Lower Gordon River erosion monitoring 2018

Update report for the period February 2018 to December 2018

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Executive Summary

Since the 1980s the lower Gordon River has been subject to bank erosion caused by vessel wave wake. A long standing erosion monitoring program has guided management decisions aimed at reducing the rate of unnatural erosion.

Measurements taken during 2018 have been analysed and utilizing multiple lines of evidence, a decline in the rate of estuarine bank erosion over the last monitoring period is indicated, however the lower parts of sandy levee banks continue to erode and remain susceptible to wave wake erosion.

Turbidity monitoring data indicates that the majority of geomorphic activity at the site downstream of Heritage Landing still occurs at the times of scheduled cruises.

When erosion pin and turbidity monitoring data are considered together we see no new erosion problems, however passage of cruise vessels continues to cause elevated turbidity levels due to the action of wake waves suspending nearshore and bank sediments as the vessels pass the monitoring stations. Such a result indicates active geomorphic process and confirms that some erosion remains attributable to these vessels.

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1 Introduction

The lower Gordon River erosion monitoring program is comprehensively documented in the report *Lower Gordon River erosion monitoring, Tasmanian Wilderness World Heritage Area-report for the period February 2004 to March 2013* (DPIPWE 2013).

This current brief report covers work undertaken during 2018 and is the fourth in a series of update reports since the 2013 report. This update contains only the most recent monitoring results and updated time-series plots. For geomorphological description, methods, previous results and discussion of their significance please refer to the earlier comprehensive report.

The monitoring documented here was conducted from 4 – 7 December 2018.

2 Methods

2.1 Erosion Pin Monitoring

Use of erosion pins is a well established method of measuring the rate and magnitude of river bank change (Wolman 1959, Lawler 1993). Erosion rate is determined by repeated measurement of pins installed perpendicular to the river bank face.

Change in the exposed length of pins between measurements indicates the nett amount of erosion or deposition that occurred during the monitoring period. Measurements are normalised and reported as a rate in mm/year, thus allowing straightforward comparison of monitoring periods of varying length.

2.2 Study Area

There are presently 40 sites in the annual pin monitoring program, with locations indicated in Figure 1.

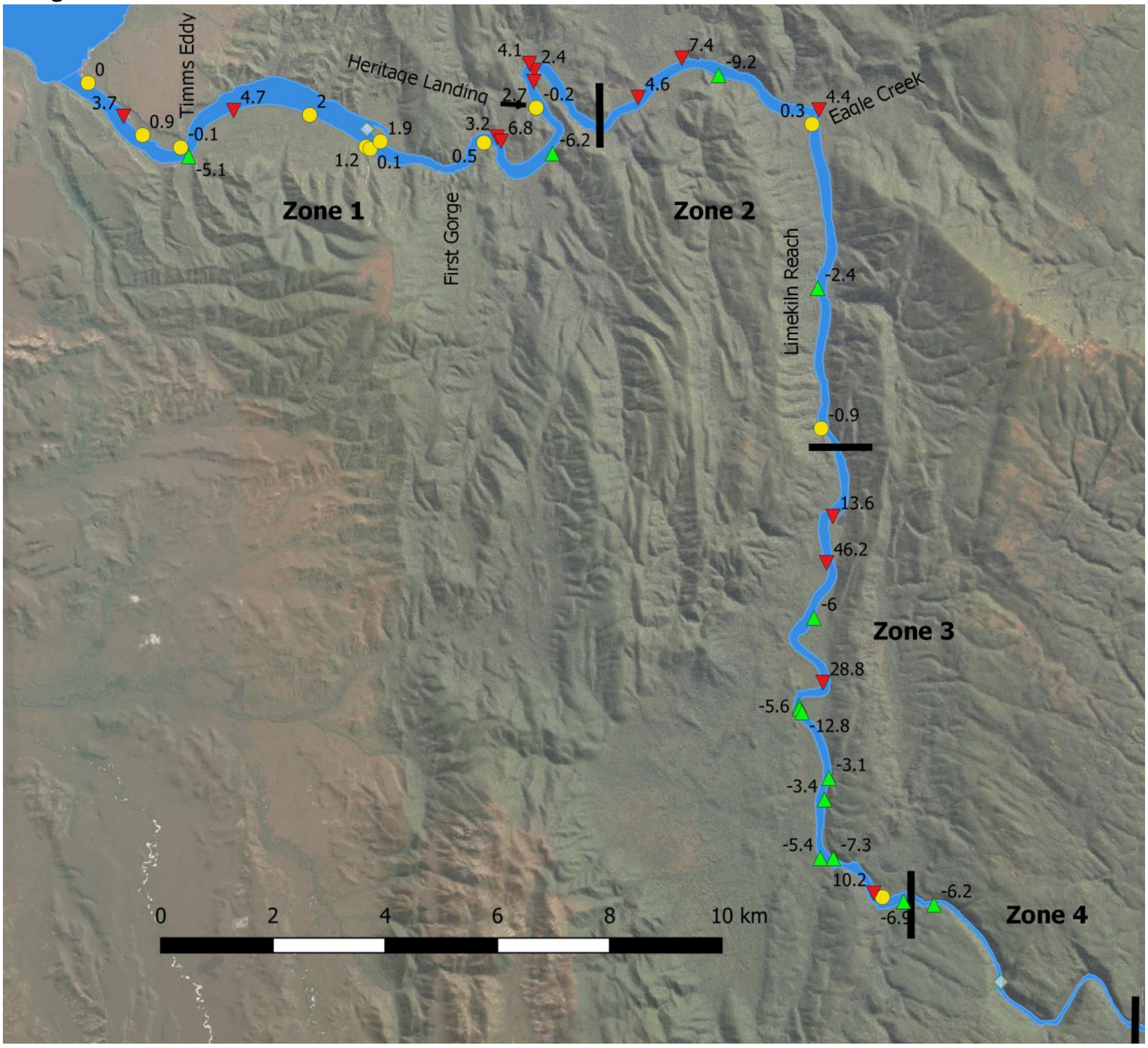

Figure 1: Map of the lower Gordon River area showing the mean rate of erosion of critical landforms (estuarine and alluvial scarps and lower levees) as recorded by multiple pins at each of 40 monitoring sites. Key: red inverted triangles = erosion, yellow circle = no change in average pin exposure exceeding measurement resolution (conservatively +/- 2 mm), green triangle = deposition, grey diamond = not measured. Numbers indicate the average rate of change at each site in mm/yr, zone boundaries are shown as thick black lines.

3 Results

3.1 Estuarine banks

Estuarine banks are the very low lying banks comprised of organic rich mud and minor sand that occur between the mouth of the river and First Gorge. The general form of these banks is depicted in Figure 2. Geomorphological evidence including radiocarbon dating (Bradbury et al. 1995) indicates that these banks were actively depositional until recent decades.

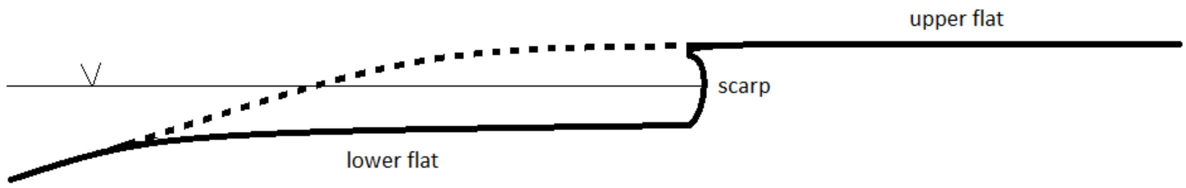

Figure 2: A generalised estuarine bank profile showing a near-vertical erosion scarp, typically 30 – 50 cm high, separating two sub-horizontal surfaces. The dashed line shows the pre-erosion profile, as preserved on similar banks in some relatively untrafficked estuaries elsewhere in southwest Tasmania. The fine line indicates average water level.

Most erosion pins are installed sub-horizontally in the eroded scarp, with a smaller number vertically in either the permanently submerged shoal below or in the occasionally inundated, vegetated surface above. It is only on those flats where deposition can occur, although a few low scarp pins may record deposition burying the scarp foot. Due to the low angle between pin and depositional surface measurements from those pins overestimate the true rate of sediment accumulation.

Estuarine bank erosion rates are summarised in Table 1 and Figure 3. Sustained high water level during the monitoring period meant that some 35% of pins could not be located, or if located could not be measured with sufficient accuracy. This is not unprecedented and simply means that some caution is required when interpreting the results. In particular the most recent downturn in the erosion rate should not be considered significant by itself. However, turbidity monitoring data (section 3.4) is somewhat supportive of a decline in erosion rate over the most recent monitoring period. Those pins that could not be measured will, upon next measurement, record the cumulative erosion over two monitoring periods.

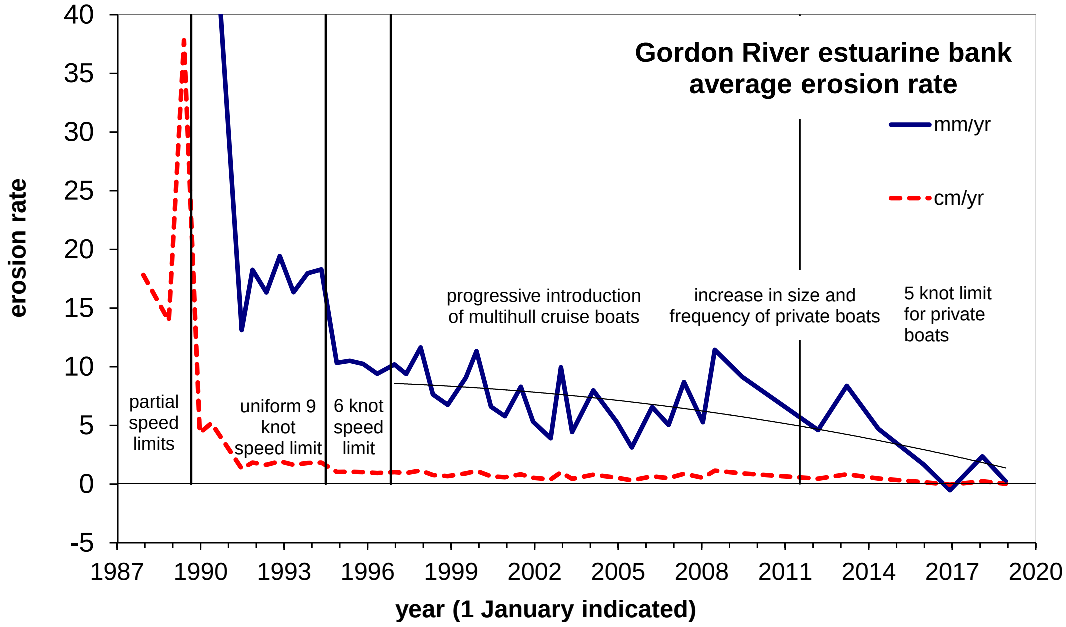

Figure 3: Mean rate of estuarine bank erosion (combined scarp and flat) through time. The fine smoothed line shows the best fit trend of the data since the first introduction of multi-hulled cruise vessels.

Table 1: Summary estuarine bank erosion pin measurement statistics for the reporting period. All values except n are in mm/yr. Negative values indicate deposition.

	count (n)	min.	max.	mean	st. dev.	n < 0	n = 0
overall	47	-49.6	47.2	0.2	12.1	12	14
scarp	37	-18.9	47.2	2.4	9.4	6	13
lower flat	7	-49.6	10.7	-8.6	21.2	4	0
upper flat	3	-9.5	0.0	-5.9	5.2	2	1

3.2 Alluvial banks

Alluvial banks consist of silt and fine sand and display a flat to subdued levee morphology with a crest typically about 0.3 - 1 m above mean water level. They occur in the floodplain areas between First Gorge and Eagle Creek, and also sporadically in Limekiln Reach. These banks were stable, supporting millennia old Huon pines, until the 1980s. The general form of these banks is depicted in Figure 4. Again most pins are installed in the eroded scarp, with a smaller number in the shoal below or vegetated surface above. Alluvial bank erosion rates are summarised in table two and figure five.

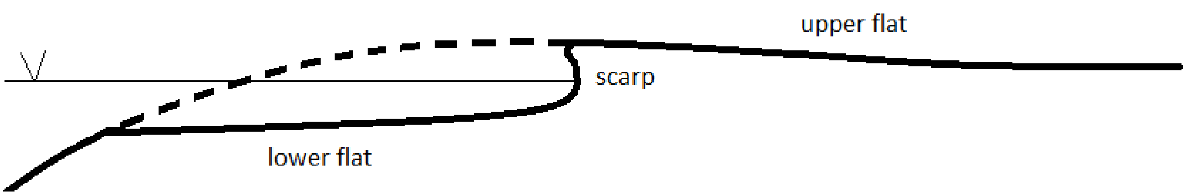

Figure 4: A generalised alluvial bank profile showing a near-vertical erosion scarp, typically 30 – 80 cm high, separating two sub-horizontal surfaces.

Since 1989, when commercial cruises were excluded from zone two, the rate of alluvial bank erosion in that zone has typically (but not always) been lower than that in zone one (Figure 5). That difference has been at times statistically significant and attributed to the effect of cruise boat wave wake. However for the past few years, the difference has been reversed and for the most recent monitoring period, was effectively negligible.

Table 2: Summary alluvial bank erosion pin measurement statistics for the reporting period. All values except n in mm/yr. Negative values indicate deposition.

	count (n)	min.	max.	mean	st. dev.	n < 0	n = 0
Zone 1 alluvial banks							
overall	33	-21.3	33.2	1.2	9.2	11	6
scarp	24	-21.3	33.2	2.8	10.2	5	5
lower flat	8	-11.8	1.2	-3.7	4.0	6	1
upper flat	1	2.4	2.4	2.4	N/A	0	0
Zone 2 alluvial banks							
overall	67	-66.1	49.6	1.3	15.9	22	14
scarp	51	-39.0	49.6	3.6	14.4	10	14
lower flat	14	-66.1	17.7	-6.1	19.4	11	0
upper flat	2	-16.6	1.2	-7.7	12.6	1	0

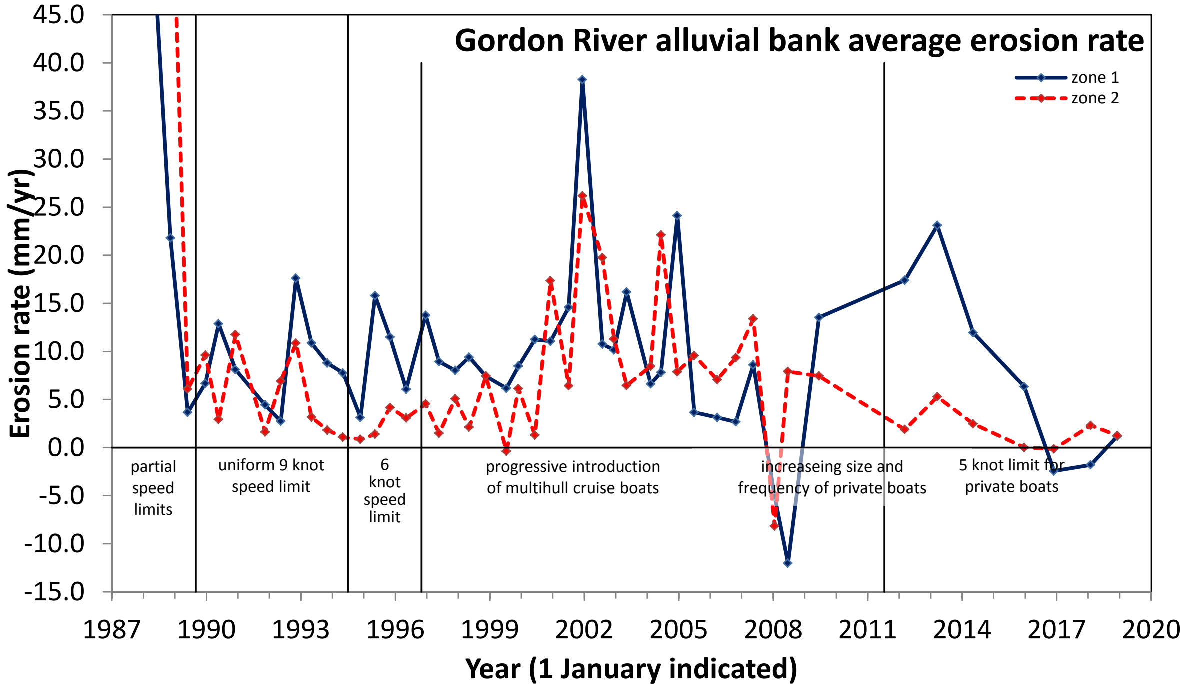

Figure 5: Mean rate of alluvial bank (combined scarp and flat) erosion through time

3.3 Levee banks

The sandy levee banks of zone 3 and small areas of zone 4 are very susceptible to wake wave erosion and the formerly stable landforms were rapidly eroded in the 1980s. The monitoring program recognises three discrete landforms; an upper scarp, a mid-level debris apron and low sandy bars (Figure 6). The latter consist of unconsolidated and unvegetated to sparsely colonised sand; these represent partial recovery from a prior event or series of events that resulted in significant impact, and are a fragile buffer against renewed levee retreat. Levee bank erosion rates are summarised in table three and figure seven.

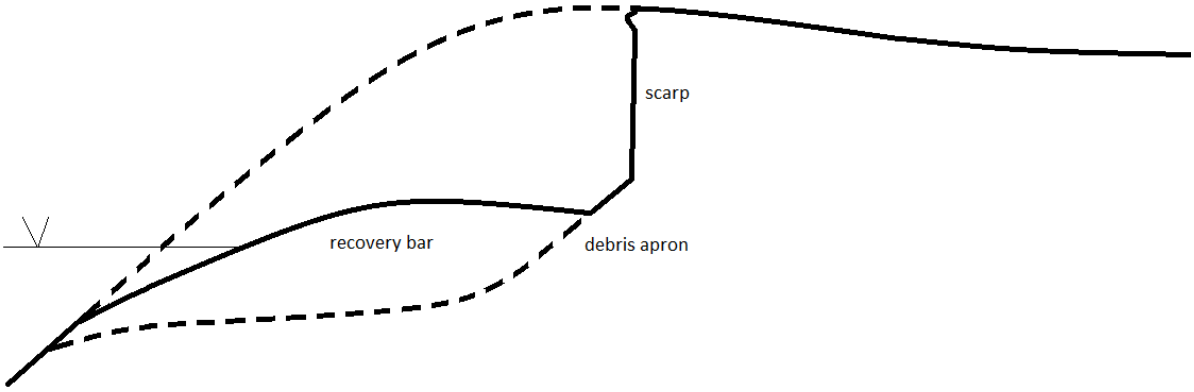

Figure 6: Generalised form of levee banks showing upper levee scarp, middle levee debris apron and lower levee recovery bar. The volume removed by erosion during the 1980s is shown between the dashed lines. The top of the scarp is typically 2 – 3.5 m above the normal water level shown.

Over the 2018 monitoring period only minor adjustments of the upper and middle levee landforms were recorded. The lower levees were considerably more active, with both deposition and erosion rates in excess of 100 mm/yr being recorded for an average of 6 mm/yr erosion. Note that the time-series plot (Figure 7) appears somewhat different to previous versions. That is because when levee bank erosion experiments were done in 2008-09 the experimental sites were excluded from results because of the artificially higher rate of erosion caused by numerous experimental boat passes during the relevant monitoring period. However they were also erroneously excluded from 2012 and 2013 data sets. That error has now been corrected.

Deposition on the lower levees is limited to periods of high flow, most notably occurring during the floods of 1995 and 2007. Recent erosion therefore is of some concern, as rainfall records indicate that 2018 was a relatively wet year in the catchment. Strathgordon power station received an annual total of 3361 mm, compared to an average of 2941 mm. That included a record March daily total of 108.4 mm, not far short of the absolute maximum daily rainfall record of 125.0 mm set in 2009 (BoM 2019). Either there was insufficient flood magnitude to deliver sediment to the levee bank reaches in 2018 or there has been a recent acceleration of erosive process there.

Table 3: Summary levee bank erosion pin measurement statistics for the reporting period. All values except n in mm/yr. Negative values indicate deposition.

	count (n)	min.	max.	mean	st. dev.	n < 0	n = 0
upper levee	25	-1.2	2.4	0.1	0.6	3	20
middle levee	28	-23.6	13.0	-1.7	7.4	12	9
lower levee	89	-124.0	121.3	6.0	33.5	42	6

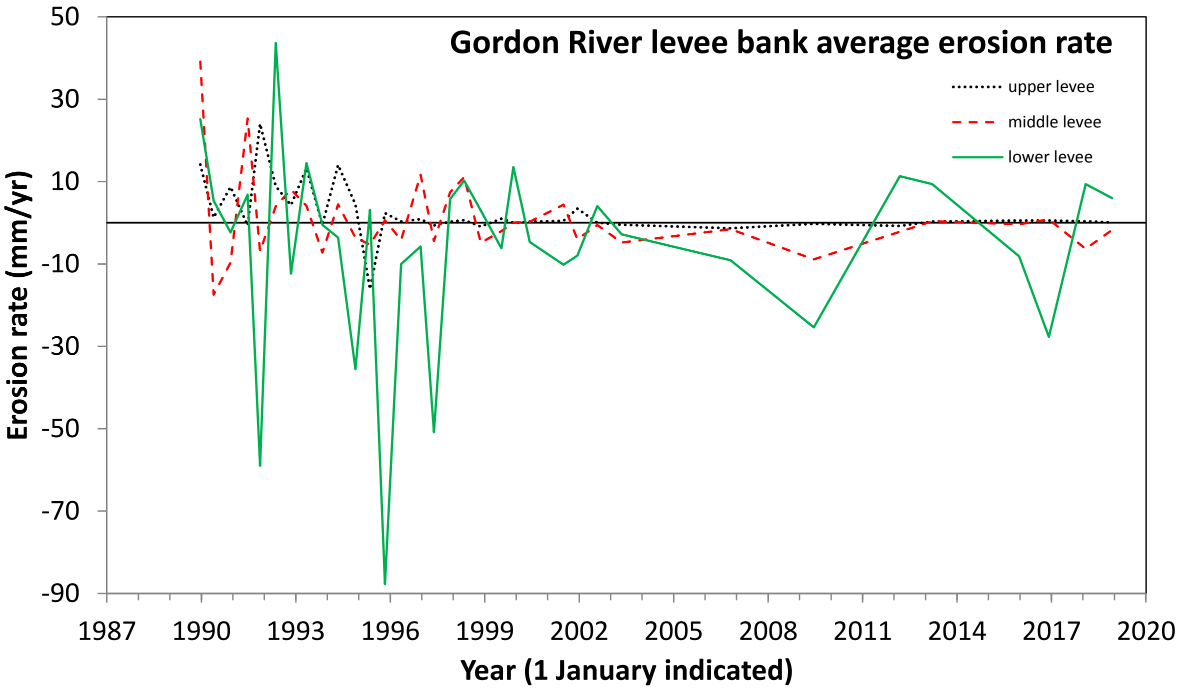

Figure 7: Mean rate of levee bank erosion through time. Prior to 1989, when the erosion rate was much greater before cruise vessels were excluded from these reaches, no distinction was made between upper, middle and lower levee.

3.4 Turbidity monitoring

Instrumental monitoring of near bank turbidity at 15 second intervals occurs at two sites, one above and one below Heritage Landing. Greenspan TS 100 instruments have replaced the original Analite sensors, otherwise the installations and data analysis remain as described in DPIPWE (2013). The installations essentially act as boat counters, providing a record of each vessel pass that causes geomorphic activity. They do not however record vessel passage that does not cause geomorphic effect. Battery power and memory capacity constraints limit data collection to approximately 180 days between services. In 2018 a full 305 days of data from 2 February to 4 December 2018, was acquired from the upstream site. However only 229 days were recorded by the downstream site, with data lost during the period 22 July to 21 August and from 22 October onwards. That data loss was probably caused by water entering the logger housing although once the equipment was dried, normal operation was apparently resumed.

At the downstream site, a total of 755 turbidity events characteristic of wave wake impact were recorded, for an average of 3.3 per day over the 229 day operational period. The upstream site recorded 211 events, an average of 0.69 per day. Note that due to the difference in bank type (estuarine vs. alluvial) and water depth, the two sites are not directly comparable, with the upstream site being less sensitive to vessel effects. The daily event count at both sites is shown in Figure 8.

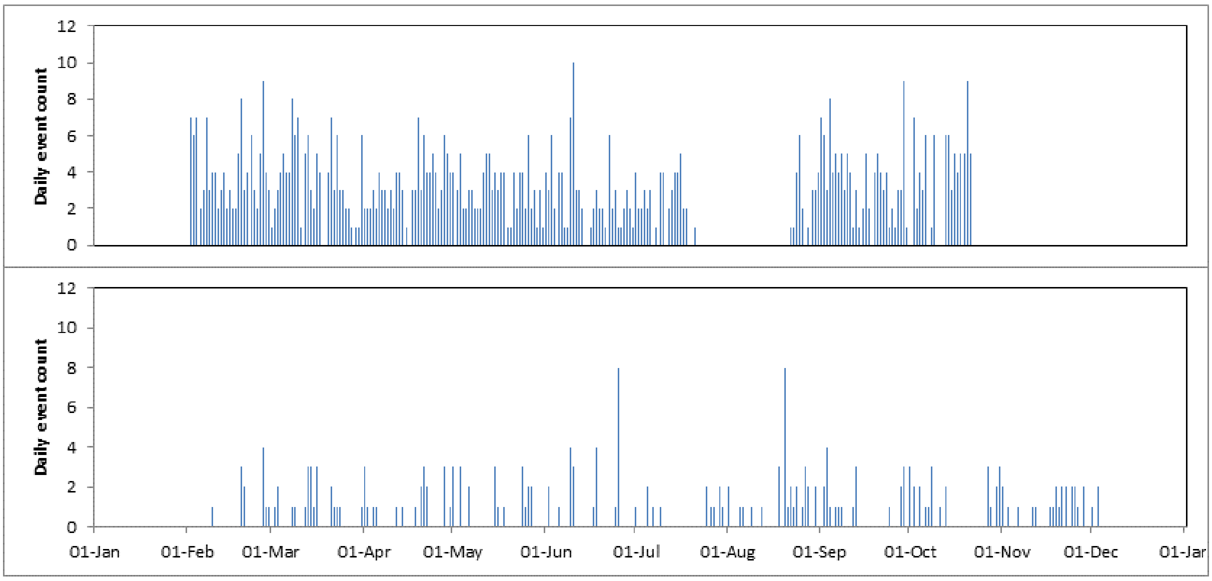

Figure 8: Histograms showing daily event counts at the two turbidity monitoring sites during 2018, downstream top and upstream bottom.

From the timing of turbidity events (Figure 9) it is clear that near bank geomorphic activity at the downstream site is still dominated by scheduled cruises, which pass the site shortly after 10:00 am (upstream), noon (upstream and downstream) and about 2:00 pm (downstream).

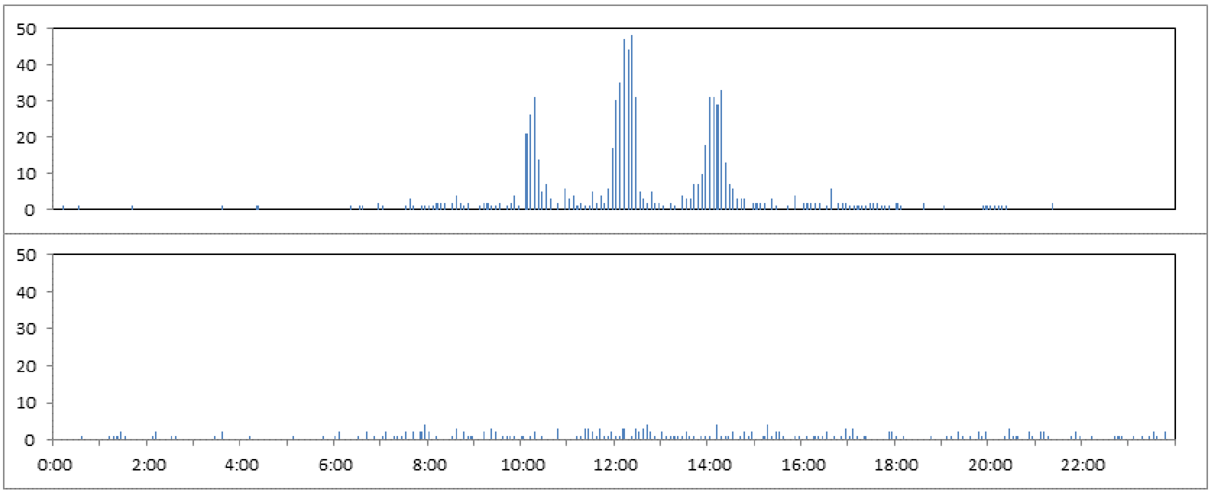

Figure 9: Histograms showing timing of 2018 turbidity events in 5 minute bins, downstream top and upstream bottom.

The maximum turbidity reading for each event recorded by the downstream logger since monitoring was reestablished in late 2015 is plotted in Figure 10. This shows that on average, the events of 2018 had a lower geomorphic effect than those of 2017. A one-tailed Monte Carlo randomisation test for difference in the means of the two groups indicates that the probability of observed difference in arithmetic means arising from random regrouping of the data = 0. Such a statistically significant difference between the turbidity monitoring datasets supports the above suggestion that erosion pin monitoring indicates a downturn in estuarine bank erosion rate since 2017 despite incompleteness of the erosion pin data.

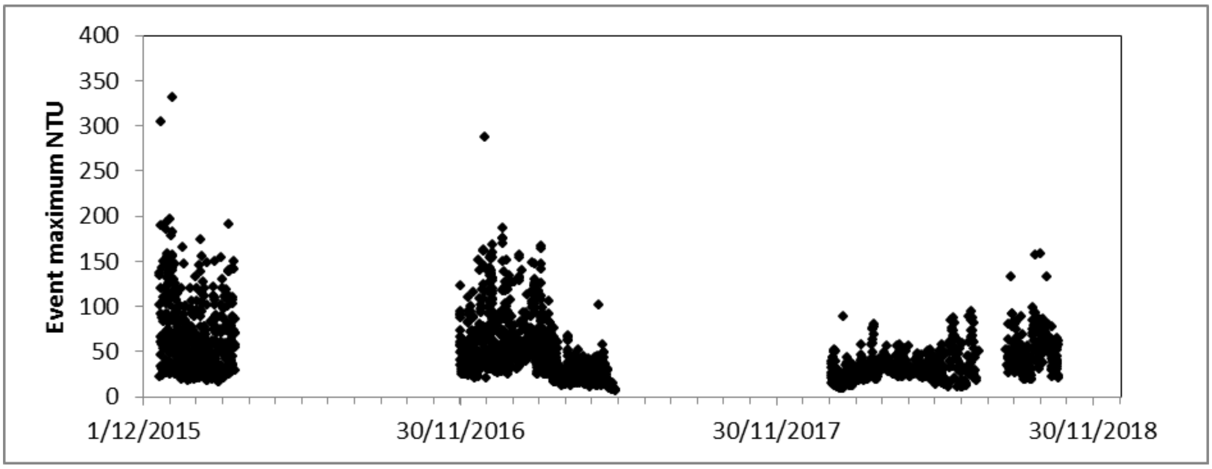

Figure 10: Maximum turbidity attained for each event recorded at the downstream logging site since reinstatement in late 2015.

4 Discussion

The previously depositional estuarine banks recorded near zero erosion over the 2018 monitoring period while formerly stable alluvial and levee banks continued to erode. The 2018 results show a reduction over 2017 levels for the estuarine banks, albeit a minor reduction.

Alluvial banks showed negligible difference in their erosion rates between zones 1 and 2. Levee bank scarps and debris slopes showed little activity, mostly confined to minor slope adjustments and accumulation of organic debris. Despite above average catchment rainfall, for the second year running the scarp foot recovery bars recorded net erosion.

Despite some recovery in the form of deposition on estuarine and alluvial flats and on the levee foot bars, all bank types in all zones continue to remain susceptible to wave erosion.

When erosion pin and turbidity monitoring data are considered together we see no new erosion problems, however passage of cruise vessels continues to cause elevated turbidity events due to the action of wake waves suspending nearshore and bank sediments as the vessels pass the monitoring stations. Such a result indicates active geomorphic process and confirms that some erosion remains attributable to these vessels at the site downstream of Heritage Landing. That is counter to the Lower Gordon River Recreation Zone Plan (PWS 1998) management target of zero wash induced erosion.

While the erosion rates reported here may appear low, the lower Gordon River was a stable to actively depositional environment until the 1980s. Then, with the introduction of a new class of cruise vessels the nature of the landforming processes shifted from depositional to erosive. Speed limits to target wave wake impacts have seen a reduction in bank erosion generally although small amounts of erosion continue to impact some of the levee banks on the river. Whilst the amounts of erosion we see may be considered small, the environmental objectives in the Lower Gordon River Recreation Zone Plan (1998) is to restore the natural propensity of the river banks towards stability or deposition (as appropriate to particular sites)

The ongoing monitoring is designed to inform management decisions regarding vessel operation on the lower Gordon River. Figure 3 provides clear indication that management action has been effective in reducing the rate of erosion.

Erosion due to vessel operations will only occur with exceedance of the wave power threshold above which sediment motion is initiated. In this context, zero geomorphic impact of boating on the river may be possible and potential management options should be considered when revising the Recreation Zone Plan for the River.

Given the ongoing benefits and use of the monitoring data by PWS since its inception, it is recommended that erosion pin and turbidity monitoring be continued at the present frequency.

5 References

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