

Salt Ecology Report 029. Prepared for Greater Wellington Regional Council by Leigh Stevens, November 2019.

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 17 January 2019 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 Fig. 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 (n=3) and used to indicate the mean annual sediment rate at each site.

Sediment condition is further 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 plate coordinates

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



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

Table 1. Summary of subjective condition ratings referred to in the present report.

Indicator	Unit	Very Good	Good	Moderate	Poor
Sedimentation rate ¹	mm/yr	< 1	1 to ≤ 2	> 2 to ≤ 5	> 5
Mud content ²	%	≤ 5	5 to ≤ 10	10 to ≤ 25	≥ 25
aRPD ³	mm	≥ 50	20 to ≤ 50	10 to ≤ 20	≤ 10

Ratings derived from: ¹Townsend and Lohrer (2015), ²Robertson et al. (2016b), ³FGDC (2012).

RESULTS

2010-2019 Sedimentation Rate

Fig. 2 and Table 2 summarise changes in sediment levels at Site A since 2010. There has been an overall mean sedimentation rate of +17.5mm/yr across the nine years of monitoring, with a rolling mean over the past 5 years of 10.4mm, a condition rating of 'poor'. Figure 2 shows a consistent increase in sedimentation from 2010 to 2016, followed by sediment erosion in 2017 and 2018, and a further increase in sedimentation in 2019. Variation such as this is very much driven by flood deposition and erosion events, and the timing of sampling in relation to recent events 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.

Table 3 presents the first year of measured change at Sites B and C since the baseline was established in

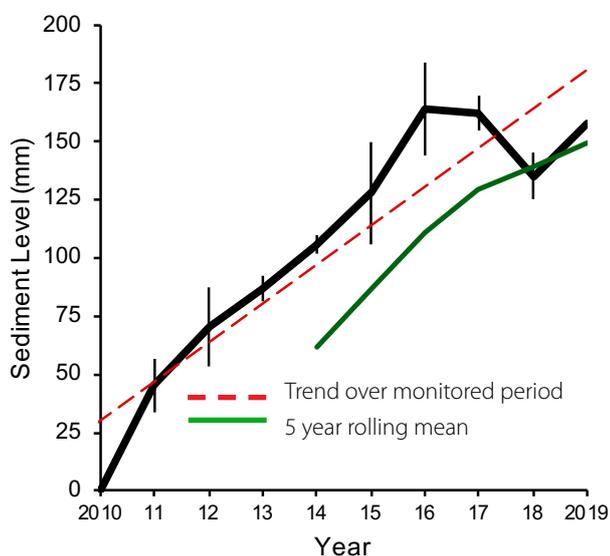


Fig. 2. Change in mean sediment level over buried plates (\pm annual range), Waikanae Estuary, 2010 to 2019.

2018. While too early to include in any formal trend analyses, the results are consistent with those recorded at Site A. Overall they show a strong trend of increasing sedimentation, with the deposition of marine sands and terrestrial muds a dominant feature of the upper estuary flats.

2019 Sediment Mud Content

Mean sediment mud content at Site A in 2019 was 19.1% (Table 4). 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 (data not shown). This is also apparent at the newly established sites B and C. As in 2018, sediment mud contents were similar at Sites A and B and higher at Site C (the most upstream site) (Table 4). Mud contents are rated 'moderate' at Sites A and B, and 'poor' at Site C.

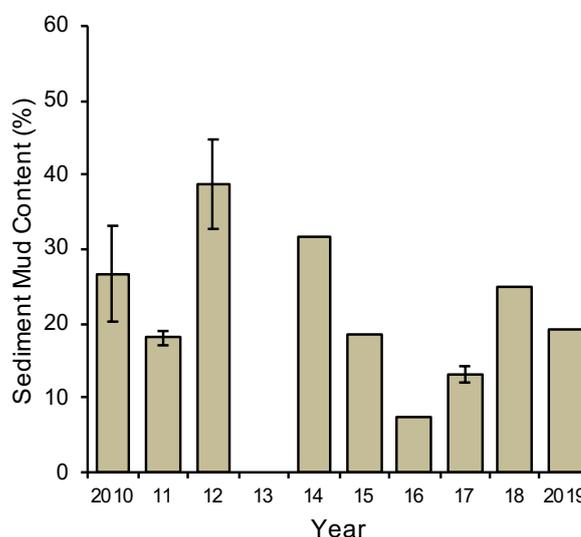


Fig. 3. Sediment mud content (\pm SE, n=3*), Waikanae Estuary Site A, 2010-2019.

*replicates taken during fine scale sampling 2010-12, 2017

Table 2. Sediment monitoring results for Waikanae Estuary Site A, January 2010 - January 2019.

Measured Mean Depth to Sediment Plate (mm)											Change in Sediment Level Over Plate (mm)								
SITE A	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	17/1/19	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19
	Plate 1	180	238	276	296	315	361	378	383	346	367	+58	+38	+20	+19	+46	+17	+5	-37
Plate 2	213	261	295	305	324	355	380	374	350	373	+48	+34	+10	+19	+31	+25	-6	-24	+23
Plate 3	231	270	295	310	333	335	392	382	365	386	+39	+25	+15	+23	+2	+57	-10	-17	+21
Plate 4	235	270	274	295	310	319	365	369	339	364	+35	+4	+21	+15	+9	+46	+4	-30	+25
Mean Change in Sediment Level (mm/yr)											+45.0	+25.3	+16.5	+19.0	+22.0	+36.3	-1.8	-27.0	+23

MEAN SEDIMENTATION RATE 2010-2019: 17.5 (mm/yr) (SE=1.51)

Mean sedimentation rate over the past 5 years: 10.4mm

ETI RATING: POOR

Table 3. Baseline depth (mm) of sediment plates established in January 2018, and change over 1 year (Jan 2018-Jan 2019).

Site	Plate	Depth (mm)		Change (mm)
		2018	2019	2018-19
B	1	50	84	+34
B	2	59	96	+37
B	3	48	96	+48
B	4	55	83	+28
C	1	55	98	+43
C	2	63	111	+48
C	3	67	102	+35
C	4	50	59	+9

Table 4. Mean grain size and aRPD results for the Waikanae Estuary sedimentation plate sites, 2010-2019.

Year	Site	aRPD (mm)	Mud%	Sand%	Gravel%
2010	A	30	26.7	60.7	0.5
2011	A	51	18.0	81.3	0.7
2012	A	11	38.7	72.7	0.6
2013	A	11	-	-	-
2014	A	15	31.7	68.0	0.3
2015	A	15	18.7	81.0	0.3
2016	A	25	7.4	91.7	0.9
2017	A	29	13.2	83.8	3.0
2018	A	30	24.9	73.8	1.3
2018	B	30	24.6	73.7	1.7
2018	C	20	32.7	65.8	1.4
2019	A	26	19.1	80.9	< 0.1
2019	B	22	18.4	81.3	0.3
2019	C	25	26.1	73.6	0.2

Note: Grain size results are based on either a single composite sample collected adjacent to each plate e.g. 4 sub-samples/site, or from 3 composite samples when fine scale sampling is undertaken.

REFERENCES

- FGDC. 2012. Coastal and Marine Ecological Classification Standard Catalog of Units, Federal Geographic Data Committee FGDC-STD-018-2012. 343p.
- Robertson BM, Stevens L. 2010. Waikanae Estuary: Fine Scale Monitoring 2009/10. Prepared for Greater Wellington Regional Council. 20p.
- Robertson BM, Stevens L, Robertson BP, Zeldis J, Green M, Madarasz-Smith A, Plew D, Storey R, Hume T, Oliver M. 2016b. NZ Estuary Trophic Index. 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.
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2019 Sediment aRPD depth

The average aRPD depth (based on replicate measurements adjacent to each plate) was between 20-50mm at all three sites and within the condition rating band of 'good'. This level of oxygenation 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.

CONCLUSION

The sedimentation rate over the past nine 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.