

OVERVIEW

Since 2010, Greater Wellington Regional Council has undertaken annual State of the Environment (SOE) monitoring of sediment indicators in Waikanae Estuary to assess trends in the deposition rate, mud content, and oxygenation of intertidal sediments. This work was repeated on 22 January 2018 and this report card summarises the monitoring results including baseline data from two newly established sites (B and C) in the upper estuary. Site details are presented in Figure 1 below.

METHODS

The approach, described in detail in Robertson and Stevens (2010), measures changes in the depth of sediment overlying buried concrete plates stabilised on steel waratahs. Plates are positioned at 90° to the river channel and, because of the relatively narrow sediment deposition zone in the upper estuary flats, are spaced relatively closely together (2m apart). Measurements

are made by vertically inserting a measuring probe in the sediment and measuring the depth to the underlying plate with a straight edge used to average out any minor surface height irregularities. Site measurements are averaged and used to indicate the mean annual sediment rate at each site.

Sediment condition is also assessed by laboratory analysis of grain size (wet sieving with dispersant, 2mm and 63µm sieves, gravimetry - calculation by difference). This allows changes in sediment muddiness to be determined even where there are no changes in sediment depth. Sediment oxygenation, a key measure of biological health, is visually assessed by measuring the apparent Redox Potential Discontinuity (aRPD) depth, the depth at which sediments show a change in colour to grey/black. Results are compared to indicator bands (Table 1) developed as part of the NZ Estuary Trophic Index (ETI) to determine the risk of adverse ecological impacts.



Sedimentation rate monitoring plate coordinates (NZGD 2000).

Site	Plate	NZTM East	NZTM North
A	1	1769247	5473369
A	2	1769249	5473370
A	3	1769252	5473371
A	4	1769253	5473371
B	1	1769272	5473284
B	2	1769273	5473284
B	3	1769275	5473285
B	4	1769277	5473285
C	1	1769307	5473212
C	2	1769308	5473213
C	3	1769309	5473215
C	4	1769310	5473215

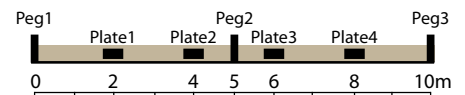


Figure 1. Location of Waikanae Estuary intertidal sediment plate sites.

Table 1. Indicator ratings used to assess the risk of adverse ecological impacts.

INDICATOR	ETI Band* Risk	A - Very Good	B - Good	C - Moderate	D - Poor
		Very Low	Low	Moderate	High
Sedimentation Rate (mm/year)		<1	1-2	>2-5	>5
Sediment Mud Content (% mud)		<5%	5-10%	>10-25%	>25%
Sediment Oxygenation (apparent Redox Potential Discontinuity)		>2cm (visual assessment unreliable)		0.5-2cm	<0.5cm

*see Robertson et al. (2016a,b) for supporting information on indicator ratings.

RESULTS

2010-2018 Sedimentation Rate

Figure 2 and Table 2 summarise sediment level changes since 2010. There has been an overall mean sedimentation rate of +16.9mm/yr across the eight years of monitoring, with a rolling mean over the past 5 years of 9.7mm, an ETI rating of “poor”. Figure 2 shows a consistent increase in sedimentation from 2010 to 2016, followed by sediment erosion in 2017 and 2018. Variation such as this is very much driven by flood deposition and erosion events and the timing of sampling in relation to recent flood deposition or scouring has a significant influence on results. Consequently, the long term trend of net deposition or erosion should be used to guide monitoring management and decisions.

Overall, there is a strong trend of increasing sedimentation,

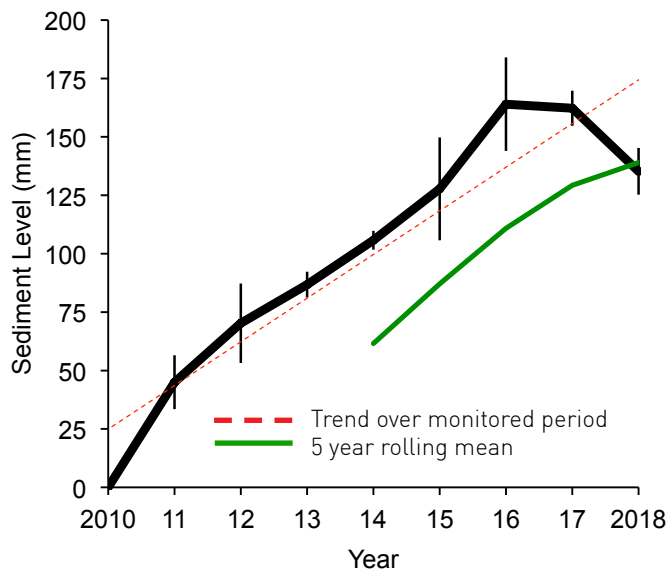


Figure 2. Change in mean sediment level over buried plates (\pm annual range), Waikanae Estuary, 2010 to 2018.

with the deposition of marine sands and terrestrial muds a dominant feature of the upper estuary flats.

2018 Sediment Mud Content

Mean sediment mud content at Site A in 2018 was 24.9% (Table 3). Mud content has been variable across years at Site A (Figure 3), and shows no clear trend over time, although a gradient is evident at a within site scale with muddier sediments located closest to the river channel. This is also apparent at the newly established sites B and C. Compared to Site A, sediment mud content was very similar at Site B and higher at Site C (the most upstream site) (Table 3). Mud contents are on the transition between “moderate” and “poor” ETI rating categories at Sites A and B, and are rated “poor” at Site C.

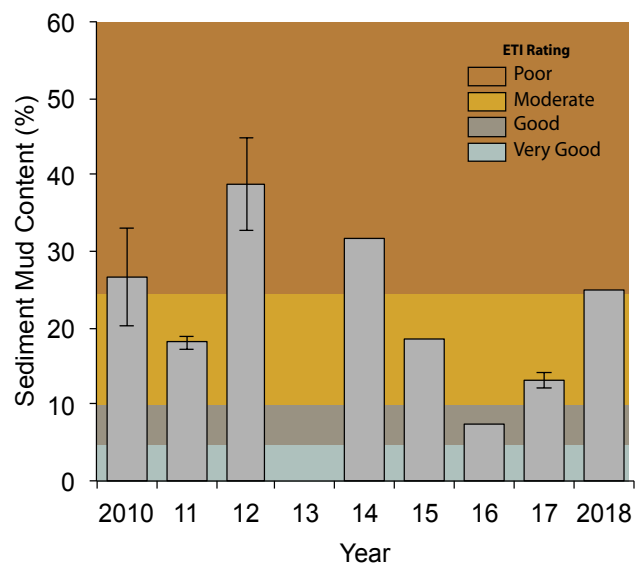


Figure 3. Sediment mud content (\pm SE, n=3), Waikanae Estuary Site A, 2010-2018.

Table 2. Sediment monitoring results for Waikanae Estuary, January 2010 - January 2018.

SITE A	Measured Mean Depth to Sediment Plate (mm)									Change in Sediment Level Over Plate (mm)							
	20/01/10	16/01/11	20/02/12	14/01/13	21/01/14	18/01/15	28/1/16	29/1/17	22/1/18	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
Plate 1	180	238	276	296	315	361	378	383	346	+58	+38	+20	+19	+46	+17	+5	-37
Plate 2	213	261	295	305	324	355	380	374	350	+48	+34	+10	+19	+31	+25	-6	-24
Plate 3	231	270	295	310	333	335	392	382	365	+39	+25	+15	+23	+2	+57	-10	-17
Plate 4	235	270	274	295	310	319	365	369	339	+35	+4	+21	+15	+9	+46	+4	-30
Mean Change in Sediment Level (mm/yr)										+45.0	+25.3	+16.5	+19.0	+22.0	+36.3	-1.8	-27.0
MEAN SEDIMENTATION RATE 2010-2018: 16.9 (mm/yr) (SE=1.83)																	
Mean sedimentation rate over the past 5 years: 9.7mm																	
ETI RATING: POOR																	

2018 Sediment aRPD depth

The average aRPD depth was between 2-3cm at all three sites and within the ETI rating bands of either “good” or “very good”. This is partially maintained by the presence of crabs, shellfish and macroinvertebrate worms in the upper sediments creating voids that allow air and water to transfer oxygen to underlying sediments.



Photo showing oxygenated brown surface sediments overlying the grey-black aRPD layer.

Conclusion

The sedimentation rate over the past 8 years shows a strong overall trend of deposition, a relatively consistent elevated sediment mud content, and a moderately shallow aRPD depth. Consequently the upper estuary remains under pressure from sediment related impacts related to poor water clarity and muddy intertidal substrates, with a macrofaunal community dominated by mud tolerant species - a common situation in NZ tidal river estuaries.

Recommended Monitoring

Continue annual monitoring of sediment rate, aRPD and grain size to measure sediment deposition and temporal change. Report results annually via a summary card report, with detailed reporting undertaken five yearly in conjunction with fine scale monitoring.

Table 4. Baseline depth (mm) to new sediment plates established in January 2018.

Site	Plate	Depth (mm)
B	1	50
B	2	59
B	3	48
B	4	55
C	1	55
C	2	63
C	3	67
C	4	50



Site C located on the muddy intertidal flats of the upper estuary.

Table 3. Mean grain size and aRPD results for the Waikanae Estuary sedimentation plate sites, 2010 - 2018.

Date	Site	aRPD depth (cm)	Mud	Sand	Gravel
2010	A	3.0 (range 2-3.5)	26.7%	60.7%	0.5%
2011	A	5.1 (range 3-10)	18.0%	81.3%	0.7%
2012	A	1.1 (range 1-2)	38.7%	72.7%	0.6%
2013	A	1.1 (range 1-2)	-	-	-
2014	A	1.5 (range 1-2)	31.7%	68.0%	0.3%
2015	A	1.5 (range 1-2)	18.7%	81.0%	0.3%
2016	A	2.5 (range 2-4)	7.4%	91.7%	0.9%
2017	A	2.9 (range 2-5)	13.2%	83.8%	3.0%
2018	A	3 (range 3-3)	24.9%	73.8%	1.3%
2018	B	3 (range 3-3)	24.6%	73.7%	1.7%
2018	C	2 (range 2-2)	32.7%	65.8%	1.4%

Note: Grain size results are based on a single composite sample comprising 10 sub-samples collected from the site. Mean RPD depth is derived from 4-10 replicate measures.

REFERENCES

- Robertson, B.M. and Stevens, L. 2010. Waikanae Estuary: Fine Scale Monitoring 2009/10. Prepared for Greater Wellington Regional Council. 20p.
- Robertson, B.M., Stevens, L., Robertson, B.P., Zeldis, J., Green, M., Madarasz-Smith, A., Plew, D., Storey, R., Hume, T. and Oliver, M. 2016a. NZ Estuary Trophic Index. Screening Tool 1. Determining eutrophication susceptibility using physical and nutrient load data. Prepared for Envirolink Tools Project: Estuarine Trophic Index MBIE/NIWA Contract No: C01X1420. 47p.
- Robertson, B.M., Stevens, L., Robertson, B.P., Zeldis, J., Green, M., Madarasz-Smith, A., Plew, D., Storey, R., Hume, T. and Oliver, M. 2016b. NZ Estuary Trophic Index. Screening Tool 2. Screening Tool 2. Determining Monitoring Indicators and Assessing Estuary Trophic State. Prepared for Envirolink Tools Project: Estuarine Trophic Index MBIE/NIWA Contract No: C01X1420. 68p.