Annual coastal monitoring report for the Wellington region, 2011/12

Quality for Life

greater WELLINGTON
REGIONAL COUNCIL
Te Pane Matua Taiao

greater WELLINGTON
REGIONAL COUNCIL
Te Pane Matua Taiao

Annual coastal monitoring report for the Wellington region, 2011/12

MD Oliver

Environmental Science Department

For more information, contact the Greater Wellington Regional Council:

Wellington
PO Box 11646

T 04 384 5708
F 04 385 6960
www.gw.govt.nz

Masterton
PO Box 41

T 06 378 2484
F 06 378 2146
www.gw.govt.nz

GW/ESCI-G-13/31

March 2013

www.gw.govt.nz
info@gw.govt.nz

DISCLAIMER

This report has been prepared by Environmental Science staff of Greater Wellington Regional Council (GWRC) and as such does not constitute Council policy.

In preparing this report, the authors have used the best currently available data and have exercised all reasonable skill and care in presenting and interpreting these data. Nevertheless, GWRC does not accept any liability, whether direct, indirect, or consequential, arising out of the provision of the data and associated information within this report. Furthermore, as GWRC endeavours to continuously improve data quality, amendments to data included in, or used in the preparation of, this report may occur without notice at any time.

GWRC requests that if excerpts or inferences are drawn from this report for further use, due care should be taken to ensure the appropriate context is preserved and is accurately reflected and referenced in subsequent written or verbal communications. Any use of the data and information enclosed in this report, for example, by inclusion in a subsequent report or media release, should be accompanied by an acknowledgement of the source.

The report may be cited as:

Oliver MD. 2013. *Annual coastal monitoring report for the Wellington region, 2011/12*. Greater Wellington Regional Council, Publication No. GW/ESCI-G-13/31, Wellington.

Cover photo: Whareama Estuary, Eastern Wairarapa (Leigh Stevens, Wriggle Coastal Management)

Contents

1. Introduction

Greater Wellington Regional Council (GWRC) 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. The coastline of the region is almost 500 km long and stretches from Otaki on the west coast, south through Cook Strait and north along the east coast to Mataikona. It is characterised by long stretches of wide sandy beaches, rugged rocky shores and some of the strongest tidal currents in the world. The 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 (Figure 1.1).

This report summarises the results of water quality, sediment quality and ecological health monitoring undertaken in the Wellington region's near-shore coastal environment for the period 1 July 2011 to 30 June 2012. Note that the suitability of coastal waters for contact recreation purposes is assessed separately under Greater Wellington's recreational water quality monitoring programme (see Morar & Greenfield 2012).

(Source: Wriggle Coastal Management)

Figure 1.1: Windsurfers in Porirua Harbour

2. Overview of coastal monitoring programme

2.1 Background

Coastal monitoring in the Wellington region began around 25 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, between 2004 and 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 would enable GWRC to fulfil state of the environment monitoring obligations with respect to coastal ecosystems.

2.2 Monitoring objectives

The aims of GWRC'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 information required to determine the effectiveness of regional policies and plans.

2.3 Monitoring and investigations during 2011/12

Coastal monitoring and investigations undertaken over the period 1 July 2011 to 30 June 2012 included:

- Microbiological water quality monitoring at 74 sites across the region (Section 3);

- Monthly water quality monitoring at six sites in Porirua Harbour (Section 4);

- Fine scale ecological monitoring in Porirua Harbour (Section 5), Waikanae Estuary (Section 6), Hutt Estuary (Section 7), and Whareama Estuary (Section 8); and

- A survey of subtidal sediment quality at 16 sites in Wellington Harbour (Section 9).

3. Microbiological water quality monitoring

3.1 Introduction

Microbiological water quality was monitored at 74 coastal sites across the Wellington region over 2011/12 (Figure 3.1, Appendix 1), as follows:

- Kapiti Coast District – 21 sites
- Porirua City – 13 sites
- Hutt City – 15 sites
- Wellington City – 21 sites
- Wairarapa – 4 sites

There were several changes to the microbiological water quality monitoring network during 2011/12. From November 2011, 13 sites were removed from the network while one was added. On the Kapiti Coast, seven sites (Otaki Beach at Rangiuru Road, Te Horo Beach South of Mangaone Stream, Te Horo Beach at Kitchener Street, Waikanae Beach at Tutere Street Tennis Courts, Paraparaumu Beach at Wharemauku Road, Raumati Beach at Hydes Road and Paekakariki Beach at Memorial Hall) were removed from the network and one site, Te Horo Beach at Sea Road, was added. In addition, three sites were removed in the Porirua area (Pauatahanui Inlet at Motukaraka Point, Pauatahanui Inlet at Browns Bay and Onehunga Bay), along with two sites in the Hutt (Petone Beach at Settlers Museum and Camp Bay) and one in the Wairarapa (Riversdale Beach at Lagoon Mouth). The rationale for these changes is documented in Greenfield et al. (2012).

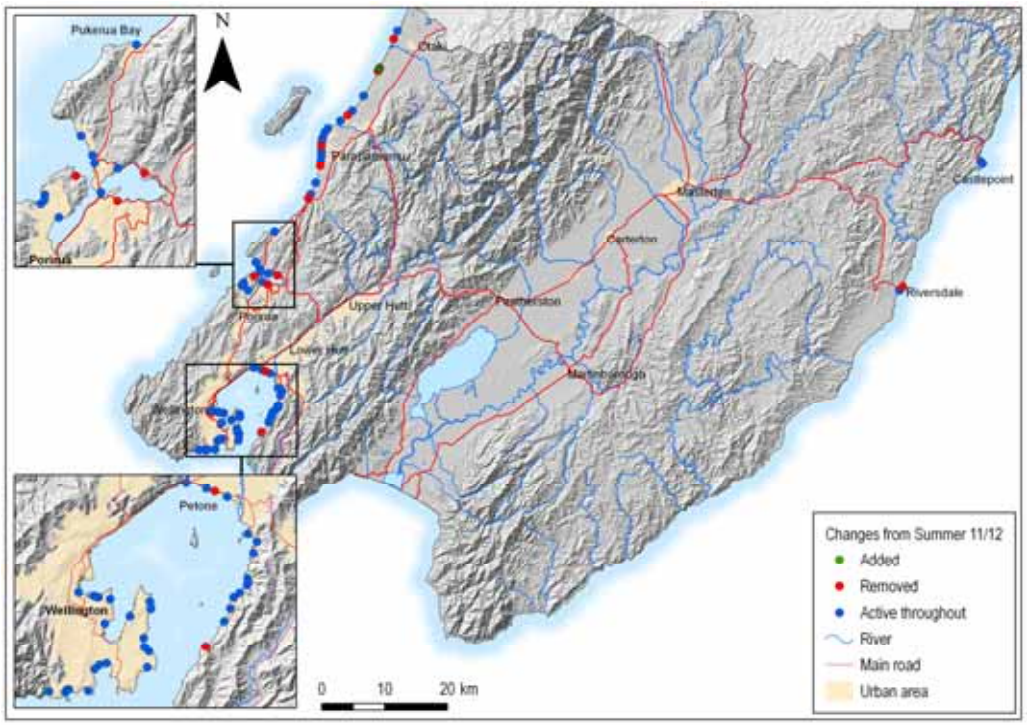


Figure 3.1: Coastal water quality sites monitored between July 2011 and June 2012. Sites in blue were sampled throughout 2011/12 while sites in red or green were removed or added, respectively, from the beginning of the summer bathing season (starting November 2011)

Monitoring was a joint effort involving GWRC, 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.

3.2 Monitoring protocol

Sites were sampled weekly – for 20 weeks – during the summer bathing season (November to March) and once monthly outside of this period, as part of GWRC's recreational water quality monitoring programme (see Morar & Greenfield 2012). On each sampling occasion a single water sample was collected 0.2 m below the surface in 0.5 m water depth and analysed for enterococci indicator bacteria.

In addition, water samples from seven sites popular for recreational shellfish gathering, and three sites in Porirua Harbour[1], were tested for faecal coliform bacteria (Appendix 1).

Observations of weather and the state of the tide, and visual estimates of seaweed cover, were also 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 decaying seaweed. There is evidence that some strains of enterococci are able to replicate or persist in decaying seaweed (Anderson 2000).

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 Morar and Greenfield (2012).

3.3 Results

The results of microbiological water quality testing undertaken during the official summer bathing season are discussed in detail in Morar and Greenfield (2012). Table 3.1 and 3.2 summarise the median, 95th percentile and maximum enterococci and faecal coliform counts recorded from all sampling conducted during the period 1 July 2011 to 30 June 2012 for each of the 74 marine sites (ie, 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).

[1] These sites, introduced in July 2007, are not recommended shellfish gathering sites but are monitored in response to community interest.

Table 3.1: Summary of enterococci counts recorded at 74 coastal sites monitored between 1 July 2011 and 30 June 2012 inclusive

Site	Total no. of samples	Enterococci (cfu/100 mL)		
		Median	95th percentile	Max
Kapiti Coast				
Otaki Beach at Rangiuru Rd*	5	18	186	220
Otaki Beach at Surf Club	29	10	84	230
Paekakariki Beach at Memorial Hall*	4	19	65	70
Paekakariki Beach at Surf Club	27	5	46	126
Paekakariki Beach at Whareroa Rd	28	4	83	325
Paraparaumu Beach at Maclean Park	28	15	92	335
Paraparaumu Beach at Nathan Ave	29	20	179	295
Paraparaumu Beach at Ngapotiki St	30	22	220	290
Paraparaumu Beach at Toru Rd	32	15	434	600
Paraparaumu Beach at Wharemauku Rd*	5	85	162	171
Peka Peka Beach at Rd End	29	3	195	295
Raumati Beach at Aotea Rd	28	9	126	560
Raumati Beach at Hydes Rd*	6	80	359	430
Raumati Beach at Marine Gardens	31	15	505	890
Raumati Beach at Tainui St	30	20	136	232
Te Horo Beach at Kitchener St*	5	30	170	195
Te Horo Beach at Sea Rd**	24	15	110	495
Te Horo Beach S of Mangaone Stream*	4	35	120	130
Waikanae Beach at Ara Kuaka Carpark	29	8	131	195
Waikanae Beach at Tutere St Tennis Court*	6	27	255	255
Waikanae Beach at William St	29	5	209	315
Porirua				
Karehana Bay at Cluny Rd	30	8	146	340
Onehunga Bay*	4	16	114	130
Pauatahanui Inlet at Browns Bay*	3	32	39	40
Pauatahanui Inlet at Motukaraka Pt*	5	80	520	590
Pauatahanui Inlet at Paremata Br.	28	8	113	250
Pauatahanui Inlet at Water Ski Club	28	12	120	230
Plimmerton Beach at Bath St	28	8	189	410
Porirua Harbour at Rowing Club	40	60	791	1,100
Pukerua Bay	29	4	65	390
South Beach at Plimmerton	31	20	610	930
Titahi Bay at Bay Drive	29	8	112	540
Titahi Bay at South Beach Access Rd	33	28	664	2,200
Titahi Bay at Toms Rd	28	8	110	520
Wellington City				
Aotea Lagoon	30	8	126	1,500
Balaena Bay	29	<4	50	68
Breaker Bay	29	<4	4	4
Hataitai Beach	31	<4	110	290
Island Bay at Derwent St	29	4	22	130
Island Bay at Reef St Recreation Ground	35	12	289	860
Island Bay at Surf Club	35	8	475	720
Lyall Bay at Onepu Rd	30	4	32	150
Lyall Bay at Queens Drive	30	4	16	400
Lyall Bay at Tirangi Rd	29	4	61	110

Table 3.1 *continued*: Summary of enterococci counts recorded at 74 coastal sites monitored between 1 July 2011 and 30 June 2012 inclusive

Site	Total no. of samples	Enterococci (cfu/100 mL)		
		Median	95th percentile	Max
Mahanga Bay	29	4	43	60
Oriental Bay at Band Rotunda	31	<4	160	300
Oriental Bay at Freyberg Beach	29	<4	30	36
Oriental Bay at Wishing Well	30	<4	180	690
Owhiro Bay	49	88	760	2,200
Princess Bay	30	<4	45	240
Scorching Bay	30	<4	25	420
Seatoun Beach at Inglis St	30	<4	73	220
Seatoun Beach at Wharf	30	<4	52	210
Shark Bay	30	4	100	160
Worser Bay	30	<4	120	520
Hutt				
Camp Bay*	4	27	110	120
Days Bay at Moana Rd	29	4	172	1,100
Days Bay at Wellesley College	31	8	385	1,300
Days Bay at Wharf	29	4	132	1,100
Lowry Bay at Cheviot Rd	29	<4	486	1,200
Petone Beach at Kiosk	30	12	190	330
Petone Beach at Settlers Museum*	4	6	56	64
Petone Beach at Sydney St	29	12	158	270
Petone Beach at Water Ski Club	29	4	146	190
Robinson Bay at HW Shortt Recreation Ground	29	8	224	930
Robinson Bay at Nikau St	29	4	252	930
Rona Bay at N end of Cliff Bishop Park	33	8	1,394	2,200
Rona Bay at Wharf	28	12	82	990
Sorrento Bay	31	4	830	1,500
York Bay	29	<4	164	1,000
Wairarapa				
Castlepoint Beach at Castlepoint Stream	28	4	139	360
Castlepoint Beach at Smelly Creek	27	<4	82	160
Riversdale Beach at Lagoon Mouth*	4	30	150	170
Riversdale Beach Between the Flags	27	<4	56	220

* Monitoring discontinued from November 2011

** Site added to monitoring network from November 2011

A total of 11 sites recorded a maximum enterococci sample result of greater than or equal to 1,000 cfu/100mL. The highest maximum count recorded was 2,200 cfu/100mL and was recorded in samples from Titahi Bay at South Beach Access Road, Owhiro Bay and Rona Bay at Northern end of Cliff Bishop Park on the 29 November 2011, 24 January 2012 and 7 February 2012, respectively. While the results at Owhiro Bay and Rona Bay at Northern end of Cliff Bishop Park coincided with more than 10 mm of rainfall (14 and 43 mm, respectively) in the 48 hours before sampling, the high result at Titahi Bay at South Beach Access Road was only preceded by 1.5 mm of rain the previous day. The reason for the high result at this site may be related to contamination from sewer/stormwater infrastructure (see Greenfield et al. 2012).

Six sites recorded particularly high 95th percentile enterococci counts (above 600 cfu/100mL), indicating that significantly elevated bacteria levels were recorded on multiple occasions at these sites. These sites were Rona Bay at Northern end of Cliff Bishop Park (1,394 cfu/100mL), Sorrento Bay (830 cfu/100mL), Porirua Harbour at Rowing Club (791 cfu/100mL), Owhiro Bay (760 cfu/100mL), (664 cfu/100mL) Titahi Bay at South Beach Access Road and South Beach at Plimmerton (610 cfu/100mL).

Three of the ten sites monitored for faecal coliform bacteria recorded maximum counts of 1,000 cfu/100mL (Table 3.2): Pauatahanui Inlet at Motukaraka Point (1,000 cfu/100mL on 18 October 2011), Sorrento Bay (1,020 cfu/100mL on 6 December 2011) and Otaki Beach at Surf Club (1,180 cfu/100mL on 11 January 2012). The high results at Pauatahanui Inlet at Motukaraka Point and Sorrento Bay coincided with heavy rainfall (>10 mm) in the 24 hours before sampling. However, the Otaki Beach result coincided with only a minimal amount of rainfall (4.5 mm) in the three days before the sample was taken; the cause of the high results at this site is unknown.

Table 3.2: Summary of faecal coliform counts recorded at ten coastal sites monitored between 1 July 2011 and 30 June 2012 inclusive

Site	Total no. of samples	Faecal coliforms (cfu/100 mL)		
		Median	95th percentile	Max
Kapiti Coast				
Otaki Beach at Surf Club	29	22	656	1,180
Peka Peka Beach at Rd End	29	15	655	975
Raumati Beach at Hydes Rd*	6	118	510	575
Raumati Beach at Tainui St**	25	35	276	500
Porirua				
Pauatahanui Inlet at Browns Bay*	3	32	61	64
Pauatahanui Inlet at Motukaraka Pt*	5	80	844	1,000
Porirua Harbour at Rowing Club	37	60	532	900
Wellington City				
Mahanga Bay	29	2	66	100
Shark Bay	29	2	178	990
Hutt				
Sorrento Bay	30	6	267	1,020

* Monitoring discontinued from November 2011

** Site added to monitoring network from November 2011 (replaced Hydes Road)

4. Porirua Harbour water quality monitoring

4.1 Introduction and background

Broad scale habitat mapping and fine scale intertidal monitoring undertaken between 2008 and early 2010 consistently rated Porirua Harbour as a moderately eutrophic estuary (Robertson & Stevens 2008a; 2009a; 2010a; Stevens & Robertson 2008). The estuary sediments were found to have low to moderate stores of nitrogen and phosphorus and localised nuisance conditions related to excessive macroalgae growth. In 2010 Robertson and Stevens (2010a) recommended monitoring of nutrient and chlorophyll *a* concentrations in the water column of Porirua Harbour to assess the potential for ongoing nuisance conditions. In January 2011 Greater Wellington commenced monthly water sampling at six sites to in the harbour. This section briefly summarises the results of the first 18 months of water quality monitoring.

4.2 Monitoring sites, variables and methods

Harbour water samples were collected monthly on a mid-ebb tide from six sites in Porirua Harbour (Figure 4.1, Appendix 1). On each sampling occasion field measurements of water temperature, conductivity and dissolved oxygen were taken and the weather conditions recorded. Samples were collected 0.25 m below the surface in approximately 0.75 m water depth and analysed for pH, salinity, conductivity, turbidity, total suspended solids (TSS), soluble and total nitrogen and phosphorus, and chlorophyll *a* (see Oliver & Milne 2012 for analytical methods).

Figure 4.1: Location of Porirua Harbour water quality sampling sites

4.3 Key findings

Overall, based on the first 18 months of monitoring, results indicate that water quality was more variable at the Onepoto Arm sites (O1 and O2) and the inner estuary monitoring site of Pauatahanui Arm (P2); median concentrations of nutrients, suspended sediments and chlorophyll *a* were all higher at these sites (Table 4.1). This reflects the proximity of these sites to stream and stormwater inputs.

In marine environments, nitrogen is generally considered to be the nutrient limiting plant growth and a useful measure of the nitrogen available for plant growth is dissolved inorganic nitrogen (DIN); the combined amount of ammoniacal nitrogen and nitrate-nitrite nitrogen. Although there are no national guidelines for acceptable concentrations of DIN in coastal waters, international guidelines indicate that concentrations need to exceed 0.25 mg/L for prolonged periods to cause eutrophic conditions in estuaries (B. Robertson, pers. comm. 2013[2]). Figure 4.2 indicates that DIN concentrations only exceeded 0.25 mg/L on several occasions during winter, especially at the inner estuary sites of both arms, P2 and O2.

Table 4.1: Median (and range)[1] of values for selected variables measured during monthly water sampling in Porirua Harbour between January 2011 and June 2012

	Porirua Harbour – Entrance E1	Pauatahanui Arm – North P1	Pauatahanui Arm – East P2	Pauatahanui Arm – South P3	Onepoto Arm – West O1	Onepoto Arm – South O2
TSS (mg/L)	7.5 (2–51)	13.0 (4–230)	10.5 (4–210)	12.5 (3—67)	11.5 (5–460)	21.5 (6–230)
Turbidity (NTU)	2.4 (1.2–19.5)	6.8 (2–86)	4.7 (1.7–169)	5.9 (1.2–15.6)	5.9 (2.2–210)	11.7 (1.6–126)
Salinity (ppt)	34 (24–35)	33 (20–35)	31 (11–35)	33 (22–35)	32 (27–35)	31 (16–34)
Chlorophyll *a* (mg/L)	0.0015 (0.0015–0.007)	0.0015 (0.0015–0.008)	0.0015 (0.0015–0.016)	0.0015 (0.0015–0.007)	0.0015 (0.0015–0.014)	0.0015 (0.0015–0.019)
Ammoniacal N (mg/L)	0.005 (0.005–0.034)	0.005 (0.005–0.043)	0.005 (0.005–0.108)	0.005 (0.005–0.038)	0.005 (0.005–0.064)	0.0165 (0.005–0.110)
Nitrate-Nitrite N (mg/L)	0.002 (0.001–0.25)	0.004 (0.001–0.35)	0.006 (0.001–0.660)	0.003 (0.001–0.23)	0.005 (0.001–0.21)	0.084 (0.001–0.370)
Dissolved inorganic nitrogen (mg/L)	0.009 (0.006–0.284)	0.024 (0.006–0.393)	0.028 (0.006–0.734)	0.013 (0.006–0.235)	0.027 (0.006–0.246)	0.136 (0.006–0.48)
Total phosphorus (mg/L)	0.016 (0.012–0.046)	0.028 (0.015–0.181)	0.029 (0.015–0.24)	0.025 (0.014–0.038)	0.031 (0.018–0.4)	0.041 (0.024–0.25)
Dissolved reactive phosphorus (mg/L)	0.005 (0.002–0.019)	0.006 (0.002–0.021)	0.008 (0.002–0.019)	0.006 (0.002–0.022)	0.005 (0.002–0.035)	0.008 (0.002–0.024)

[1] Values reported as below the laboratory detection limit have been halved.

[2] Dr Barry Robertson, Principal Scientist, Wriggle Coastal Management.

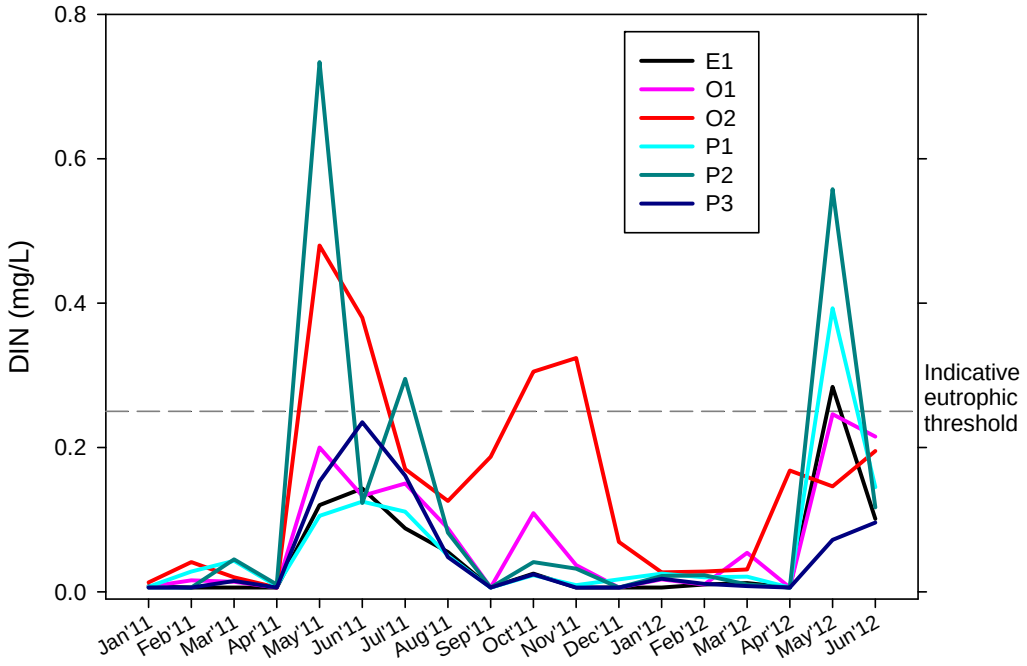


Figure 4.2: Dissolved inorganic nitrogen (DIN) concentrations recorded in monthly sampling at six sites in Porirua Harbour, January 2011 to June 2012

Chlorophyll *a* concentrations remained below the analytical detection limit (<0.003 mg/L) on most occasions. Only 19 of the 108 results returned a value above 0.003 mg/L and most of these were recorded at sites O1 and O2 in the Onepoto Arm.

Overall, the results indicate that the pulses of nutrients were related to wind and rainfall events, and that catchment sources, rather than ocean sources of nutrients, likely drive the macroalgal growth observed in the estuary (see Section 5).

4.4 Future monitoring

Water quality monitoring will continue for a further six months to obtain a full two years of data, at which point the results will be reviewed and the need for further monitoring assessed.

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. Three detailed fine scale surveys were completed in 2008, 2009 and 2010 with the results showing that Porirua Harbour had low to moderate intertidal sedimentation rates, increasingly muddy sediments that were not well oxygenated and moderate nutrient concentrations (Robertson & Stevens 2008a; 2009a; 2010a).

Based on these findings it was decided to continue the annual monitoring to measure sedimentation rates, grain size, sediment oxygenation and macroalgal cover. This section briefly summarises the latest monitoring results; full details of the monitoring are reported in Stevens and Robertson (2012b; 2012c). Refer to Section 4 for the related water quality monitoring results.

5.2 Monitoring sites, variables and methods

The fifth intertidal survey was undertaken in February 2012 at two intertidal sites in each arm of Porirua Harbour (Figure 5.1 and Appendix 1) and a single

(Source: Stevens & Robertson 2012c)

Figure 5.1: Location of the four fine scale intertidal monitoring sites and sedimentation monitoring plates within Porirua Harbour – site Por West represents the single subtidal sedimentation monitoring location

subtidal site in the Onepoto Arm. The monitoring included measurements of sediment depth over buried sediment plates, grain size analyses to monitor changes in mud content, and redox potential discontinuity (RPD) depth as a proxy for sediment oxygenation. In addition, the percentage cover of macroalgae (eg, sea lettuce) was mapped for the fifth time as a broad measure of nutrient enrichment within the estuary. Four new sediment plate sites were also established to monitor sedimentation rates over a wider spatial area in both arms.

5.3 Key findings

Mean sedimentation rates across the four intertidal sites in 2011/12 were very low to moderate, ranging from -5.3 to +3.0 mm/yr. The highest rates of intertidal deposition occurred in the Onepoto Arm at site PorB near Whitireia Institute (1.5 mm/yr), and the subtidal site, PorWest (3.0 mm/yr). Mean overall rates of sedimentation, taking into account all data collected between 2007 and 2012, indicate sedimentation is moderate in the upper Onepoto Arm at 2.8 mm/yr and very low at all other sites. Sedimentation rates over the new sediment plates installed at four sites in 2012 will be reported on in 2013.

Sediments at all four intertidal sites have remained poorly oxygenated for the last three years, as indicated by a shallow RPD depth (1–1.5 cm). Sediments at the subtidal site recorded an increase in RPD depth from 1 cm in 2011 to 5 cm in 2012, giving the site a RPD condition rating of ‘good’. The mud content of sediments ranged from 4.7 to 13.2%, with the muddiest sites being in the lower estuary (PorA and PauA) and subtidal (PorWest) locations.

A macroalgal cover condition rating of ‘fair’ was assigned to the 2012 survey results, consistent with annual surveys since 2008. In 2012 it was noted that there was high cover of *Ulva* sp. near the mouth of Porirua Stream and high cover of *Gracilaria* sp. near the mouth of Horokiri Stream (Figure 5.2). Localised nuisance conditions, such as poorly oxygenated and sulphide rich sediments, were associated with this high macroalgal cover.

(Source: Stevens & Robertson 2012b)

Figure 5.2: Dense macroalgal (*Gracilaria* sp.) cover near the Horokiri Stream in the Pauatahanui Arm

5.4 Future monitoring

Annual monitoring of sediment oxygenation, mud content, sedimentation rates, and macroalgal cover will continue in 2013. In addition, broad scale habitat mapping will be repeated in 2013, five years after the previous broad scale survey. Following recommendations by Stevens and Robertson (2012c), nine new sediment monitoring sites, including eight subtidal and one intertidal, will be established in 2013.

6. Waikanae Estuary intertidal ecological monitoring

6.1 Introduction and background

In February of 2012, the third in a series of three fine scale ecological surveys was undertaken in Waikanae Estuary, a 2 km long, 'tidal river mouth' type estuary located on the Kapiti Coast. This monitoring, summarised here from reports by Robertson and Stevens (2012b) and Stevens and Robertson (2012d), follows identical surveys carried out in January 2010 and January 2011. The surveys were undertaken following a 2007 assessment of coastal habitats in the western Wellington region (Robertson & Stevens 2007) which recommended monitoring the long-term condition of the Waikanae Estuary, focusing on core indicators of sedimentation, eutrophication and, to a lesser extent, contamination.

6.2 Monitoring sites, variables and methods

Monitoring included a broad scale assessment of macroalgal cover over the estuary's intertidal habitat and a fine scale assessment of ecological health at one 60 m by 15 m site located on unvegetated intertidal mudflats in the upper estuary (Figure 6.1 & Appendix 1). Within this site 10 plots were assessed for selected fine scale sediment condition indicators – including grain size (texture), the degree of oxygenation, nutrient and organic content, and heavy metal concentrations – as well as benthic (sediment-dwelling) fauna abundance and diversity. In addition, the depths to four sedimentation monitoring plates buried in 2010 adjacent to the fine scale monitoring site were measured to assess sedimentation rates in the upper estuary reaches.

(Source: Robertson & Stevens 2012b)

Figure 6.1: Location of the fine scale monitoring site and sedimentation monitoring plates within the Waikanae Estuary

6.3 Key findings

The third year of baseline monitoring of fine scale estuarine health indicators showed that the intertidal habitat in the Waikanae Estuary is generally in a 'fair' condition; this represents a more degraded state than in 2011 when the condition rating was 'good' to 'fair'. The change in condition rating was attributed to an increase in sediment mud content, along with an increase in concentrations of metals, total organic carbon and total nitrogen and a reduction in sediment oxygenation. Consistent with previous assessments, these findings indicate that the estuary is moderately eutrophic and receives excessive fine sediment.

Sedimentation rates continue to be ranked as 'very high' with mean annual sedimentation rates ranging from +25 to +45 mm/yr, and an overall mean annual rate of +35.2 mm/yr. The total increase in sediment level at the fine scale site was +70 mm over the three survey years indicating that the intertidal flats of the estuary are rapidly infilling.

The concentration of mud within the sediments has increased considerably from 18% in the 2011 survey to 39% in 2012 (Figure 6.2). The source of sediment is unknown[3] but such an increase in mud content over a short interval has the potential to negatively impact the benthic invertebrates living in the sediments. The mud content, though high, is typical of tidal river estuaries elsewhere that drain developed catchments; in 2012 the mud content of sediments in the Whareama Estuary ranged from 51–70% and in the Hutt River Estuary from 22–28%.

(Source: Wriggle Coastal Management)

Figure 6.2: A sediment core from the Waikanae Estuary, illustrating the recently deposited surface layer of mud

[3] There were no significant flood events or instream works in the Waikanae catchment between February 2011 and January 2012.

Concentrations of total organic carbon, total nitrogen and total phosphorus were higher than previously recorded in the 2010 and 2011 assessments. Furthermore, sediment oxygenation declined, as measured by the depth to the RPD layer, which decreased from 3–10 cm in 2011 to 1–2 cm in 2012.

The concentrations of the six heavy metals measured were higher in 2012 than in previous years. This increase could be attributed to the two-fold increase in the percentage of mud because contaminants are known to bind with fine grain sediments. However, the metal concentrations, as in previous years, remain well below the ANZECC (2000) Interim Sediment Quality Guideline-Low trigger values.

The invertebrate community was represented by a small number of species having decreased from a mean of 9.1 species in 2010 to 7.2 species in 2012. The community was dominated by species tolerant of muddy conditions and low to moderate enrichment levels, such as the small native snail *Potamopyrgus* spp., amphipods and polychaetes.

The 2012 survey of intertidal macroalgae cover reported a slight increase in the presence of macroalgae, especially near the floodgate that drains the Waimanu Lagoons (Figure 6.3). The macroalgae coefficient, a measure of condition based on percentage cover, increased from 0.20 in 2011 to 0.25 in 2012 and nuisance conditions such as rotting macroalgae, and poorly oxygenated, sulphide and nutrient-rich sediments persist near the floodgate.

(Source: Wriggle Coastal Management)

Figure 6.3: Macroalgae (*Ulva intestinalis*) cover and associated nuisance conditions near the floodgate of the Waikanae Estuary

6.4 Future monitoring

The 2012 fine scale ecological assessment and macroalgal mapping constitute the third and final in the series to establish a baseline of existing conditions in

the Waikanae Estuary. The results indicate that the estuary is experiencing high nutrient and sediment inputs and subsequent annual monitoring of sediment oxygenation, mud content, sedimentation rates, and macroalgal cover will continue in 2013. A full fine scale assessment, including invertebrate sampling, will likely be repeated around 2016/17.

7. Hutt River Estuary ecological monitoring

7.1 Introduction and background

Following two identical fine scale assessments of the Hutt Estuary in 2010 and 2011, a third and final baseline assessment was undertaken in February 2012. This monitoring, summarised here from reports by Robertson and Stevens (2012a) and Stevens and Robertson (2012a), follows a preliminary assessment of coastal habitats in the western Wellington region (Robertson & Stevens 2007) which recommended monitoring the long-term condition of the Hutt Estuary, with a focus on core indicators of sedimentation, eutrophication and contamination.

7.2 Monitoring sites, variables and methods

Monitoring included a broad scale assessment of macroalgal cover over the estuary's intertidal habitat and a fine scale assessment of ecological health at two shallow subtidal margin locations which represented the dominant estuarine habitat (Figure 7.1 & Appendix 1). At each of these two sites a 20 m long transect, aligned parallel to the edge of the channel, was marked out. At 2 m intervals along each transect, 10 sampling points were assessed for selected fine scale sediment condition indicators – including grain size (texture), the degree of oxygenation, nutrient and organic content, and heavy metal and polycyclic aromatic hydrocarbon (PAH) concentrations – as well as benthic (sediment-dwelling) fauna abundance and diversity. In addition, the depths to four sedimentation monitoring plates buried on a small intertidal flat near the mouth of the estuary in 2010 were measured to assess sedimentation rates in this area of the estuary.

(Source: Robertson & Stevens 2012a)

Figure 7.1: Location of the fine scale monitoring sites and sedimentation monitoring plates within the Hutt Estuary

7.3 Key findings

Similar to 2011, the 2012 results for the selected physical, chemical and biological indicators of estuary condition found that the dominant habitat of unvegetated subtidal mud and sand was in a 'fair' condition.

The sediments were deemed poorly oxygenated (RPD depth of 1–3 cm) with low to moderate concentrations of total organic carbon, total nitrogen and total phosphorus; results consistent with the previous two surveys. The sedimentation rate was reported as very low (mean rate -2.75 mm/yr) though the sediment had high concentrations of mud (23–28%) (Figure 7.2) and a benthic community dominated by species with a moderate to high tolerance of mud and organic enrichment. The most abundant species was once again the tube-dwelling amphipod *Paracorophium excavatum* which has a strong mud preference. Surprisingly, there were also moderate numbers of juvenile pipis (*Paphies australis*) and cockles (*Austrovenus stutchburyi)*. Cockle numbers were higher in 2012, despite growing in what are deemed to be sub-optimal conditions (ie, high mud content and low oxygen – such species typically have a preference for sand-dominated habitats).

(Source: Robertson & Stevens 2012a)

Figure 7.2: A sediment core from site B of the Hutt River Estuary, showing black anoxic mud and cockles

The macroalgal rating for the estuary decreased from 'fair' in 2010 and 2011 to 'poor' in 2012, reflecting the greater cover of *Ulva intestinalis* (Figure 7.3). Despite the high cover, nuisance conditions were found in only a few intertidal areas, and in subtidal areas near the mouth which are muddy, poorly oxygenated and rich in sulphides.

(Source: Robertson & Stevens 2012a)

Figure 7.3: Dense macroalgal cover on the intertidal flats of the Hutt River Estuary

Despite exposure to urban run-off, heavy metal concentrations in the surface sediments were all well below ANZECC (2000) Interim Sediment Quality Guideline Low-trigger values, and concentrations of PAHs were all below analytical detection limits. These results indicate that there is no widespread toxicity in the mud/sand habitat of the estuary.

Overall, it is recognised that the Hutt Estuary has been highly modified with extensive areas of reclamation and channelisation for urban development and flood protection. Consequently the estuary lacks significant areas of high value habitats, such as saltmarsh, seagrass, intertidal flats, and naturally vegetated margins, which reduces the healthy functioning of the estuary.

7.4 Future monitoring

The 2012 fine scale ecological assessment constitutes the third and final in the series of three annual assessments to establish a baseline of existing conditions in the Hutt Estuary. However, the current symptoms of eutrophication and sedimentation necessitate annual monitoring of relevant indicators such as RPD, sedimentation rates and macroalgal cover. A full fine scale assessment, including invertebrate sampling, will likely be repeated around 2016/17.

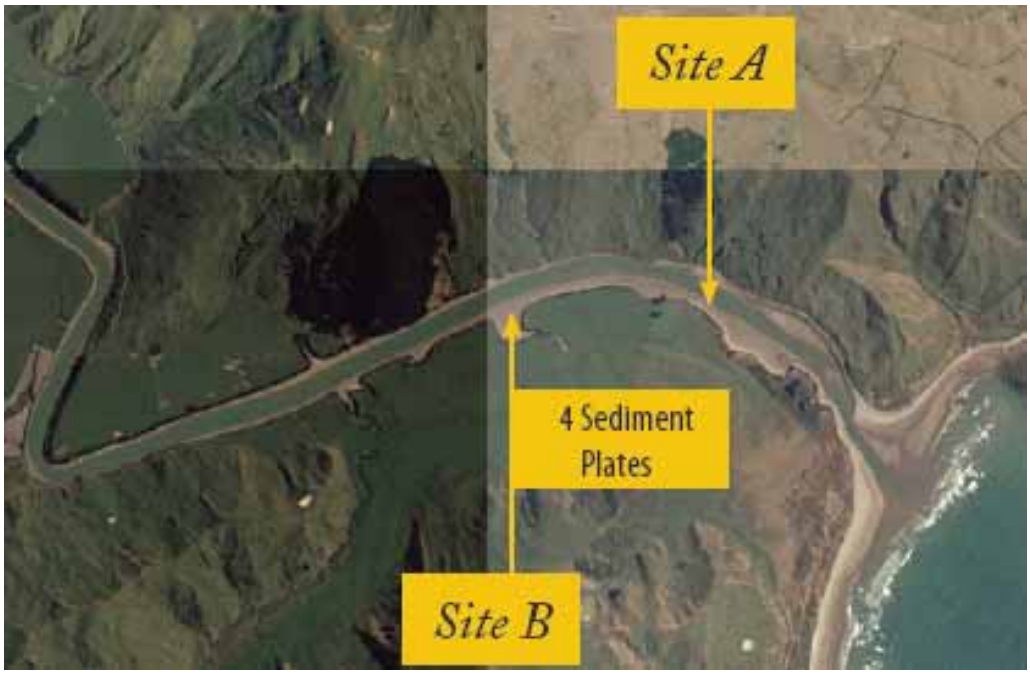
8. Whareama Estuary intertidal ecological monitoring

8.1 Introduction and background

The Whareama Estuary is a 12 km long, tidal river lagoon estuary located on Wairarapa's eastern coast. Three years of detailed fine scale monitoring (Robertson & Stevens 2008b; 2009b; 2010b) found the estuary to have high rates of sedimentation from the naturally erosion-prone catchment, poorly oxygenated sediments with high mud content and a benthic invertebrate community increasingly dominated by mud-tolerant species. These findings triggered further annual monitoring of sedimentation rates, grain size and sediment oxygenation. This section briefly summarises the latest monitoring results; full details of the monitoring are reported in Stevens and Robertson (2012e).

8.2 Monitoring sites, variables and methods

Monitoring was undertaken at two sites located on the unvegetated intertidal mudflats during February 2012 (Figure 8.1 & Appendix 1). This monitoring included grain size analyses to monitor changes in mud content, redox potential discontinuity (RPD) depth as a proxy for sediment oxygenation, and the depths to four sedimentation monitoring plates deployed at right angles to the Whareama River channel in January 2008.



(Source: Stevens & Robertson 2011a)

Figure 8.1: Location of the fine scale monitoring sites and sedimentation monitoring plates within the Whareama Estuary

8.3 Key findings

The fifth year of intertidal sediment monitoring found that both fine scale monitoring sites are still excessively muddy (51–71% mud) and the depth to the RPD layer remains shallow at 1–2 cm. This indicates that the sediments are poorly oxygenated and anoxic (Figure 8.2); such sediments are rich in sulphides and can be toxic to some aquatic life.

(Source: Wriggle Coastal Management)

Figure 8.2: Sediment sampling at site A in the Whareama Estuary shows the shallow anoxic layer underlying recently deposited marine sands

The mean sedimentation rate in 2012 was +3 mm/yr; in previous years mean sedimentation rates have ranged between -2 mm/yr and +21.8 mm/yr. The overall mean annual sedimentation rate for the period 2008 to 2012 is 9.3 mm/yr and the total increase in sediment level is 39 mm since 2008. This is deemed to be a 'high' sedimentation rate and indicates that the intertidal habitat is rapidly infilling. The source of sediment is undoubtedly the soft, erosion-prone rock and soils in the catchment, which following wet weather events are deposited in large volumes as mud in the estuary.

8.4 Future monitoring

Annual monitoring of sediment indicators will be carried out again in early 2013. A detailed fine scale assessment, incorporating measures of sediment chemistry and invertebrate health is due to be repeated in early 2015.

9. Wellington Harbour subtidal sediment quality monitoring

9.1 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. In late 2011, GWRC undertook a second survey of Wellington Harbour subtidal sediments with the primary focus of assessing the levels of contamination from heavy metals, hydrocarbons and organochlorine pesticides and their potential impact on the health of the sediment-dwelling invertebrates.

In addition, the 2011 survey investigated levels of metal and hydrocarbon contamination in the roadside catchpits (stormwater drains) of five Wellington city stormwater catchments. The results of catchpit sampling are expected to identify the relative contribution of contaminants to the harbour from inner city and suburban sources.

This section briefly summarises the sampling sites and methods of the 2011 harbour and catchpit sediment survey. Results were not available at the time of preparing this report; a comprehensive report on the 2011 survey is expected later in 2013.

9.2 Sampling sites

Sixteen subtidal sites were sampled in Wellington Harbour between October and December 2011 (Figure 9.1 & Appendix 1). Following recommendations from the 2006 survey (see Stephenson et al. 2008), six new sites were surveyed in 2011 and seven sites previously sampled in 2006 sites were not resurveyed. Ten sites were sampled on both occasions. Stormwater catchpit samples were also collected from the bottom of five Wellington city catchments to investigate the relative sources of contamination from urban areas (Figure 9.2).

9.3 Sampling methods

Subtidal sediment and benthic fauna samples were collected by the use of a boat, GPS and scuba divers using identical protocols to those employed during the 2006 survey of Wellington Harbour (Stephenson et al. 2008).

At each site 25 sediment core samples were collected from a sampling area 20 m in diameter, with the top 30 mm of each core randomly assigned into five replicate groups for composite analysis. Samples were tested for particle size distribution (sediment texture), total organic carbon (TOC), weak acid-extractable and total heavy metals, polycyclic aromatic hydrocarbons (PAHs) and selected organochlorine pesticides.

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, and measurement of shell lengths of selected species (eg, bivalve molluscs).

Figure 9.1: Map of Wellington Harbour showing the subtidal locations sampled between October and December 2011

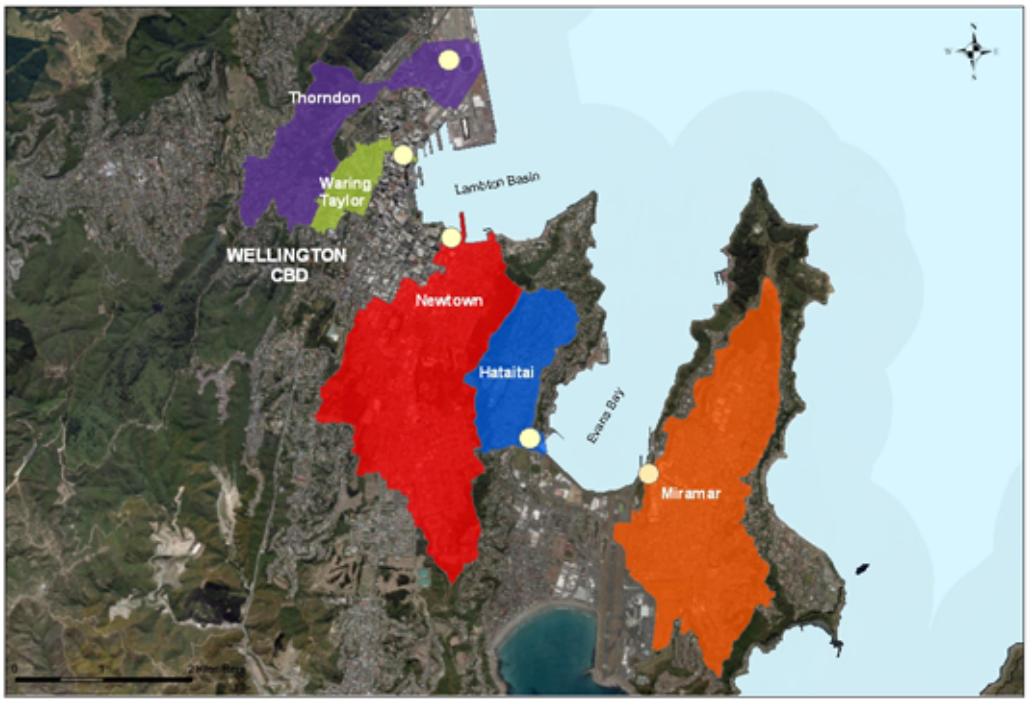


Figure 9.2: Map of Wellington city showing the location of catchpit samples (yellow circles) and stormwater catchments sampled in September 2011

9.3.1 Catchpit sediments

Three roadside catchpits were sampled within each of five Wellington city stormwater catchments (Figure 9.2). Samples were collected by hand using a trowel and composited by catchment. Samples were analysed for the same contaminants as the harbour sediments.

9.4 Sampling results

At the time of preparing this report, benthic invertebrate identifications were complete but sediment sample analyses were ongoing. Results will be presented in a detailed report later in 2013. This report will also set out recommendations for future monitoring of sediment quality in Wellington Harbour.

In terms of the benthic fauna, a total of 124 taxa were identified in the samples collected during the 2011 Wellington Harbour survey. A total of 10,878 individuals were counted, of which polychaetes were the most abundant group (32% of all individuals), followed by crustaceans (26%), sipunculids (17%) and bivalve molluscs (15%). The sea urchin, *Echinocardium*, was a dominant member of the biomass at all but two of the sites.

References

Anderson SA. 2000. *Occurrence and characterisation of enterococci in terrestrial and aquatic environments.* PhD thesis. School of Biological Sciences, University of Auckland.

Australian and New Zealand Environment and Conservation Council. 2000. *Australian and New Zealand guidelines for fresh and marine water quality, volume 1, the guidelines*. Agriculture and Resource Management Councils of Australia and New Zealand, Canberrra.

Greenfield S, Ryan A and Milne JR. 2012. *Recreational water quality in the Wellington region: States and trends.* Greater Wellington Regional Council, Publication No. GW/EMI-T-12/142, Wellington.

Milne JR. 2006. *Contaminants in shellfish flesh: An investigation into microbiological and trace metal contaminants in shellfish from selected locations in the Wellington region.* Greater Wellington Regional Council, Publication No. GW/EMI-G-06/285, Wellington.

Ministry for the Environment and Ministry of Health. 2003. *Microbiological water quality guidelines for marine and freshwater recreational areas*. Ministry for the Environment, Wellington.

Morar S and Greenfield S. 2012. *On the beaches 2011/12: Annual recreational water quality monitoring report for the Wellington region.* Greater Wellington Regional Council, Publication No. GW/ESCI-G-12/153, Wellington.

Oliver MD and Milne JR. 2012. *Coastal water quality and ecology in the Wellington region: States and trends.* Greater Wellington Regional Council, Publication No. GW/EMI-T-12/144, Wellington.

Robertson B and Stevens L. 2007. *Kapiti, Southwest, South Coasts and Wellington Harbour: Risk assessment and monitoring recommendations.* Report prepared for Greater Wellington Regional Council by Wriggle Coastal Management, Nelson.

Robertson B and Stevens L. 2008a. *Porirua Harbour: Fine scale monitoring 2007/08.* Report prepared for Greater Wellington Regional Council by Wriggle Coastal Management, Nelson.

Robertson B and Stevens L. 2008b. *Whareama Estuary 2008: Fine scale monitoring.* Report prepared for Greater Wellington Regional Council by Wriggle Coastal Management, Nelson.

Robertson B and Stevens L. 2009a. *Porirua Harbour: Intertidal fine scale monitoring 2008/09.* Report prepared for Greater Wellington Regional Council by Wriggle Coastal Management, Nelson.

Robertson B and Stevens L. 2009b. *Whareama Estuary: Fine scale monitoring 2008/09.* Report prepared for Greater Wellington Regional Council by Wriggle Coastal Management, Nelson.

Robertson B and Stevens L. 2010a. *Porirua Harbour: Intertidal fine scale monitoring 2009/10.* Report prepared for Greater Wellington Regional Council by Wriggle Coastal Management, Nelson.

Robertson B and Stevens L. 2010b. *Whareama Estuary: Fine scale monitoring 2009/10.* Report prepared for Greater Wellington Regional Council by Wriggle Coastal Management, Nelson.

Robertson B and Stevens L. 2012a. *Hutt Estuary: Fine scale monitoring 2011/12.* Report prepared for Greater Wellington Regional Council by Wriggle Coastal Management, Nelson.

Robertson B and Stevens L. 2012b. *Waikanae Estuary: Fine scale monitoring 2011/12.* Report prepared for Greater Wellington Regional Council by Wriggle Coastal Management, Nelson.

Stephenson G, Milne J R and Sorenson P. 2008. *Wellington Harbour marine sediment quality investigation.* Greater Wellington Regional Council, Publication No. GW/EMI-T-08/83, Wellington.

Stevens L and Robertson B. 2008. *Porirua Harbour: Broad scale habitat mapping 2007/08*. Report prepared for Greater Wellington Regional Council and Porirua City Council by Wriggle Coastal Management, Nelson.

Stevens L and Robertson B. 2012a. *Hutt Estuary: Intertidal macroalgal monitoring 2011/12.* Report prepared for Greater Wellington Regional Council by Wriggle Coastal Management, Nelson.

Stevens L and Robertson B. 2012b. *Porirua Harbour: Intertidal macroalgal monitoring 2011/12.* Report prepared for Greater Wellington Regional Council by Wriggle Coastal Management, Nelson.

Stevens L and Robertson B. 2012c. *Porirua Harbour: Intertidal sediment monitoring 2011/12.* Report prepared for Greater Wellington Regional Council by Wriggle Coastal Management, Nelson.

Stevens L and Robertson B. 2012d. *Waikanae Estuary: Intertidal macroalgal monitoring 2011/12.* Report prepared for Greater Wellington Regional Council by Wriggle Coastal Management, Nelson.

Stevens L and Robertson B. 2012e. *Whareama Estuary: Intertidal sediment monitoring 2011/12.* Report prepared for Greater Wellington Regional Council by Wriggle Coastal Management, Nelson.

Acknowledgements

Shyam Morar compiled the microbiological summary statistics. Juliet Milne provided review comments on a draft version of this report.

Appendix 1: Monitoring sites

Table A1.1: Microbiological water quality sampling locations

Site	NZTM co-ordinates Easting	Northing	Type
Kapiti Coast			
Otaki Beach at Rangiuru Road*	1778010	5487069	Recreation
Otaki Beach at Surf Club	1778622	5488330	Recreation
Paekakariki Beach at Memorial Hall*	1764433	5461590	Recreation
Paekakariki Beach at Surf Club	1764791	5462273	Recreation & shellfish gathering
Paekakariki Beach at Whareroa Road	1765598	5464128	Recreation
Paraparaumu Beach at Maclean Park	1766694	5471267	Recreation
Paraparaumu Beach at Nathan Avenue	1767033	5472174	Recreation
Paraparaumu Beach at Ngapotiki Street	1767543	5472762	Recreation
Paraparaumu Beach at Toru Road	1766577	5470715	Recreation
Paraparaumu Beach at Wharemauku Road*	1766503	5470070	Recreation
Peka Peka Beach at Road End	1773215	5477905	Recreation & shellfish gathering
Raumati Beach at Aotea Road	1766414	5467529	Recreation
Raumati Beach at Hydes Road*	1766318	5466835	Recreation & shellfish gathering
Raumati Beach at Marine Gardens	1766516	5468441	Recreation
Raumati Beach at Tainui Street	1766531	5469229	Recreation & shellfish gathering
Te Horo Beach at Kitchener Street*	1775495	5481933	Recreation
Te Horo Beach at Sea Road**	1775692	5482324	Recreation
Te Horo Beach S of Mangaone Stream*	1775779	5482478	Recreation
Waikanae Beach at Ara Kuaka Carpark	1769514	5473978	Recreation
Waikanae Beach at Tutere St Tennis Court*	1770655	5474862	Recreation
Waikanae Beach at William Street	1771388	5475584	Recreation
Porirua			
Karehana Bay at Cluny Road	1756093	5451360	Recreation
Onehunga Bay*	1755796	5449181	Recreation
Pauatahanui Inlet at Browns Bay*	1758039	5447833	Recreation & shellfish gathering
Pauatahanui Inlet at Motukaraka Point*	1759486	5449338	Recreation & shellfish gathering
Pauatahanui Inlet at Paremata Bridge	1757153	5448284	Recreation
Pauatahanui Inlet at Water Ski Club	1758074	5449593	Recreation
Plimmerton Beach at Bath Street	1756706	5450316	Recreation
Porirua Harbour at Rowing Club	1754891	5446947	Recreation & shellfish gathering
Pukerua Bay	1759058	5456278	Recreation
South Beach at Plimmerton	1756810	5449874	Recreation
Titahi Bay at Bay Drive	1754132	5448169	Recreation
Titahi Bay at South Beach Access Road	1753906	5447682	Recreation
Titahi Bay at Toms Road	1754110	5447857	Recreation
Wellington City			
Aotea Lagoon	1748985	5427683	Recreation
Balaena Bay	1750958	5427267	Recreation
Breaker Bay	1753312	5422970	Recreation
Hataitai Beach	1750632	5425730	Recreation
Island Bay at Derwent Street	1748155	5421415	Recreation
Island Bay at Reef St Recreation Ground	1748229	5421542	Recreation
Island Bay at Surf Club	1748377	5421590	Recreation
Lyall Bay at Onepu Road	1750286	5423116	Recreation
Lyall Bay at Queens Drive	1749990	5422868	Recreation

Table A1.1 *continued*: Microbiological water quality sampling locations

Site	NZTM co-ordinates		Type
	Easting	Northing	
Lyall Bay at Tirangi Road	1750747	5423230	Recreation
Mahanga Bay	1753468	5427115	Recreation & shellfish gathering
Oriental Bay at Band Rotunda	1750243	5427375	Recreation
Oriental Bay at Freyberg Beach	1749920	5427464	Recreation
Oriental Bay at Wishing Well	1750118	5427386	Recreation
Owhiro Bay	1747122	5421463	Recreation
Princess Bay	1749586	5421504	Recreation
Scorching Bay	1753517	5426647	Recreation
Seatoun Beach at Inglis Street	1753405	5423994	Recreation
Seatoun Beach at Wharf	1753129	5424234	Recreation
Shark Bay	1752211	5426197	Recreation & shellfish gathering
Worser Bay	1753074	5424823	Recreation
Hutt			
Camp Bay*	1756990	5424288	Recreation
Days Bay at Moana Road	1759582	5428120	Recreation
Days Bay at Wellesley College	1759616	5428529	Recreation
Days Bay at Wharf	1759654	5428313	Recreation
Lowry Bay at Cheviot Road	1760206	5430891	Recreation
Petone Beach at Kiosk	1758326	5433711	Recreation
Petone Beach at Settlers Museum*	1757555	5434056	Recreation
Petone Beach at Sydney Street	1757045	5434248	Recreation
Petone Beach at Water Ski Club	1755744	5434591	Recreation
Robinson Bay at HW Shortt Rec Ground	1758519	5426674	Recreation
Robinson Bay at Nikau Street	1758131	5425856	Recreation
Rona Bay at N end of Cliff Bishop Park	1759109	5427654	Recreation
Rona Bay at Wharf	1758730	5427371	Recreation
Sorrento Bay	1759632	5431384	Recreation & shellfish gathering
York Bay	1759977	5430160	Recreation
Wairarapa			
Castlepoint Beach at Castlepoint Stream	1871366	5467559	Recreation
Castlepoint Beach at Smelly Creek	1871670	5467202	Recreation
Riversdale Beach at Lagoon Mouth*	1858965	5447543	Recreation
Riversdale Beach Between the Flags	1858435	5446948	Recreation

* Monitoring discontinued at this site from November 2011

** Site added to monitoring network from November 2011

Table A1.2: Porirua Harbour water quality sampling locations

Sampling site	Location	NZTM co-ordinates	
		Easting	Northing
PH–E1	Porirua Harbour Entrance (Ngati Toa domain)	1756592	5448786
PH–P1	Pauatahanui Arm north (water ski club)	1757999	5449405
PH–P2	Pauatahanui Arm east (Ration Pt)	1760219	5448516
PH–P3	Pauatahanui Arm north (Brady's Bay)	1758653	5447986
PH–O1	Onepoto Arm north (speed boat club)	1755335	5446946
PH–O2	Onepoto Arm south (waka ama club)	1754535	5445707

Table A1.3: Porirua Harbour intertidal sampling locations

Sampling site	NZTM co-ordinates	
	Easting	Northing
Por A (Railway)	1756457 (Plot 01) 1756494 (Plot 10)	5447774 (Plot 01) 5447811 (Plot 10)
Por B (Polytech)	1754615 (Plot 01) 1754587 (Plot 10)	5445422 (Plot 01) 5445503 (Plot 10)
Pau A (Boatsheds)	1757243 (Plot 01) 1757246 (Plot 10)	5448644 (Plot 01) 5448601 (Plot 10)
Pau B (Upper East)	1760358 (Plot 01) 1760378 (Plot 10)	5448343 (Plot 01) 5448341 (Plot 10)

Table A1.4: Waikanae Estuary intertidal sampling location

Sampling site	NZTM co-ordinates	
	Easting	Northing
Waikanae A	1769248 (Plot 01) 1769261 (Plot 10)	5473364 (Plot 01) 5473355 (Plot 10)

Table A1.5: Hutt Estuary sampling locations

Sampling site	NZTM co-ordinates	
	Easting	Northing
Hutt A (South)	1759174 (Peg 1) 1759174 (Peg 2)	5433638 (Peg 1) 5433618 (Peg 2)
Hutt B (North)	1759369 (Peg 1) 1759369 (Peg 2)	5434135 (Peg 1) 5434116 (Peg 2)

Table A1.6: Whareama Estuary intertidal sampling locations

Sampling site	NZTM co-ordinates	
	Easting	Northing
Whareama A (North)	1860703 (Plot 01) 1860684 (Plot 10)	5455343 (Plot 01) 5455338 (Plot 10)
Whareama B (South)	1860084 (Plot 01) 1860067 (Plot 10)	5455318 (Plot 01) 5455294 (Plot 10)

Table A1.7: Wellington Harbour subtidal sediment quality sampling locations (2011 survey)

Sampling site	Location	NZTM coordinates Easting	Northing	Depth (m)
WH1 WH1B	Southern Evans Bay	1751530 1751492	5425348 5425333	19
WH2 WH2B	Northern Evans Bay	1751710 1751744	5427288 5427271	19
WH3 WH3B	Lambton Basin entrance	1750056 1750055	5428340 5428303	18
WH4 WH4B	~ 0.7 km NW of Point Jerningham	1750763 1750775	5428789 5428760	20
WH5 WH5B	~ 1.2 km NNE of Point Jerningham	1751748 1751743	5429138 5429104	21
WH6 WH6B	~1.25 km NW of Point Halswell	1752665 1752646	5429581 5429560	22
WH7 WH7B	~1.5 km N of Point Halswell	1753581 1753604	5429932 5429907	22
WH8 WH8B	~1.5 km SW of Matiu/Somes Island	1754566 1754571	5430282 5430310	23
WH9 WH9B	~ 1.5 km SSE of Ngauranga Stream mouth	1751921 1751975	5430708 5430747	20
WH10 WH10B	~ 0.5 km SSE of Ngauranga Stream mouth	1752012 1752008	5431724 5431740	20
WH11 WH11B	~0.5 km E of Ngauranga Stream mouth	1752508 1752541	5432084 5432099	20
WH12 WH12B	~1.5 km E of Ngauranga Stream mouth	1753480 1753516	5431786 5431804	21
WH13 WH13B	~ 1.25 km S of Petone Wharf	1756023 1756061	5433121 5433126	16
WH14 WH14B	~0.65 km S of Petone Wharf	1756382 1756422	5433576 5433553	12
WH15 WH15B	~ 1.1 km SW of Seaview (Hutt River mouth)	1758160 1758176	5431778 5431750	16
WH16 WH16B	~2.1 km SW of Seaview (Hutt River mouth)	1757243 1757129	5431336 5431335	19
WH17 WH17B	~ 1.6 km NNW of Makaro/Ward Island	1756770 1756793	5428847 5428858	21
WH18 WH18B	~1.75 km WSW of Seaview (Hutt River mouth)	1757450 1757460	5432426 5432435	16
EB EB B	SW Evans Bay ~250 m from shore (Cobham Drive)	1750921 1750920	5424829 5424860	7
LB1 LB1B	Lambton Harbour ~ 250 m from shore (FK Park)	1749263 1749262	5427887 5427872	10
LB2 LB2 B	Lambton Harbour ~ 500 m from shore (FK Park)	1749576 1749541	5427939 5427940	14
AQ1 AQ1 B	~ 0.5 km ENE of Aotea Quay east	1750317 1750331	5429346 5429374	20
AQ2 AQ2 B	~ 0.5 km ENE of Aotea Quay west	1750125 1750133	5430214 5430254	16

B = benthic ecology collection area

The Greater Wellington Regional Council promotes **Quality for Life** by ensuring our environment is protected while meeting the economic, social and cultural needs of the community

For more information contact the Greater Wellington Regional Council:

Wellington office
PO Box 11646
Manners Street
Wellington 6142

T 04 384 5708
F 04 385 6960

Wairarapa office
PO Box 41
Masterton 5840

T 06 378 2484
F 06 378 2146

info@gw.govt.nz
www.gw.govt.nz

March 2013
GW/ESCI-G-13/31