NSW GOVERNMENT | Office of Water

Snowy River Recovery

Snowy flow response monitoring and modelling

Ecological response to the spring 2010 environmental flow release to the Snowy River below Jindabyne

Publisher

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Snowy flow response monitoring and modelling:
Ecological response to the spring 2010 environmental flow release to the Snowy River below Jindabyne

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Introduction

The spring 2010 environmental release was the largest active environmental water release to the Snowy River since the construction and operation of Jindabyne Dam, in 1967. The NSW, Victorian and Commonwealth Governments agreed to release a total of 16.6 GL of environmental water to the Snowy River to improve the river condition.

The main objective of the spring environmental flow was to scour the Snowy River bed below Jindabyne. The condition of the Snowy River bed is seen as one of the key factors limiting the Snowy's recovery.

The loss of high flow events in the Snowy River has caused a build up of sediment in the river bed (Figure 1). Sediment is delivered to the Snowy River via many of the smaller tributaries after local storm events. This sediment deposition occurs as the water velocity of the tributary water reduces when it enters the larger channel of the Snowy River and drops its sediment load. This build up of sediment has occurred over a long period as there have been few discharge events to scour the sediment, and it has been recently exacerbated by wildfires in the Snowy catchment. Post the 2002-03 bushfires, large amounts of sediment have entered the Snowy River and deposited on the river bed.

The build up of sediment in the Snowy River bed has two key impacts: (i) by directly smothering the plants and animals of the Snowy River, and (ii) indirectly by reducing the quality of the in-stream habitat condition. Many of the spaces on the river bed required by aquatic animals are filled by fine sediment, making the habitat unsuitable.

These scouring flows attempted to move some of the fine sediment on the Snowy River bed. Flow rates of 1,000 MLd^{-1} are known to move the unconsolidated very fine silts in the Snowy River bed. Flow rates of between 2,000 and 3,000 MLd^{-1} were previously estimated to initiate the movement of fine sediment in the riffles of the Snowy River.

The secondary objectives include: the inundation of the old river bed, initiate some local scale fish movement and scour the periphyton on the river bed.

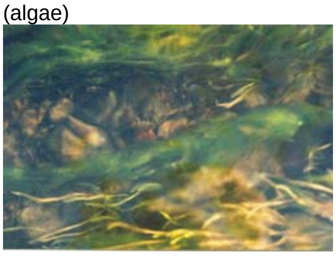
It was expected that some of the benthic algae attached to the Snowy River bed (Figure 1), would be scoured. High densities of benthic algae are a common feature of river regulation, particularly where large discharge events are infrequent. High densities of the benthic algae are not common in the unregulated snowmelt rivers of the Snowy Mountains, and alter in-stream habitat and food sources for aquatic animals.

Figure 1: Comparison of the river bed substrate in an unregulated snowmelt river with a regulated snowmelt river. Note the heavy cover of **fine silt** and **attached algae** on the river bed below dams.

River bed of an unregulated snow melt river

River bed of a regulated snow melt river (Silt)

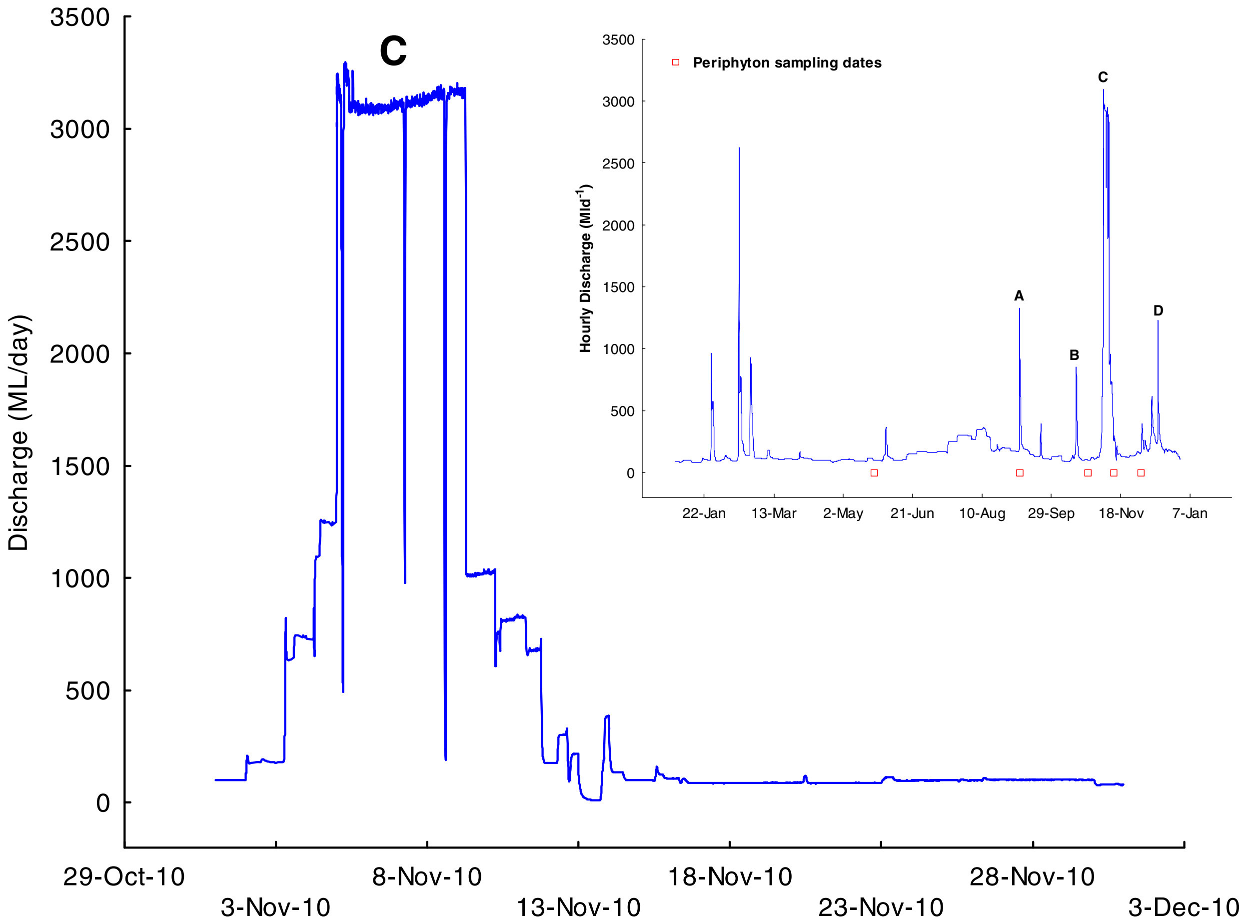
River bed of a regulated snow melt river (algae)



The spring 2010 scouring flow

The 2010 spring release increased from 80 MLd^{-1} to a peak of 3,080 MLd^{-1} on 5 November 2010 (Figure 2). The peak flow was maintained for four days before being reduced to 100 MLd^{-1} by 12 November 2010. Variations in the flow record show operational difficulties with new infrastructure and procedures to calibrate and test valves and improve the rating of the gauging station. Additional, to the planned release (Figure 2), there were two natural flow events prior to the release and subsequent events after the release.

Figure 2: Release pattern for the spring 2010 environmental flow release from Jindabyne dam, November 2010. Inset – the discharge pattern for the Snowy River at Dalgety 2010 and showing natural flow events pre and post the active environmental release and the periphyton sampling occasion.



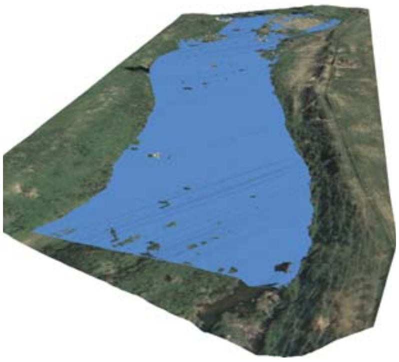
Water inundation patterns

Photo point monitoring was conducted as part of the assessment of the spring flow release and Figure 3 shows the inundation patterns and the predicted wetted area for different discharges at the Snowy River in the Dalgety Uplands. These observations showed that the former river bed is fully inundated at 3,080 Mld^{-1}. The inundation patterns also appear to be in agreement with modelled inundation patterns for the Dalgety Uplands site, Snowy River downstream of Blackburn Creek (Site 4).

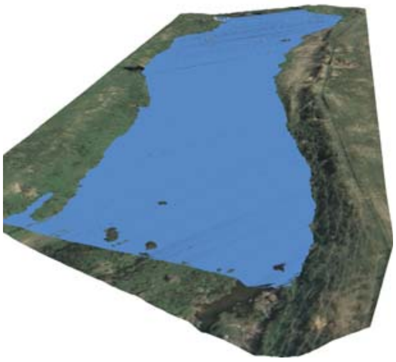
Figure 3: Modelled and observed inundation patterns for the Snowy River d/s Blackburn Creek (Site 4), November 2010.

100 $ML d^{-1}$

1000 $ML d^{-1}$



3000 $ML d^{-1}$



Water quality responses

Physio-chemical variables (pH, electrical conductivity (EC), oxidation reduction potential (ORP), dissolved oxygen (DO), water temperature and turbidity) were logged continuously in half hourly intervals during the flow release at the Snowy River in the Jindabyne Gorge (Snowy River downstream of Mowamba River, Site 1), (Figure 4).

Figure 4: Installation of the Hydrolab at the Snowy River downstream of the Mowamba River (Site 1).

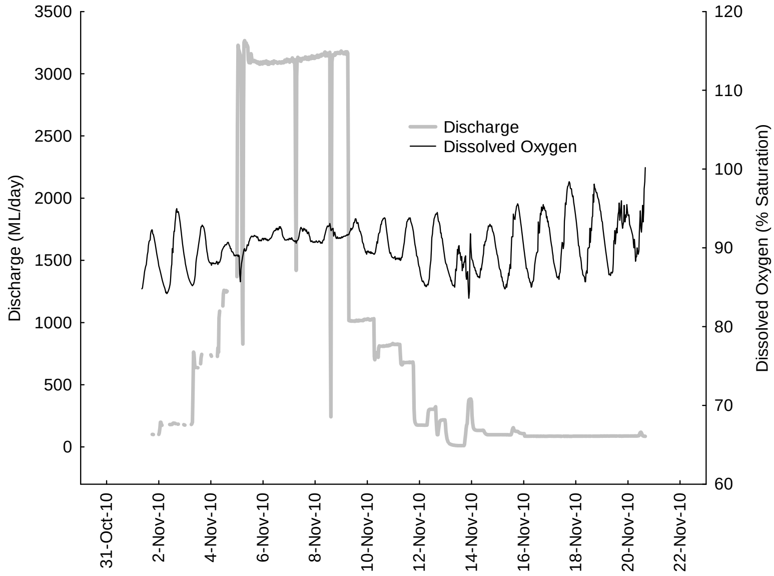
The spring flow release reduced the diurnal range of dissolved oxygen and water temperature (Figure 5A and B). Previous studies in the Jindabyne Gorge have shown that atmospheric exchange is the key driver for explaining the large diurnal variability in water temperature and dissolve oxygen. The greater mixing of the water in the pools by the active environmental release resulted in less influence of atmospheric exchange between the air and water.

The other water quality variables pH, EC and ORP showed no obvious flow response patterns.

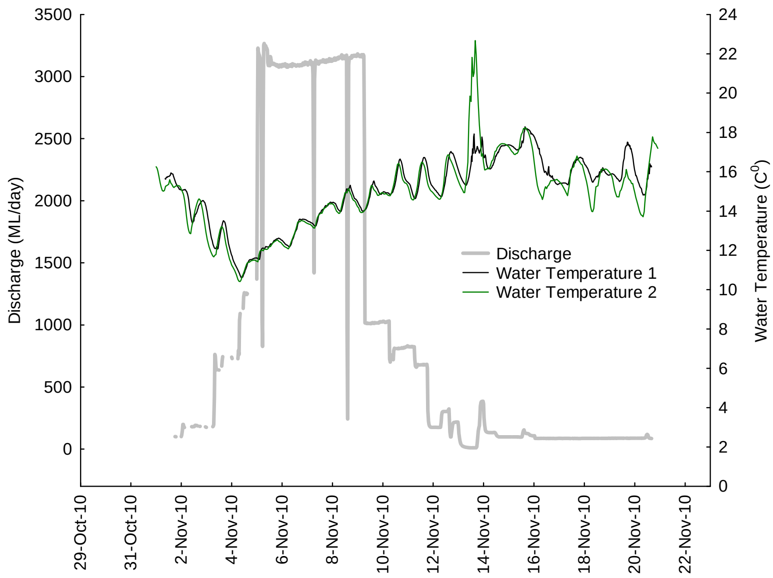
Turbidity displayed the most prominent response to the spring 2010 flow event. Initial analysis of water quality data indicates that the large scale movement of fines in the Jindabyne Gorge were initiated with onset of the larger 1,000 MLd^{-1} flows, but reached the maximum turbidity levels with the peak discharge rate. This is reflected by Figure 5C that shows an initial acute increase in turbidity then tailing off even though discharge remained high. The threshold for the transport of fine sediments are known to occur at 1000 MLd^{-1}. However, it appears that larger flows were required to push sediment through the larger pools of Jindabyne Gorge such as the pool where the turbidity logger was situated.

Figure 5: Physio-chemical response (A) dissolved oxygen (B) water temperature and (C) turbidity to the spring 2010 release at the Snowy River d/s Mowamba River (Site 1).

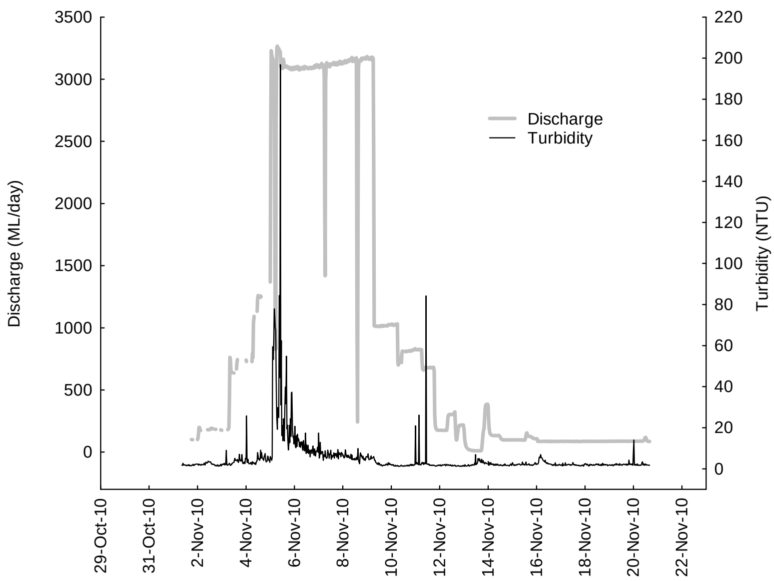
A



B



C



Sediment scour and deposition

The spring flow event was sufficient to mobilise, transport and deposit sediment at sites in the Jindabyne Gorge (Sites 1 and 2) and Dalgety uplands (Sites 3 and 4).

Marked changes were observed in the Snowy River upstream of Sugarloaf Creek (Site 2) because of the high stream power and steep bed slope, relative to other Snowy River sites (Figure 6). The physical response was very localised within a site and dependent on local physical characteristics of the river. In some locations the habitat condition improved through scour of the bed (Figure 6d) but degraded in others through deposition (Figure 6C). Additionally, a chute channel was partially scoured then overlain by coarse sand deposit (d_{50} coarse sand, 1 mm diameter) (Figure 6A and B). Under higher flows, this chute will cut through to the main channel providing additional in-stream habitat.

The bulk of the sediment derived from immediately upstream of the site was deposited some 500 m downstream of the rapid as flows slowed (Figure 6B). In future, it is expected that this slightly granular medium sand (d_{50} medium sand, 0.5 mm diameter) approximately 0.5 m high deposit will be re-mobilised and deposited further downstream with larger events.

Figure 6: Geomorphic response in the Jindabyne Gorge (Site 2): (A) partially scoured chute channel upstream of the rapid, (B) deposition of 0.5 m of sand below the rapid, (C) smothering of river cobbles, and (D) scouring of cobble habitat. The Jindabyne gorge at Site 2 was considered to be most geomorphic responsive to the November 2010 release.

Riffle maintenance and benthic algae

It was expected that the EFR in the Snowy River would scour benthic biofilms (accrued mass of periphyton, microbes, fine particulate organic matter, and mineral fines). Thickened biofilms are common in regulated rivers (e.g. Figure 1), particularly where large discharge events are infrequent and nutrients are available, such as in the Snowy River below Jindabyne Dam. Conversely, thick biofilms are not common in the unregulated snowmelt rivers of the Snowy Mountains, creating very different in-stream habitat and food sources for aquatic animals.

Riffle maintenance (the scour and cleaning of riffle substrate) were predicted to occur between 2,000 and 3,000 MLd^{-1}. Field observations (Figure 7) indicated that scouring of riffles had occurred as a result of the spring flow release as riffle substrate appeared to be cleaner than before the flow event.

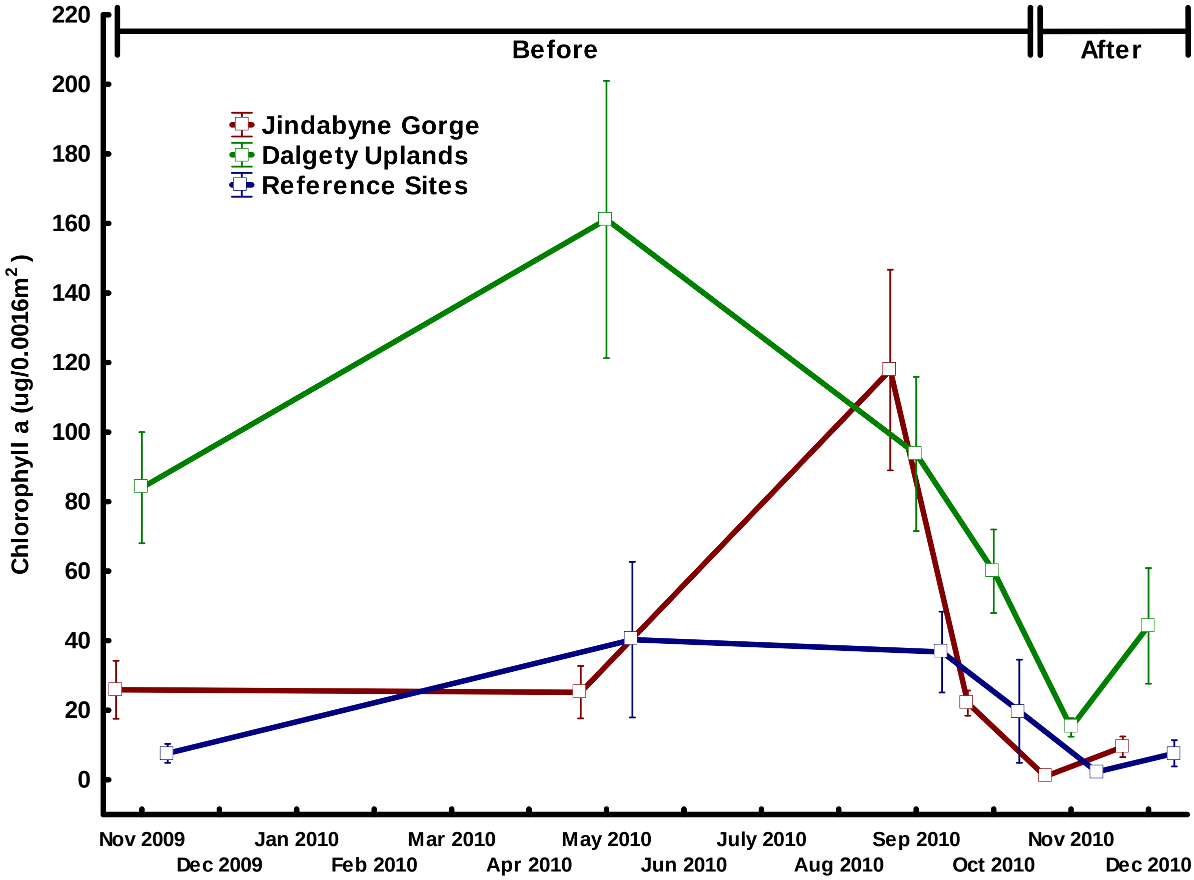
Figure 7: Field observations of riffle maintenance at the Snowy River ds Mowamba River (Site 1).

Although biofilm samples are typically collected biannually, additional samples were collected before and after this managed spring flow event. Samples were analysed for three dependent variables: identification and cell counts (the type and number of algae); ash free dry weight (measuring the inorganic component of the sample); and chlorophyll *a* (estimates the mass of chlorophyll-*a* bearing cells in the sample).

Chlorophyll-*a*

Preliminary results show more chlorophyll-*a* in biofilms from the Dalgety Upland sites which averaged 76 µg (47,500 µg/m^2) over the sampling period. Jindabyne Gorge sites and reference sites averaged 33.6 µg (21,000 µg/m^2) and 19 µg (11,875 µg/m^2) respectively. Chlorophyll-*a* declined across all sites immediately after the flow release in November 2010 (Figure 8). However, it is problematic to infer the flow event as the main cause of this decline as chlorophyll-*a* appeared to be declining at Jindabyne Gorge, Dalgety Upland and reference sites prior to the EFR. This reduction in chlorophyll-*a* levels possibly reflects the influence of the natural flow events prior to the active release (Figure 2).

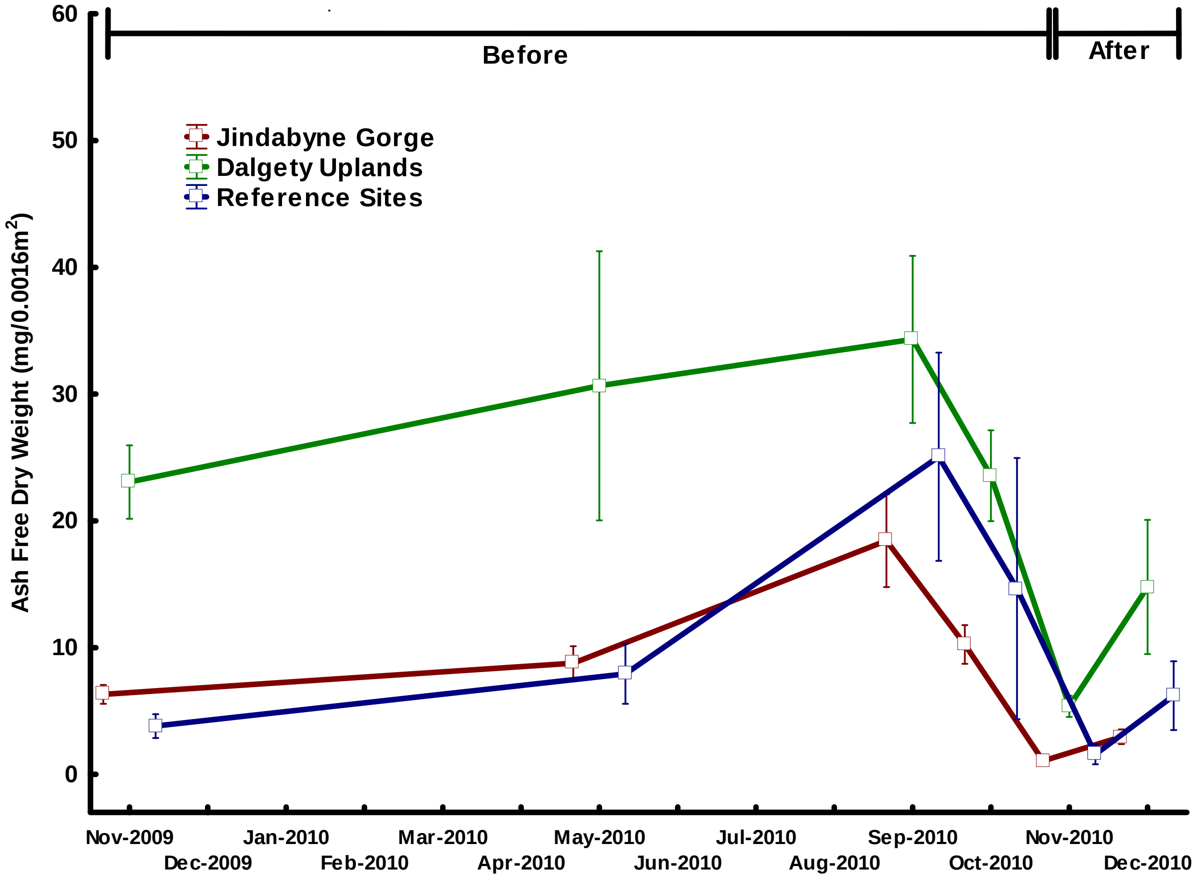
Figure 8: Chlorophyll-*a* results of Jindabyne Gorge, Dalgety Uplands and reference sites (Nov 2009-Dec 2010)



Ash free dry weight

The preliminary results indicate that ash free dry weight (AFDW) is highest in the Dalgety Upland sites which averaged 21.6 mg (13,500 mg/m^2) over the sampling period. Jindabyne Gorge sites and reference sites averaged 7.9 mg (4,937.5 mg/m^2) and 9.8 mg (6,125 mg/m^2) respectively. All sites show a gradual build up of inorganic matter since November 2009 sampling to September 2010, consistent with the increase in algal biomass and thickening of the biofilm. Dalgety Upland sites appear to show the most marked decrease in AFDW after the flow release. Jindabyne Gorge sites appear to have AFDW more similar to reference sites of the sampling periods (Figure 9).

Figure 9: Ash free dry weight results of Jindabyne Gorge, Dalgety Uplands and reference sites.



Fish passage

The predicted magnitude to initiate fish passage through one of the smaller major barriers (Pinch Falls) was 8,640 Mld^{-1} for adult Bass and 11,230 Mld^{-1} for juvenile Bass. As expected flows of 3,080 Mld^{-1} are insufficient to drown out one of the smaller major natural flow induced barriers on the Snowy River (Figure 10). Based on the visual inspection and the previous hydraulic modelling upstream movement of fish were unlikely at 3,080 Mld^{-1}.

Figure 10: The Snowy River at Pinch Falls during the peak of the environmental release November 2010.

Summary

Based on the preliminary results the following were observed in the Snowy River below Jindabyne:

- The river reaches of the Jindabyne Gorge and the Dalgety Uplands were physically responsive to the event of a magnitude of 3,080 MLd^{-1}.
- The objective of scouring the river bed was partially achieved, with localised scour, movement and deposition occurring. This was most notable in the higher gradient reaches of Jindabyne Gorge.
- At a discharge of 1,000 MLd^{-1} fine silts were suspended and a turbidity peak of 196.8 NTU was associated with the hydrological peak of 3,080 MLd^{-1}.
- The event reduced the diurnal variation of water temperature and dissolved oxygen, indicating greater mixing of the water column and less influence of atmospheric exchange with the water column.
- At a discharge of between 2,000 and 3,080 MLd^{-1} the scouring of riffle habitats occurred, as visually the riffles appeared to contain less biofilms and were consistent with previous modelling results.
- Declines in chlorophyll-*a* and ash free dry weight were recorded post the environmental flow release, but declines were also recorded in the reference reaches over the same period. Two natural discharge events occurred prior to the active release and most likely explains the reduction in chlorophyll-*a* and ash free dry weight.
- At a discharge of 3,080 MLd^{-1} the river bed in the Dalgety Uplands becomes inundated and the inundation patterns showed good agreement with the hydraulic model.
- Previous hydraulic modelling of fish passage at Pinch falls, estimates that much higher flows are required to drown out the smaller of the larger natural barriers on the Snowy River. The visual inspection of the Pinch Falls shows that it’s unlikely upstream fish passage would have occurred at a maximum discharge of 3,080 MLd^{-1} being released from Jindabyne.