

Opunake Artificial Reef  
Monitoring Programme  
2005-2009  
Technical Report 2009–33

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## Executive summary

The Opunake Artificial Reef Trust is undertaking to construct an artificial reef in Opunake Bay for the purpose of surfing. This report for the period July 2005-June 2009 describes the monitoring programme implemented by the Taranaki Regional Council to collect data prior to the construction of the artificial reef at Opunake, along with assessing the environmental performance of the Opunake Artificial Reef Trust in the initial construction of the artificial reef.

The Trust holds a total of three resource consents, which include a total of 41 conditions setting out the requirements that the Company must satisfy. The Trust holds one consent to allow it to occupy the coastal marine area, one consent to erect a geo-textile structure, and one consent to discharge sandy sediments during construction.

The Council's monitoring programme for the period under review included various inspections, five kaimoana surveys and five intertidal ecological surveys.

Intertidal and kaimoana surveys were undertaken in order to gather baseline data for comparison with data collected post construction.

Inspections of the area during construction found no significant adverse effects on the environment.

During the pre-construction and initial construction phase of the Opunake Artificial Reef, the Opunake Artificial Reef Trust has demonstrated a good level of environmental performance and compliance with the resource consents. Consent conditions were generally complied with, however as the reef is basically in place it is considered that conditions relating to signage should be complied with. During the period under review there were no unauthorised incidents associated with the site.

This report includes recommendations for the 2009-2010 year.



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# **1. Introduction**

## **1.1 Compliance monitoring programme reports and the Resource Management Act 1991**

### **1.1.1 Introduction**

This Monitoring Report for the period July 2005-June 2009 by the Taranaki Regional Council describing the monitoring programme associated with resource consents held by the Opunake Artificial Reef Trust (OART). The OART is involved in the development of an artificial surfing reef (ASR) situated in Opunake Bay.

This report covers the results and findings of the monitoring programme implemented by the Council in respect of the consents held by the OART that relate to the construction of an ASR in Opunake Bay. This is the first Monitoring Report to be prepared by the Taranaki Regional Council to cover the OART 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 compliance monitoring under the Resource Management Act and the Council's obligations and general approach to monitoring sites through annual programmes, the resource consents held by OART, the nature of the monitoring programme in place for the period under review, and a description of the activities and operations conducted in relation to the Opunake artificial reef.

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

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

Section 4 presents recommendations to be implemented in the 2009-2010 monitoring year.

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

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

(e) risks to the neighbourhood or environment.

In drafting and reviewing conditions on discharge permits, and in implementing monitoring programmes, the Taranaki Regional Council is recognising the comprehensive meaning of 'effects' inasmuch as is appropriate for each discharge source. Monitoring programmes are not only based on existing permit conditions, but also on the obligations of the Resource Management Act to assess the effects of the exercise of consents. In accordance with section 35 of the Resource Management Act 1991, the Council undertakes compliance monitoring for consents and rules in regional plans; and maintains an overview of performance of resource users against regional plans and consents. Compliance monitoring, including impact monitoring, also enables the Council to continuously assess its own performance in resource management as well as that of resource users particularly consent holders. It further enables the Council to continually re-evaluate its approach and that of consent holders to resource management, and, ultimately, through the refinement of methods, 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 OART during the period under review, this report also assigns an overall rating. The categories used by the Council, and their interpretation, are as follows:

- a **high** level of environmental performance and compliance indicates that essentially there were no adverse environmental effects to be concerned about, and no, or trivial (such as data supplied after a deadline) non-compliance with conditions.
- a **good** level of environmental performance and compliance indicates that adverse environmental effects of activities during the year were negligible or minor at most, items of concern were resolved positively, co-operatively, and quickly, the Council did not record any verified unauthorised incidents involving significant environmental impacts and was not obliged to issue any abatement notices, there were perhaps some items noted on inspection notices for attention but these items were not urgent nor critical, and follow-up inspections showed they have been dealt with.
- **improvement desirable** indicates that the Council may have been obliged to record a verified unauthorised incident involving significant environmental impacts against the company, and/or abatement notices may have been issued; there were adverse environmental effects arising from activities and intervention by Council staff was required, and there were matters that required urgent intervention, took some time to resolve, or remained unresolved at end of the period under review.
- **poor** performance is used when there were grounds for prosecution or infringement notice

## 1.2 Process description

The purpose of the artificial reef was to *“enhance the natural wave energy in the bay to provide a surfing break which is challenging and unique within the Taranaki Region”*. The idea of developing an artificial surfing reef at Opunake was first pursued in 1998 by

Mr Eddie Klaassen and members of the future OART. The trust requested that Dr Kerry Black undertake a site selection study to determine potential sites within 10 km of Opunake township. The assessment concluded that the most beneficial sites were in Opunake Bay.

A Phase I feasibility study was completed by ASR Ltd in 2001 which included computer modelling and data collection. The study assessed the surfing potential and any potential environmental impacts. The study showed that the project was feasible and that there were two potential satisfactory positions for the reef: on both the northern and southern sides of Opunake Bay. After consultation with various groups, the northern side of the bay was chosen as the preferred site, and a Phase II study subsequently undertaken by ASR Ltd for the detailed design and environmental impact studies required for consents for reef construction.

The reef was designed to produce a fast hollow wave, which would be suitable for surfers and body boarders, and which would be a unique wave in the area.

The positioning of the reef (Figure 1) was based on bathymetric data, spatial distribution in rock and sand cover, aerial photographs, video and visual observations, numerical modelling, and wave angle measurements.

The reef has been constructed in 3.0 to 1.8 m water depth (below chart datum), with the depth of the shallowest contour to be 0.0 m below chart datum. In order to ensure the reef breaks as often as possible, it needed to be as shallow as possible, without emerging (except in extreme low tide conditions).



**Figure 1** Aerial photograph showing the location of the artificial reef and the areas used for construction

The reef covers an area of approximately 2970m<sup>2</sup>, with a volume of approximately 4900m<sup>3</sup>, and dimensions of approximately 30 metres wide, 3.5 metres high, and 99 metres long.

The reef was placed on an area of seabed that has a thin layer of sand over underlying rock strata. The location identified was chosen so that no excavation was required to form a base for the reef, and therefore ecological effects were kept to a minimum, and any risk of damage from sharp protruding rocks is minimised.

Construction was undertaken using large sand-filled geo-textile containers, which were specifically manufactured to allow the most accurate reproduction of the designed reef profile. Geo-textiles are synthetic materials that can be formed into flexible and durable sheet fabrics that are resistant to tension and tear.

Each empty geo-textile unit (Photograph 1) was lowered onto the seabed and secured in the correct position before the unit is filled with sand (slurried with water) *in-situ* using an outlet pipe from a suction dredge.



**Photograph 1** Geo-textile bags awaiting deployment

The reef structure did not need to be fixed to the seafloor, because the stability of the geo-textile units under wave action is ensured due to the large weight of each individual container, in combination with the friction between adjacent units.

Construction of the artificial reef began in early 2006 before being halted due to unfavourable weather and the equipment being required at Mount Manganui. Further work was undertaken the following two summers, and as of April 2008 the 27 geo-textile bags were in place with fine-tuning required to complete the job planned in the summer of 2009/2010.

## 1.3 Resource consents

### 1.3.1 Coastal permits

Section 12(1)(b) of the Resource Management Act stipulates that no person may erect, reconstruct, place, alter, extend, remove, or demolish any structure that is fixed in, on, under, or over any foreshore or seabed, unless the activity is expressly allowed for by a resource consent, a rule in a regional plan, or by national regulations.

Opunake Artificial Reef Trust holds coastal permit **6376** to occupy an area of the coastal marine area within Opunake Bay for the purposes of constructing and maintaining an artificial surfing reef. This permit was issued by the Taranaki Regional Council on 31 May 2005 under Section 87(c) of the Resource Management Act. It is due to expire on 1 June 2018.

There are seven special conditions attached to the consent. Condition 1 requires that the consent is undertaken in accordance with documentation submitted in support of the application.

Conditions 2 and 3 deal with notification prior to construction, both to the Council and the public (Photograph 1).

Conditions 4 and 5 deal with public access to the marine area.

Conditions 6 and 7 deal with lapse and review of the consent.

Opunake Artificial Reef Trust holds coastal permit **6377** to erect, place and maintain a geo-textile structure within the coastal marine area for the purposes of creating an artificial surfing reef. This permit was issued by the Taranaki Regional Council on 31 May 2005 under Section 87(c) of the Resource Management Act. It is due to expire on 1 June 2018.



**Photograph 2** Signage erected in accordance with various consent conditions

There are 22 special conditions attached to the consent. Condition 1 requires the consent holder to adopt the best practicable option to prevent or minimise adverse effects on the environment. Condition 2 requires the exercise of the consent to be in accordance with documentation submitted in support of the application.

Conditions 3 and 4 require a programme for the installation and a contingency plan, to be provided to the Council prior to works commencing.

Conditions 5 and 6 stipulate that the consent holder notify both the Council and the public prior to commencement of construction.

Condition 7 stipulates that material used to fill the geo-textile bags is similar to that of existing sands in Opunake Bay.

Condition 8 requires that construction and maintenance of the structure comply with relevant noise standards.

Condition 9 requires that the consent holder arranges for a suitably qualified person to provide written confirmation that the works have been constructed in accordance with the design plan.

Condition 10 stipulates that the consent holder survey and map the position of the reef within 90 days of completion, while condition 11 requires the erection and maintenance of signs on Opunake Beach advising of this location.

Condition 12 stipulates that the consent is subject to annual compliance monitoring inspections to be undertaken by the Council.

Condition 13 stipulates that there be no adverse ecological effects, including effects to kaimoana.

Condition 14 requires the consent holder to remove any geo-textile cloth that is washed up on local beaches.

Condition 15 requires a written report on the structural integrity of the reef be submitted to the Council: following construction, after a significant storm event, and annually thereafter. Condition 16 stipulates that the structure be maintained to the satisfaction of the Council.

Condition 17 requires that the consent holder be responsible for meeting all the conditions of the consent. Condition 18 requires a bond of \$50,000 be paid on commencement of the construction of the reef.

Conditions 19 and 20 deal with provisions for the removal of the reef.

Conditions 21 and 22 deal with lapse and review of the consent.

Opunake Artificial Reef Trust holds coastal permit **6378** to discharge sandy sediment into the coastal marine area during the construction and maintenance of an artificial surfing reef. This permit was issued by the Taranaki Regional Council on 31 May 2005 under Section 87(c) of the Resource Management Act. It is due to expire on 1 June 2018.

There are 12 special conditions attached to the consent. Condition 1 requires the consent holder to adopt the best practicable option to prevent or minimise any adverse effects on the environment.

Condition 2 requires that the exercise of the consent be undertaken in accordance with documentation submitted in support of the application.

Conditions 3 and 4 requires that prior to construction, the consent holder provide the Council with a contingency plan and programme of works.

Conditions 5 and 6 stipulate that the consent holder notify both the Council and the public prior to commencement of construction.

Condition 7 and 8 deal with discharges. Condition 9 stipulates that the volume of seabed and foreshore disturbance be minimised. Condition 10 requires that there be no significant adverse ecological effects, including effects on kaimoana.

Conditions 11 and 12 deal with lapse and review of consent.

Copies of the permits are attached to this report in Appendix I.

## **1.4 Monitoring programme**

### **1.4.1 Introduction**

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

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

The monitoring programme for the Opunake Artificial Reef consisted of four primary components.

### **1.4.2 Programme liaison and management**

There is generally a significant investment of time and resources by the Taranaki Regional Council in ongoing liaison with resource consent holders over consent conditions and their interpretation and application, in discussion over monitoring requirements, preparation for any reviews, renewals, or new consents, advice on the Council's environmental management strategies and the content of regional plans, and consultation on associated matters.

### 1.4.3 Site inspections

The site was visited occasionally during construction periods. This consisted of viewing activities from the cliff top, mainly to check for excess turbidity.

### 1.4.4 Kaimoana surveys

Kaimoana surveys were undertaken prior to construction of the artificial reef at five sites within Opunake Bay, Middleton Bay and at Manihi Road during January and February 2006 (Photograph 3).

### 1.4.5 Intertidal ecology

Intertidal ecological surveys were carried out at five sites prior to construction of the reef during February 2006 and February 2007.



**Photograph 3** Measuring paua during a kaimoana survey

## 2. Results

### 2.1 Inspections

The site was visited several times during the initial phase of construction (Photographs 4 and 5). This consisted of a visual inspection from the cliff-top to assess compliance with various conditions of the consents, such as construction in accordance with application, best practicable option to prevent and minimise effects to the environment, and maintenance of public access as far as practicable.



**Photograph 4** Buoys float the pipe used for pumping the sand slurry mix out to the geo-textile bags



**Photograph 5** Sand pumping equipment

## 2.2 Kaimoana surveys

There were concerns raised in the pre hearing process that kaimoana gathering from the local reefs would be affected by sand inundation. As a result of this concern, special conditions 13 and 7, of consents 6377 and 6378 respectively, require that the exercise of the consents shall not result in any significant adverse ecological effects including effects to kaimoana. In order to assess this, five reef sites were monitored pre-construction, with three sites at Opunake Bay, one at Middleton Bay and a control site at Manihi Road. Kaimoana surveys will be undertaken regularly following completion of the artificial reef to assess if there have been any adverse effects on the kaimoana beds.

The kaimoana considered most important to monitor were Paua (*Haliotis iris* and *Haliotis australis*); Kina (*Evechinus chloroticus*), cook's turban (*Cookia sulcata*) and pupu or cat's eye (*Melagraphia aethiops* and *Turbo smaragdus*).

The first pre construction kaimoana survey was carried out between 30 January and 1 February 2006 as part of the pre-construction compliance monitoring programme. The sites were Opunake Bay 1 - 500m S of Opunake Beach, Opunake Bay 2 - 50 metres E of Opunake Bay boat ramp, Opunake Bay 3 - Mid Opunake Beach/Middleton Bay, Middleton Bay and a control site at Manihi Road approximately 12 kilometres north west of the proposed artificial reef site (Figure 2).



**Figure 2** Kaimoana and intertidal survey sites around the Opunake artificial reef

Each inspection included the low intertidal to shallow subtidal zone, which is recognised to be abundant in kaimoana species. The monitoring technique has to quantify kaimoana stocks or numbers in order to be able to detect any impact. Quantitative sampling using transects and quadrats, although typically preferable, are inadequate to estimate population numbers when the species are cryptic, in low average densities and aggregated in shallow, wave-swept habitats. Therefore, a time-count sampling method was used, otherwise known as a rapid visual technique. Although this technique is semi-quantitative it can provide information regarding relative abundance and size frequency of paua. The only difficulty in using this method is that quantitative estimates of abundance cannot be readily derived from the data collected. For each site, all available rocky crevice and under rock habitat was searched for 30 minutes (Photograph 6). Within this time interval all paua encountered are measured and counted. All other kaimoana species are also counted but not measured.

From the five kaimoana reefs surveyed pre-construction, 445 paua were counted and measured during the 30 minute search at each site. Table 1 shows that Middleton Bay had many more paua than the other four sites. Opunake Bay sites 1 and 3 had a similar number of paua, followed by the Manihi Road site and Opunake Bay 2. It should be noted that the aim of these surveys is not to compare the various sites to each other, but to compare individual sites over time, both pre-construction and once construction of the reef is complete.

**Table 1** Details of paua found at the five intertidal sites

	Opunake Bay 1	Opunake Bay 2	Opunake Bay 3	Middleton Bay	Manihi Road
Count	81	56	82	162	64
Min (mm)	20	20	30	20	35
Max (mm)	95	98	85	90	100
Mean (mm)	62	64	65	59	82
Count (paua/min)	2.7	1.9	2.7	5.4	2.1

Habitat was very important to the distribution of paua, with a higher number found where suitable habitat was present. More paua were observed when there was a greater under boulder habitat present in conjunction with the presence of the kelp species *Carpophyllum maschalocarpum*. The number of paua and kina counted was lower when large boulders or sand was present, or when kelp was absent. Differences occurred between the sites in terms of habitat, which is also reflected in the results. At the Opunake Bay 2 and 3 sites, larger boulders were more common which were not as suitable for the paua to live on, as in Taranaki most paua are found on the underside of smaller rocks. As a result of this few paua were found at these sites. At the Middleton Bay site smaller rocks were present in conjunction with a large distribution of kelp, which resulted in a large number of paua found during the 30 minute survey.

All paua counted during the survey period were less than 101 mm in length, which is below the legal size of 125 mm. It is believed that paua off the Taranaki coastline have a slower growth rate which could be influenced by excessive physical exposure and limited resource availability, which are linked to wave exposure and sediment flux. The mean size of paua surveyed across all sites was 66 mm. This mean size is

significantly greater than the mean size of paua found off the New Plymouth coastline, where during the most recent kaimoana survey conducted as part of Port Taranaki Ltd compliance monitoring (summer 2009), 45mm was the mean size of paua found across five locally important kaimoana beds (there were many more of these smaller paua found at these northern sites compared with at Opunake).

All kina counted during the survey were reasonably small also. This is supported by previous studies undertaken by Howse *et al.* (2000) and the Taranaki Regional Council which found that kina are smaller in areas with both high wave exposure, and high-suspended sediment concentrations.

During the survey period a large number of people were present gathering kaimoana on all of the reefs surveyed. The numbers gathering seafood were not recorded, but it was observed that a large number of undersize paua were being taken from the reef, and total numbers being taken were well in excess of the Ministry of Fisheries daily limit of 10 per person.

With this baseline data set, and the collection of kaimoana and intertidal data in the future, an assessment of any ecological effects that may be attributable to the artificial reef will be made. Differentiation between effects due to localized natural causes or the artificial reef will be made with the aid of the control site which is well out of the influence of Opunake Bay.

A full copy of the kaimoana survey report is contained in Appendix II.



**Photograph 6** Searching for paua at Opunake 1

## 2.3 Intertidal surveys

A pre-construction survey was carried out at five reef sites during February 2006 and February 2007 (this was undertaken over two summers due to the availability of suitably low tides). The objective of the survey was to gather information on biological community structure prior to construction, so that any adverse impacts as a result of construction of the reef may be determined.

The survey was conducted at five sites. The sites were Opunake Bay 1 - 500m S of Opunake Beach, Opunake Bay 2 - 50 metres E of Opunake Bay boat ramp, Opunake Bay 3 - Mid Opunake Beach/Middleton Bay, Middleton Bay and a control site at Manihi Road approximately 12 kilometres north west of the proposed artificial reef site (Figure 2).

At each site, a 50 metre transect was laid parallel to the shore, approximately 0.6 metres above chart datum. This transect was used to establish five, 5 metre x 3 metre blocks. Within each block 5 random 0.25 m<sup>2</sup> 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 overturned.

As with the kaimoana survey data, the objective of the surveys is not to compare the five sites to one another, but to collect baseline data in order to compare individual sites over time following completion of the artificial reef. However, some analysis was undertaken on the data and is discussed briefly below.

Analyses of the pre-construction mean number of total species per quadrat showed that the control site at Manihi Road had the highest number of species followed by Middleton Bay. This was then followed in decreasing order by Opunake 2, Opunake Bay 1 and Opunake Bay 3.

Analyses of Shannon-Weiner diversity index showed a similar pattern as for species richness, however the Opunake Bay 3 site had a slightly higher diversity than the site Opunake Bay 1 site.

A relatively high number of species were found during the pre-construction survey, indicated healthy and diverse reefs around the (then proposed) site of the artificial reef. The results of this survey will be able to be used in future to compare pre-construction abundance and diversity of species, with post-construction levels.

A full copy of the results is attached in Appendix III.

## 2.4 Register of incidents

The Taranaki Regional 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 register ('unauthorised incident register' or UIR) includes events where the company concerned has itself notified the Council. The register contains details of any investigation and corrective action taken.

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

During the period July 2005 to June 2009, there were no incidents recorded by the Council that were associated with the Opunake Artificial Surf Reef.



**Photograph 7** Opunake Bay 2 intertidal monitoring site

### 3. Discussion

#### 3.1 Environmental effects of exercise of consents

No obvious environmental effects caused by the construction of the reef have been noted. As construction has been intermittent over the last few years, this would have distributed any periods where silt/sand may have been released over a long period of time, and hence reduced any potential effects.

Although condition 11 of consent 6377 requiring the erection and maintenance of signs at Opunake Beach and Middleton Bay boat ramp advising of the location of the artificial reef, was intended for when the reef was completed, as the 27 geo-textile bags are in place and only need minor amounts of filling the reef is already a potential hazard for activities such as boating, and these signs should be erected as soon as practicable.

#### 3.2 Evaluation of performance

A tabular summary of the consent holder's compliance record for the year under review is set out in Tables 2-4.

**Table 2** Summary of performance for Consent 6376-1 to occupy coastal marine area

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Exercise of consent undertaken in accordance with application	Inspections	Yes
2. Notification to Council prior to commencement of works	Received March 2006 and February 2007	Yes
3. Notification to public prior to commencement of works	Signage noted on inspections	Yes
4. Exercise of consent not to prevent free passage of public through area	Inspections and complaints register (no complaints received)	Yes
5. Public access limited to minimum for safety purposes, no restriction to Opunake Beach	Inspections and complaints register (no complaints received)	Yes
6. Lapse after 5 years if not exercised		N/A
7. Review of consent	Not reviewed	N/A

N/A = not applicable

**Table 3** Summary of performance for Consent 6377-1 – construction of artificial reef

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Best practicable option to avoid, remedy, or mitigate effects	Inspections found no evidence of adverse effects. No complaints received during period under review	Yes
2. Exercise of consent undertaken in accordance with application	Inspections	Yes
3. Programme for installation	Received March 2006	Yes

Condition requirement	Means of monitoring during period under review	Compliance achieved?
4. Contingency plan	Received March 2006	Yes
5. Notification to Council prior to commencement of works	Received March 2006 and February 2007	Yes
6. Notification to public prior to commencement of works	Signage noted on Inspections	Yes
7. Material used to fill geo-textile containers similar to existing sands at Opunake Bay	Inspections during construction	Yes
8. Construction and maintenance to comply with relevant noise standards	Inspections, no complaints received	Yes
9. Written confirmation reef has been constructed in accordance with application	Reef not yet complete	N/A
10. Survey and map position of reef	Due within 90 days of completion	N/A
11. Erect and maintain signs at Opunake Bay with location of reef	No signage regarding location of the reef	No
12. Consent subject to annual compliance monitoring	Monitoring programme prepared	Yes
13. No significant adverse ecological effects including on kaimoana	Intertidal and kaimoana surveys	Ongoing
14. Geo-textile cloth to be removed from local beaches if washed ashore		N/A
15. Written report on structural integrity of the reef	Due within one month of completion, then every three months for two years, annually thereafter	N/A
16. Structure maintained to satisfaction of Council	Reef survey scheduled during 2009-2010 monitoring period	N/A
17. Consent holder responsible for meeting conditions of consent		N/A
18. Provision of \$50,000 bond	Bond guaranteed by STDC	Yes
19. Notification of removal		N/A
20. Removal and reinstatement		N/A
21. Lapse of consent		N/A
22. Review of consent	Review not exercised	N/A

**Table 4** Summary of performance for Consent 6378-1 – to discharge sandy sediment

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Best practicable option to avoid, remedy, or mitigate effects	Inspections found no evidence of adverse effects. No complaints received during period under review	Yes
2. Exercise of consent undertaken in accordance with application	Inspections	Yes
3. Contingency plan	Received March 2006	Yes
4. Programme for installation	Received March 2006	Yes
5. Notification to Council prior to commencement of works	Received March 2006 and February 2007	Yes
6. Notification to public prior to commencement of works	Signage noted during inspections	Yes
7. Discharge uncontaminated water and material similar to existing sands	Inspections	Yes
8. Discharge, sediment loading and turbidity kept to a minimum	Inspections	Yes
9. Area and volume of seabed disturbance minimised	Not monitored during period under review	N/A
10. No adverse ecological effects, including effects on kaimoana	Intertidal and kaimoana surveys	Ongoing
11. Lapse of consent		N/A
12. Review of consent	No review undertaken	N/A

During the pre-construction and initial construction phase of the Opunake Artificial Reef, the Opunake Artificial Reef Trust has demonstrated a good level of environmental performance and compliance with the resource consents. Consent conditions were generally complied with, however as the reef is basically in place it is considered that conditions relating to signage should be complied with. During the period under review there were no unauthorised incidents associated with the site.

### 3.3 Alterations to monitoring programmes for 2009-2010

In designing and implementing the monitoring programmes for coastal activities in the region, the Taranaki Regional Council has taken into account the extent of information made available by previous authorities, its relevance under the Resource Management Act, the obligations of the Act in terms of monitoring and effects, and subsequently reporting to the regional community, and the scope of assessments required at the time of renewal of permits.

In the case of the Opunake Artificial Reef, the programme was undertaken during February 2006 and February 2007 as a pre-construction monitoring programme to collect baseline data. It was intended that post-construction data would be collected

the following summer, however the reef is yet to be completed. The reef is now at a stage where a dive survey can be carried out and it is proposed that for 2009-2010, this is undertaken. Should the reef be completed during the period under review, then post-construction kaimoana and intertidal surveys should be undertaken if and when sufficiently low tides are available. A recommendation to this effect is attached to this report.

#### **4. Recommendations**

1. THAT monitoring of the Opunake Artificial Reef in the 2009-2010 year consist of a dive survey of the reef structure.
2. THAT post-construction kaimoana and intertidal surveys are undertaken as soon as practicable, following notification of completion of the Opunake Artificial Reef.

## Glossary of common terms and abbreviations

The following abbreviations and terms are used within this report:

Chart datum	the lowest astronomical tide (the datum of the lowest possible tide)
Geo-textile	synthetic materials that can be formed into flexible and durable sheet fabrics that are resistant to tension and tear
Kaimoana	food collected from the sea
OART	Opunake Artificial Reef Trust
Quantitative (data)	is data measured or identified on a numerical scale
Resource consent	refer Section 87 of the RMA. Resource consents include land use consents (refer Sections 9 and 13 of the RMA), coastal permits (Sections 12, 14 and 15), water permits (Section 14) and discharge permits (Section 15)
RMA	Resource Management Act 1991 and subsequent amendments
Subtidal	below the level of low tide

## **Bibliography and references**

Black, K. and Mead, S. 2006. Opunake Reef Construction Manual. Prepared for the Opunake Reef Trust by ASR Limited.

## **Appendix I**

### **Resource consents held by Opunake Artificial Reef Trust**





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

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

Please quote our file number  
on all correspondence

**Name of  
Consent Holder:** Opunake Artificial Reef Trust  
P O Box 13  
OPUNAKE

**Consent Granted  
Date:** 31 May 2005

**Conditions of Consent**

**Consent Granted:** To discharge sandy sediment into the coastal marine area during the construction and maintenance of an artificial surfing reef at or about GR: P20:832-937

**Expiry Date:** 1 June 2018

**Review Date(s):** June 2006, June 2009, June 2012

**Site Location:** Coastal marine area offshore from Opunake Beach, Beach Road, Opunake

**Legal Description:** n/a

**Catchment:** Tasman Sea

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

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### **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 at all times adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any adverse effects on the environment from the exercise of this resource consent.
2. The exercise of this consent shall be undertaken generally in accordance with the documentation submitted in support of application 3027. In the case of any contradiction between the documentation submitted in support of application 3027 and the conditions of this consent, the conditions of this consent shall prevail.
3. Prior to the exercise of this consent the consent holder shall provide, to the satisfaction of the Chief Executive, Taranaki Regional Council, a written contingency plan, outlining measures to be taken in the event of a spill as a result of works authorised by this consent.
4. At least 14 working days prior to the commencement of works the consent holder shall provide the Taranaki Regional Council with a programme for the installation/construction of the artificial reef including but not limited to: a detailed design plan; methodology for construction; a schedule of proposed start dates and an estimation of the duration of the works; and details of the contractor including contact information for the project manager.
5. The consent holder shall notify the Chief Executive, Taranaki Regional Council in writing at least 7 working days prior to the commencement and upon completion of the initial installation and again at least 7 working days prior to and upon completion of any subsequent maintenance works which would involve the discharge disturbance of or deposition to the seabed or discharges to water.
6. The consent holder shall notify the public of the commencement of construction works through the erection of notices within the vicinity of the affected area(s) and through public notices in the Taranaki Daily News, and the Opunake and Coastal News newspapers.

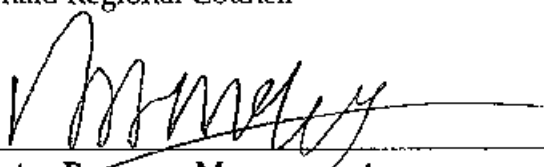
7. Discharge into the coastal marine area shall be limited to uncontaminated water and material that is similar to existing sands at Opunake Bay, including but not limited to colour and size, and shall be free of any organics (excluding shell material) or contaminants.
8. The consent holder shall undertake all practicable measures to ensure that any discharge, sediment loading, and turbidity from the operation is kept to an absolute minimum.
9. The consent holder shall ensure that the area and volume of seabed and foreshore disturbance shall, so far as is practicable be minimised and any areas which are disturbed shall, so far as practicable be reinstated.
10. The exercise of this consent shall not result in any significant adverse ecological effects including effects to kaimoana.
11. This consent shall lapse on the expiry of five years after the date of issue of this consent, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.
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 2006 and/or June 2009 and/or June 2012, 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.

Footnote:

- (i) *The grant of consent does not preclude the possibility that the consent holder may need to reach agreement with tangata whenua in the exercise of the consent, in the event that any claim to customary ownership of the site is upheld by a New Zealand Court of Law.*

Signed at Stratford on 31 May 2005

For and on behalf of  
Taranaki Regional Council

  
\_\_\_\_\_  
Director-Resource Management





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Please quote our file number  
on all correspondence

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

**Name of  
Consent Holder:** Opunake Artificial Reef Trust  
P O Box 13  
OPUNAKE

**Consent Granted  
Date:** 31 May 2005

**Conditions of Consent**

**Consent Granted:** To erect, place, and maintain a geo-textile structure within the coastal marine area for the purposes of creating an artificial surfing reef at or about GR: P20:832-937

**Expiry Date:** 1 June 2018

**Review Date(s):** June 2006, June 2009, June 2012

**Site Location:** Coast marine area offshore from Opunake Beach, Beach Road, Opunake

**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 at all times adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any adverse effects on the environment from the exercise of this resource consent.
2. The exercise of this consent shall be undertaken generally in accordance with the documentation submitted in support of application 3026. In the case of any contradiction between the documentation submitted in support of application 3026 and the conditions of this consent, the conditions of this consent shall prevail.
3. At least 14 working days prior to the commencement of works the consent holder shall provide the Taranaki Regional Council with a programme for the installation/construction of the artificial reef including but not limited to: a detailed design plan; methodology for construction; a schedule of proposed start dates and an estimation of the duration of the works; and details of the contractor including contact information for the project manager.
4. Prior to the exercise of this consent, the consent holder shall provide for the written approval of the Chief Executive, Taranaki Regional Council, a contingency plan, which is to include methods to contain and recover geo-textile material in the event of the reef rupturing.

## Consent 6377-1

5. The consent holder shall notify the Chief Executive, Taranaki Regional Council in writing at least 7 working days prior to the commencement and upon completion of the initial installation and again at least 7 working days prior to and upon completion of any subsequent maintenance works on the artificial reef.
6. The consent holder shall notify the public of the commencement of construction works through the erection of notices within the vicinity of the affected area(s) and through public notices in the Taranaki Daily News, and the Opunake and Coastal News newspapers.
7. Material used to fill the geo-textile containers for the artificial surf reef shall be similar to existing sands at Opunake Bay, including but not limited to colour and size, and shall be free of any organics (excluding shell material) or contaminants. Proof of the sand source shall be supplied to the Chief Executive, Taranaki Regional Council prior to commencement of construction.
8. The construction and maintenance of the structure authorised by this consent shall comply with the relevant noise standards set out in New Zealand Standard 6803:1999 *Acoustics – Construction Noise*.
9. The consent holder shall arrange for a suitably qualified person to provide written confirmation that the works have been constructed in accordance with the detailed design plan submitted to the Chief Executive, Taranaki Regional Council as provided in accordance with condition 3 above. Such written confirmation shall be submitted to the Chief Executive, Taranaki Regional Council within 20 working days of the completion of the works.
10. The consent holder shall survey and map the position of the artificial reef within 90 days of the completion of construction and shall provide a copy of the plan showing the location [to within plus or minus 5 metres] of the structure on the seabed, and the location of the occupied area to the Taranaki Regional Council, the Hydrographic Office – Land Information New Zealand, Royal New Zealand Navy, and the Maritime Safety Authority.
11. The consent holder shall erect and maintain signs at Opunake Beach, and at the Middleton Bay boat ramp, advising of the location of the artificial reef.
12. This consent shall be subject to annual compliance monitoring inspections and any additional monitoring as required by the Taranaki Regional Council, including the payment of related charges.
13. The exercise of this consent shall not result in any significant adverse ecological effects including effects to kaimoana.
14. If during the term of this consent, any geo-textile cloth [used in construction of the artificial reef] is washed up on any beach within 10 km of the site, then the consent holder shall remove the material forthwith.

15. The consent holder shall provide to the Chief Executive, Taranaki Regional Council, a written report on the structural integrity of the artificial reef:
  - a) in the month following completion of construction;
  - b) after a significant storm event, or every three months for the first two years after construction of the reef, if no significant storm event occurs; and
  - c) annually thereafter.

The reports shall describe that state of the reef and its immediate environs, including but not limited to any scouring around the reef structure, any evident wear and tear in the structure, and any repair works(s) undertaken.

16. The structure shall be maintained to the satisfaction of the Chief Executive, Taranaki Regional Council.
17. The consent holder or any entity to whom this consent may be transferred, shall remain in existence for the duration of the consent, and be responsible for meeting all conditions of the consent.
18. The consent holder shall, prior to the exercise of this consent, enter into and maintain a performance bond drawn in terms to be agreed to provide for the removal of the surf reef by the Taranaki Regional Council, if this is deemed necessary pursuant to condition 16, or in circumstances where no entity remains responsible for the consents pursuant to condition 17. The bond shall be in the favour of the Taranaki Regional Council and shall be to the value of \$50,000 to be available immediately on the commencement of construction of the reef.
19. In the event that part of or the whole of the artificial reef structure is to be removed, the consent holder shall provide written notice of the commencement of removal, how long it is anticipated to take, the volume of natural material to be released, and the methodology for removing other materials at least ten working days prior to the commencement of removal.
20. The structure authorised by this consent shall be removed and the area reinstated, if and when the structure is no longer required, upon expiry of this consent, or if the reef is deemed by the Taranaki Regional Council or the consent holder to be structurally unsound or irreparable. The consent holder shall notify the Chief Executive, Taranaki Regional Council, in writing at least 48 hours prior to the structure's removal and areas reinstatement.
21. This consent shall lapse on the expiry of five years after the date of issue of this consent, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.

Consent 6377-1

22. 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 2006 and/or June 2009 and/or June 2012, 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.

Footnote:

- (i) *The grant of consent does not preclude the possibility that the consent holder may need to reach agreement with tangata whenua in the exercise of the consent, in the event that any claim to customary ownership of the site is upheld by a New Zealand Court of Law.*

Signed at Stratford on 31 May 2005

For and on behalf of  
Taranaki Regional Council

  
\_\_\_\_\_  
Director Resource Management





**Coastal Permit  
Pursuant to the Resource Management Act 1991  
a resource consent is hereby granted by the  
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FAX: 06-765 5097  
[www.trc.govt.nz](http://www.trc.govt.nz)

Please quote our file number  
on all correspondence

Name of  
Consent Holder: Opunake Artificial Reef Trust  
P O Box 13  
OPUNAKE

Consent Granted  
Date: 31 May 2005

**Conditions of Consent**

Consent Granted: To occupy an area of the coastal marine area within Opunake Bay defined by the Taranaki local circuit grid co-ordinates 257484E-663800N, 267650E-663887N, 267696E-663803N, 267525E-663718N for the purposes of constructing and maintaining an artificial surfing reef at or about GR: P20:832-937

Expiry Date: 1 June 2018

Review Date(s): June 2006, June 2009, June 2012

Site Location: Coastal marine area offshore from Opunake Beach, Beach Road, Opunake

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 exercise of this consent shall be undertaken generally in accordance with the documentation submitted in support of application 3025. In the case of any contradiction between the documentation submitted in support of application 3025 and the conditions of this consent, the conditions of this consent shall prevail.
2. The consent holder shall notify the Chief Executive, Taranaki Regional Council in writing at least 7 working days prior to the commencement and upon completion of the initial installation, and again at least 7 working days prior to and upon completion of any subsequent maintenance works which would involve restriction of public access within the coastal marine area.
3. The consent holder shall notify the public of the commencement of construction works through the erection of notices within the vicinity of the affected area(s) and through public notices in the Taranaki Daily News, and the Opunake and Coastal News newspapers.
4. The exercise of this consent shall not prevent the free passage of any member of the public through the coastal marine area, except that as required for safety purposes during construction, inspection, or maintenance of the structure licensed by coastal permit 6377.
5. The restriction of public access to the foreshore at Opunake shall be limited in time and space to the minimum required for the purposes of safety requirements related to the construction, inspection, maintenance or removal of the structure licensed by coastal permit 6377; or the disturbance licensed by coastal permit 6378. In any case there shall be no restriction of public access to Opunake Beach.
6. This consent shall lapse on the expiry of five years after the date of issue of this consent, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.

7. 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 2006 and/or June 2009 and/or June 2012, 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.

Footnote:

- (i) *The grant of consent does not preclude the possibility that the consent holder may need to reach agreement with tangata whenua in the exercise of the consent, in the event that any claim to customary ownership of the site is upheld by a New Zealand Court of Law.*

Signed at Stratford on 31 May 2005

For and on behalf of  
Taranaki Regional Council



~~Director-Resource Management~~



## **Appendix II**

### **Kaimoana survey report**



## Memorandum

**To** P Canvin, Consents Manager  
**From** D Govier, Scientific Officer  
**Document** 139825  
**Date** 10 February 2006

### Opunake Artificial Reef - Pre construction Kaimoana Survey January 2006

#### 1. Introduction

Opunake Artificial Reef Trust (OART) were granted resource consent 6377 to erect, place and maintain a geo-textile structure within the coastal marine area for the purposes of creating an artificial reef. This consent was granted on 31 May 2005. Resource consents 6376 and 6378 were also granted to the OART to occupy an area of the coastal marine area within the Opunake Bay and to discharge sandy sediment during the construction and maintenance of an artificial surfing reef.

Special conditions of the consent require that the exercise of the consents shall not result in any significant adverse ecological effects including effects to kaimoana. As part of the environmental monitoring requirements for the OART, ecological monitoring of kaimoana was undertaken. Five reef sites were monitored, three sites at Opunake Bay, one at Middleton Bay and a control site at Manahi Road. The kaimoana considered most important to monitor were Paua (*Haliotis iris* and *Haliotis australis*); Kina (*Evechinus chloroticus*), cook's turban (*Cookia sulcata*) and pupu or cat's eye (*Melagraphia aethiops* and *Turbo smaragdus*). The kaimoana surveys will be undertaken each year after the completion of the artificial reef to assess if there have been any adverse effects to the Kaimoana beds.

This first pre construction kaimoana survey was carried out at five reef sites between 30 January and 1 February 2006 as part of the 2005-2006 compliance monitoring programme. The objective of the survey is to gather information on kaimoana abundance as well as gaining information on size frequency for paua. This data will be an important component of assessment of any effects from the artificial reef construction. There are two marine components to the Opunake artificial reef monitoring programme, intertidal and kaimoana surveys. This is the first survey of the kaimoana monitoring.

## **2. Methods**

### **2.1 Field Work**

Each inspection included the low intertidal to shallow subtidal zone which is not specifically surveyed as part of the intertidal monitoring but is recognised to be abundant in kaimoana species. The monitoring technique has to quantify kaimoana stocks or numbers in order to be able to detect any impact. Quantitative sampling using transects and quadrats although typically preferable are inadequate to estimate population numbers when the species are cryptic, in low average densities and aggregated in shallow, wave-swept habitats. In a previous kaimoana monitoring programme a time-count sampling method was used, otherwise known as a rapid visual technique. Although this technique is semi-quantitative it can provide information regarding relative abundance and size frequency of paua. The only difficulty in using this method is that quantitative estimates of abundance cannot be readily derived from data collected.

For each site all available rocky crevice and under rock habitat is searched for 30 minutes. Within this time interval all paua encountered are measured and counted. All other kaimoana species are also counted but not measured.

### **2.2 Data analysis**

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

Timed searches in appropriate habitat are used to find, measure, and count paua, collect information about paua aggregations and collect size frequency data. This method allows relative abundance of paua, expressed in terms of paua encountered per unit search time (number per minute), and size frequency distribution of paua for each site. This is the first survey of the pre construction monitoring and will provide baseline data to compare the post construction monitoring results to.

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

## **3. Results**

All paua counted in the 30 minutes at each site were measured and the results were standardised to the number of paua counted per minute for comparison between sites and over time.

**Table 1** Number of paua counted from the 5 Kaimoana sites

	Opunake Bay 1	Opunake Bay 2	Opunake Bay 3	Middletons Bay	Manihi Road
Count	81	56	82	162	64
Min (mm)	20	20	30	20	35
Max (mm)	95	98	85	90	100
Mean (mm)	62	64	65	59	82
Count (paua/min)	2.7	1.9	2.7	5.4	2.1

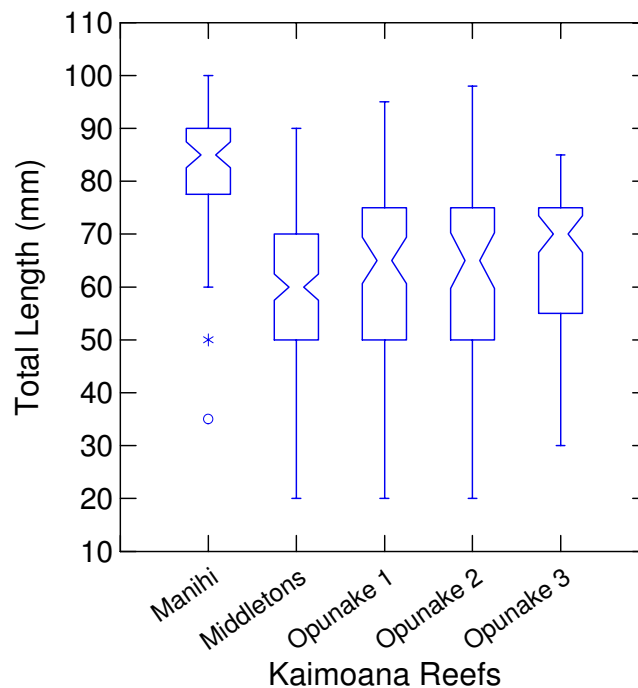
Other kaimoana species that were observed during the survey were only counted not measured. The pupu or cats eyes were not counted, as these were very abundant at some sites and just recorded as present or abundant.

**Table 2** Results of other Kaimoana species found on the 5 kaimoana sites

	Opunake Bay 1	Opunake Bay 2	Opunake Bay 3	Middleton's Bay	Manihi Road
Kina	14	3	54	12	0
Cooks Turbin	1	1	0	0	0
Cats eyes	abundant	abundant	abundant	abundant	common

The cats eyes found within the Opunake Bay sites were exceptionally large, compared to all other reef sites around Taranaki. Kina numbers were reasonably low at each site, which was unusual due to the suitable habitat with kelp present. One explanation for this could be due to sand movement throughout both Opunake and Middleton Bay's. At the Manihi Road site no kina were found within the surveyed area although kina were present in large numbers on other parts of the reef not surveyed.

**Figure 1** Box and whisker plot for total lengths of Paua at the 5 Kaimoana Reefs



The results from the Lilliefors test showed that all sites differed from a normal distribution at the 95% limit in terms of paua length. This result is due to the difference in size of the paua measured which ranged from 20 to 30mm long up to nearly 100mm long, although most paua were between 60 to 90 mm. The ANOVA test carried out on the five kaimoana beds revealed a statistically significant difference between the sites ( $F = 29.762, P = 0$ ) at a 95% confidence level.

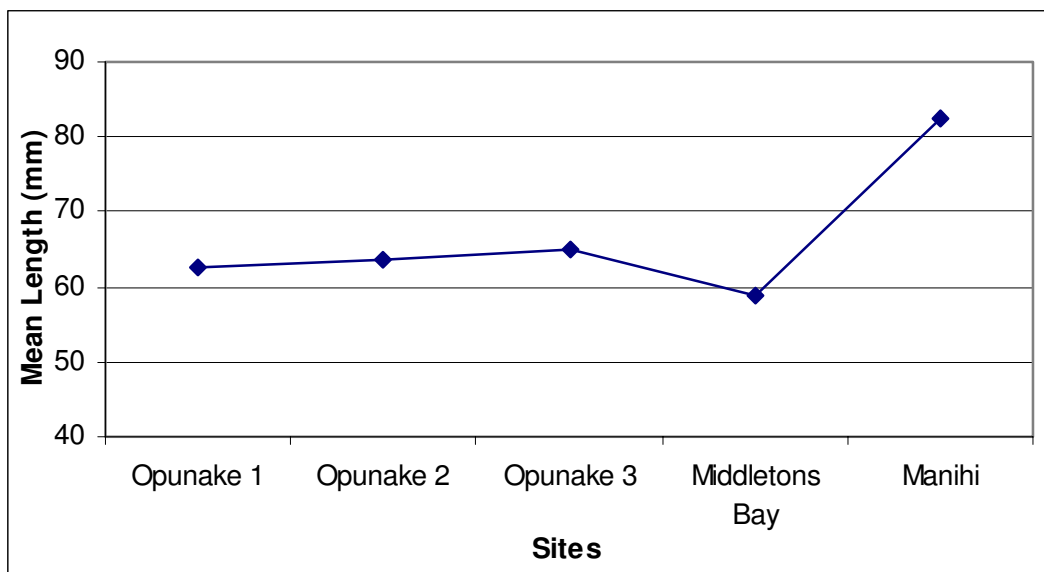
**Table 3** Results of Tukey multiple comparison test for mean lengths of Paua

Site	Opunake 1	Opunake 2	Opunake 3	Middleton Bay	Manihi Road
Opunake 1	-				
Opunake 2	NS	-			
Opunake 3	NS	NS	-		
Middleton Bay	NS	NS	SIG	-	
Manihi Road	SIG	SIG	SIG	SIG	-

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

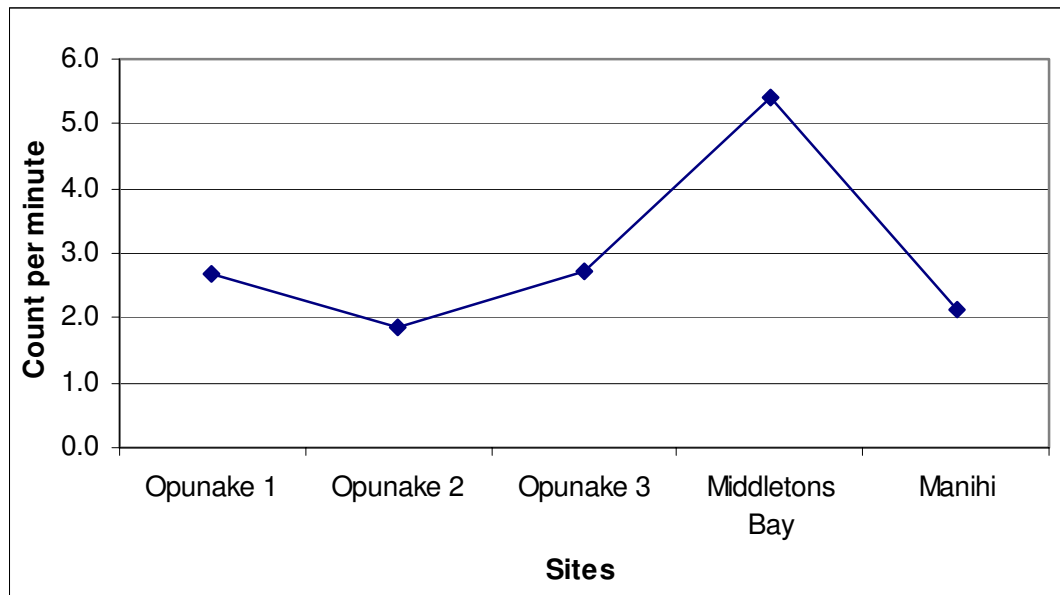
From the five kaimoana reefs surveyed when the mean lengths were compared it can be seen that there is a significant difference between Manihi Road reef and the other four sites in terms of paua length at the 95% confidence level. Manahi road had the largest size class of paua present whereas Middleton Bay had the smaller sized paua present among the five sites. This difference can be seen in Figure 1 above, where the notched area of the box and whisker plots represent the 95% confidence interval around the median length. When this notched area between two sites overlap there is no significant difference between sites.

**Figure 2** Mean length of paua at the 5 Kaimoana reefs



From this graph it can be seen that the mean length of Paua at sites Opunake 1, 2 and 3 are relatively similar. These sites relate to the Opunake Bay and on the north headland. Middleton's Bay had a smaller size of paua although there was a larger abundance present. The control site at Manahi Road, northwest of Opunake was significantly larger in terms of mean length of paua

Figure 3 Number of paua counted per minute searched



When the results are standardised into the number of paua counted per minute differences between the sites are observed. Middleton's Bay which had the smaller size of paua present in Figure 2 had the highest number of paua found per minute. The least number of paua were found at the Opunake 2 site which is in the Opunake embayment, inshore of the artificial reef location. At the Manahi Road site where the largest paua were found a low count per minute was found.

#### 4. Discussion

This is the first survey for the kaimoana monitoring programme for the Opunake artificial reef before construction begins during summer 2006. There were concerns raised in the pre hearing process that kaimoana gathering from the local reefs will be affected by sand inundation. Gathering this baseline information on the locally important kaimoana species will help determine whether or not the construction of the reef will have an effect on the surrounding reefs.

In another kaimoana monitoring programme after a pilot study it was recommended by Dr Russell Cole from NIWA that instead of using random quadrats a time count method would be more beneficial. This is due to the distribution of paua being cryptic in habit, clumped together, present in low mean densities and in wave-swept environments.

Given the natural variability and harvesting pressure upon paua it would be difficult to quantify any impact solely due to sand inundation. This is why the monitoring of kaimoana prior to the reef's construction is scheduled, to attempt to provide a measure (albeit somewhat limited) of the natural variability that can occur within populations.

From the five kaimoana reefs surveyed, 445 paua were counted and measured during the 30 minute search at each site. This allowed comparisons to be made between number of paua and mean lengths at each site. Habitat was very important to the distribution of paua where there was a higher frequency when suitable habitat was present. Larger counts were observed when there was a greater under boulder habitat present and the kelp species *Carpophyllum maschalocarpum* was present. When large boulders, sand or no kelp were present, the number of paua and kina counted was lower.

Differences did occur between the sites in terms of habitat which is also reflected in the results. At the Opunake Bay 2 and 3 sites, larger boulders were more common which is not as suitable for the paua to live on, as most paua are found on the underside of rocks and boulders around Taranaki. As a result of this few paua were found at these sites. At the Middleton Bay site smaller rocks were present with a large distribution of kelp which resulted in a large number of paua found within the 30 minute survey.

All paua counted during the survey period were less than 101 mm in length, which is below the legal size of 125 mm. It is believed that paua off the Taranaki coastline have a slower growth rate which could be influenced by excessive physical exposure and limited resource availability, which are linked to wave exposure and sediment flux. The mean size of paua surveyed across all sites was 66mm. This mean size is significantly greater than the mean size of paua found off the New Plymouth coastline where from the last kaimoana survey conducted as part of Port Taranaki Ltd compliance monitoring, 51mm was the mean size of paua found across 5 locally important kaimoana beds.

All kina counted during the survey were reasonably small also. This is supported by previous studies undertaken by Howse *et al.* (2000) and the Taranaki Regional Council which found that kina are smaller in areas with both high wave exposure and high-suspended sediment concentrations.

During the survey period a large number of people were present gathering kaimoana throughout all of the survey sites during the spring low tides. The numbers gathering seafood were not recorded but it was observed that a large number of undersize paua were being taken from the reef, well in excess of the Ministry of Fisheries daily limit of 10 per person.

It has been found during this survey and previous surveys that when rocks are overturned and paua are exposed, they can move very quickly, both over rock and sand. This suggests that when natural sand inundation occurs the paua may be forced from the shallow subtidal into raised rocky areas. This has been witnessed during kaimoana surveys at sites with sand inundation where the paua are only found further up the shore out of the influence of sand. Kina are more likely to be influenced by sand inundation where they cannot move easily over sandy areas and often die when large beds of sand are present.

With this baseline set of data and the collection of kaimoana and intertidal data in the future an assessment of any ecological effects that may be attributable to the artificial reef will be made. Differentiation between effects due to natural causes or the artificial reef will be made with the use of the control site which is well out of the influence of Opunake Bay. If a significant decline in both kaimoana and intertidal species richness and species diversity occurs around Opunake, it will be assessed against the control site. If this same decline occurs at the control site it will be concluded that a natural phenomenon is occurring and likewise if there is no effect at the control site, it may be due to the artificial reef.

Dan Govier

**Marine Ecologist**

## **Appendix III**

### **Intertidal ecological survey**



## Memorandum

To: Environmental Monitoring Manager, Peter Ashe  
From: Marine Ecologist, Kate Giles  
File: #270986  
Date: 6 March 2007

## Opunake Artificial Reef – Pre-construction Intertidal Ecological Survey 2006/2007

### 1. Introduction

Opunake Artificial Reef Trust (OART) were granted resource consent 6377 to erect, place and maintain a geo-textile structure within the coastal marine area for the purposes of creating an artificial reef. This consent was granted on 31 May 2005. Resource consents 6376 and 6378 were also granted to the OART to occupy an area of the coastal marine area within the Opunake Bay and to discharge sandy sediment during the construction and maintenance of the Opunake Artificial Surfing Reef.

Special conditions of the consent require that the exercise of the consents shall not result in any significant adverse ecological effects including effects to kaimoana. As part of the environmental monitoring requirements for the OART, ecological monitoring was undertaken. This included kaimoana and intertidal surveys at five reef sites: three sites at Opunake Bay, one at Middleton Bay and a control site at Manihi Road. The results of kaimoana monitoring are discussed in a separate report.

This first pre-construction survey was carried out at five reef sites between 1 February 2006 and 21 February 2007 as part of the 2005-2007 compliance monitoring programme (reef construction was halted shortly after construction began and due to the availability of low tides the final two surveys were conducted in 2007, prior to recommencement of construction). The objective of the survey is to gather information on biological community structure prior to construction so that any adverse impacts as a result of construction of the reef may be determined.

### 2. Methods

#### 2.1 Field Work

The survey was conducted at five sites. The sites were 500m S of Opunake Beach (SEA 904092), 50 metres E of Opunake Bay boat ramp (SEA 904088), Mid Opunake Beach/Middleton Bay (SEA 904086), Middleton Bay (SEA904081) and a control site at Manihi Road (SEA 904065) approximately 12 kilometres north west of the proposed artificial reef site.

At each site, a 50 metre transect was laid parallel to the shore, approximately 0.6 metres above chart datum. This transect was used to establish five, 5 metre x 3 metre blocks. Within each block 5 random 0.25 m<sup>2</sup> 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 overturned.

## 2.2 Data Analysis

For each site the mean and standard deviation was calculated for the number of algae, animal species and the total number of species per quadrat. Shannon-Weiner diversity indices were calculated for each quadrat and a mean Shannon-Weiner index for each site. The Shannon-Weiner diversity index ( $H'$ ) can give additional information to that provided by the number of species per quadrat data, as this index also incorporates the relative abundance of individual species in addition to the number of species present.

Graphical summaries of the total number of species per quadrat and Shannon-Weiner indices at each site were made using box and whisker plots. Assumptions of normality were tested using the Lilliefors test. One-way analysis of variance (ANOVA) tests were carried out on total number of species per quadrat data and Shannon-Weiner indices for total species. A Tukey multiple comparison test was used to determine where differences occurred when a significantly different result was obtained using the ANOVA.

A graphical comparison of the mean number of total species per quadrat found in summer surveys undertaken in previous years and the present survey is also included.

## 3. Results

Summary statistics for the number of algae, animal and total species per quadrat and Shannon Weiner indices are presented in Table 1.

**Table 1** Summary statistics

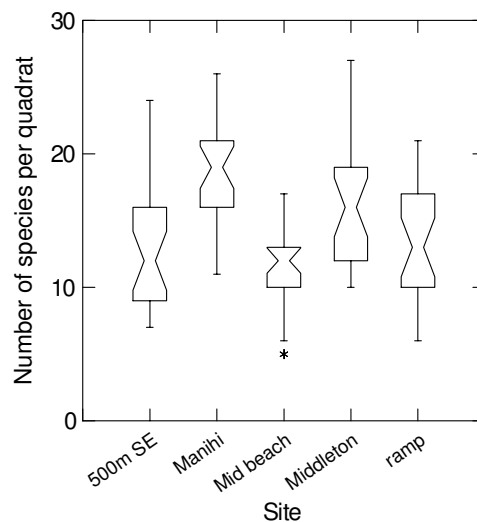
Site	No. of quadrats	Parameter	No. of species per quadrat			Shannon-Weiner indices per quadrat		
			Algae	Animals	Total Species	Algae	Animals	Total Species
Manihi Road	25	Mean	7.16	11.36	18.52	0.704	0.873	1.088
		Std dev	1.74	2.79	3.54	0.105	0.109	0.082
Middleton Bay	25	Mean	7.76	8.60	16.36	0.624	0.745	0.963
		Std dev	2.12	4.24	4.94	0.138	0.221	0.117
Mid/Opunake	25	Mean	7.20	4.12	11.32	0.671	0.445	0.854
		Std dev	1.84	2.68	3.50	0.143	0.286	0.181
East boat ramp	25	Mean	7.20	6.40	13.60	0.685	0.602	0.942
		Std dev	1.50	3.93	4.34	0.108	0.108	0.163
500m S beach	25	Mean	5.56	7.36	12.92	0.526	0.655	0.847
		Std dev	1.44	4.00	4.63	0.103	0.221	0.152

Manihi Road had the highest number of species, followed by Middleton Bay, East of the boat ramp, 500m S of the beach and mid Middleton Bay/Opunake Beach. A similar pattern occurred with the Shannon-Weiner diversity data, however the site mid Middleton Bay/Opunake Beach had a slightly higher diversity than the site 500m S of the beach.

### 3.1 Number of Species per Quadrat Data

Graphical summaries of the total (algae and animals) number of species per quadrat at each site are shown as box and whisker plots in Figure 1. The notched area of the box represents the median plus and minus the 95% confidence interval. This form of graphical representation allows a quick comparison to be made between sites. Generally, if the notched areas of the boxes for the different sites do not overlap you would expect to obtain a significantly different result when an ANOVA test was carried out.

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



A Lilliefors test indicated that there was no significant deviation from a normal distribution at a 95% confidence level for the number of species per quadrat at any of the five sites.

The ANOVA test revealed a statistically significant difference between the sites ( $F = 11.494$ ,  $P = 0.000$ ) at a 95% confidence level. This can be seen in Figure 1 above, where the notched areas of the box and whisker plots do not overlap between sites.

A Tukey multiple comparison test was used to indicate which sites had significantly different means. Table 2 shows which combinations of sites were significantly different at a 95% confidence level.

**Table 2** Results of Tukey multiple comparison test of number of species per quadrat

Site	500m S	Boat ramp	Manihi Rd	Mid/Opunake
Boat ramp	NS			
Manihi Rd	SIG	SIG		
Mid/Opunake	NS	NS	SIG	
Middleton Bay	SIG	NS	NS	SIG

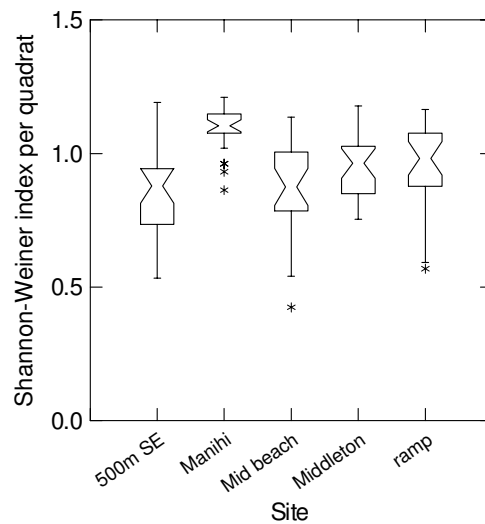
**Key:** SIG = significant difference at 95% confidence level  
NS = no significant difference

From the table above it can be seen that the mean number of species differed significantly between Manihi Road and three of the sites- 500m S, E of the boat ramp and mid Middleton Bay/Opunake Beach. This can be seen in the box and whisker plot above (Figure 1) where Manihi Road has a higher abundance of species than these sites. Also with a high number of species, Middleton Bay differed significantly from both 500m S and mid Middleton Bay/Opunake Beach sites.

### 3.2 Shannon-Weiner Diversity Index Data

Graphical summaries of the Shannon-Weiner index data at each site are shown as box and whisker plots in Figure 2.

**Figure 2** Box and whisker plots of Shannon-Weiner diversity indices



A Lilliefors test indicated that only the Manihi Road site significantly deviated from a normal distribution at a 95% confidence level using the Shannon-Weiner diversity data. This is supported by the box and whisker plot above in Figure 2 by the skewed shape of the box plot. The ANOVA test is considered to be robust even when assumptions of normality are not met.

The ANOVA test revealed a statistically significant difference between the sites ( $F = 11.606$ ,  $P = 0.000$ ) at a 95% confidence level. A Tukey multiple comparison test was used to indicate which sites had significantly different means. Table 3 shows which combinations of sites were significantly different at a 95% confidence level.

**Table 3** Results of Tukey multiple comparison test of Shannon-Weiner diversity indices

Site	500m S	Boat ramp	Manihi Rd	Mid/Opunake
Boat ramp	NS			
Manihi Rd	SIG	SIG		
Mid/Opunake	NS	NS	SIG	
Middleton Bay	SIG	NS	SIG	NS

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

In terms of Shannon-Weiner diversity, the site at Manihi Road varied significantly from all the other sites. This can be seen in Figure 2 above, where the notches of the box and whisker plots do not overlap. The sites 500m S and Middleton Bay also varied significantly from each other.

### 3.3 Sand Coverage

In addition to the number of algae and animals in each quadrat, the percentage coverage of sand is also recorded for each quadrat. The mean percent sand coverage per quadrat at each site is presented in Table 4 below.

**Table 4** Mean percent sand coverage per quadrat at each site

Site	Mean coverage per quadrat (%)
Manihi Road	0.0
Middleton Bay	0.3
Mid/Opunake	0.0
East boat ramp	5.2
500m S beach	0.1

Table 4 shows that a low level of sand was found east of the boat ramp, while all other sites had very low levels. Previous studies on intertidal reefs in Taranaki have demonstrated that at 30% coverage, sand begins to negatively influence the number and diversity of species.

## 4. Discussion

OART were granted resource consent 6377 to erect, place and maintain a geo-textile structure within the coastal marine area for the purposes of creating an artificial reef. This consent was granted on 31 May 2005. Resource consents 6376 and 6378 were also granted to the OART to occupy an area of the coastal marine area within the Opunake Bay and to discharge sandy sediment during the construction and maintenance of an artificial surfing reef.

Special conditions of the consent require that the exercise of the consents shall not result in any significant adverse ecological effects including effects to kaimoana. As part of the environmental monitoring requirements for the OART, ecological monitoring was undertaken. This included kaimoana and intertidal surveys at five reef sites: three sites at Opunake Bay, one at Middleton Bay and a control site at Manihi Road. The results of kaimoana monitoring are discussed in a separate report.

This first pre construction survey was carried out at five reef sites between 1 February 2006 and 21 February 2007 as part of the 2005-2006 compliance monitoring programme. The objective of the survey is to gather information on biological community structure prior to construction so that any adverse impacts as a result of construction of the reef may be determined.

The marine ecological survey was carried out at five sites between 1 February 2006 and 21 February 2007 as part of the 2005-2007 monitoring programme. The objective of the survey was to collect baseline data prior to construction of the Opunake Artificial Surf Reef.

This report investigates the effect of the Opunake Artificial Surf Reef on the local intertidal community in terms of ecological diversity by using three different methods of data analysis. The first is a comparison of mean number of species per quadrat (species richness) at the five sites. The second is a comparison of the Shannon-Weiner diversity index per quadrat (incorporating both the number of different species present and the relative abundance of those species) at the five sites. The third method is a graphical comparison of the temporal changes of species richness and Shannon-Weiner diversity index using data obtained in the present survey and in previous surveys undertaken at the same sites. The results from each of these three methods of data analysis are discussed below.

The graphical and statistical analyses of the pre-construction mean number of total species per quadrat showed that the control site at Manihi Road had the highest number of species followed by Middleton Bay. This was then followed in decreasing order by East of the boat ramp, 500m S of Opunake Beach and mid Middleton Bay/Opunake Beach.

The graphical and statistical analyses of Shannon-Weiner diversity index showed a similar pattern as for species richness, however the site mid Middleton Bay/Opunake Beach had a slightly higher diversity than the site 500m S of the beach.

## **5. Conclusions**

The pre-construction marine ecological survey conducted during 2006/2007 as part of the 2005-2007 monitoring programme. A relatively high number of species indicated healthy and diverse reefs around the Opunake Artificial Surfing Reef site.

The results of this survey will be able to be used in future to compare pre-construction abundance and diversity of species, with post-construction levels.

Kate Giles  
**Marine Ecologist**