

Waikanae Estuary

Intertidal Sediment Monitoring 2012/13



Prepared
for
**Greater
Wellington
Regional
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Fine scale and sediment plate monitoring site, Waikanae Estuary, January 2013.

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By

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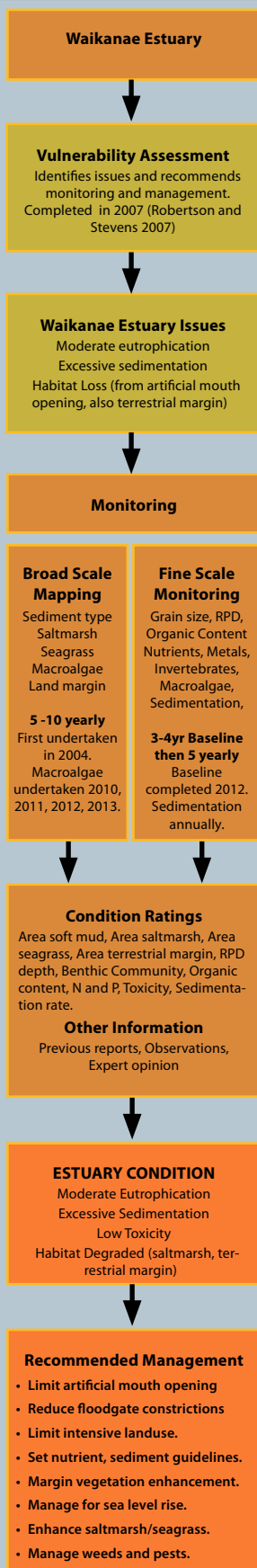
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1. INTRODUCTION AND METHODS



Soil erosion is a major issue in New Zealand and the resulting suspended sediment impacts are of particular concern in estuaries because they act as a sink for fine sediments or muds. Sediments with a high mud content (i.e. around 30% with a grain size $<63\mu\text{m}$) are now typical in NZ estuaries that drain developed catchments. In such mud-impacted estuaries, the muds generally occur in the areas that experience low energy tidal currents and waves [i.e. the intertidal margins of the upper reaches of estuaries (e.g. Waikanae Estuary), and in the deeper subtidal areas at the mouth of estuaries (e.g. Hutt Estuary)]. In estuaries where there are no large intertidal flats, the presence of mud along the narrow channel banks in the lower estuary can also be elevated.

Sedimentation rates have been measured annually in Waikanae Estuary since 2010 in conjunction with fine scale and macroalgal monitoring (Robertson and Stevens 2010, 2011, 2012, Stevens and Robertson 2010, 2011, 2012, 2013). The current report summarises the intertidal sedimentation rate monitoring results for Waikanae Estuary, one of the key estuaries in the Greater Wellington Regional Council (GWRC) coastal monitoring programme. The report presents the results from sampling on 14 January 2013, and uses condition ratings developed for Wellington's estuaries to rate the condition of the estuary, and recommend monitoring and management actions.

Detailed descriptions of sampling sites and methods are provided in Robertson and Stevens (2010), and are briefly summarised below.

Sedimentation Rate

To measure the sedimentation rate from now and into the future, a set of 4 concrete plates were buried in the estuary in 2010. Each plate, marked by wooden pegs and GPS referenced, was located and the depth of sediment over the plate measured by pushing a probe into the sediment until it hit the plate. A number of measurements on each plate were averaged to account for irregular sediment surfaces.

Redox Potential Discontinuity (RPD) depth

To assess sediment oxygenation, the depth to the RPD was measured at 10 plots at the fine scale site by digging down from the surface with a hand trowel until the RPD transition was located.



Figure 1. Location of fine scale site and buried sediment plates in Waikanae Estuary.

1. Introduction and Methods (Continued)

WELLINGTON ESTUARIES: CONDITION RATINGS



A series of interim fine scale estuary “condition ratings” (presented below) have been proposed for Waikanae Estuary (based on the ratings developed for New Zealand estuaries - e.g. Robertson & Stevens 2006, 2007, 2008, 2009). The ratings are based on a review of estuary monitoring data, guideline criteria, and expert opinion. They are designed to be used in combination with each other, and with other fine and broad scale indicators (usually involving expert input) when evaluating overall estuary condition and deciding on appropriate management. The condition ratings include an “early warning trigger” to highlight rapid or unexpected change, and each rating has a recommended monitoring and management response. In most cases initial management is to further assess an issue and consider what response actions may be appropriate (e.g. develop an Evaluation and Response Plan - ERP).

Sedimentation Rate

Elevated sedimentation rates are likely to lead to major and detrimental ecological changes within estuary areas that could be very difficult to reverse, and indicate where changes in land use management may be needed.

SEDIMENTATION RATE CONDITION RATING

RATING	DEFINITION	RECOMMENDED RESPONSE
Very Low	0-1mm/yr (typical pre-European rate)	Monitor at 5 year intervals after baseline established
Low	1-2mm/yr	Monitor at 5 year intervals after baseline established
Moderate	2-5mm/yr	Monitor at 5 year intervals after baseline established
High	5-10mm/yr	Monitor yearly. Initiate ERP
Very High	>10mm/yr	Monitor yearly. Manage source
Early Warning Trigger	Rate increasing	Initiate Evaluation and Response Plan

Redox Potential Discontinuity

The RPD is the grey layer between the oxygenated yellow-brown sediments near the surface and the deeper anoxic black sediments. It is an effective ecological barrier for most but not all sediment-dwelling species. A rising RPD will force most macrofauna towards the sediment surface to where oxygen is available. The depth of the RPD layer is a critical estuary condition indicator in that it provides a measure of whether nutrient enrichment in the estuary exceeds levels causing nuisance anoxic conditions in the surface sediments. The majority of the other indicators (e.g. macroalgal blooms, soft muds, sediment organic carbon, TP, and TN) are less critical, in that they can be elevated, but not necessarily causing sediment anoxia and adverse impacts on aquatic life. Knowing if the surface sediments are moving towards anoxia (i.e. RPD close to the surface) is important for two main reasons:

1. As the RPD layer gets close to the surface, a “tipping point” is reached where the pool of sediment nutrients (which can be large), suddenly becomes available to fuel algal blooms and to worsen sediment conditions.
2. Anoxic sediments contain toxic sulphides and very little aquatic life.

The tendency for sediments to become anoxic is much greater if the sediments are muddy. In sandy porous sediments, the RPD layer is usually relatively deep (>3cm) and is maintained primarily by current or wave action that pumps oxygenated water into the sediments. In finer silt/clay sediments, physical diffusion limits oxygen penetration to <1cm (Jørgensen and Revsbech 1985) unless bioturbation by infauna oxygenates the sediments.

RPD CONDITION RATING

RATING	DEFINITION	RECOMMENDED RESPONSE
Very Good	>10cm depth below surface	Monitor at 5 year intervals after baseline established
Good	3-10cm depth below sediment surface	Monitor at 5 year intervals after baseline established
Fair	1-3cm depth below sediment surface	Monitor at 5 year intervals. Initiate ERP
Poor	<1cm depth below sediment surface	Monitor at 2 year intervals. Initiate ERP
Early Warning Trigger	>1.3 x Mean of highest baseline year	Initiate Evaluation and Response Plan

2. RESULTS, RATING AND MANAGEMENT

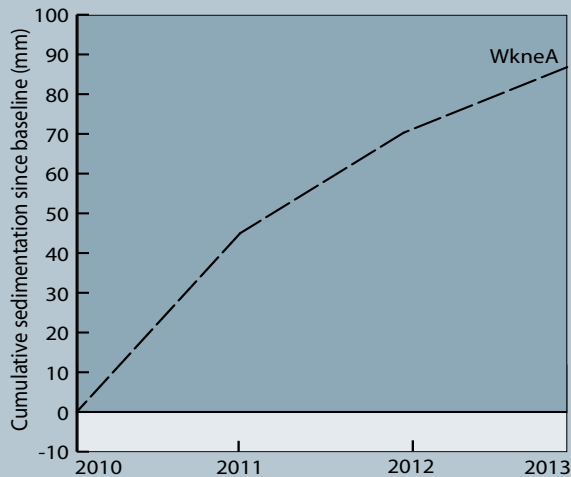


Figure 2. Cumulative change in sediment level from 2010-2013.

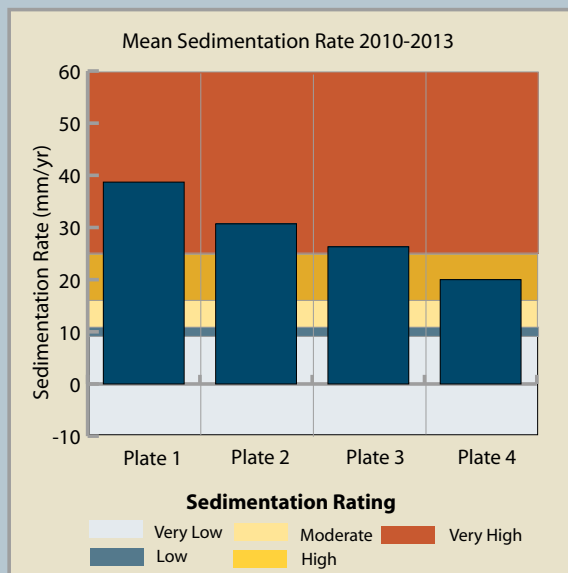


Figure 3. Mean sedimentation rate from plate data, Waikanae Estuary (2010-2013).

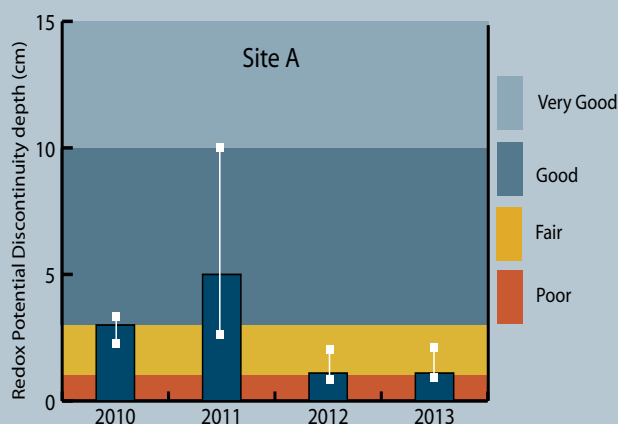


Figure 4. RPD depth (mean and range), Waikanae Estuary (2010-2013).

The two indicators used to assess sediment in Waikanae Estuary in 2013 were the rate of sedimentation, and RPD depth.

Rate of Sedimentation

The depths to four plates buried in Waikanae Estuary (see Robertson and Stevens 2010, 2011) were re-measured in January 2013 as part of annual long term sedimentation rate monitoring in the estuary (Figures 2 and 3, Table 1).

As in 2011 and 2012, fine soft muds were evident along the edge of the Waikanae river channel and across the tidal flats adjacent to the fine scale site. In 2013, the site was covered by 30-50cm of water at the time of sampling due to raised river levels following rainfall, combined with a build up of sand at the estuary mouth on Waikanae beach temporarily constraining draining of the estuary.

Since 2010 there has been a total increase in sediment depth of +87mm, at a mean overall rate of +28.9mm/yr. Annual sedimentation rates range from +16.5 to +45mm/yr. These sedimentation rates fall in the "very high" category and indicate that the intertidal flats in the mid-upper Waikanae Estuary are rapidly infilling. Figure 3 shows the greatest deposition over the individual buried plates was near the channel edge (Plate 1), reflecting fine muds depositing from the Waikanae River.

Redox Potential Discontinuity (RPD)

The depth to the RPD boundary is a critical estuary condition indicator in that it provides a direct measure of sediment oxygenation. This commonly shows whether nutrient enrichment in the estuary exceeds levels causing nuisance anoxic conditions in the surface sediments, and also reflects the capacity of tidal flows to maintain and replenish sediment oxygen levels.

In well flushed sandy intertidal sediments, tidal flows typically oxygenate the top 10cm of sediment. However, when fine muds fill the interstitial pore spaces, less re-oxygenation occurs and the RPD moves closer to the surface.

In response to the presence of fine muds and, to a lesser extent, nutrient enrichment, the RPD depth has decreased at the Waikanae sites from 2010 to 2013 (Figure 4, Table 2). In 2013 it was shallow (1-2cm), indicating poorly oxygenated sediments, particularly in the muddier areas along the channel edge. The RPD value falls within the "fair-poor" condition rating.

2. Results, Rating and Management (Continued)

2013 SEDIMENTATION RATE CONDITION RATING

VERY HIGH

2013 RPD DEPTH CONDITION RATING

FAIR

Table 1. Sediment plate data, Waikanae Estuary (2010-2013).

SITE	Mean Sediment Depth (mm)				Change (mm)			Site Mean (mm/yr)			2010-2013 Overall Rate (mm/yr)
	20/01/10	16/01/11	20/02/12	14/01/13	2010-2011	2011-2012	2012-2013	2010-2011	2011-2012	2012-2013	
Plate 1	180	238	276	296	58	38	20	+45.0	+25.3	+16.5	+28.9
Plate 2	213	261	295	305	48	34	10				
Plate 3	231	270	295	310	39	25	15				
Plate 4	235	270	274	295	35	4	21				

Table 2. RPD depth, Waikanae Estuary fine scale site (2010-2013).

Waikanae A	Mean RPD (cm) n=10	Condition Rating
2010	3.0 (range 2-3.5)	GOOD
2011	5.1 (range 3-10)	GOOD
2012	1.1 (range 1-2)	FAIR
2013	1.1 (range 1-2)	FAIR

CONCLUSION

The very high rate of sedimentation, "fair RPD" rating, and continued presence of muddy sediments, signify rapid infilling and consequent degradation of this important part of Waikanae Estuary.

RECOMMENDED MONITORING

It is recommended that the sedimentation rate continue to be measured annually at the same time the estuary is being quickly assessed for macroalgal growths or the presence of nuisance conditions. The next monitoring in Waikanae River Estuary is therefore due in January/February 2014.

RECOMMENDED MANAGEMENT

The sedimentation rate results reinforce the need for the identification and management of fine sediment sources entering the estuary.

ACKNOWLEDGEMENTS

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