WAIKOUAITI ESTUARY: 2022/2023 INTERTIDAL SEDIMENT MONITORING SUMMARY

Salt Ecology Short Report 023. Prepared by Barrie Forrest for Otago Regional Council, March 2023

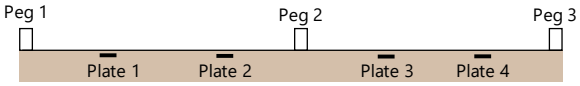
OVERVIEW

Since December 2016, Otago Regional Council has undertaken annual State of the Environment (SOE) monitoring in Waikouaiti Estuary to assess trends in the deposition rate, mud content, and oxygenation of intertidal sediments. Sediment monitoring is undertaken at three sites (Fig. 1), with the latest survey carried out on 26 November 2022.

Fig. 1. Location of Waikouaiti Estuary monitoring sites. In 2020, Site B1 replaced nearby Site B, which was washed away.

METHODS

Estuary sedimentation is measured using the 'sediment plate' method (e.g. Forrest et al. 2021). The approach involves measuring sediment depth from the sediment surface to the top of each of four buried concrete pavers. Measurements are averaged across each plate (n=3) and used to calculate a mean annual sedimentation rate for each site.



A composite sample of the surface 20mm of sediment is collected adjacent to the plates and analysed for particle grain size (wet sieve, RJ Hill laboratories), enabling assessment of sediment muddiness. Sediment oxygenation is visually assessed in the field by measuring the depth at which sediments show a change in colour to grey/black, commonly referred to as the apparent Redox Potential Discontinuity (aRPD). Results for all indicators are compared to condition ratings of ecological state shown in Table 1.

RESULTS

Table 2 shows a summary of results for the latest survey and their respective condition ratings. Annual results for all surveys are provided in Table 3.

Table 2. Indicator summary and condition ratings from the November 2022 survey.

Indicator	A	B1	C
Sedimentation (mm/yr)*	-4.4	4.9	-3.1
Mud content (%)	8.7	3.8	33.0
aRPD (mm)	60	50	10

* Long-term mean sedimentation is measured relative to the baseline for Sites A & B1 (n=3 yrs), with a 5-yr value shown for Site C. Five years of data are required for a meaningful trend.

Sedimentation rate

The cumulative change in sediment depth over plates at each site is shown in Fig. 2. Changes in sediment depth across sites have been highly variable from year-to-year at Sites A and B1, with net erosion from the baseline recorded at Site A (Fig. 2). By contrast, there was considerable sediment accrual at Site B1 between November 2021 and November 2022 (rated 'poor'), despite erosion in the two earlier surveys (Table 3). The recent accrual at Site B1 was due to deposition of sands. The variability at Sites A and B1 likely reflects the dynamic hydrological environment of these sites as they are both close to the river channel. By comparison, Site C is in a relatively sheltered estuary side-arm, and has experienced a small but steady amount of sediment erosion from year-to-

Table 1. Summary of condition ratings for sediment plate monitoring.

Indicator	Unit	Very Good	Good	Fair	Poor
Sedimentation rate[1]	mm/yr	< 0.5	≥0.5 to < 1	≥1 to < 2	≥ 2
Mud content[2]	%	< 5	5 to < 10	10 to < 25	≥ 25
aRPD[3]	mm	≥ 50	20 to < 50	10 to < 20	< 10

Condition ratings derived or modified from: [1]Townsend and Lohrer (2015), [2]Robertson et al. (2016), [3]FGDC (2012).

year, possibly due to localised influences from two small streams.

Sediment mud content and oxygenation

Mud content was low at Sites A and B1, where sand and gravel (>2mm particle diameter) fractions were dominant. By contrast, at upper estuary Site C the sediment condition was rated as 'poor' due to the mud content exceeding the biologically relevant threshold of 25% (Fig. 3). Sediment mud content has remained at a similar level within each site across each monitoring survey to date.

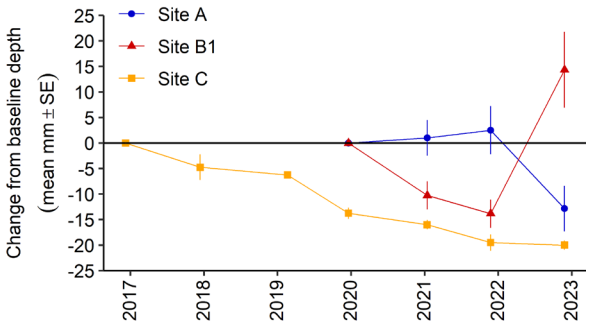


Fig. 2. Temporal change in mean sediment depth over buried plates (±SE) relative to baselines at Sites A and B1 (Dec-2019), and Site C (Dec 2016).

Table 3. Annual sedimentation, grain size and aRPD results up to November 2022.

Site	Survey	Sed rate mm/yr	Gravel %	Sand %	Mud %	aRPD mm
A	Dec-2019	na	11.8	80.4	7.8	75
	Jan-2021	0.9	24.9	69.4	5.7	30
	Nov-2021	1.7	15.4	78.0	6.6	50
	Nov-2022	-15.2	7.3	83.9	8.7	60
B1	Dec-2019	na	25.3	67.7	7.0	10
	Jan-2021	-9.6	27.8	66.8	5.4	8
	Nov-2021	-4.2	18.7	76.7	4.6	8
	Nov-2022	28.0	4.1	92.1	3.8	50
C	Dec-2016	na	0.3	68.9	30.9	0
	Dec-2017	-4.7	0.2	69.5	30.3	-
	Feb-2019	-1.3	0.4	71.4	28.3	20
	Dec-2019	-9.1	0.2	70.8	29.1	18
	Jan-2021	-2.1	0.3	71.3	28.4	25
	Nov-2021	-4.1	0.2	73.3	26.5	12
	Nov-2022	-0.5	< 0.1	67.0	33.0	10

< All values below lab detection limit

The relatively deep aRPD depth of ≥50mm (condition rating 'very good', Table 2) at Sites A and B1 reflects the sandy sediment at those sites, with oxygenation also maintained by the presence of crabs, numerous cockles and other organisms, which turn over surface sediments and create voids that allow air and water to transfer oxygen to underlying layers. As evident in Table 3, aRPD at Site B1 has been highly variable over time, with the improved aRPD recorded in November 2022 likely owing to recent sand deposition. The relatively shallow aRPD at Site C (rated 'fair') is indicative of the muddy sediment, which limits oxygen diffusion into deeper layers. At Site C the moderate growths of filamentous algae evident the year previous were absent in November 2022.

Soft mud at Site C November 2022.

CONCLUSIONS

There have significant changes in sediment plate depth at the Waikouaiti Estuary sites; however, they appears to reflect erosion or accrual due to hydrodyamic processes rather than deposition of sediment from the catchment. Nonetheless, the November 2022 results show that upper estuary Site C is consistently muddy. As such, the results reinforce previous recommendations (e.g. Robertson et al. 2017) to manage catchment influences on the estuary.

RECOMMENDED MONITORING

Continue annual monitoring of sedimentation rate, sediment grain size and aRPD depth, and report results annually via a summary report. Comprehensive reporting should be undertaken 5-yearly as part of 'fine scale' ecological and sediment monitoring (next scheduled in the summer of 2023/24).

REFERENCES

FGDC. 2012. Coastal and Marine Ecological Classification Standard Catalog of Units, Federal Geographic Data Committee FGDC-STD-018-2012. 343p.

Forrest BM, Roberts, KL, Stevens LM. 2021. Fine Scale Intertidal Monitoring of Blueskin Bay. Salt Ecology Report 070, prepared for Otago Regional Council. 34p.

Robertson BM, Robertson BP, Stevens LM. 2017. Waikouaiti Estuary: Fine Scale Monitoring 2016/17. Prepared for Otago Regional Council. 37p.

Robertson BM, Stevens L., Robertson BP, et al. 2016. NZ Estuary Trophic Index. Screening Tool 2. Envirolink Tools Project, MBIE/NIWA Contract No: C01X1420. 68p.

Townsend M, Lohrer D. 2015. ANZECC Guidance for Estuary Sedimentation. NIWA client report number HAM2015-096, prepared for Ministry for the Environment 45p.