# Annual coastal monitoring report for the Wellington region, 2008/09

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Juliet R Milne

Environmental Monitoring and Investigations Department

For more information, contact:

Greater Wellington
142 Wakefield Street
PO Box 11646
Manners Street
Wellington 6142
T 04 384 5708
F 04 385 6960
www.gw.govt.nz

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# Contents

# 1. Introduction

Greater Wellington Regional Council (Greater Wellington) has a responsibility to manage and monitor the Wellington region's near-shore coastal environment; the area extending from mean high water springs to 12 nautical miles offshore. This near-shore environment contains significant habitats for a wide variety of plants and animals, and also provides for a diverse range of human activities and values.

Greater Wellington's Environmental Monitoring and Investigations Department oversees monitoring and investigations of water quality, sediment quality and ecological health in the Wellington region's near-shore coastal environment. This report summarises the results of such monitoring and investigations undertaken over the period 1 June 2008 to 30 June 2009. Note that the suitability of coastal waters for contact recreation purposes is assessed separately under Greater Wellington's recreational water quality monitoring programme (see Warr 2009).

# 2. Overview of coastal monitoring programme

## 2.1 Background

Coastal monitoring in the Wellington region began over 20 years ago, with a focus on microbiological water quality – a reflection of the high usage of much of the region's coastline for contact recreation such as swimming and surfing. Periodic assessments of contaminants in shellfish flesh commenced around 1997, with the most recent assessment undertaken at 20 sites in 2006 (see Milne 2006). In 2004 monitoring expanded into coastal ecology and sediment quality, with a key focus being the effects of urban stormwater on our coastal harbour environments. In addition, over 2004-2008 broad-scale surveys of the region's coastal habitats were carried out, with fine-scale sediment and ecological assessments undertaken at representative intertidal locations of selected estuaries and sandy beaches. The information gained from these surveys was combined with ecological vulnerability assessments to identify priorities for a long-term monitoring programme that will enable Greater Wellington to fulfil state of the environment monitoring obligations with respect to coastal ecosystems.

## 2.2 Monitoring objectives

The aims of Greater Wellington's coastal monitoring programme are to:

1. Assist in the detection of spatial and temporal changes in near-shore coastal waters;

2. Contribute to our understanding of coastal biodiversity in the region;

3. Determine the suitability of coastal waters for designated uses;

4. Provide information to assist in targeted investigations where remediation or mitigation of poor water quality is desired; and

5. Provide a mechanism to determine the effectiveness of policies and plans.

Note: the suitability of coastal waters for contact recreation purposes is assessed separately under Greater Wellington's recreational water quality monitoring programme.

## 2.3 Monitoring and investigations during 2008/09

Coastal monitoring and investigations undertaken over the period 1 June 2008 to 30 June 2009 included:

- Microbiological water quality monitoring at 77 sites across the region (Section 3);

- Sediment quality monitoring at five subtidal sites in Porirua Harbour (Section 4);

- fine-scale ecological monitoring, sedimentation rate monitoring and macroalgal cover mapping at four intertidal sites in Porirua Harbour (Section 5);

- A targeted investigation of contaminants in Porirua Harbour sediments, focussing on intertidal areas close to contaminant sources such as stormwater outfalls and stream outflows (Section 6);

- Fine-scale ecological monitoring at two intertidal sites in Whareama Estuary (Section 7); and

- Fine-scale ecological monitoring at two sites on Castlepoint Beach (Section 8).

# 3. Microbiological water quality monitoring

## 3.1 Introduction

Microbiological water quality was monitored at 77 coastal sites across the Wellington region over 2008/09 (Figure 3.1, Appendix 1), as follows:

- Kapiti Coast District – 20 sites
- Porirua City – 15 sites
- Hutt City – 15 sites
- Wellington City – 22 sites
- Wairarapa – 5 sites

Monitoring was a joint effort involving Greater Wellington, Kapiti Coast District Council, Porirua City Council, Hutt City Council, and Wellington City Council. The sites monitored reflect their use by the public for contact recreation; in particular, swimming, surfing, and boating.

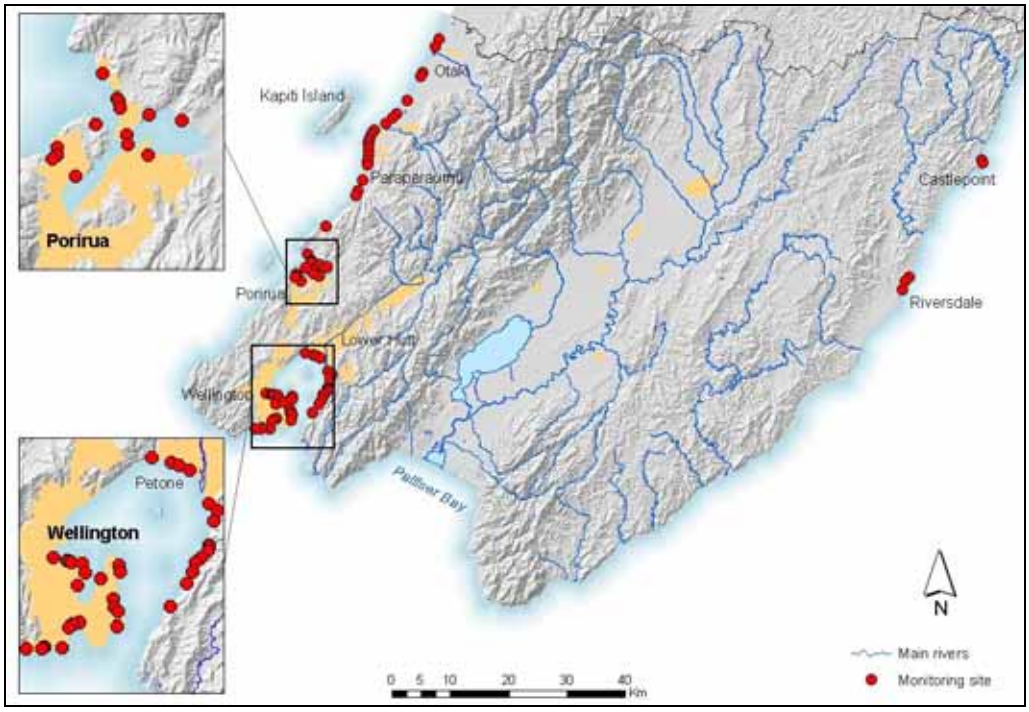



Figure 3.1: Coastal water quality sites monitored over 2008/09

## 3.2 Monitoring protocol

Sites were sampled weekly during the summer bathing season (1 November to 31 March inclusive) as part of Greater Wellington's recreational water quality monitoring programme (see Warr 2009), and at least monthly during the remainder of the year[1]. On each sampling occasion a single water sample was collected 0.2 metres below the surface in 0.5 metres water depth and analysed for enterococci indicator bacteria using a membrane filtration method. In addition, water samples from six sites popular for recreational shellfish

[1] Camp Bay (Hutt City), Breaker Bay (Wellington City), Princess Bay (Wellington City) and Riversdale Beach South (Wairarapa) were sampled fortnightly during the summer months (see Warr 2009).

gathering, and three sites in Porirua Harbour, were tested for faecal coliform indicator bacteria (Appendix 1).

Observations of weather and the state of the tide, and visual estimates of seaweed cover, were made at each site to assist with the interpretation of the monitoring results. For example:

- Rainfall may increase enterococci counts by flushing accumulated debris from urban and agricultural areas into coastal waters.
- Wind direction can influence the movement of currents along the coastline and can therefore affect water quality at a particular site.
- In some cases, an increase in enterococci counts may be due to the presence of seaweed. Under warm conditions when seaweed is excessively photosynthesising or decaying, enterococci may feed off the increased carbonaceous material produced during photosynthesis or off the decaying seaweed.

An estimate of the daily rainfall in the catchment adjoining each site over the bathing season was made by obtaining records from the nearest rain gauge.

A list of field and laboratory methods can be found in Warr (2009).

## 3.3 Results

The results of microbiological water quality testing undertaken during the official summer bathing season are discussed in detail in *On the Beaches 2008/09: Annual recreational water quality monitoring report for the Wellington region* (Warr 2009). Tables 3.1 and 3.2 summarise the median, 95$^{th}$ percentile and maximum enterococci and faecal bacteria counts recorded from all sampling conducted during the period 1 July 2008 to 30 June 2009 for each of the 77 marine sites (i.e., these statistics include the results of additional follow-up sampling conducted in response to an exceedance of the Ministry for the Environment/Ministry of Health (2003) microbiological water quality guidelines). In the majority of instances, elevated indicator bacteria counts coincided with rainfall.

The highest enterococci counts were recorded in water samples from Porirua Harbour (including Pauatahanui Inlet), with the monitoring site adjacent to the Rowing Club exceeding counts of 1,000 cfu/100 mL on five separate sampling occasions. The highest counts at this site were 1,600 cfu/100 mL on both 15 July 2008 and 17 February 2009. A small unnamed stream that enters the Porirua Harbour immediately adjacent to the Rowing Club may be linked to the elevated bacteria counts (Warr 2009). Further sampling is to be undertaken in the stream catchment to identify the source of these high indicator bacteria counts.

Table 3.1: Summary of enterococci counts recorded at 77 coastal sites monitored over 1 July 2008 to 30 June 2009 inclusive

| Bathing Site | Total no. of samples | Enterococci (cfu/100 mL) | | |
|---|---|---|---|---|
| | | Median | 95th percentile | Max |
| *Kapiti Coast* | | | | |
| Otaki Beach @ Surf Club | 29 | 5 | 63 | 490 |
| Otaki Beach @ Rangiuru Rd | 28 | 4 | 68 | 113 |
| Te Horo Beach S of Mangaone Strm | 28 | 15 | 52 | 74 |
| Te Horo Beach @ Kitchener St | 28 | 5 | 37 | 40 |
| Peka Peka Beach @ Rd End | 28 | 6 | 37 | 45 |
| Waikanae Beach @ William St | 28 | 8 | 32 | 50 |
| Waikanae Beach @ Tutere St T.C. | 28 | 5 | 31 | 110 |
| Waikanae Beach @ Ara Kuaka C.P. | 28 | 5 | 57 | 91 |
| Paraparaumu Beach @ Ngapotiki St | 28 | 10 | 89 | 115 |
| Paraparaumu Beach @ Nathan Ave | 29 | 10 | 63 | 150 |
| Paraparaumu Beach @ Maclean Pk | 31 | 15 | 148 | 170 |
| Paraparaumu Beach @ Toru Rd | 30 | 13 | 154 | 220 |
| Paraparaumu Beach @ Wharemauku Rd | 28 | 8 | 103 | 135 |
| Raumati Beach @ Tainui St | 28 | 5 | 50 | 105 |
| Raumati Beach @ Marine Gardens | 30 | 7 | 106 | 180 |
| Raumati Beach @ Aotea Rd | 28 | 6 | 37 | 120 |
| Raumati Beach @ Hydes Rd | 28 | 5 | 28 | 55 |
| Paekakariki Beach @ Whareroa Rd | 28 | 6 | 44 | 85 |
| Paekakariki Beach @ Surf Club | 28 | 4 | 27 | 35 |
| Paekakariki Beach @ Memorial Hall | 28 | 5 | 30 | 70 |
| *Porirua* | | | | |
| Pukerua Bay | 30 | 4 | 122 | 1,300 |
| Karehana Bay @ Cluny Rd | 31 | 32 | 355 | 900 |
| Plimmerton Beach @ Bath St | 33 | 32 | 402 | 1,400 |
| Plimmerton Beach @ Queens Ave | 30 | 24 | 191 | 600 |
| South Beach @ Plimmerton | 35 | 32 | 410 | 790 |
| Paremata Beach @ Pascoe Ave | 32 | 30 | 250 | 400 |
| Pauatahanui Inlet @ Water Ski Club | 35 | 60 | 325 | 850 |
| Pauatahanui Inlet @ Motukaraka Pt | 32 | 24 | 211 | 1,400 |
| Pauatahanui Inlet @ Browns Bay | 37 | 48 | 318 | 1,900 |
| Pauatahanui Inlet @ Paremata Bridge | 28 | 18 | 113 | 130 |
| Porirua Harbour @ Rowing Club | 46 | 130 | 1,425 | 1,600 |
| Titahi Bay @ Bay Drive | 34 | 38 | 233 | 390 |
| Titahi Bay at Toms Rd | 29 | 12 | 68 | 380 |
| Titahi Bay @ South Beach Access Rd | 31 | 20 | 850 | 1,500 |
| Onehunga Bay | 28 | 4 | 78 | 100 |
| *Hutt* | | | | |
| Petone Beach @ Water Ski Club | 29 | 8 | 59 | 160 |
| Petone Beach @ Sydney St | 30 | 14 | 147 | 240 |
| Petone Beach @ Settlers Museum | 31 | 8 | 240 | 590 |
| Petone Beach @ Kiosk | 28 | 10 | 100 | 120 |

Table 3.1 *cont.*: Summary of enterococci counts recorded at 77 coastal sites monitored over 1 July 2008 to 30 June 2009 inclusive

| Bathing Site | Total no. of samples | Enterococci (cfu/100 mL) | | |
|---|---|---|---|---|
| | | Median | 95th percentile | Max |
| *Hutt* | | | | |
| Sorrento Bay | 28 | 8 | 64 | 130 |
| Lowry Bay @ Cheviot Rd | 28 | 10 | 102 | 130 |
| York Bay | 28 | 2 | 28 | 48 |
| Days Bay @ Wellesley College | 29 | 12 | 90 | 450 |
| Days Bay @ Wharf | 28 | 4 | 110 | 130 |
| Days Bay @ Moana Rd | 28 | 4 | 88 | 96 |
| Rona Bay @ N end of Cliff Bishop Pk | 29 | 12 | 96 | 680 |
| Rona Bay @ Wharf | 28 | 4 | 38 | 120 |
| Robinson Bay @ HW Shortt Rec Grd | 28 | 8 | 71 | 88 |
| Robinson Bay @ Nikau St | 29 | 4 | 100 | 210 |
| Camp Bay | 18 | 2 | 24 | 72 |
| *Wellington City* | | | | |
| Aotea Lagoon | 29 | 8 | 84 | 920 |
| Oriental Bay @ Freyberg Beach | 28 | 8 | 31 | 64 |
| Oriental Bay @ Wishing Well | 30 | 10 | 636 | 1,200 |
| Oriental Bay @ Band Rotunda | 28 | 6 | 64 | 130 |
| Balaena Bay | 29 | 2 | 51 | 270 |
| Kio Bay | 28 | 2 | 79 | 130 |
| Hataitai Beach | 28 | 3 | 68 | 130 |
| Shark Bay | 28 | 4 | 42 | 130 |
| Mahanga Bay | 29 | 2 | 101 | 500 |
| Scorching Bay | 28 | 2 | 61 | 68 |
| Worser Bay | 28 | 3 | 35 | 120 |
| Seatoun Beach @ Wharf | 28 | 2 | 32 | 84 |
| Seatoun Beach @ Inglis St | 28 | 4 | 52 | 92 |
| Breaker Bay | 19 | 2 | 41 | 340 |
| Lyall Bay @ Tirangi Rd | 28 | 4 | 53 | 100 |
| Lyall Bay @ Onepu Rd | 28 | 3 | 20 | 76 |
| Lyall Bay @ Queens Drive | 29 | 4 | 109 | 240 |
| Princess Bay | 18 | 2 | 5 | 8 |
| Island Bay @ Surf Club | 29 | 8 | 198 | 460 |
| Island Bay @ Reef St Recreation Grd | 28 | 4 | 90 | 120 |
| Island Bay @ Derwent St | 28 | 4 | 35 | 60 |
| Owhiro Bay | 31 | 40 | 245 | 630 |
| *Wairarapa* | | | | |
| Castlepoint Beach @ Castlepoint Strm | 30 | 2 | 148 | 890 |
| Castlepoint Beach @ Smelly Creek | 28 | 2 | 31 | 130 |
| Riversdale Beach @ Lagoon Mouth | 29 | 2 | 46 | 72 |
| Riversdale Beach Between the Flags | 28 | 2 | 7 | 20 |
| Riversdale Beach South | 18 | 2 | 5 | 12 |

Table 3.2: Summary of faecal coliform counts recorded at nine coastal sites monitored over 1 July 2008 to 30 June 2009 inclusive

| Site | Total no. of samples | Faecal coliforms (cfu/100 mL) | | |
|---|---|---|---|---|
| | | Median | 95th percentile | Max |
| *Kapiti Coast* | | | | |
| Otaki Beach @ Surf Club | 29 | 20 | 246 | 570 |
| Peka Peka Beach @ Rd End | 28 | 18 | 115 | 172 |
| Raumati Beach @ Hydes Rd | 28 | 15 | 103 | 170 |
| *Porirua* | | | | |
| Pauatahanui Inlet @ Motukaraka Point | 32 | 4 | 332 | 860 |
| Pauatahanui Inlet @ Browns Bay | 36 | 17 | 235 | 770 |
| Porirua Harbour @ Rowing Club | 42 | 36 | 608 | 1,100 |
| *Hutt* | | | | |
| Sorrento Bay | 28 | 3 | 225 | 420 |
| *Wellington City* | | | | |
| Shark Bay | 28 | 2 | 46 | 830 |
| Mahanga Bay | 29 | 2 | 232 | 740 |

# 4. Porirua Harbour subtidal sediment quality monitoring

## 4.1 Introduction and background

Contaminants in urban stormwater discharges have been identified as a potential medium to long-term risk to the health of the marine organisms living in our harbours, largely through the accumulation of these contaminants in the sediments. Greater Wellington's Porirua Harbour subtidal sediment quality monitoring programme primarily focuses on heavy metals and several classes of organic contaminants which tend to be bound to the mud fraction of sediments. The subtidal basins in each arm of the harbour are dominated by fine muds and provide a "sink" in which contaminants accumulate. Regular assessments of contaminant concentrations in the surface sediments of these basins, together with surveys of the health of benthic fauna present, allow an ongoing evaluation of urban stormwater management actions directed at maintaining or enhancing the Porirua Harbour receiving environment.

This section briefly summarises the results of the third survey of sediment quality and benthic community health at five subtidal sites in Porirua Harbour, based on a report by Milne et al. (2009). The 2008 survey was narrower in scope than the first two surveys (May 2004 and October 2005), with the sediment chemistry component restricted to assessing concentrations of just one group of contaminants, the heavy metals.

## 4.2 Monitoring sites, methods and variables

Five subtidal sites were sampled in Porirua Harbour in November 2008, three in the Pauatahanui Arm and two in the Onepoto Arm (Figure 4.1 & Table A2.1,

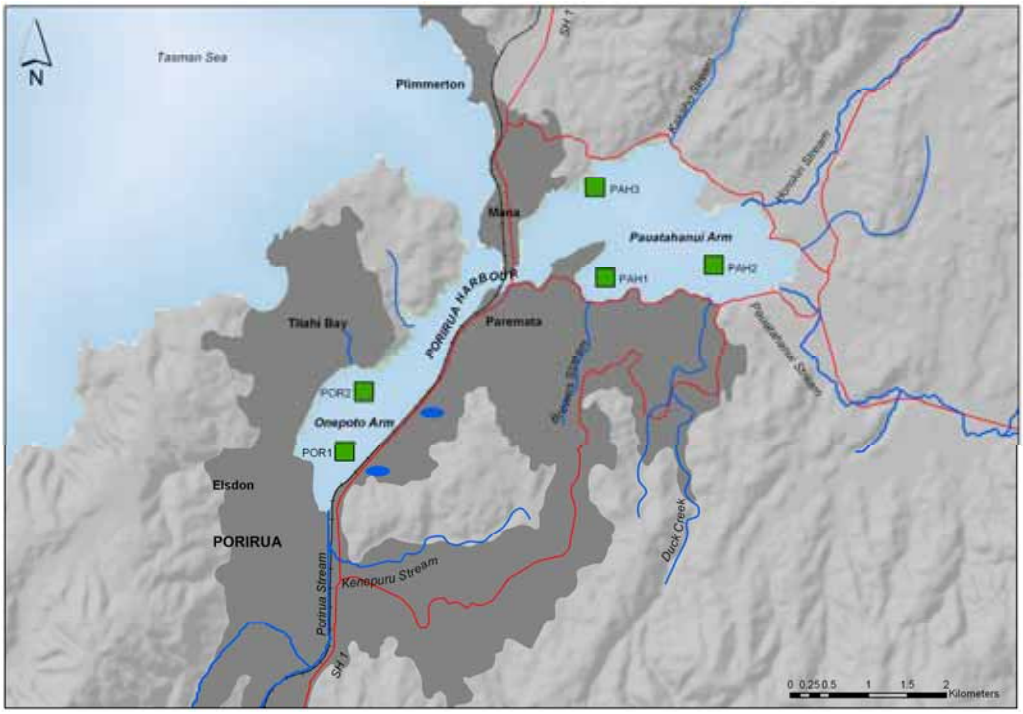



Figure 4.1: The five subtidal monitoring sites sampled in Porirua Harbour during November 2008

Appendix 2). Samples were collected by the use of a boat, GPS and scuba divers using similar protocol to previous surveys of contaminants in Porirua Harbour sediments (Williamson et al. 2005, Stephenson & Mills 2006).

### 4.2.1 Sediments

At each site 25 sediment core samples were collected from a sampling area 20 m in diameter, with samples randomly assigned into five replicate groups for analysis (top 30 mm). Samples were tested for:

- particle size distribution (sediment texture);
- total organic carbon (TOC); and
- weak acid-extractable and total heavy metals[2].

### 4.2.2 Benthic fauna

Eight benthic (sediment-dwelling) fauna samples were collected from an area adjacent to each sediment sampling site. Processing of the samples included:

- identification (to the lowest taxonomic level practicable) and enumeration of benthic fauna;
- measurement of shell lengths of selected species (e.g., bivalve molluscs); and
- selection and labelling of specimens for a reference collection.

### 4.2.3 Guidelines

Both the ANZECC (2000) Interim Sediment Quality Guidelines (ISQG) and the Auckland Regional Council's (2004) Environmental Response Criteria (ERC) were used to assess the sediment chemistry results. These guidelines are not "pass or fail" numbers; they are set at the concentrations which experimental and/or field evidence suggests are likely to result in impacts on aquatic life. Both the ANZECC and ERC guidelines have "low" (effectively "alert") and "high" values[3]; exceedances of these "low" and "high" values are indicated by orange and red colouring respectively in the graphs in subsection 4.3.

## 4.3 Key findings

Consistent with the results of the previous surveys, concentrations of total copper, lead and zinc are above "early warning" sediment quality guidelines in the subtidal sediments of the Onepoto Arm of Porirua Harbour (Figure 4.2). Concentrations of the other metals analysed are currently below guideline levels in the Onepoto Arm, as are the concentrations of all metals in the subtidal sediments of the Pauatahanui Arm.

[2] Five replicate sediment samples from each site were analysed for weak acid-extractable metals while one composite sediment sample from each site was tested for total metals (see Milne et al. 2009).

[3] These two sets of guidelines differ with respect to how they were derived and how they are interpreted– see Stephenson et al. (2008) for details.

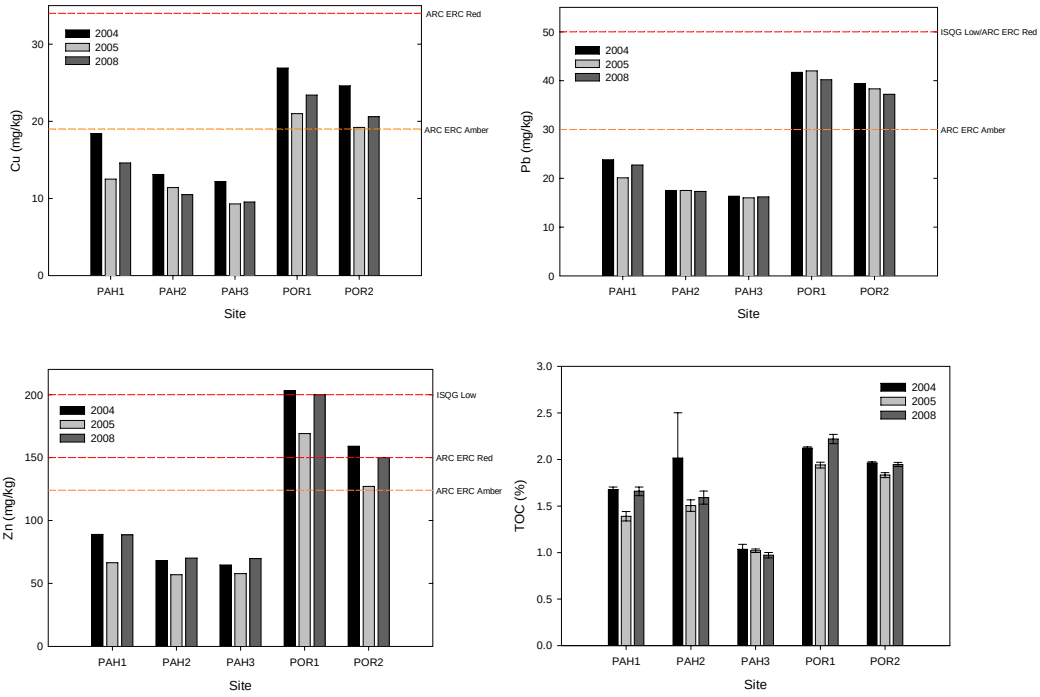



Figure 4.2: Concentrations of total copper, lead and zinc in sediments of five sites sampled in Porirua Harbour in 2004, 2005 and 2008, based on the <500 µm fraction of a single composite sample from each site. Mean concentrations of total organic carbon (± 95% CI) are also shown, based on five composite samples from each site.

Note: assessment of this sediment fraction is appropriate for comparison against sediment quality guidelines but a different – and more "precise" – assessment is used to determine trends in heavy metal concentrations over time

A total of 64 species of benthic fauna were identified, with all but two found in the samples taken from sites in the Pauatahanui Arm. In contrast, only 32 of the 64 species were found in the samples taken from two sites in the Onepoto Arm. Overall, the fauna were composed predominantly of polychaetes (25 species), crustaceans (17 species), and bivalve and gastropod molluscs (6 and 4 species respectively). The biomass at each site was dominated either by the bivalve *Cyclomactra ovatra*, Sipunculida #2, the echinoderm *Paracaudina chilensis*, or a combination of these. A second bivalve, *Nucula hartvigiana*, was also a significant contributor to the biomass at some sites.

Multivariate statistical analysis of the monitoring data indicates that some of the environmental variables measured are influencing lower-order benthic community structure. However, at this stage, any effects of metal contamination cannot be separated from the effects of differences in sediment texture and organic carbon content. Both monitoring sites in the Onepoto Arm clearly have higher sediment metal contaminant concentrations and support a lower diversity of benthic species than sites in the Pauatahanui Arm, but the mud and organic carbon contents are also higher in the sediments of these sites (Figure 4.2).

Although, statistically significant trends in the concentrations of weak acid-extractable copper, lead and zinc have been detected since 2004, it is still too early to tell whether these trends are ecologically significant and whether they

will continue into the future[4]. The reliability of trend detection, and the ability to form meaningful conclusions from any detected trends, should continue to improve as more monitoring data are added and the length of the time-series increases.

## 4.4 Future monitoring

The next subtidal sediment chemistry survey will be undertaken in Porirua Harbour in late 2010 to continue the monitoring of trends in contaminant concentrations over time. This will coincide with another benthic fauna survey in order to continue monitoring for changes in benthic community structure with possible links to changes in sediment quality. The sediment chemistry survey is to include analysis of sediment samples for polycyclic aromatic hydrocarbons and organochlorine pesticides.

[4] A mixture of both increasing and decreasing temporal trends were evident but these are based on only three data points.

# 5. Porirua Harbour intertidal ecological monitoring

## 5.1 Introduction and background

Routine intertidal sediment quality and ecological monitoring in Porirua Harbour began in January 2008, with the monitoring programme designed primarily to assess common estuary issues of sedimentation, eutrophication (nutrient enrichment), contamination and habitat loss (e.g., changes in substrate or vegetation cover). This section briefly summarises the results of the second round of intertidal monitoring undertaken in early 2009. This survey focused primarily on assessing indicators of sedimentation, eutrophication and, to a lesser extent, contamination. Full details of the monitoring are reported in Robertson & Stevens (2009a) and Stevens & Robertson (2009).

## 5.2 Monitoring sites, variables and methods

The second intertidal survey was undertaken in January 2009 at two sites in each arm of Porirua Harbour (Figure 5.1 & Table A2.2, Appendix 2). This monitoring included assessments of up to 10 plots per site for selected "fine-scale" sediment condition indicators (including grain size or texture, "oxygenation", nutrient and organic content, and heavy metal concentrations) and benthic (sediment-dwelling) fauna abundance and diversity. The methods used were based on an extension of the tools included in the National Estuary Monitoring Protocol (Robertson et al. 2002). The depths to 15 sedimentation monitoring plates buried in various locations in December 2007 were also measured (with four additional plates buried near the Paremata boatsheds) and the percentage cover of macroalgae (e.g., sea lettuce) mapped.

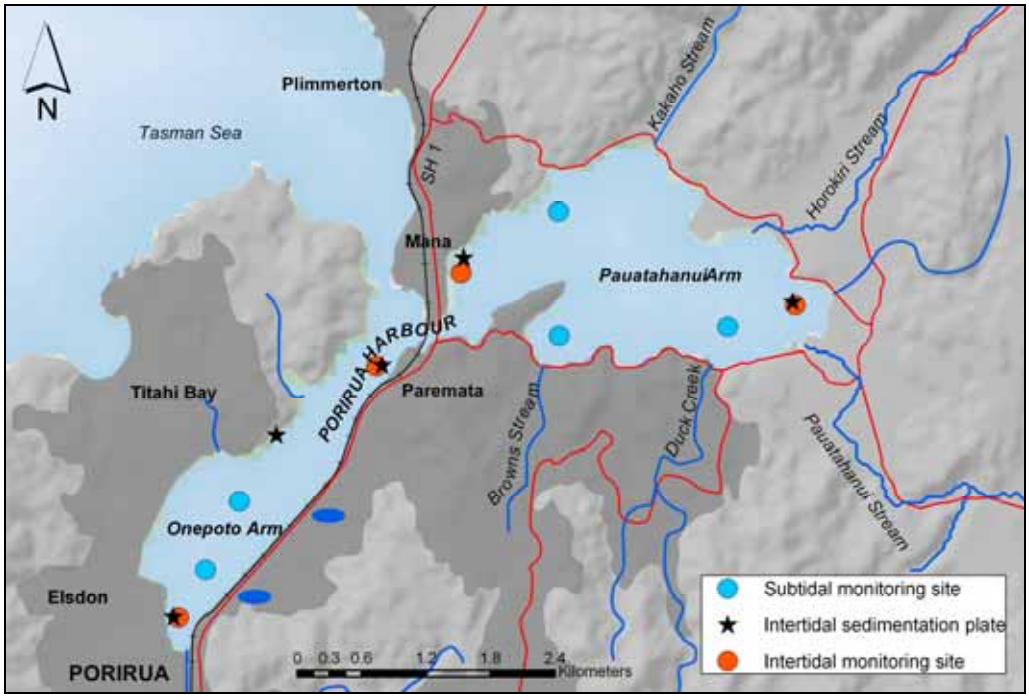



Figure 5.1: Intertidal monitoring sites and sedimentation plates in Porirua Harbour, including the locations of the five subtidal monitoring sites reported on in Section 4

## 5.3 Key findings

In terms of the key estuary issues the monitoring addresses, the January 2009 survey showed:

- *Sedimentation*: After one year, sedimentation rates at most sites are low. The exception is one site in the upper Onepoto Arm (average of 7mm in 13 months); further plates need to be put in place at this site as the variability across the two sedimentation plates was high (0-14 mm).

- *Eutrophication*: Similar to last year's findings, sediment nutrient concentrations and the depth of the oxygenated surface sediment layer indicate that both arms of the harbour are moderately eutrophic or enriched. This conclusion is supported by the presence of elevated numbers of benthic fauna that tolerate moderate levels of mud and/or organic enrichment, and the widespread coverage of macroalgae. More than 10% of the intertidal habitat in the Pauatahanui Arm, and more than 30% of the intertidal habitat in the Onepoto Arm had greater than 50% coverage of macroalgae (Figure 5.2), resulting in localised nuisance conditions (rotting macroalgae and poorly oxygenated and sulphide-rich sediments). At this stage, enrichment is not a major problem, but there is a need for caution in relation to factors that could increase nutrient concentrations and fine sediment in the harbour.

- *Toxicants:* Total heavy metal concentrations in the sediments of all sites (measured as an indicator of potential toxicants) are well within national sediment quality guidelines. As noted in Section 4, the situation is different in the mud-dominated subtidal basins, particularly in the Onepoto Arm.

Figure 5.2: Dense cover of sea lettuce (*Ulva* sp.) in the Onepoto Arm of Porirua Harbour

## 5.4 Future monitoring

The 2009 fine-scale ecological assessment is the second in a proposed series of three or four annual assessments to establish a "baseline" of existing conditions in the intertidal habitats of Porirua Harbour. After the baseline has been established, the frequency of monitoring is likely to be reduced to five-yearly intervals or as determined otherwise by the monitoring results.

# 6. Porirua Harbour sediment "hotspot" investigation

## 6.1 Introduction and background

Routine monitoring and various investigations have reported elevated concentrations of persistent contaminants in the surface sediments of Porirua Harbour, in particular the heavy metals copper, lead and zinc (e.g., Glasby et al. 1990, Botherway & Gardner 2002, Stephenson & Mills 2006, Milne et al. 2009). The highest contaminant concentrations have generally been recorded in sediments at the southern end of the Onepoto Arm, with urban stormwater outfalls and the Porirua Stream identified as the primary contaminant sources (e.g., Glasby 1990, Robertson & Stevens 2008) (Figure 6.1). With this area of the harbour ear-marked for possible future development, Greater Wellington, in association with Porirua City Council, carried out a targeted sediment investigation to obtain further information on the magnitude and spatial extent of sediment contamination. The investigation – summarised briefly here from a report by Sorensen & Milne (2009) – was designed primarily as a screening exercise, with spatial coverage favoured over sample replication.

Figure 6.1: Outflow from the Semple Street stormwater outfall at the southern end of the Onepoto Arm of Porirua Harbour

## 6.2 Sampling sites, methods and variables

A total of 17 intertidal sites in Porirua Harbour were selected for sediment sampling (Figure 6.2 & Table A2.3, Appendix 2). Ten of these sites were located at the southern-most end of the Onepoto Arm, in the area between several large stormwater outfalls and the outflow from the Porirua Stream. The other seven sites were located near the mouths of several urban streams that discharge into the harbour, including an unnamed stream that runs through Onepoto Park (for the purposes of this report referred to as Onepoto Stream), and Browns Stream and Duck Creek in the Pauatahanui Arm.

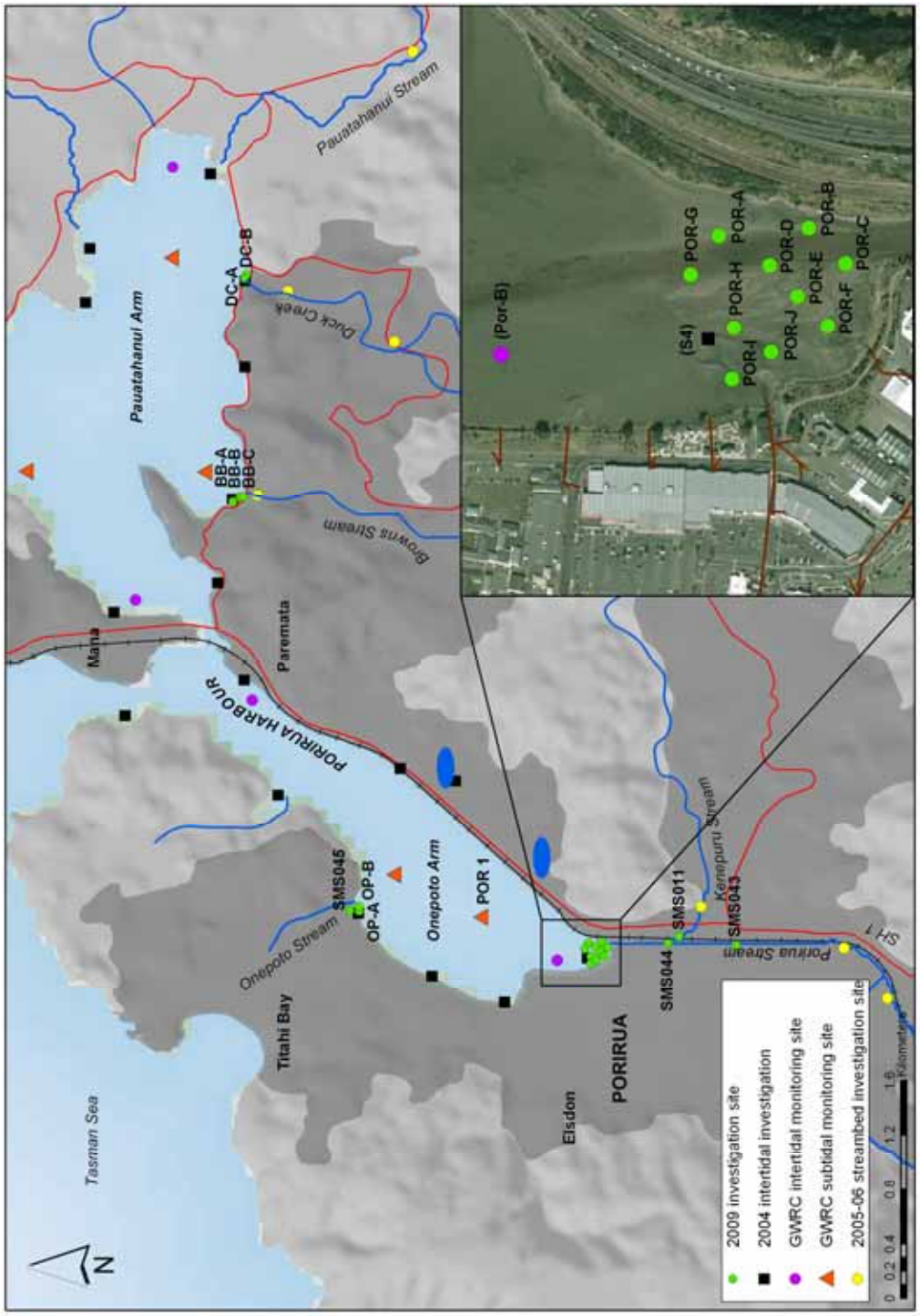



Figure 6.2: Map of Porirua Harbour showing the 2009 sediment sampling locations, and the sediment sampling locations in other relevant monitoring programmes and investigations (see Sorensen & Milne 2009 for details). The red lines on the inset map denote stormwater inputs.

Four streambed sites were also selected for sampling: the Porirua Stream upstream and downstream of the Kenepuru Stream confluence, the lower reaches of the Kenepuru Stream, and the lower reaches of the Onepoto Stream (Figure 6.2). These streams all receive urban stormwater inputs.

A single composite surface (top 20 mm) sediment sample was collected from each site and analysed (sub-2 mm fraction[5]) for:

- Particle size distribution (sediment texture);
- Total organic carbon;
- Total nitrogen and total recoverable phosphorus;
- Total recoverable arsenic, cadmium, chromium, copper, mercury, nickel, lead and zinc;
- 16 USEPA priority polycyclic aromatic hydrocarbons (PAHs); and
- Organochlorine pesticides (OCPs), including DDT and dieldrin.

A sediment core sample was also collected at two sites close to the Semple Street stormwater outfall (POR-H and POR-I). Sample results were compared against both the ANZECC (2000) and ARC (2004) sediment quality guidelines (refer subsection 4.2.3).

## 6.3 Key findings

The results of the targeted investigation confirm that there is clear evidence of stormwater-derived contamination at intertidal sites in Porirua Harbour. Zinc is present above sediment quality guidelines at all 10 sites sampled between the Semple Street stormwater outfall and the Porirua Stream channel at the southern end of the Onepoto Arm (Figure 6.3). Copper, lead and total high molecular weight polycyclic aromatic hydrocarbon (HMW PAH) concentrations are also present above guideline values at some sites in this area, and total DDT is present above guidelines at all sites. Although only two sediment core samples were taken, zinc was present in one at a concentration equal to the ANZECC (2000) "high" guideline value. This suggests that contamination may exist to some depth, at least in the vicinity of the Semple Street stormwater outfall.

Sediments at the mouth of the 'Onepoto' Stream beside the Porirua Rowing Club contain concentrations of lead, zinc, total DDT and various PAH compounds above sediment quality guidelines. Sediments adjacent to the mouths of Browns Stream and Duck Creek have total DDT concentrations above guideline values, with lead and total HMW PAH concentrations also above guidelines in the sediments adjacent to the mouth of Browns Stream.

Stormwater-derived contaminants are also present in the sediments from the beds of streams that discharge into the Porirua Harbour. Concentrations of total DDT, and to a lesser extent zinc, exceed sediment quality guidelines in Porirua, Kenepuru and 'Onepoto' streams. Sediments in the 'Onepoto' Stream also contain concentrations of several HMW PAH compounds and dieldrin above guideline values.

[5] The exceptions were particle size and PAHs, where the laboratory analysed the samples on an "as received" basis.

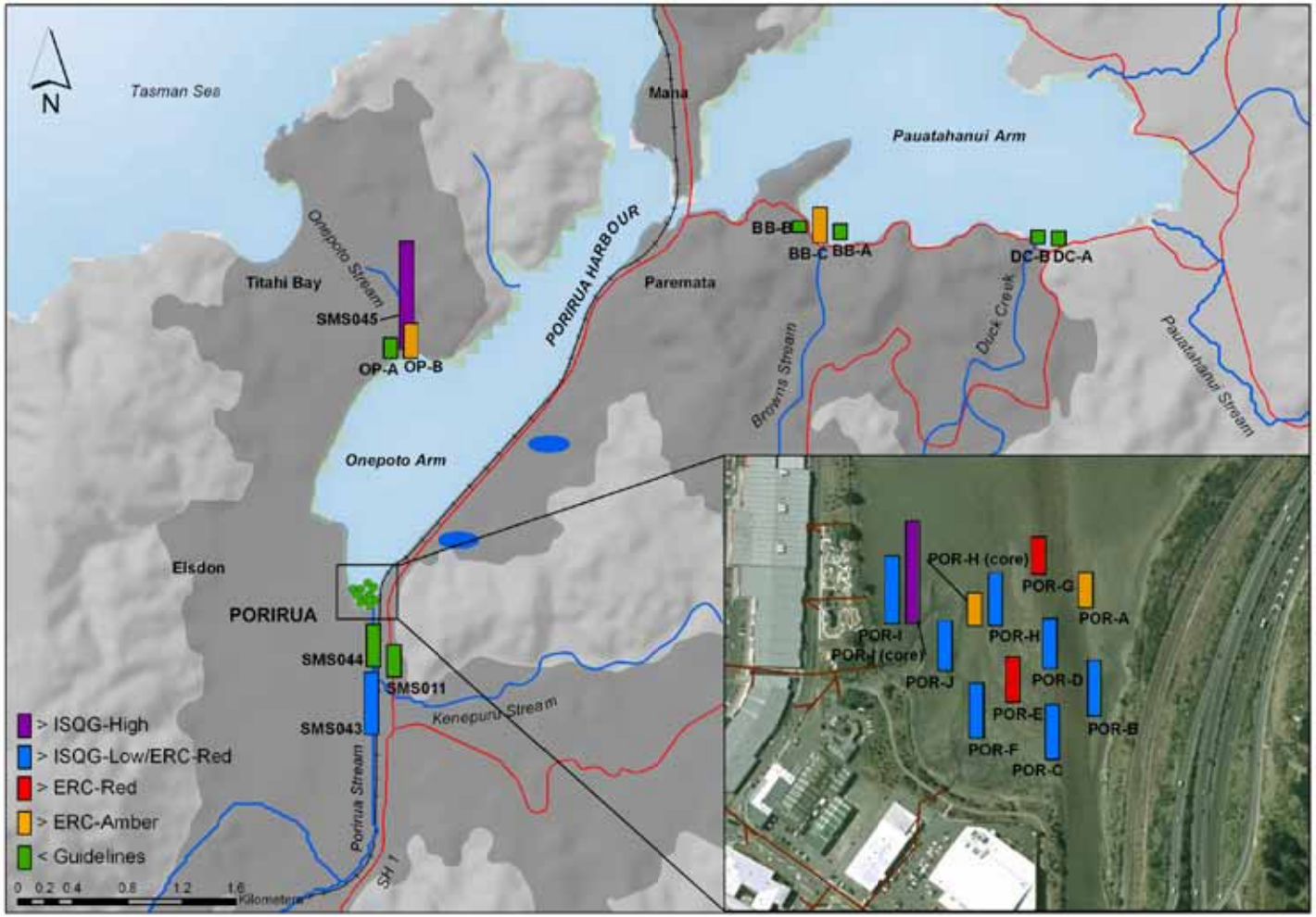



Figure 6.3: Concentration of total zinc in sediments of sites sampled as part of the Porirua Harbour targeted intertidal sediment quality assessment in February 2009, based on the <2 mm fraction of a single composite sample from each site. The concentrations present are coloured in accordance with sediment quality guidelines exceeded, with the length of each bar directly proportional to the zinc concentration present.

In most cases, sediment contaminant concentrations only exceed “alert level” or “early warning” guidelines. This indicates that there is an opportunity for management intervention to limit the extent of degradation and prevent adverse environmental effects from occurring. Zinc and DDT are the contaminants of greatest concern; these are persistent contaminants and stormwater and stream investigations to date confirm inputs of both are ongoing (e.g., KML 2005, Milne & Watts 2008).

# 7. Whareama Estuary intertidal ecological monitoring

## 7.1 Introduction and background

In January 2009 a second round of fine-scale ecological monitoring was undertaken in Whareama Estuary, a 12 km long, tidal river lagoon estuary located on Wairarapa's eastern coast. This monitoring, summarised here from a report by Robertson & Stevens (2009b), followed an earlier assessment of Wairarapa coastal habitats (Robertson & Stevens 2007) which recommended a long-term monitoring programme for Wairarapa coastal habitats. Included in the programme was monitoring of the long-term condition of the Whareama Estuary, focusing on core indicators of sedimentation, eutrophication and, to a lesser extent, contamination.

## 7.2 Monitoring sites, methods and variables

Monitoring was undertaken at two sites located on the unvegetated intertidal mudflats (Figure 7.1 & Table A2.4, Appendix 2). This monitoring included assessments of up to 10 plots per site for selected "fine-scale" sediment condition indicators – including grain size (texture), the degree of oxygenation, nutrient and organic content, and heavy metal concentrations – and benthic (sediment-dwelling) fauna abundance and diversity. The fine-scale monitoring methods were based on an extension of the tools included in the National Estuary Monitoring Protocol (Robertson et al. 2002). The depths to four sedimentation monitoring plates deployed at right angles to the Whareama River channel in January 2008 were also measured.

(Source: Robertson & Stevens (2009b)

Figure 7.1: Sampling the Whareama Estuary intertidal mudflats in January 2009

## 7.3 Key findings

The results for the selected physical, chemical and biological indicators of estuary condition showed that the dominant intertidal habitat was generally in "fair" to "good" condition. Nitrogen, phosphorus and organic carbon concentrations were classed as low to moderate, and heavy metal concentrations were very low. However, the sediments comprise 70% muds (i.e., <63 micron in size) and have a shallow oxygenated surface layer (1-3 cm depth). While such conditions result in a benthic community largely dominated by small subsurface deposit-feeding organisms that prefer moderate mud and organic enrichment levels (e.g., the bivalve *Arthritica* sp. and polychaete *Scolecolepides benhami*), the 2009 benthic fauna results indicate that there was a slight improvement in the diversity of the estuary's biological community over the last year.

Measurements from the sediment plates reveal a high sedimentation rate over January 2008 to January 2009 (average 14.5 mm). Excessive inputs of sediment are largely a natural phenomenon given the erosion-prone mudstone soils in the catchment. Greater Wellington has a soil conservation programme in place within the Whareama catchment designed to reduce soil erosion.

## 7.4 Future monitoring

The 2009 fine-scale ecological assessment is the second in a proposed series of three or four annual assessments to establish a "baseline" of existing conditions in the Whareama Estuary. After the baseline has been established, the frequency of monitoring will probably be reduced to five-yearly intervals.

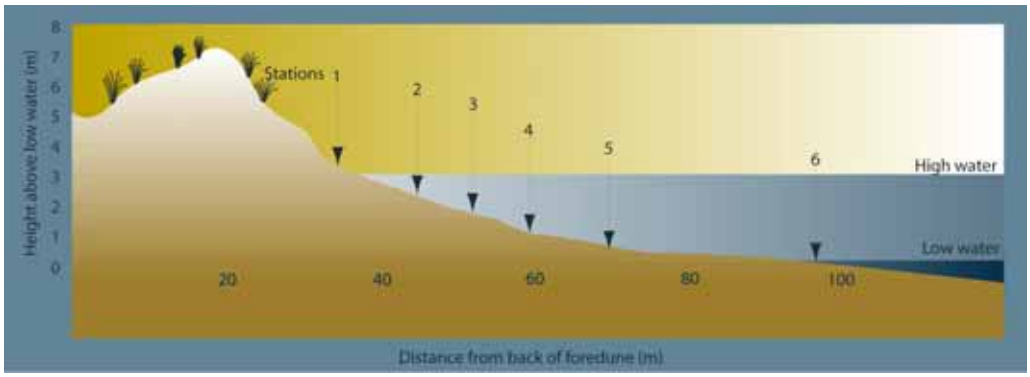
# 8. Castlepoint Beach ecological monitoring

## 8.1 Introduction and background

In January 2009 a second round of fine-scale ecological monitoring was undertaken at Castlepoint Beach, a 4.5 km long exposed beach located on the Wairarapa's northeastern coast. This monitoring, summarised here from a report by Robertson & Stevens (2009c), followed an earlier assessment of Wairarapa coastal habitats (Robertson & Stevens 2007) which recommended a long-term monitoring programme for the Wairarapa coast. Included in the programme was the establishment of one long-term monitoring site for dissipative[6] beach types between Castlepoint and the Whakataki River.

## 8.2 Monitoring sites, variables and methods

Monitoring was undertaken along two transects, 50 m apart, located towards the northern end of Castlepoint Beach, approximately 750 m south of the Whakataki Estuary (Table A2.5, Appendix 2). Six stations were sampled along each transect (Figure 8.1), with assessments made of sediment grain size (texture), sediment oxygenation and benthic (sediment-dwelling) fauna. Sediment nutrient and contaminant concentrations were not assessed; there are no major nutrient inputs on semi-exposed beaches like Castlepoint, and the risk of toxic contamination is very low.




(Source: Robertson & Stevens (2009c)

Figure 8.1: Cross-section of sampling transect at Castlepoint Beach

## 8.3 Key findings

Similar to the first survey (undertaken in January 2008), the results for the selected physical and biological indicators of beach condition showed that the dominant intertidal habitat was generally in "good" condition. The beach sediments consisted of well-oxygenated sands and support benthic invertebrates that are typical of exposed oligotrophic (nutrient-poor) beach environments, such as isopods, amphipods, beetles and polychaete worms (Figure 8.2).

[6] Castlepoint Beach is classified as dissipative-intermediate beach, meaning that is relatively flat, and fronted by a moderately wide surf zone in which waves dissipate much of their energy.

(Source: Robertson & Stevens (2009c)

Figure 8.2: Examples of some of the benthic fauna found at Castlepoint Beach in January 2009

## 8.4 Future monitoring

The 2009 fine-scale ecological assessment is the second in a proposed series of three annual assessments to establish a "baseline" of existing conditions at Castlepoint Beach. After the baseline has been established, the frequency of monitoring will reduce to five-yearly intervals.

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## Acknowledgements

Alice Ryan compiled the microbiological summary statistics. Alton Perrie kindly reviewed a draft version of this report.

# Appendix 1: Microbiological water quality monitoring sites

| Area | Site Name | NZ Map Grid | | Type |
|---|---|---|---|---|
| | | Easting | Northing | |
| Kapiti | Otaki Beach @ Surf Club | 2688639 | 6050044 | Marine* |
| Kapiti | Otaki Beach @ Rangiuru Road | 2688028 | 6048783 | Marine |
| Kapiti | Te Horo Beach S of Mangaone Stream | 2685797 | 6044192 | Marine |
| Kapiti | Te Horo Beach @ Kitchener Street | 2685513 | 6043648 | Marine |
| Kapiti | Peka Peka Beach @ Road End | 2683233 | 6039620 | Marine* |
| Kapiti | Waikanae Beach @ William Street | 2681406 | 6037299 | Marine |
| Kapiti | Waikanae Beach @ Tutere St Tennis Courts | 2680673 | 6036577 | Marine |
| Kapiti | Waikanae Beach @ Ara Kuaka Carpark | 2679532 | 6035693 | Marine |
| Kapiti | Paraparaumu Beach @ Ngapotiki Street | 2677561 | 6034477 | Marine |
| Kapiti | Paraparaumu Beach @ Nathan Avenue | 2677051 | 6033889 | Marine |
| Kapiti | Paraparaumu Beach @ Maclean Park | 2676712 | 6032982 | Marine |
| Kapiti | Paraparaumu Beach @ Toru Road | 2676595 | 6032430 | Marine |
| Kapiti | Paraparaumu Beach @ Wharemauku Road | 2676521 | 6031785 | Marine |
| Kapiti | Raumati Beach @ Tainui Street | 2676549 | 6030944 | Marine |
| Kapiti | Raumati Beach @ Marine Gardens | 2676535 | 6030156 | Marine |
| Kapiti | Raumati Beach @ Aotea Road | 2676433 | 6029244 | Marine |
| Kapiti | Raumati Beach @ Hydes Road | 2676337 | 6028550 | Marine* |
| Kapiti | Paekakariki Beach @ Whareroa Road | 2675617 | 6025843 | Marine |
| Kapiti | Paekakariki Beach @ Surf Club | 2674810 | 6023988 | Marine |
| Kapiti | Paekakariki Beach @ Memorial Hall | 2674452 | 6023305 | Marine |
| Porirua | Pukerua Bay | 2669309 | 6017968 | Marine |
| Porirua | Karehana Bay @ Cluny Road | 2666113 | 6013074 | Marine |
| Porirua | Plimmerton Beach @ Bath Street | 2666726 | 6012030 | Marine |
| Porirua | Plimmerton Beach @ Queens Avenue | 2666790 | 6011888 | Marine |
| Porirua | South Beach @ Plimmerton | 2666830 | 6011588 | Marine |
| Porirua | Paremata Beach @ Pascoe Avenue | 2667137 | 6010447 | Marine |
| Porirua | Pauatahanui Inlet @ Water Ski Club | 2668094 | 6011307 | Marine |
| Porirua | Pauatahanui Inlet @ Motukaraka Point | 2669506 | 6011052 | Marine* |
| Porirua | Pauatahanui Inlet @ Paremata Bridge | 2667173 | 6009998 | Marine |
| Porirua | Pauatahanui Inlet @ Browns Bay | 2668059 | 6009547 | Marine* |
| Porirua | Porirua Harbour @ Rowing Club | 2664911 | 6008661 | Marine* |
| Porirua | Titahi Bay @ Bay Drive | 2664152 | 6009883 | Marine |
| Porirua | Titahi Bay at Toms Road | 2664130 | 6009571 | Marine |
| Porirua | Titahi Bay @ South Beach Access Road | 2663926 | 6009396 | Marine |
| Porirua | Onehunga Bay | 2665816 | 6010895 | Marine |
| Hutt | Petone Beach @ Water Ski Club | 2665765 | 5996304 | Marine |
| Hutt | Petone Beach @ Sydney Street | 2667067 | 5995961 | Marine |
| Hutt | Petone Beach @ Settlers Museum | 2667577 | 5995770 | Marine |
| Hutt | Petone Beach @ Kiosk | 2668348 | 5995425 | Marine |
| Hutt | Sorrento Bay | 2669654 | 5993098 | Marine* |
| Hutt | Lowry Bay @ Cheviot Road | 2670228 | 5992605 | Marine |
| Hutt | York Bay | 2669999 | 5991874 | Marine |
| Hutt | Days Bay @ Wellesley College | 2669639 | 5990243 | Marine |
| Hutt | Days Bay @ Wharf | 2669677 | 5990027 | Marine |
| Hutt | Days Bay @ Moana Road | 2669605 | 5989834 | Marine |
| Hutt | Rona Bay @ N end of Cliff Bishop Park | 2669132 | 5989367 | Marine |
| Hutt | Rona Bay @ Wharf | 2668753 | 5989084 | Marine |
| Hutt | Robinson Bay @ HW Shortt Rec Ground | 2668542 | 5988387 | Marine |
| Hutt | Robinson Bay @ Nikau Street | 2668154 | 5987569 | Marine |
| Hutt | Camp Bay | 2667013 | 5986001 | Marine |

| Area | Site Name | NZ Map Grid | | Type |
|---|---|---|---|---|
| | | Easting | Northing | |
| Wellington | Aotea Lagoon | 2659007 | 5989395 | Marine |
| Wellington | Oriental Bay @ Freyberg Beach | 2659942 | 5989176 | Marine |
| Wellington | Oriental Bay @ Wishing Well | 2660140 | 5989098 | Marine |
| Wellington | Oriental Bay @ Band Rotunda | 2660265 | 5989087 | Marine |
| Wellington | Balaena Bay | 2660980 | 5988979 | Marine |
| Wellington | Kio Bay | 2661163 | 5988311 | Marine |
| Wellington | Hataitai Beach | 2660654 | 5987442 | Marine |
| Wellington | Shark Bay | 2662233 | 5987909 | Marine* |
| Wellington | Mahanga Bay | 2663490 | 5988828 | Marine* |
| Wellington | Scorching Bay | 2663539 | 5988360 | Marine |
| Wellington | Worser Bay | 2663097 | 5986535 | Marine |
| Wellington | Seatoun Beach @ Wharf | 2663152 | 5985946 | Marine |
| Wellington | Seatoun Beach @ Inglis Street | 2663428 | 5985706 | Marine |
| Wellington | Breaker Bay | 2663335 | 5984682 | Marine |
| Wellington | Lyall Bay @ Tirangi Road | 2660770 | 5984942 | Marine |
| Wellington | Lyall Bay @ Onepu Road | 2660309 | 5984828 | Marine |
| Wellington | Lyall Bay @ Queens Drive | 2660013 | 5984580 | Marine |
| Wellington | Princess Bay | 2659609 | 5983216 | Marine |
| Wellington | Island Bay @ Surf Club | 2658400 | 5983302 | Marine |
| Wellington | Island Bay @ Reef St Recreation Ground | 2658252 | 5983254 | Marine |
| Wellington | Island Bay @ Derwent Street | 2658178 | 5983127 | Marine |
| Wellington | Owhiro Bay | 2657145 | 5983174 | Marine |
| Wairarapa | Castlepoint Beach @ Castlepoint Stream | 2781366 | 6029287 | Marine |
| Wairarapa | Castlepoint Beach @ Smelly Creek | 2781670 | 6028931 | Marine |
| Wairarapa | Riversdale Beach @ Lagoon Mouth | 2768974 | 6009275 | Marine |
| Wairarapa | Riversdale Beach Between the Flags | 2768445 | 6008680 | Marine |
| Wairarapa | Riversdale Beach South | 2767844 | 6007246 | Marine |

* Water quality is also monitored for recreational shellfish gathering purposes (see Warr 2009)

# Appendix 2: Sediment and benthic fauna sampling sites

Table A2.1: Site position and collection details for the Porirua Harbour subtidal sediment quality monitoring undertaken in November 2008

| Site | Location | Date | Position (NZMG coordinates) Easting | Northing | Depth[1] (m) |
|---|---|---|---|---|---|
| PAH1 | Pauatahanui Arm off Browns Bay | 10/11/2008 | 2668177 | 6009767 | 2.0 |
| PAH1B | | 10/11/2008 | 2668156 | 6009789 | |
| PAH2 | Pauatahanui Arm off Duck Creek | 10/11/2008 | 2669747 | 6009854 | 1.8 |
| PAH2B | | 10/11/2008 | 2669779 | 6009831 | |
| PAH3 | Pauatahanui Arm off Camborne | 10/11/2008 | 2668171 | 6010921 | 1.7 |
| PAH3B | | 10/11/2008 | 2668174 | 6010937 | |
| POR1 | Onepoto Arm South | 20/11/2008 | 2664884 | 6007585 | 2.0 |
| POR1B | | 20/11/2008 | 2664854 | 6007604 | |
| POR2 | Porirua Harbour North | 20/11/2008 | 2665199 | 6008220 | 2.9 |
| POR2B | | 20/11/2008 | 2665178 | 6008252 | |

[1] Approximate water depth at mean low water neap tide

B = Benthic fauna collection area

Table A2.2: Porirua Harbour intertidal sampling locations (Jan 2009)

| Sampling Station | NZ Map Grid Easting | Northing |
|---|---|---|
| Porirua A | 2666477 (Plot 01) | 6009488 (Plot 01) |
| | 2666514 (Plot 10) | 6009525 (Plot 10) |
| Porirua B[1] | 2664635 (Plot 01) | 6007136 (Plot 01) |
| | 2664607 (Plot 10) | 6007217 (Plot 10) |
| Pauatahanui A | 2667263 (Plot 01) | 6010358 (Plot 01) |
| | 2667266 (Plot 10) | 6010315 (Plot 10) |
| Pauatahanui B | 2670378 (Plot 01) | 6010057 (Plot 01) |
| | 2670398 (Plot 10) | 6010055 (Plot 10) |

[1] The location details for this site were incorrectly listed in the 2007/08 annual coastal monitoring report

Table A2.3: Site position and collection details for the Porirua Harbour targeted intertidal sediment quality assessment undertaken in February 2009

| Site | Location | Date | Position (NZMG coordinates) | |
|---|---|---|---|---|
| | | | Easting | Northing |
| POR-A | Onepoto Arm, adjacent to Porirua Stream, true right bank | 02/02/2009 | 2664714 | 6006981 |
| POR-B | Onepoto Arm, adjacent to Porirua Stream, true right bank | 02/02/2009 | 2664722 | 6006885 |
| POR-C | Onepoto Arm, adjacent to Porirua Stream, true left bank | 02/02/2009 | 2664684 | 6006846 |
| POR-D | Onepoto Arm, adjacent to Porirua Stream, true left bank | 02/02/2009 | 2664682 | 6006927 |
| POR-E | Onepoto Arm, midway Porirua Stream & stormwater outfall | 02/02/2009 | 2664649 | 6006897 |
| POR-F | Onepoto Arm, 100 m NE from a stormwater outfall | 02/02/2009 | 2664617 | 6006865 |
| POR-G | Onepoto Arm, adjacent to Porirua Stream, true left bank | 02/02/2009 | 2664672 | 6007011 |
| POR-H | Onepoto Arm, 100 m NE of Semple St stormwater outfall | 02/02/2009 | 2664615 | 6006965 |
| POR-I | Onepoto Arm, 50 m N of Semple St stormwater outfall | 02/02/2009 | 2664560 | 6006967 |
| POR-J | Onepoto Arm, 50 m SE of Semple St stormwater outfall | 02/02/2009 | 2664589 | 6006925 |
| OP-A | Onepoto Stream mouth, adjacent to jetty | 03/02/2009 | 2664950 | 6008665 |
| OP-B | Onepoto Stream mouth | 03/02/2009 | 2664985 | 6008665 |
| BB-A | Browns Bay, 50 m W of stream outflow | 03/02/2009 | 2668003 | 6009539 |
| BB-B | Browns Bay, 100 m W stream outflow | 03/02/2009 | 2667966 | 6009593 |
| BB-C | Browns Bay, stream channel banks | 03/02/2009 | 2668003 | 6009516 |
| DC-A | Duck Creek, 50 m N from creek outflow | 03/02/2009 | 2669646 | 6009491 |
| DC-B | Duck Creek, 20 m W of creek outflow | 03/02/2009 | 2669614 | 6009506 |
| SMS043 | Porirua Stream, upstream of Kenepuru Stream | 02/02/2009 | 2664697 | 6005900 |
| SMS011 | Kenepuru Stream upstream of Porirua S confluence | 02/02/2009 | 2664762 | 6006321 |
| SMS044 | Porirua Stream, downstream of Kenepuru Stream | 02/02/2009 | 2664711 | 6006398 |
| SMS045 | Onepoto stream, upstream of Onepoto Road | 02/02/2009 | 2664954 | 6008734 |

Table A2.4: Whareama Estuary intertidal sampling locations (Jan 2009)

| Sampling Station | NZ Map Grid | |
|---|---|---|
| | Easting | Northing |
| Whareama A | 2770710 (Plot 01)<br>2770691 (Plot 10) | 6017073 (Plot 01)<br>6017068 (Plot 10) |
| Whareama B | 2770091 (Plot 01)<br>2770074 (Plot 10) | 6017048 (Plot 01)<br>6017024 (Plot 10) |

Table A2.5: Castlepoint Beach sampling locations (Jan 2009)

| Sampling Station | NZ Map Grid | |
|---|---|---|
| | Easting | Northing |
| Castlepoint A | 2781628 (Plot 01)<br>2781679 (Plot 06) | 6031520 (Plot 01)<br>6031502 (Plot 06) |
| Castlepoint B | 2781609 (Plot 01)<br>2781664 (Plot 06) | 6031467 (Plot 01)<br>6031458 (Plot 06) |

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