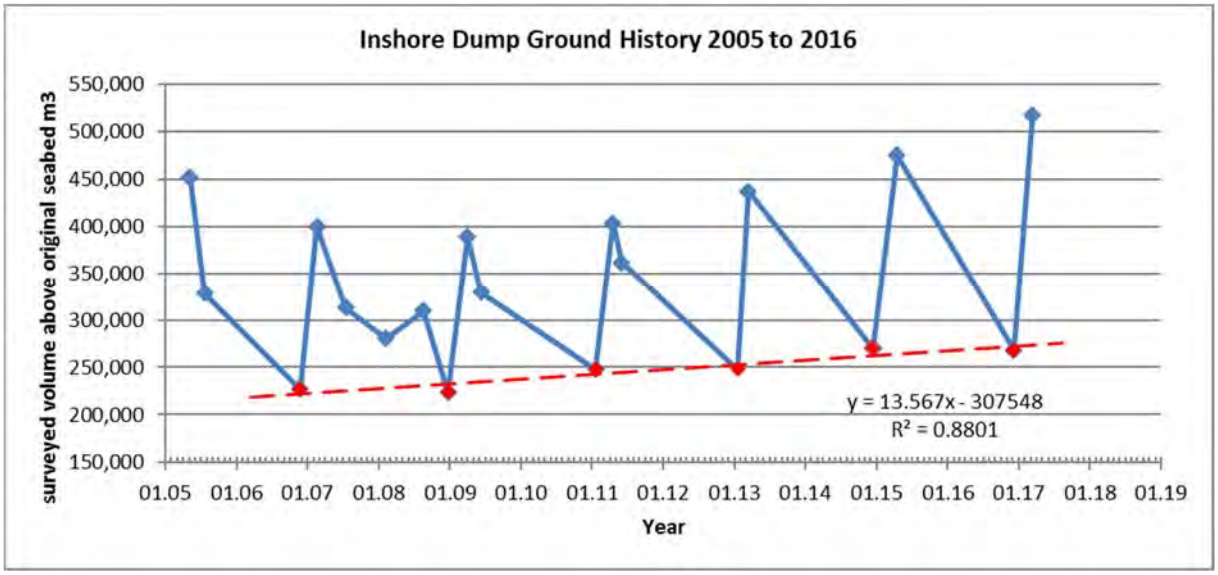

Figure 12 Inshore dump ground volumes surveyed before and after each dredge campaign (provided by Port Taranaki Ltd)

The 2017 campaign was not the first to exceed this limit, although it has been the greatest exceedance to date. Final sand volumes at the inshore dump ground exceeded the limit in 2015, 2013 and marginally in 2007. The Company had identified this issue and suggested corrective actions prior to the 2017 campaign. However, the final volume was ultimately exceeded once more.

The Council is awaiting response from a 14 day letter which required a formal explanation for the non-compliance. A decision will subsequently be made regarding further enforcement action.

3.2 Environmental effects of exercise of consents

No adverse environmental effects were discovered in relation to the exercise of the Company's consents during the period under review.

Based on the intertidal sand inspections, the dredge campaign did not appear to result in significant volumes of sand inundating either Kawaroa or Arakaitai Reefs in the period under review.

It was 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 2016-2018 monitoring period.

It was also expected that detectable adverse effects of the dredging activities on kaimoana species would have been evident as a significant decline in paua and kina counts in post-dredging surveys relative to pre-dredging surveys, in addition to a major build-up of sand on the reefs in association with the dredging activities. There has been an apparent decrease in the abundance of paua and kina on these reefs in recent years, as well as a uniform decrease in average paua length across all sites since 2016. However, there are a number of factors that could have potentially influenced these results, including natural variation in environmental conditions, increased (and illegal) kaimoana harvesting, dredging activities and changes in personnel undertaking the surveys. Determining how these factors have influenced paua and kina counts and sizes is not straightforward; though there was no major build-up of sand on the reefs noted in association with the 2017 dredge campaign. Therefore, there is no causal evidence to indicate that the inshore dredge disposal was a significant factor behind the changes observed in kaimoana communities.

There is potential for the high volume of sand remaining at the inshore dump ground following the 2017 campaign to cause adverse environmental effects. This inshore dump ground was originally chosen to maximise the potential for sand to renourish the New Plymouth's littoral system, whilst minimising adverse ecological impacts. It was anticipated that the wave climate and currents would be sufficient to transport all deposited material away from the site between successive dredge campaigns, and to that effect, the final volume limit was critical to ensure this was achieved and excessive long term sand build up did not occur. Although no conclusive evidence of this was obtained, excessive sand build could potentially led to adverse outcomes with regards to adjacent kelp systems and kaimoana habitats. Therefore, it is critical that the volume of sand deposited at the inshore dump ground is corrected in future campaigns to allow for the volume of sand already present.

3.3 Evaluation of performance

A tabular summary of the consent holder's compliance record for the year under review is set out in Tables 4-7.

Table 4 Summary of performance for Consent 3374-2

Purpose: ***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	Notice received as required	N/A
2. Dredging from within Port Taranaki and main shipping channel covered		Yes
3. Clean sand deposited at the inshore disposal site	Sand samples provided	N/A

Purpose: *To deposit dredged sand within an offshore Spoil Disposal Area*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
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		N/A
8. Option for review of consent	Next scheduled in June 2021 if required	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent Overall assessment of administrative performance in respect of this consent		**High** **High**

N/A = not applicable

Table 5 Summary of performance for Consent 3982-2

Purpose: *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	Yes
4. BPO to minimise environmental effects	Inspections, information provided	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	Information provided	Yes
7. Consent holder to undertake a representative sample of seabed sediments	Samples provided	N/A
8. Option for review of consent	Next scheduled for review in June 2021 if required	N/A

Purpose: *To dredge accumulated sediments from Port Taranaki*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
Overall assessment of consent compliance and environmental performance in respect of this consent Overall assessment of administrative performance in respect of this consent		**High** **High**

N/A = not applicable

Table 6 Summary of performance for Consent 5886-1

Purpose: *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	**No** Final volume after 2017 campaign was 517,660 m^3
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

Purpose: *To deposit dredge sands at an inshore disposal site*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
11. Results of all monitoring made publicly available prior to review	Monitoring reports	Yes
12. Review of consent	Next scheduled review June 2021, if required	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent Overall assessment of administrative performance in respect of this consent		**Improvement required** **High**

N/A = not applicable

Table 7 Evaluation of environmental performance over time

Year	Consent no	High	Good	Improvement req	Poor
2014	3374	1			
	3982	1			
	5886	1			
2016	3374	1			
	3982	1			
	5886	1			
2018	3374	1			
	3982	1			
	5886			1	
Totals		8	0	1	0

During the period, the Company demonstrated overall a good level of environmental and high level of administrative performance with the resource consents as defined in Section 1.1.4. One consent condition, regarding the maximum final volume of sand at the inshore dump ground, was breached by the Company during the dredging campaign.

3.4 Recommendations from the 2014-2016 Biennial Report

In the 2014-2016 Biennial Report, it was recommended:

1. THAT the monitoring of inshore disposal of dredged material from Port Taranaki Ltd continues as a biennial programme.
2. THAT intertidal ecological sampling is undertaken in spring every second year.
3. THAT kaimoana surveys are undertaken each summer every second year.
4. THAT intertidal inspections of sand cover on the reefs are undertaken in summer and autumn every year.
5. THAT metal analysis of sediment samples taken by Port Taranaki Ltd during the dredge campaigns are reported as part of the Port Taranaki Ltd Maintainance Dredging Monitoring Programme.

6. THAT the Council confirm the decision not to review consents 3374-2, 3982-2, and 5886-1 in June 2017.

These recommendations, with the exception of the metal analyses, were implemented during the period under review. A meeting has since been held between Council and Port Taranaki staff to establish and effective and efficient sediment sampling and analysis regime for the 2019 dredge campaign. With regard to the sand inspections, the same number were undertaken, but the timings were adjusted. Inspections were carried out immediately before, during and after the campaign, with one carried out in the following year when no dredging had occurred.

3.5 Alterations to monitoring programmes for 2018-2020

In designing and implementing the monitoring programmes for air/water discharges in the region, the Council has taken into account:

- the extent of information already made available through monitoring or other means to date;
- its relevance under the RMA;
- the Council's obligations to monitor consented activities and their effects under the RMA;
- the record of administrative and environmental performances of the consent holder; and
- reporting to the regional community.

The Council also takes into account 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 exercising resource consents.

It is proposed that for 2018-2019 the monitoring programme remains largely unchanged from that of 2017-2018. However, it is recommended that following the next dredge campaign, the Company provides the Council with a report comprising a complete assessment of the campaign with regards to the relevant conditions in their resource consents, supported by raw data records. This report should be supplied to the Council as soon as practicable following completion of the dredge campaign, and no later than 30 June 2019. Additionally, it is recommended that sediment analysis undertaken to address consent requirements. Prior to disposal at the inshore dump ground, representative samples should be collected, of which a sub-sample are to be randomly selected and analysed for grain size and metals. The kaimoana survey methodology should also be reviewed in order to better understand potential factors behind changes in kaimoana size and abundance.

It should be noted that the proposed programme represents a reasonable and risk-based level of monitoring for the activity in question. The Council reserves the right to subsequently adjust the programme from that initially prepared, should the need arise if potential or actual non-compliance is determined at any time during 2018-2019.

4 Recommendations

1. THAT in the first instance, monitoring of the consented dredging activities in the 2018-2020 year be amended from that undertaken in 2016-2018, by:
   a. Implementing a sediment analysis regime (as agreed upon by the Company and the Council; discussed further in section 3.5), and
   b. by requiring the Company to provide a complete dredge campaign compliance summary report to Council as soon as practicable following the campaign (discussed further in section 3.5), and
   c. by reviewing the current kaimoana survey methodology (discussed further in the 2018 survey memo)
2. THAT should there be issues with environmental or administrative performance in 2018-2020, monitoring may be adjusted to reflect any additional investigation or intervention as found necessary.

Glossary of common terms and abbreviations

The following abbreviations and terms may be 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.
In situ	In the original position.
Incident	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.
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.
Subtidal	The area below the low tide mark.
Transect	Tape run along the shoreline where the random quadrats are taken from.

For further information on analytical methods, contact a Science Services Manager.

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Appendix I

Coastal permits held by Port Taranaki Ltd

(For a copy of the signed resource consent
please contact the TRC Consents department)

Consent number	Purpose	Granted	Review	Expires
3374-2	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, whatever 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	28 Jan 2002	Jun 2021	1 Jun 2029
3982-2.1	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, whatever comes first), of accumulated sediments from the bed of the coastal marine area of the area commonly known as Port Taranaki	18 Mar 2015	Jun 2021	1 Jun 2029
5886-1	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	9 Apr 2002	Jun 2021	1 Jun 2029

Consent 3374-2

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

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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 PO Box 348 New Plymouth 4340	
Decision Date (Change):	18 March 2015	
Commencement Date (Change):	18 March 2015	(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
Expiry Date:	1 June 2029
Review Date(s):	June 2017, June 2021, June 2025
Site Location:	Port Taranaki, New Plymouth
Legal Description:	Tasman Sea
Grid Reference (NZTM)	1690011E-5676719N
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 as illustrated in Figure 1 (attached), 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 general accordance with the information provided in support of the original application for this consent and with any subsequent application to change consent conditions. Where there is conflict between applications the later application shall prevail, and where there is conflict between an application and consent conditions the conditions shall prevail.

4. At all times the consent holder shall adopt the best practicable option, as defined in section 2 of the Act, 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.

Signed at Stratford on 18 March 2015

For and on behalf of
Taranaki Regional Council

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A D McLay
Director - Resource Management

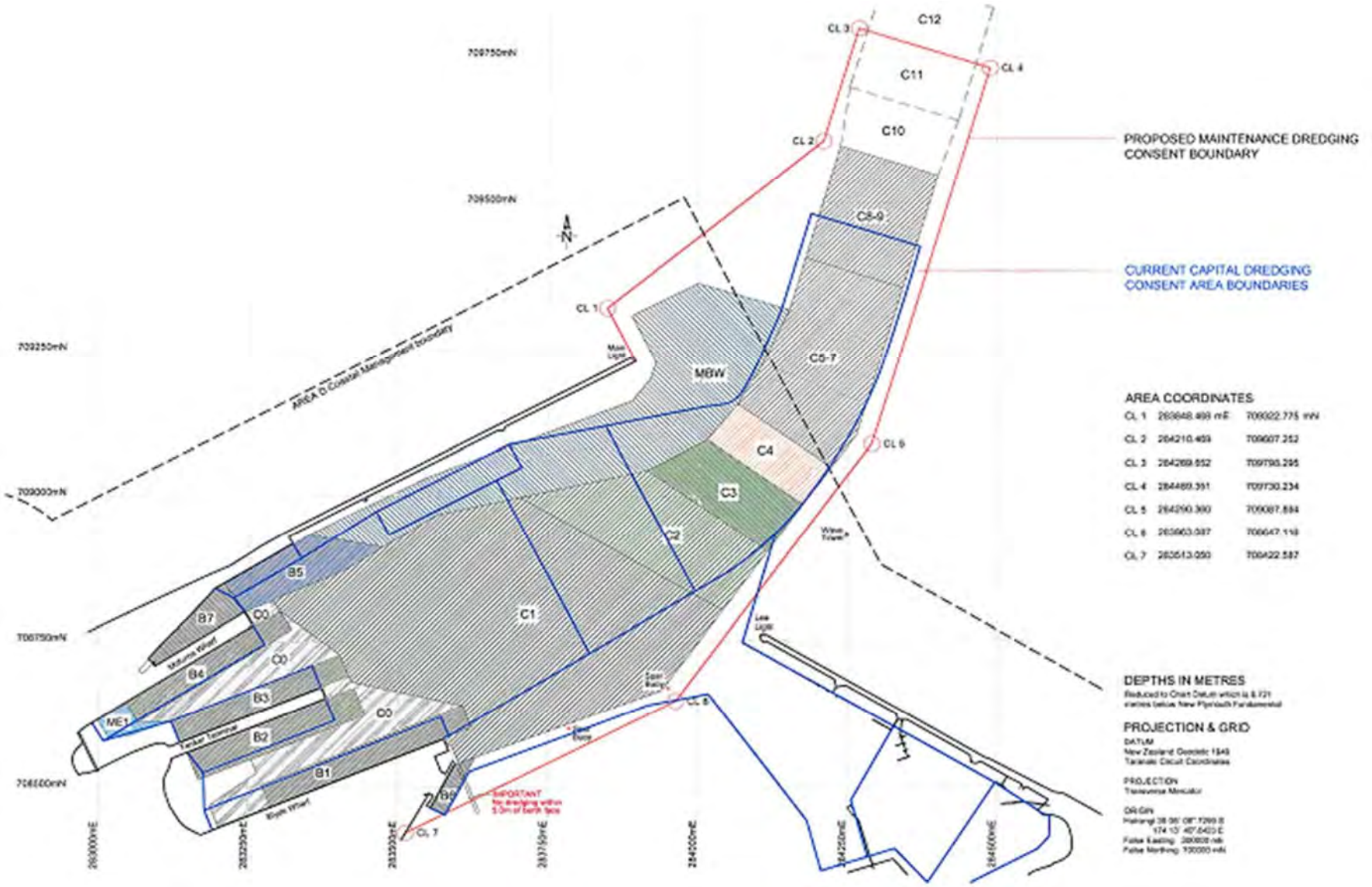

Figure 1: Map of dredging area

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

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Director-Resource Management

Appendix II

Intertidal sand inspections

To Environmental Monitoring Manager, Regan Phipps

From Environmental Scientist – Marine Biology, Thomas McElroy

Document 1850077

Date 2 July 2018

Port Taranaki 2017 Dredging Campaign - Intertidal rocky reef sand inspections

Introduction

Port Taranaki Limited holds consent 5886-1 to deposit clean sand from dredging campaigns within an inshore disposal area on the western flank of Kawaroa Reef.

Special condition 8 of consent 5886-1 states:

'*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*.'

Special condition 9 of consent 5886-1 states:

'*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*.'

In order to assess compliance with these special conditions, in addition to kaimoana and intertidal ecological surveys (undertaken once every two years), the Taranaki Regional Council (the Council) also undertakes inspections to assess intertidal sand build up on Kawaroa Reef and Arakaitai Reef. These two reefs are the main reefs located between the Lee Breakwater and the mouth of the Te Henui Stream along the New Plymouth coastline.

Four low tide reef inspections were undertaken in relation to Port Taranaki's eighth dredging campaign which ran from 8 January 2017 to 12 March 2017. The inspections took place pre (6 Jan 2017), during (17 Feb 2017), and post (10 Apr 2017) dredge campaign as well as one the following year when no dredging had occurred (28 Mar 2018). The aim of inspecting the reefs on these dates was to identify potential effects of the campaign and to differentiate from those of natural processes.

Kawaroa Reef

In front and to the west of the Aquatic Centre, most areas of the intertidal reef were predominantly rocky with the exception of breccia platforms covered by Corallina turf and/or Hormosira banksia (Figures 1 – 5). A limited pocket of sand was evident at the base of the seawall adjacent to the old swimming pool and may have enlarged following the dredge campaign (Figure 2). Occasional, localised sand accumulation was noted on the reef at mid to low shore. At this height on the shore, the extensive Corallina and Hormosira coverage appears to trap a layer of sand and sediment on the reef (Figure 8). Tide pools on the reef were generally found to be free from silt and sediment (Figure 9). The area of reef to the east of the Aquatic

Centre was predominantly rocky in nature, characterised by boulders and breccia covered with *Corallina* turf (Figure 6 & 7). A small pocket of sand was observed at the top of the shoreline east of the aquatic centre following the campaign (Figure 7). Overall, no major sand deposits were discovered over the course of the inspections across Kawaroa Reef.

Figure 1 Looking at the Kawaroa Reef from the walkway just west of the playground car park; pre (6 Jan 2017), during (17 Feb 2017), and post (10 Apr 2017) dredging campaign and the following year (28 Mar 2018).

Figure 2 Looking at the old Kawaroa tidal swimming pool from the walkway; pre (6 Jan 2017), during (17 Feb 2017), and post (10 Apr 2017) dredging campaign and the following year (28 Mar 2018)

Figure 3 Looking north-west at the Kawaroa Reef from the walkway in front of the Todd Energy Aquatic Centre; pre (6 Jan 2017), during (17 Feb 2017), and post (10 Apr 2017) dredging campaign and the following year (28 Mar 2018)

Figure 4 Looking south towards the Todd Energy Aquatic Centre from the Kawaroa Reef; pre (6 Jan 2017), during (17 Feb 2017), and post (10 Apr 2017) dredging campaign and the following year (28 Mar 2018)

Figure 5 Looking north at the Kawaroa Reef from the Todd Energy Aquatic Centre outfall; pre (6 Jan 2017), during (17 Feb 2017), and post (10 Apr 2017) dredging campaign and the following year (28 Mar 2018)

Figure 6 Looking north at the Kawaroa Reef from the Todd Energy Aquatic Centre carpark; pre (6 Jan 2017), during (17 Feb 2017), and post (10 Apr 2017) dredging campaign and the following year (28 Mar 2018)

Figure 7 Looking east at the Kawaroa Reef from the Todd Energy Aquatic Centre carpark; pre (6 Jan 2017), during (17 Feb 2017), and post (10 Apr 2017) dredging campaign and the following year (28 Mar 2018)

Figure 8 Sand accumulation amongst Corallina turf and Hormosira banksii on Kawaroa Reef ('No Dredge Year' inspection 28 Mar 2018)

Figure 9 Clear tide pools on Kawaroa Reef ('Post Dredge' inspection 10 Apr 2017)

Arakaitai Reef

Prior to the 2017 dredge campaign, a prominent belt of sand existed at the top of the shore adjacent to the old sewage outfall (Figure 10). Since then, the sand belt has almost completely eroded away (the tide was not quite low enough on the last inspection to see whether any sand remained; Figure 10). Further east towards the groyne, a significant deposition of sand was discovered at the top of the shore during the 'post dredge' inspection (Figure 11). No sand was discovered at this site in the 'pre', 'during' or 'no dredge year' inspections. A significant deposition of sand was also discovered at the top of the shore surrounding the groyne during the 'post dredge' inspection (Figure 12. Only a small amount of sand and gravel was present at this site during the other three inspections. East of the groyne, sand was present at the top of the shore only during the post dredge inspection (Figure 13). No significant depositions of sand were noted elsewhere on the intertidal reef.

Figure 10 Looking west across Arakaitai Reef towards the windwand from the walkway (west of the groyne); pre (6 Jan 2017), during (17 Feb 2017), and post (10 Apr 2017) dredging campaign and the following year (28 Mar 2018)

Figure 11 Looking north at Arakaitai Reef from the walkway just west of the groyne; pre (6 Jan 2017), during (17 Feb 2017), and post (10 Apr 2017) dredging campaign and the following year (28 Mar 2018)

Figure 12 Looking north at the groyne on Arakaitai Reef from the walkway; pre (6 Jan 2017), during (17 Feb 2017), and post (10 Apr 2017) dredging campaign and the following year (28 Mar 2018)

Figure 13 Looking east across Arakaitai Reef towards the Te Henui river mouth from the walkway; pre (6 Jan 2017), during (17 Feb 2017), and post (10 Apr 2017) dredging campaign and the following year (28 Mar 2018)

Conclusion

The intertidal zone of Kawaroa Reef appeared largely sand free following the dredging campaign. Relatively thin and localised patches of sand were found associated with *Hormosira* cover at mid to low shore heights. No significant deposits of sand were observed higher up the shore.

At Arakaitai Reef, significant depositions of sand were discovered high up the shore following the dredge campaign. However, it is not certain whether this occurrence was consequential to the campaign. Just east of where the sand had accumulated, a significant sand belt had existed prior to dredging. When the post dredge deposition was discovered, the pre dredge sand belt had diminished considerably. Although it is possible that dredging resulted in sand deposition on Arakaitai Reef, it is also possible that the natural process of littoral drift is responsible. Irrespective of mechanism, the sand was no longer present in any significant quantity one year on from the campaign.

Overall, the 2017 dredge campaign did not appear to result in significant volumes of sand inundating either Kawaroa or Arakaitai Reefs in the period under review. Further inspections scheduled around the 2019 dredging campaign will help to differentiate between the effects of dredging and those of natural processes.

Appendix III

Spring intertidal ecology report

To Science Manager – Hydrology/Biology, Regan Phipps

From Scientific Officer, Emily Roberts and Technical Officer, Angela Smith

Document 1988740

Date 09 Jan 2018

Port Taranaki Limited Dredging Programme – Intertidal Ecological Survey Spring 2017

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 deposited in 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 following dredging (Tables 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, surveys of the intertidal zone were carried out as part of the 2016-2018 monitoring programme. The surveys for the 2016-2018 monitoring period were conducted at four sites between 21 September and 19 October 2017.

Special condition 10 requires there to be no significant adverse effects on 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 a separate monitoring survey for the locally important kaimoana species, paua (*Haliotis iris*) and kina (*Evechinus chloroticus*), at Kawaroa Reef and Arakaitai Reef, with regards to potential 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
Eighth	19-January-2015 to 23-March-2015	196,227

Disposal campaign	Date	Volume (m^3) dumped inshore
Ninth	8-Jan-2017 to 12-Mar-2017	292,661

**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 (Summer 2004)
5	Summer 2005	
6	Spring 2005	2 (Winter 2005)
7	Summer 2006	
8	Spring 2006	
9	Summer 2007	3 (Summer 2007)
10	Spring 2007	
11	Summer 2008	
12	Spring 2008	4 (Emergency; Winter 2008)
13	Spring 2010	5 (Summer 2009)
14	Spring 2012	6 (Autumn 2011)
15	Spring 2014	7 (Summer 2013)
16	Spring 2015	8 (Summer 2015)
17	Spring 2017	9 (Summer 2017)

Methods

Field Work

The surveys were conducted at three potential impact sites Arakaitai Reef (SEA902045), 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 (Figure 1, Photos 1-3).

Figure 1 Site locations used for intertidal monitoring

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), 4 October 2017

Photo 2 Potential impact site Kawaroa Reef 1.2 km north east of Lee Breakwater (SEA902053), 5 October 2017

Photo 3 Control site Greenwood Road (SEA 903070), 13 January 2017

Results

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 mean number of total 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 2017 survey

Site	No. of quadrats	Mean number of species per quadrat			Mean Shannon-Weiner indices per quadrat		
		Algae	Animals	Total	Algae	Animals	Total
Arakaitai Reef	25	4.96	8.92	13.88	0.50	0.68	0.81
Kawaroa Reef 1.2 km NE	25	6.36	9.40	15.76	0.71	0.73	0.94
Kawaroa Reef 750 m NE	25	7.60	9.24	16.84	0.68	0.68	0.90
Greenwood Road	25	6.68	7.36	14.04	0.67	0.52	0.75

Number of species per quadrat data

Figure 2 shows the total number of species per quadrat as a box and whisker plot.

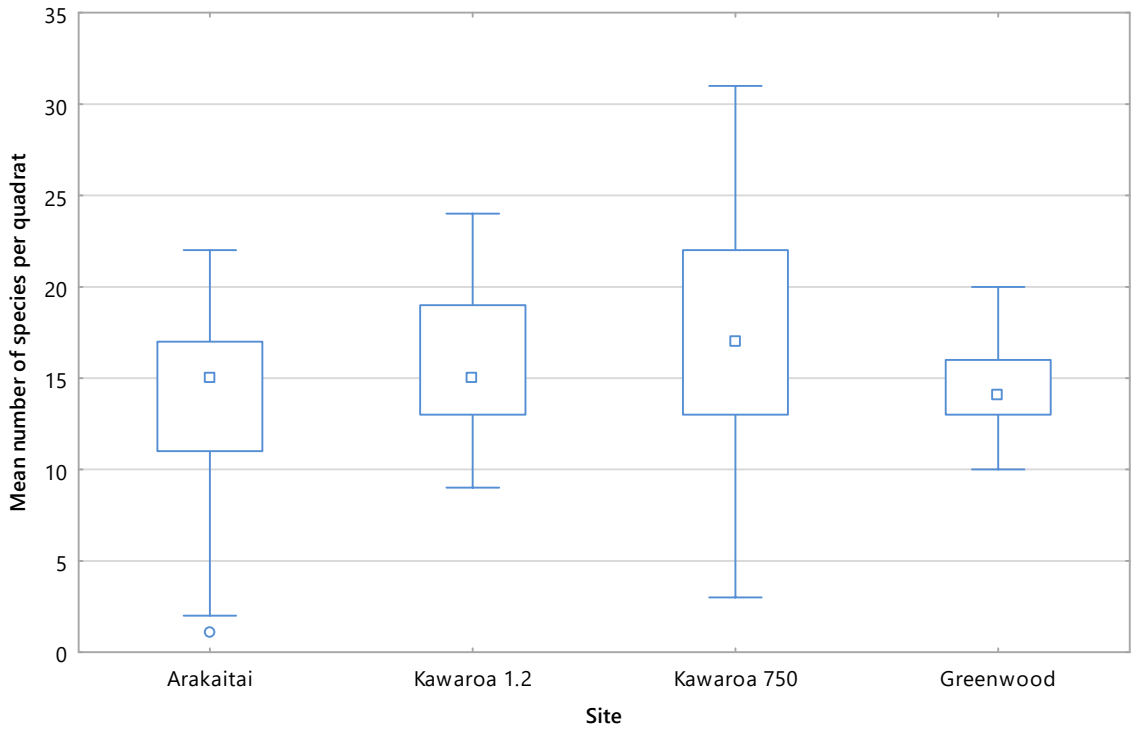

Figure 2 Box and whisker plot of the mean number of species per quadrat

The data obtained from each of the four sites conformed to the assumption of normal distribution (Lilliefors test, n=25, P>0.05), and variance was homogenous across each site (Figure 2). An ANOVA was applied to the raw data, as the data conformed to the ANOVA assumptions.

There was no significant difference in the mean number of species per quadrat between the sites (ANOVA, F=2.12, degrees of freedom (df)=3, 96, P=0.103). The mean values for the sites all ranged between approximately 14 and 17 (Figure 2).

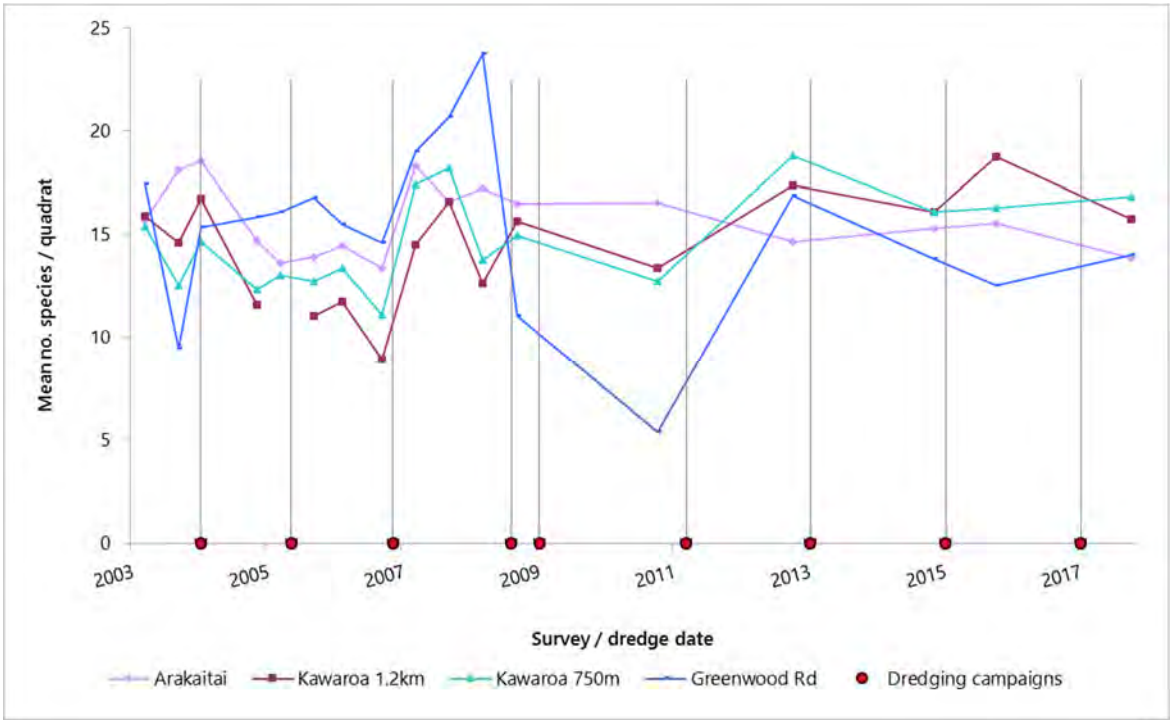

Figure 3 Mean number of species per quadrat from 2003 to 2017

Figure 3 shows the mean number of species per quadrat for all surveys undertaken as part of the Port Dredging monitoring programme. For the 2017 survey, the mean number of species per quadrat for each site was within the range of values previously recorded. The mean number of species slightly decreased at the Kawaroa 1.2 km and Arakaitai Reef sites, while slight increases were observed for the Greenwood Road and Kawaroa 750 m sites.

Shannon-Weiner Diversity Index Data

Figure 4 shows the mean Shannon-Weiner index data at each site as a box and whisker plot.

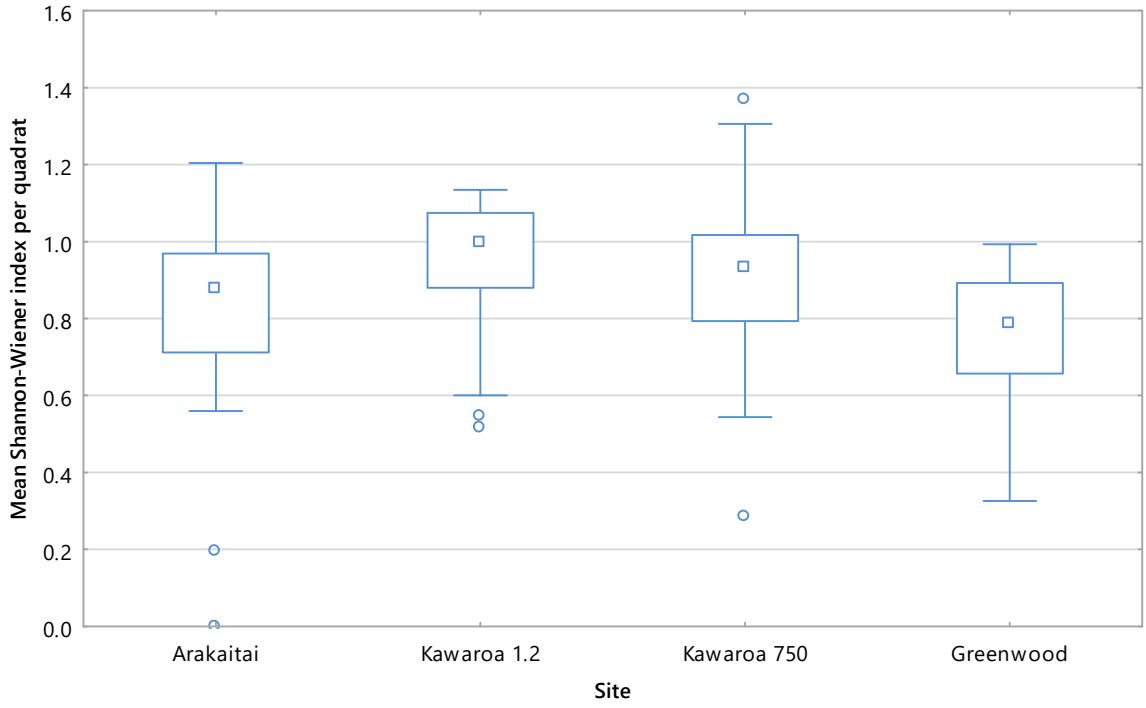

Figure 4 Box and whisker plots of Shannon-Weiner diversity indices

The data obtained from the Arakaitai, Kawaroa 750 m and Greenwood Road sites conformed to the assumption of normal distribution (Lilliefors test, $P>0.05$). However, the Kawaroa 1.2 km site showed a significant deviation from normal distribution at the 95% confidence level (Lilliefors test, $n=25$, $P<0.05$). A natural logarithmic transformation was subsequently applied to the data. However, the assumption of normal distribution failed again for the Kawaroa 1.2 km site following this transformation (Lilliefors test, $n=25$, $P<0.01$). As the ANOVA assumptions could not be met, the remaining analyses were conducted using non-parametric tests on the raw data.

There was a significant difference in the mean Shannon-Wiener index between sites (Kruskal-Wallis, $H=12.905$, $df=3$, $P<0.05$)[1]. Significant differences between sites were determined using the Wilcoxon signed-ranks test, and are presented in Table 4. The mean Shannon-Weiner index per quadrat at each site increased in the following order: Greenwood Road, Arakaitai Reef, Kawaroa 750 m, Kawaroa 1.2 km (Figure 4). The mean Shannon-Weiner index was significantly higher at the Kawaroa 1.2 km site when compared with the Arakaitai Reef potential impact site and the control site Greenwood Road; Figures 4; Table 2). The mean Shannon-Weiner index at the Kawaroa 750 m site was also significantly higher than at the

[1] The Kruskal-Wallis and Wilcoxon signed ranks tests are both non-parametric tests. This means they are not testing for differences in sample means (or medians) but rather they are testing for differences in the locations of sample distributions.

Greenwood Road control site, while the scores were not significantly different between the Arakaitai Reef site and Greenwood Road (Figure 4; Table 2).

Note: ANOVA was also conducted using the raw data; there was a significant difference between sites (ANOVA, F=3.520, df=3, P=0.018).

Table 4 Wilcoxon signed ranks test of Shannon-Weiner diversity index per quadrat

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

Key: SIG = significant difference at 95% confidence level

NS = no significant difference

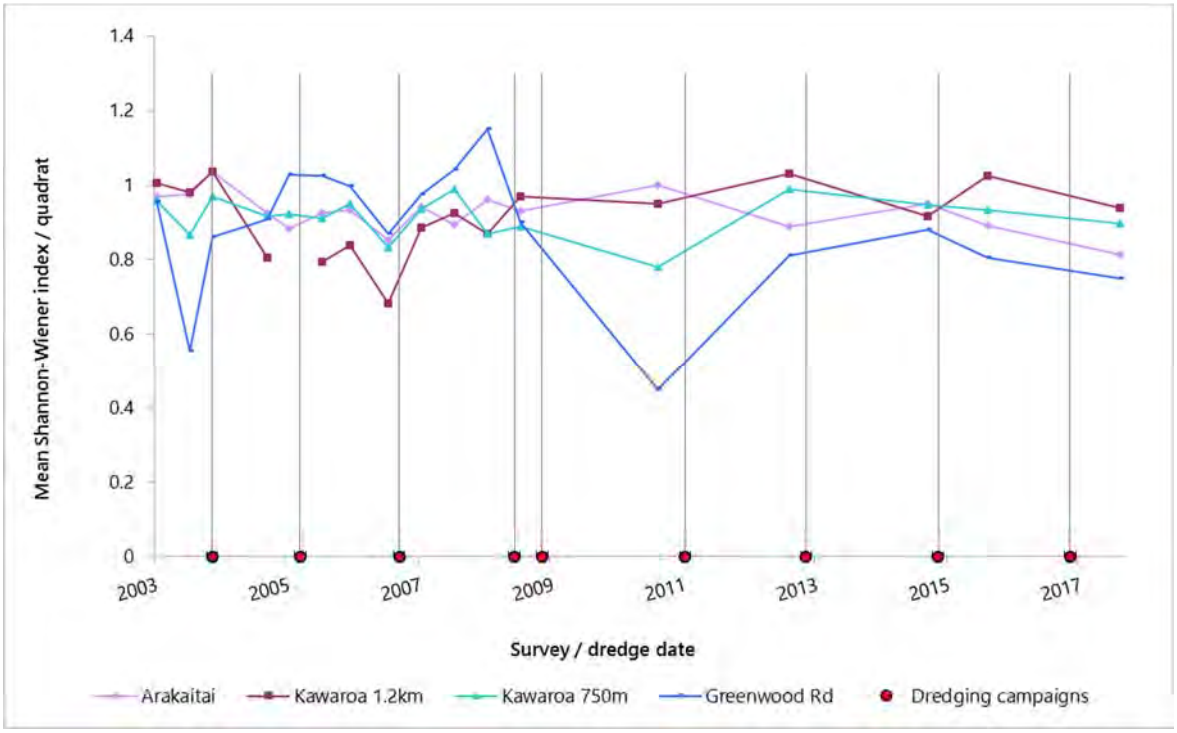

Figure 5 Mean Shannon-Weiner index per quadrat from 2003 to 2017.

Figure 5 shows mean Shannon-Weiner index per quadrat for all surveys undertaken as part of the Port dredging monitoring programme. For the 2017 survey, the mean Shannon-Weiner index per quadrat at all sites was within the range of values previously recorded at these sites. There was a small decrease in diversity from the previous survey at each of the four sites, when compared with the 2015 survey.

Sand cover

The level of sand cover recorded during the current survey was very low (<6%), and negligible silt and mud cover (<1%) was recorded at the sites (Table 4).

Table 5 Mean percent cover of sand, silt and mud per quadrat (2017-2018)

Site	Mean coverage per quadrat (%)		
	Sand	Silt/mud	Total
Arakaitai Reef	1.44	0.0	1.44
Greenwood Road	0.76	0.60	1.36
Kawaroa Reef 1.2 km NE	5.64	0.0	5.64
Kawaroa Reef 750 m NE	0.92	0.0	0.92

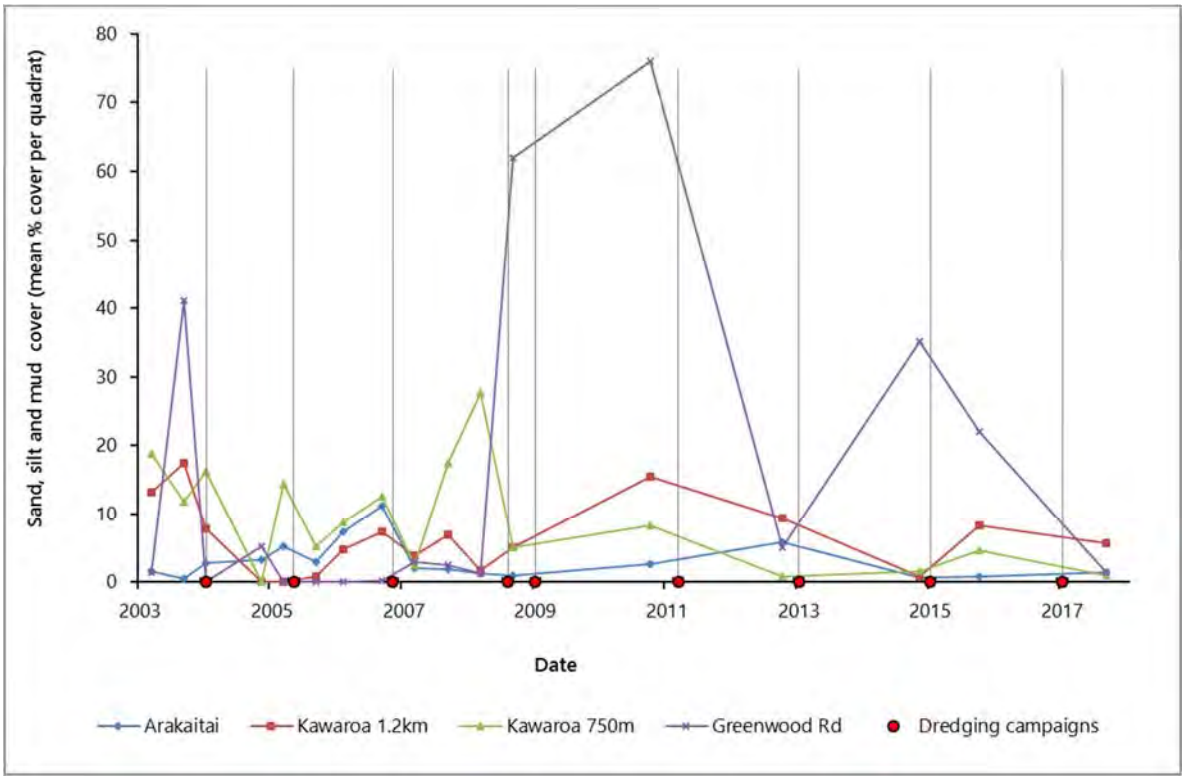

Figure 6 Mean total percentage of sand, silt and mud cover by site from 2003 to 2018

The Greenwood Road site has on occasion been susceptible to heavy sand inundation. During the 2003, 2008, 2010 and 2014 surveys, sand/silt cover at this site was 41%, 62%, 76% and 35%, respectively. Sand cover greater than 30% can significantly affect the abundance and diversity of intertidal species and communities. This is discussed further in Section 4.

Historically, sand cover has typically been low to moderate at the three potential impact during surveys (Figure 6). Sand cover at the Kawaroa 750 m site has been moderate on occasion, with sand often trapped in the turf that is abundant across the extensive lahar platform at the site. Low levels of sand cover are typically present at Arakaitai, with sand cover having exceeded 5% during only two surveys. The accumulation and dispersal of sand, a cycle that is common along Taranaki's coastline, is regularly observed upshore at Arakaitai Reef (Photo 5). Although the site at Kawaroa 1.2 km NE had moderate levels of sand in initial, pre-dredging surveys, sand cover at this site has been low in most post-dredging surveys, with the exception of the 2010 survey (Figure 6).

Photo 4 The variable extent of sand accumulation observed on the high-shore at Arakaitai in 2010 (a) and 2015 (b)

Discussion and conclusions

Given that no significant adverse environmental effects were detected as a result of the 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 fifth round of surveys undertaken since changing the frequency of the intertidal surveys from biannual to biennial.

The results from the 2017 intertidal survey indicate that the disposal of dredged material was not having detectable adverse effects on the intertidal reef communities at the New Plymouth sites surveyed. Differences in species diversity between the sites were minor and statistically insignificant. Additionally, the mean Shannon-Weiner index, an indicator of species evenness and diversity, was found to be significantly lower at the Greenwood Road control site than at two of the potential impact sites (Kawaroa 1.2 km and Kawaroa 750 m).

It is likely that the high levels of sand cover recorded at the Greenwood Road site since the sand inundation event of 2015 are still influencing the intertidal reef community. Although sediment cover recorded during this survey was low and there was no difference in algal diversity when compared with the other sites, animal diversity was slightly lower here than at the potential impact sites (Table 3). Sand deposition has a profound effect on under-rock colonisation on intertidal hard-shore environments in Taranaki (Walsby, 1982), and can also result in reduced diversity due to sand scour of the biota, reduced water movement between rocks and temporary burial. Turf-forming and opportunistic macrophytes (e.g. *Cladophora* sp., *Ulva* sp., *Chaetomorpha* sp.) tend to dominate areas routinely buried by sediment, with foliar algae developing where grazers are restricted in abundance and diversity by sediment cover (Airoldi, 2003). The composition and relative abundance of intertidal reef assemblages can also change drastically, following significant changes in sedimentation regimes (Airoldi, 2003). Although the species diversity of the intertidal reef community at the Greenwood Road site is recovering since the sand inundation event of 2015, it is possible that the frequency of sand inundations at the reef in recent years has resulted in a subtle species shift, resulting in the relative dominance of algal species.

Summary

In order to assess the effects of dredging on the nearby intertidal communities, ecological surveys were carried out between 21 September and 19 October 2017 at three potential impact sites adjacent to the inshore disposal area, and at one control site further southwest around the coast. Any adverse effects of dredging on the intertidal communities at the potential impact sites would most likely have resulted in significant declines in species diversity, relative to the control site.

Measures of species diversity at the potential impact sites were found to be greater than or similar to species diversity at the control site. Furthermore, there had been no significant decline in species diversity at the potential impact sites when compared with survey results from previous years. The results therefore indicate that dredging activities are not having detectable adverse effects on the intertidal reef communities of New Plymouth. Natural environmental factors, including wave exposure, sand cover and substrate mobility, appeared to be dominant drivers of species diversity at the sites surveyed.

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Appendix IV

Summer kaimoana report

To Science Manager – Hydrology/Biology, Regan Phipps

From Technical Officer – Angela Smith, Environmental Scientist – Marine Biology, Thomas McElroy

Document 2061157

Date 29 May 2018

Port Taranaki Limited Dredging Programme – 17th Kaimoana Survey, Summer/Autumn 2018

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. Special conditions of the consent require that the sand used for the inshore disposal area shall be restricted to clean sand dredged from the outer harbour deposits. The Minister of Conservation granted this permit on 9 April 2002.

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. Kaimoana surveys are now undertaken biennially in the summer following each dredge campaign, focusing on five sites across two locally important reefs for gathering kaimoana (Kawaroa Reef and Arakaitai Reef). Historically, the kaimoana considered most important to monitor have been paua (*Haliotis iris, Haliotis australis* and *Haliotis virginea*), kina (*Evechinus chloroticus*), Cook's turban (*Cookia sulcata*) and pūpū or cat's eye (*Lunella smaragdus*).

This survey was conducted between 3 January and 30 April 2018 and is the 17th kaimoana survey to be carried out as part of the Port Taranaki Limited maintenance dredging monitoring programme. The objective of the survey is to gather information on kaimoana abundance and the size frequency of paua. This data forms an important component in assessing any effects on the reefs from the sand disposal programme. Table 1 summarises the previous dredge campaigns.

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
Fourth (emergency dredging)	5-Aug-2008 to 18-Aug-2008	29,166
Fifth campaign	3-Jan-2009 to 2 April-2009	165,995
Sixth campaign	18-Mar-2011 to 19-April-2011	156,086
Seventh campaign	19-Jan-2013 to 13-Mar-2013	189,677
Eighth campaign	19-Jan-2015 to 23-Mar-2015	196,277
Ninth campaign	8-Jan-2017 to 12-Mar-2017	292,661

Methods

Field Work

The January-April 2018 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 regime 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 techniques 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 during this survey. However, the difficulty with this technique is that quantitative estimates of species density 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,* Photo 1; *Haliotis australis* and *Haliotis virginea,* Photo 2) encountered were measured and counted. Other kaimoana species (kina *Evechinus chloroticus* and Cook's turban shell *Cookia sulcata*) were also counted as they were found, but not measured (Photo 3).

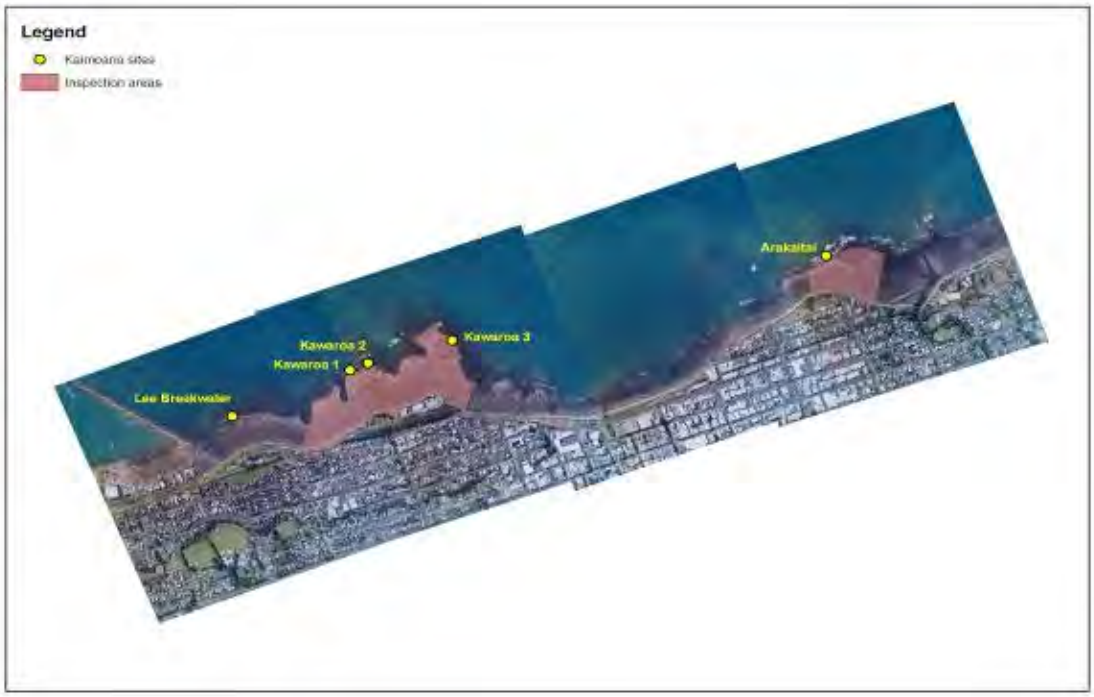

Figure 1 Intertidal kaimoana survey sites on Kawaroa and Arakaitai Reefs

Photo 1 Black-foot paua *Haliotis iris*, Arakaitai and Kawaroa Reefs (April 2018)

Photo 2 Virgin paua *Haliotis virginea*, Kawaroa Reef (March 2014)

Photo 3 Council staff undertaking a kaimoana survey (2016)

Results

Paua

Summary statistics for the paua counted during the summer/autumn 2018 survey are presented in Table 2.

Table 2 Number of paua counted at the five sites located on locally important kaimoana reefs in 2018

	Arakaitai	Lee Breakwater	Kawaroa 1	Kawaroa 2	Kawaroa 3
Time (min)	45	60	60	30	60
Actual count	56	105	112	24	158
Minimum size (mm)	10	15	20	10	20
Maximum size (mm)	75	100	95	100	80
Mean size (mm)	46	41	45	44	47
Count (paua/minute)	1.2	1.8	1.9	0.8	2.6

For the 2018 survey, the highest numbers of paua were found at Kawaroa 3, followed by Kawaroa 1, the Lee Breakwater, Arakaitai and Kawaroa 2 respectively (Table 2; Figure 2). The smallest paua were found at the Arakaitai and Kawaroa 2 sites, measuring 10 mm, and the largest were found at the Lee Breakwater and Kawaroa 2, measuring 100 mm. Mean paua length ranged from 41 mm (Lee Breakwater) to 47 mm (Kawaroa 3).

It should be noted that survey times were reduced at Arakaitai Reef and Kawaroa 2. When analysing these results, comparisons of Paua abundance across sites can still be made by standardising to a unit of effort (minutes surveyed) to produce a count of paua per minutes surveyed. Size distributions can also still be assessed, though the sample size is smaller.

Paua size frequencies were calculated for 11 size classes for each kaimoana survey site, and are presented in Figure 2. The cumulative percent contributions of each size class are also displayed.

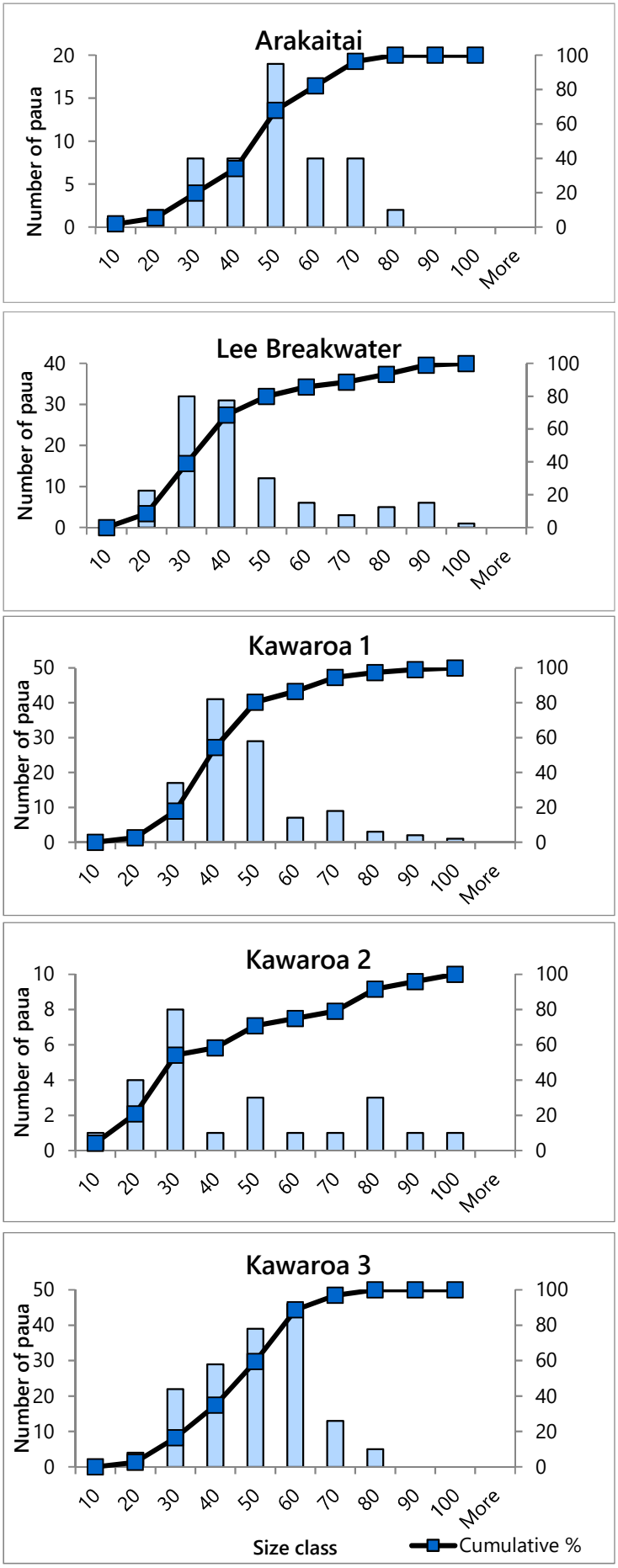

Figure 2 Size frequency distribution of paua at the five reef sites

At Arakaitai Reef, the most abundant size class was 51-60 mm, with 34% of all paua found at the site recorded within this size class. Paua were evenly distributed across the remaining size classes between 31-70 mm, with 14.3% of the paua measured at the site recorded in each of these four size classes. None of the sample population were of legal size (≥85 mm). This site was only surveyed for 45 minutes; slightly limiting the sample size.

The size frequency distribution of paua at the Lee Breakwater showed 60% of the individuals were between 30 to 50 mm in length. Although less abundant, higher size classes were also represented at this site (7% at or above minimum legal size).

The paua size frequency distribution at Kawaroa 1 was similar to that at the Lee Breakwater. The majority of paua found during the survey were in the smaller size classes, with 77.7% of paua between 21-50 mm in size. Approximately 3% of the sampled population were at or above the minimum legal size.

Paua size frequencies were more evenly distributed at Kawaroa 2, relative to the other sites. However, the size distribution was still slightly skewed to the lower end; with 50% of the recorded paua between 11-30 mm. Approximately 8% of the sampled population were at or above the minimum legal size. This site could only be surveyed for 30 minutes which has resulted in a reduced sample size.

Paua abundance increased with size at Kawaroa 3, up until the 51-60 mm size class. Counts dropped rapidly in the larger size classes. No legal paua were recorded at this site.

Other kaimoana species

Kina and Cook's turban shells present on the five reef sites were counted, but not measured. Pūpū (cat's eye) were not counted, given that this species is very common on the reefs around Taranaki and is 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 in 2018

	Arakaitai	Lee Breakwater	Kawaroa 1	Kawaroa 2	Kawaroa 3
Count duration (min)	45	60	60	30	60
Kina (actual count)	26	3	8	1	51
Kina (count/minute)	0.6	0.1	0.1	0.0	0.9
Cook's turban (actual count)	0	0	0	1	7

The site at Kawaroa 3 had the most kina, followed by Arakaitai, Kawaroa 1, the Lee Breakwater and Kawaroa 2. The kina counts per minute were similar at Kawaroa 3 and Arakaitai. Cook's turbans were relatively rare at all sites, and were only detected at Kawaroa 2 and Kawaroa 3. As in previous years, pūpū were plentiful, either common or abundant, at all five sites (TRC, 2016).

Trends over time

Paua

A summary of paua count and length data collected over all surveys to date is 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 (pre-dredge) (3 surveys)	2.57	4.03	2.23	2.63	5.13
Mean count per minute (post-dredge) (14 surveys)	5.92	3.75	3.29	2.99	5.67
Mean count per minute (all surveys)	5.29	3.81	3.10	2.92	5.57
Minimum size (mm) (all surveys)	5	5	10	4	10
Maximum size (mm) (all surveys)	95	100	110	105	100
Mean size (all surveys)	46.46	42.75	44.71	51.94	49.54

Since the kaimoana surveys began in 2003, Kawaroa 3 has had the highest average count of paua per minute, followed by Arakaitai, the Lee Breakwater, Kawaroa 1 and Kawaroa 2. Most sites have shown a higher mean count per minute in post-dredge surveys when compared with pre-dredge surveys. However, there has been a 7% decrease in the mean count per minute recorded at the Lee Breakwater since dredging was introduced. The smallest paua recorded to date was found at Kawaroa 2 and was 4 mm in length. Similarly small paua (5 mm) have also been recorded at Arakaitai and at the Lee Breakwater. The largest paua found was at Kawaroa 1, and measured 110 mm. Kawaroa 2 has the greatest historical mean length of

paua (51.94 mm), while the Lee Breakwater site has the lowest mean length (42.75 mm). Mean lengths are similar across the five sites, all between 42-52 mm.

Graphs of the mean number of paua counted per minute and mean paua lengths, for all kaimoana surveys carried out at the five sites, are presented in Figures 3 and 4.

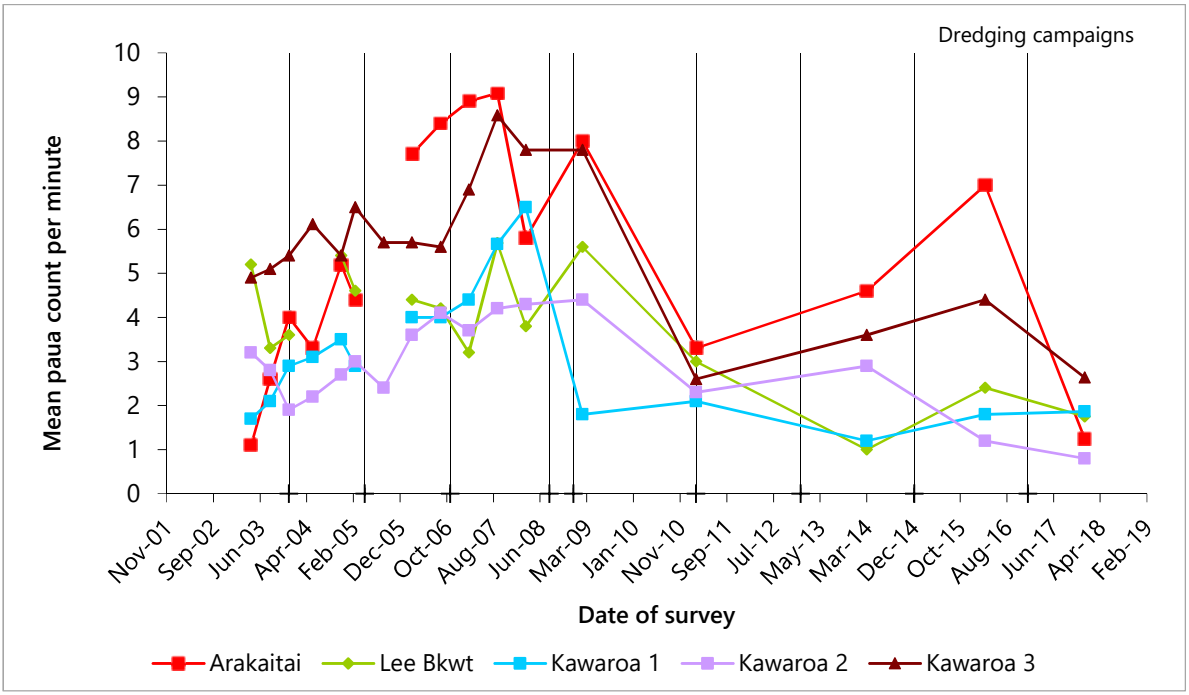

Figure 3 Mean number of paua counted per minute searched

The number of paua per minute showed a general increase at all sites from 2003 to 2007 (Figure 3). Lower numbers of paua per minute were recorded during the 2011 and 2014 surveys, with numbers increasing again during the 2016 survey. Similar or lower counts were recorded in 2018, when compared with the previous survey. In particular, there was a considerable decrease in the number of paua counted per minute at Arakaitai.

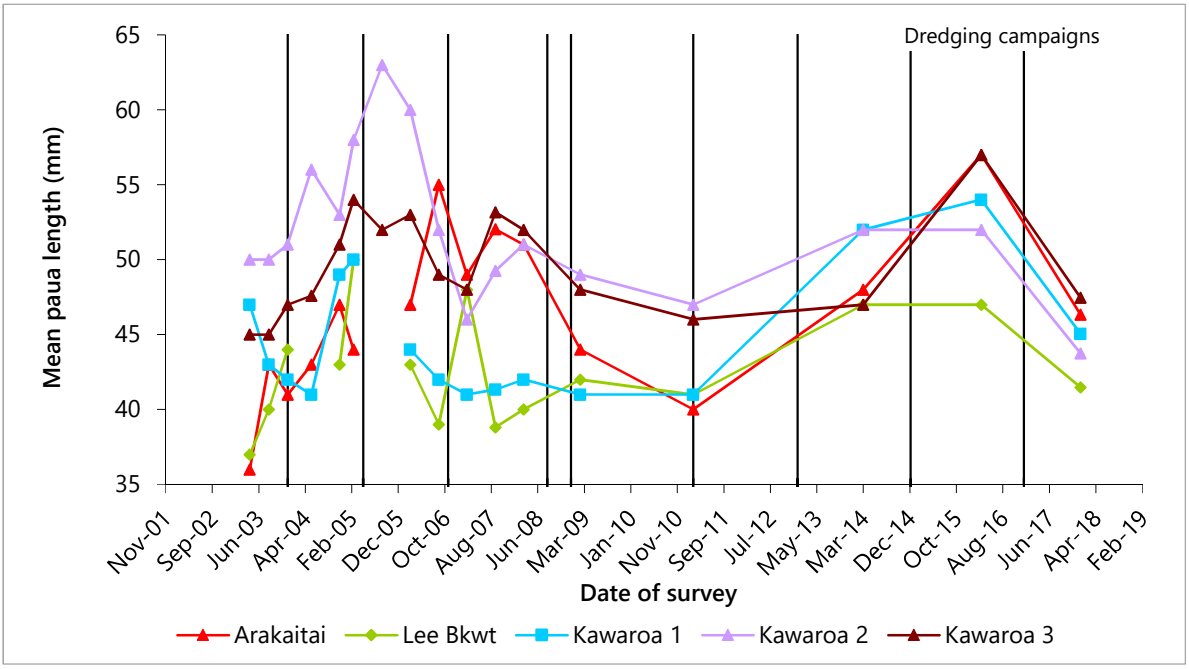

Figure 4 Mean length of paua at the five reef sites

Mean paua length has typically remained between 40-55 mm at the majority of sites, with the exception of peaks greater than 55 mm recorded at Kawaroa 2 between 2004 and 2006, and at Kawaroa 3 and Arakaitai in 2016. There was an almost uniform decrease in mean paua length at all sites in 2018, compared with 2016.

Kina

Figure 5 shows the mean number of kina recorded per minute, for all surveys carried out to date.

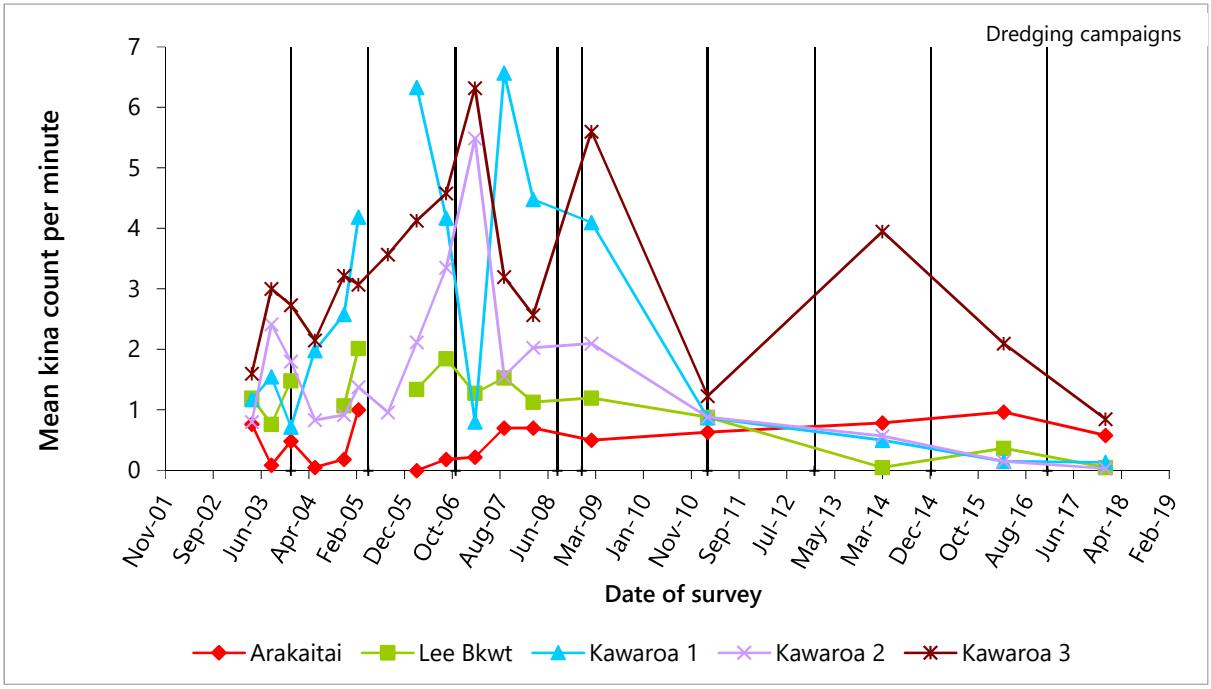

Figure 5 Kina count per minute

The Arakaitai Reef and Lee Breakwater sites have shown the least amount of variation in mean kina count per minute 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. Mean kina counts per minute have been particularly low at all five sites since 2009, with the exceptions of the higher counts recorded at Kawaroa 3 in 2014 and 2016. Although Kawaroa 3 still maintains the highest counts of the sites, kina counts have been steadily decreasing here since 2014.

Discussion

This is the 17th survey for the kaimoana monitoring programme for Port Taranaki, and the fourteenth 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-March 2004. There was concern by the general public and local iwi that sand inundation from the dredging campaigns would affect kaimoana gathering from the local reefs. 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 helps to determine whether the dispersal of sand at the inshore dumping ground is affecting the rocky reefs.

Differences between sites

During the 2018 survey, the highest mean paua count per minute was recorded at Kawaroa 3, followed by Kawaroa 1, the Lee Breakwater, Arakaitai and Kawaroa 2 respectively (Table 2). Kawaroa 3 also recorded the highest count of kina, with the next highest count recorded at Arakaitai and very few counted at the

remaining sites. These differences between sites can often be attributed to habitat availability. Habitat has a fundamental influence on the distribution of paua and kina, with both species more abundant when suitable habitat is present. Higher counts were observed when there was greater under boulder habitat available, and the macroalgal species *Carpophyllum* sp. was present. When large boulders, breccia terraces, cemented boulders or sand were present, or in areas where macroalgae cover was reduced, the numbers of paua and kina counted were generally 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* sp.

The Kawaroa 2 site has a dense population of *Carpophyllum* sp. in the bays on either side of the outcrop. The rocks and boulders at this site are generally 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 in length) providing more under boulder habitat, and abundant *Carpophyllum* sp. 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 mixture of small rocks and large boulders, and is sheltered from the prevailing wind and sea conditions. Despite these favorable conditions, and contrary to the other four sites, the mean paua count per minute at the Lee Breakwater has declined since dredging began.

At Arakaitai Reef, the large number of small loose rocks appears to provide excellent habitat for paua around the 40-70 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 typically found here (though not in the most recent survey). It should be noted that the 2018 survey at this site was carried out on a slightly higher tide than normal (0.4m). Although this was compensated for by undertaking the survey in slightly deeper water, it likely still reduced the area of optimal habitat that could be surveyed; potentially influencing the results.

Paua size frequency distributions were comparable at Kawaroa 3 and Arakaitai, which recorded relatively normal distributions around a mode between 50 to 70 mm in length. Paua at Lee Breakwater, Kawaroa 1 and Kawaroa 2 were skewed to the smaller end of the distribution with modes between 30 to 50 mm. It's unclear whether this may be due to subtle differences in habitat, recruitment variability, (illegal) harvesting, dredging, or other factors.

A common theme across all sites was the scarcity of legal size paua, a finding which may be partly attributed to the survey shore height. Surveys tend to be carried out in shallow subtidal habitat, generally on a low spring tide. This zone is commonly inhabited by smaller, immature paua, which will migrate to deeper subtidal habitats as they mature (McShane *et al*., 1994). Kaimoana gathering is also typical at this height on the shore (as is often noted during the surveys). Therefore, due to the natural subtidal migration of mature paua, and the constant pressures of kaimoana harvesting, this survey is unable to provide a complete size distribution assessment of the entire paua population. Instead, the survey data is more skewed towards the immature fraction of the population.

Change over time

The average size of paua demonstrated a uniform decrease across the five monitoring sites when comparing the 2018 results with those from the previous survey. Further analysis is required to better understand potential underlying causes, such as dredging effects, harvesting pressures and natural variation (e.g. recruitment events). Despite this decrease, sizes generally remained within the historical range.

At each site, the abundance of paua and kina was highest between 2004 and 2009. After 2009, there was a sudden and considerable decrease in their abundances. There was a divergence in trends between 2010 and 2016, particularly when comparing Kawaroa 3 and Arakaitai with the remaining sites. The results of the 2018 surveys recorded lower abundances of both paua and kina than what was recorded in 2010, and in some cases, the lowest abundances in the history of these surveys. It should be noted that survey times were reduced at Kawaroa 2 and Arakaitai in 2018 due to inclement conditions. Although the results at these sites are still standardised by time (in terms of count per minute), it is possible that the inclement conditions influenced the search effectiveness during these surveys.

There are a number of potential factors could have influenced the apparent decreases in abundance, including:

- Natural variation in environmental conditions (increased sand deposition and wave exposure);
- Human impact from increased (and illegal) 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 the relative influence of the above factors on paua and kina abundance and the size frequency of paua is not straightforward. However, further light can be shed on these results by reviewing the intertidal surveys and sand inspections that were also carried out as part of the dredge campaign monitoring programme (TRC, 2018a; TRC, 2018b). The intertidal surveys were carried out during spring in 2017, prior to the kaimoana surveys. These surveys, undertaken at two sites on Kawaroa Reef and one site on Arakaitai Reef, found no effects on intertidal communities at the mid-shore height, nor were there any increases in sand cover at any of the sites. The sand inspections were carried out prior, during, soon after and one year following the dredge campaign. No significant accretions of sand were discovered at Kawaroa Reef during the course of the inspections. Considerable sand build up was found high on the reef at Arakaitai, though evidence suggests that this was due to natural processes.

Conclusion

There has been an apparent decrease in the abundance of paua and kina on these reefs in recent years, as well as a uniform decrease in average paua length across all sites since 2016. There are a number of factors that could have potentially influenced these results, including natural variation in environmental conditions, increased (and illegal) kaimoana harvesting, dredging activities and changes in personnel undertaking the surveys. Determining how these factors have influenced paua and kina counts and sizes is not straightforward; however, there was no major build-up of sand on the reefs noted in association with the 2017 dredge campaign.

The results of this survey highlight the importance of using complimentary survey techniques (i.e. sand inspections, intertidal surveys and kaimoana surveys) to monitor potential effects from activities such as dredge disposal. It is recommended that the kaimoana survey method and analytical process is refined for the next round of monitoring, in order to better differentiate the factors potentially influencing the kaimoana communities at Kawaroa and Arakaitai Reefs. Such refinements could include:

- Visual estimates of shallow subtidal sand cover during the kaimoana survey to detect subtle changes in habitat availability and further contextualize survey results; and
- Long term comparisons of the size distribution data to identify peaks and troughs in recruitment which may be useful for interpreting changes in paua abundance and average size over time.

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