SNOWY RIVER RECOVERY: SNOWY FLOW RESPONSE MONITORING AND MODELLING PROGRAM

Outcomes of 2013/14 environmental releases for the Snowy River – Reworking the river bed sediment

Introduction

Large discharge events or pulses play a critical role in the maintenance of healthy river systems. Without these flushing flows, channel contraction and sediment deposition can lead to poor in-stream habitat condition and change the composition, abundance and distribution of aquatic biota. Regulated rivers with severe hydrological alteration such as the Snowy River (Figure 1.) often have poor habitat condition, ecological function and ecological communities.

Following completion of the Snowy Mountains Scheme in 1967, the Snowy River had not received substantial environmental flows until 2010. The first significant environmental flushing flow was provided to the Snowy River in the spring of 2011. This was delivered via a single large pulse, with similar large events occurring in March 2012 and again in September 2012 which initiated the start of the recovery process.

In 2013, a new "natural flow scaling" release method was trialled to better reflect the hydrology of a Snowy Montane River (Reinfelds *et al.* 2013; Williams and Reinfelds 2013). The annual, monthly, daily and hourly allocation pattern was based on the hydrologically scaled discharge pattern of the unregulated Thredbo River.

The 2013-14 flow strategy included five high flow spring peaks between the 4th of September and the 8th of November (Figure 2). The aim was to produce a more natural river hydrology with the available water, while also targeting the primary objective of improvements in the in-stream habitat condition.

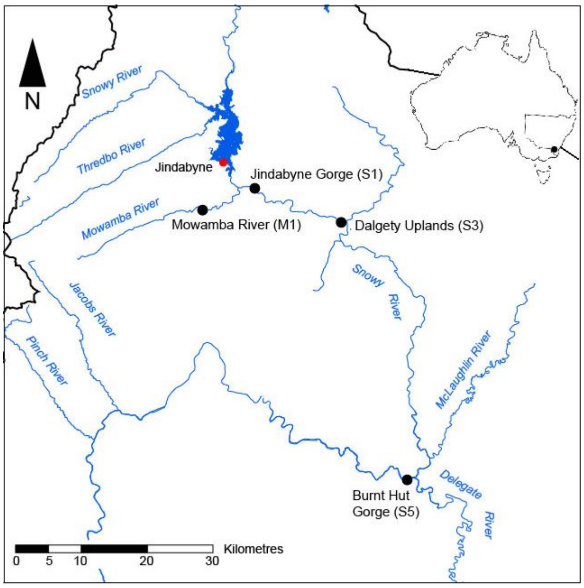

Figure 1. Location of the sites within the Snowy River macro reaches: Jindabyne Gorge, Dalgety Uplands and Burnt Hut, and the Mowamba River.

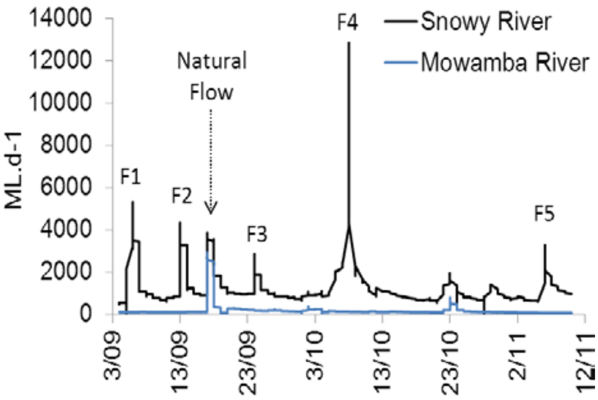

Figure 2. Hourly discharge (ML) between the first and last environmental flow (4 September – 11 November 2013). Discharge is shown for the Snowy River directly below the dam and the Mowamba River at the weir.

Aims

This factsheet reports the outcomes of the five high flow spring 2013 releases in reworking the river bed and moving fine sediment, as the build up of fine sediment in the bed of the river has been identified as a major constraint to the recovery of the Snowy.

Figure 3. Sample collection from the automatic sampler unit at the Snowy River @ Burnt Hut Crossing.

The primary long term objective of the Snowy River recovery strategy is to improve the in-stream habitat condition, as it is anticipated that secondary and tertiary ecological responses will follow over the intervening decades. Thus measuring changes in channel condition and/or sediment re-suspension is critically important for planning future Snowy River Increased Flows (SRIFs). The main aims of this factsheet are to:

1. Highlight the most efficient discharge rates required to move significant volumes of sediment within the Snowy River
2. Compare the relationship between discharge and suspended sediment during each flow event.

Measuring sediment re-suspension

The five high flow events each had an 8 hour peak discharge period. Peak discharge was equivalent to: 5,330; 4,337; 2,834; 12,830; and 3,283 ML.d^{-1} for Flow 1-5 respectively. A steep rising climb followed by an extended recession was incorporated into each flow to mimic natural flood events. During each spring high flow event, water samples were continuously collected using automatic water samplers (Figure 3) beginning 24h prior to the release and continuing until 48h after the peak discharge. This was performed at three representative macro reach Snowy River sites: (S1) Jindabyne Gorge, (S3) Dalgety Uplands and (S5) Burnt Hut Gorge and one reference in the Mowamba River (M1) (Figure 1). The Snowy River sites represented a longitudinal gradient of 2km (S1), 24km (S3) and 92km (S5) downstream from the dam. Samples were then analysed for total suspended sediment concentration (mg.L^{-1}).

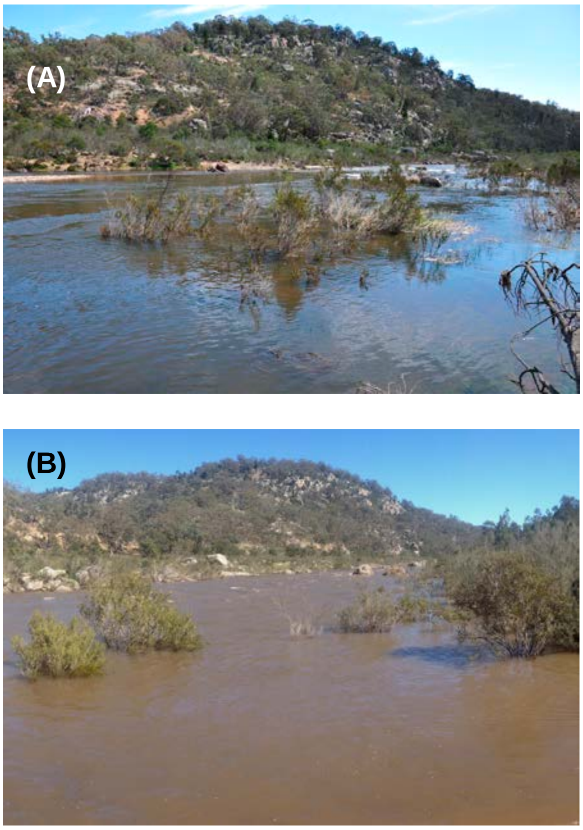

Figure 4 The Snowy River @ Burnt Hut Crossing (A) before (low turbidity water) and (B) during the peak (high turbidity water)of spring 2013 high flow.

How effective were the flows?

In total, the five events produced approximately 824 tonnes (*t*) of sediment 92km downstream at the Burnt Hut Gorge (S5). Further upstream the total sediment load was 378*t* and 134*t* at the Dalgety Uplands (S3) and Jindabyne Gorge (S1) respectively. The highest peak sediment concentration was recorded during flow 1 and flow 4. Further, suspended sediment increased with distance from the dam (Figure 5-6). Although peak discharge during flow 4 was more than double that of flow 1, sediment loads were relatively similar between the two flows, except within the Dalgety Uplands (S3) (Table 1). This indicates a degree of fine sediment supply exhaustion after the first high flow event. The least significant flow, with respect to sediment movement was flow 3, however it followed a large natural flow only 4 days earlier (Figure 2).

Table 1. Equivalent peak discharge (ML.d^{-1}), total load (*t*), and time since last flow (days) for the five high flow events during spring 2013. Time since last flow is calculated from the days since a flow equal or larger than the peak discharge during each event.

Site	Flow (F)	Peak discharge (ML.d^{-1})	Total load (*t*)	Time since last flow (days)
S1	**F1**	5,330	47	346.6
	F2	4,337	14.3	6.9
	F3	2,834	11.9	4.1
	F4	12,830	45.2	13.9
	F5	3,283	15.4	30
S3	**F1**	5,979	78.2	346.8
	F2	4,450	15.7	7.1
	F3	2,713	11.2	4.1
	F4	11,327	256.5	13.8
	F5	3,162	16.5	30.1
S5	**F1**	5,106	303.2	71.5
	F2	3,672	44.5	7.0
	F3	2,748	32.8	4.3
	F4	10,498	409.2	13.5
	F5	2,566	33.9	30.4
M1	**F1**	95	1.1	-
	F2	104	1.6	-
	F3	216	3.6	-
	F4	130	3.1	-
	F5	69	0.9	-

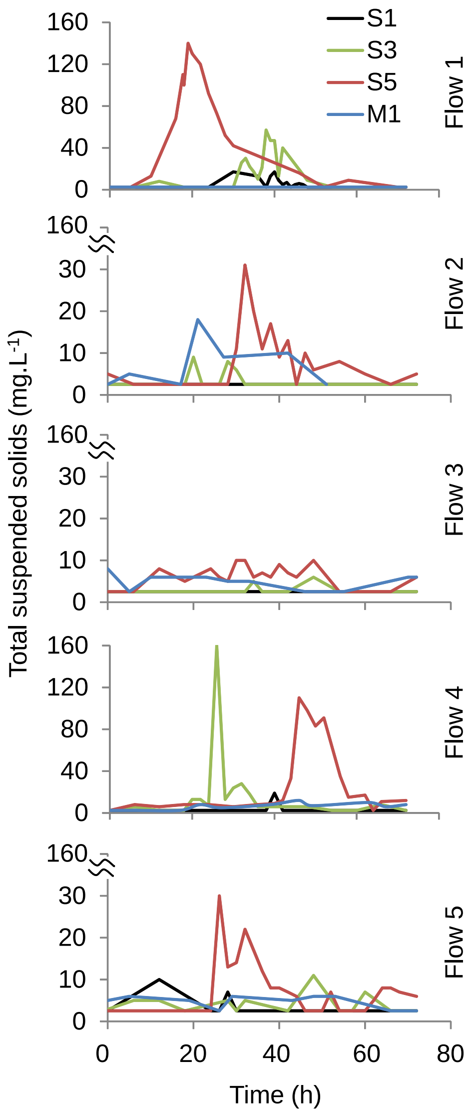

Figure 5.Time series of peak total suspended solid (mg.L^{-1}) during the five high flow events in spring 2013.

The relationship between discharge and sediment movement can be useful to identify the effectiveness of each flow pulse. It appears that the time since the last major flow plays a critical role in this relationship. For example, during flow 1 total suspended solids (TSS) correlated strongly with discharge at all the Snowy sites, (Figure 6). However, this was not the case for the other four high-flow events. Sediment mobilisation during the largest event (flow 4) also had a relatively strong positive relationship with discharge. Sediment re-suspension at the Burnt Hut Gorge (S5) was strongly linked to discharge during all five events. This indicates that the high flow events are mobilising the sediment deposited in the large deposition zone below the Dalgety Uplands. This is the anticipated response to the releases.

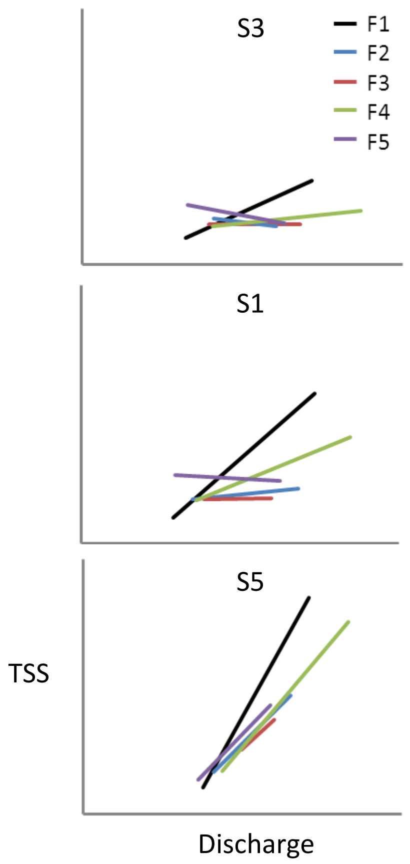

Figure 6. TSS vs discharge line of best fit for each flow within each site. All data was log[10] transformed

What does this mean for the Snowy River and future SRIF strategies?

The outcomes from this work highlights the significance of the first flow release (after a >3month period without a large pulse) and its ability to mobilise large volumes of fine sediment with much less water. Although the largest flow (peak 12,830 ML.day^{-1} below the dam) produced a greater quantity of sediment, this required more than twice the amount of water than the first environmental release. The remaining three flows, still moved small volumes of sediment and collectively will maintain and improve the quality of the in-stream habitat in the longer-term.

The SRIF strategy aims to improve the condition of the Snowy River by firstly improving in-stream habitat condition through the introduction of a new high flow regime. This new high flow regime will enhance multiple ecosystem responses and lead to secondary and tertiary ecological responses. The 2013 SRIF regime produced significant results with respect to sediment re-suspension; over 800t of TSS was recorded at the Burnt Hut Gorge region alone. We now have a greater understanding of the discharge-sediment mobilisation relationship and its dependence on peak discharge, time between events/sediment exhaustion. It is clear that bulk of the fine sediment is being generated between Dalgety and Burnt Hut, and this is consistent with the area being a large deposition zone. The knowledge gained for the 2013 spring releases will allow future SRIF strategies to program the most effective regime in respect to reworking the river substratum.

Acknowledgements

The document should be cited as

Coleman, D. and Williams, S. (2014). Reworking the river bed: Sediment movement during the spring 2013 environmental releases. Snowy Flow Response Modelling and Modelling program, NSW Office of Water, Sydney.

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More information

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