Enhancing floodplain connectivity, first steps towards habitat restoration for threatened species

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Key Points

- The broad objective of the project was to identify what works are required in the Coranderrk Bushland Reserve and Macclesfield Creek areas to restore appropriate water regimes to facilitate the recovery of critical habitat for two threatened species – the Helmeted Honeyeater and Lowland Leadbeater's Possum.
- At Coranderrk, there may be opportunities to manage water from an existing water storage (Lake Coranderrk) and deliver a seasonal watering regime to downstream floodplain areas. Additionally, it is recommended that coir log and sand bag structures are installed in channels to create shallow ponding and enhance floodplain engagement and benefits to vegetation from flow releases.
- Similar trial structures along Macclesfield Creek were shown to be effective at reducing channel capacity, increase the frequency and extent of floodplain inundation and provide multiple vegetation benefits.
- Our work demonstrates that there are a range of simple options to enhance floodplain connectivity, which is a critical first step towards habitat restoration.

Abstract

Zoos Victoria have identified several waterways in the Coranderrk Bushland Reserve and Macclesfield Creek as areas for ecological restoration to provide habitat for two critically endangered species – the Helmeted Honeyeater and Lowland Leadbeater's Possum. In the past 100 years the floodplains of these waterways and their hydrological regime have been modified by land clearing, the construction of water storages and modifications of the drainage network, including the construction of levees, drains and channels. The broad objective of the project was to identify what works are required to restore appropriate water regimes to facilitate the recovery of critical floodplain forest habitat for these threatened species. We analysed digital terrain models and built hydraulic models to understand the current hydrological condition of these floodplains. These models were integrated with the outcomes of vegetation surveys, and a series of modelled scenarios were developed to assess the effectiveness of a range of structural measures in enhancing floodplain connectivity. The work demonstrates that there are a range of simple options to enhance floodplain connectivity, which is a critical first step towards floodplain ecosystem restoration. Our insights will help guide restoration of floodplain forests critical to the conservation of Victoria's faunal emblems.

Keywords

River-floodplain connectivity, floodplain engagement, swamp forest, habitat restoration

Introduction

The Coranderrk Bushland Reserve (142 Ha) is located adjacent to Healesville Sanctuary and is managed by Zoos Victoria. It has been earmarked as a site for ecological restoration to provide habitat for the potential

release of two critically endangered species – the Helmeted Honeyeater and Lowland Leadbeater's Possum (Zoos Victoria, 2019). The reserve is traversed by several waterways, Barak Creek, Coranderrk Creek and Boggy Creek. The section of reserve of interest to the current project is the floodplain areas associated with Boggy Creek, between Lake Coranderrk and Coranderrk Creek (Figure 1).

The Boggy Creek floodplain supports a mix of Swampy Riparian Woodland, Grassy Riverine Forest and Riparian Forest. Over the past 100 years the floodplain, and its hydrological regime, has been modified by clearing (including of the upper catchment), the construction of Lake Coranderrk and modifications of the drainage network, including the construction of levees, lagoons, drains and channels. The altered hydrological regime has resulted in some parts of the floodplain being too wet and some parts being too dry. Despite these changes, the floodplain retains some important vegetation communities that if managed appropriately and expanded, could support habitat for Lowland Leadbeater's Possum and Helmeted Honeyeater.

The broad objective of the project is to identify what restoration works are required to restore the flow patterns across Boggy Creek floodplain, so as to facilitate the recovery of vegetation and restore habitat for Lowland Leadbeater's Possum and Helmeted Honeyeater.

Current condition and hydrological regime

The general configuration and management of the Lake Coranderrk system is such that flows either enter the lake or are rediverted around the south side of the lake through the siltation ponds and then along a drainage line on the south side of the floodplain. The original Boggy Creek drainage line, downstream of Lake Coranderrk, appears to have been channelised and conveys little, if any flow unless releases are made directly from the lake, which is a rare occurrence. Parts of the floodplain traversed by Boggy Creek are not receiving flow and are currently too dry to support the preferred vegetation communities. Figure 1 displays the current flow paths as well as the site topography showing a cross fall to the south-west of the floodplain.

A vegetation assessment was undertaken on the Boggy Creek floodplain within the Coranderrk Bushland Reserve. The findings of this assessment were that the floodplain vegetation is highly degraded, historical changes in land use and water regime have altered its vegetation composition with low levels of canopy cover (32%) and low vegetation structural diversity. Areas of the floodplain have experienced varying level of invasion by species typical of a more terrestrial system. High quality Lowland Leadbeater's Possum habitat generally exhibits canopy or midstorey cover of around 80% or greater (Greet *et al.* 2020). Similarly, the Helmeted Honeyeater requires high levels of vegetation structural diversity (Pearce and Minchin 2001). The Boggy Creek floodplain, with low structural diversity and an abundance of grassy and sedgy open areas with no overstorey vegetation does not meet this habitat criterion (Figure 2). In its current condition, the Boggy Creek floodplain provides limited habitat in extent and quality for the Leadbeater's Possum and Helmeted Honeyeater. However, small pockets of suitable habitat comprising of some elements of the *E. camphora* Swamp Community are present and a return of a flooding regime could assist its regeneration and increase its extent across the floodplain.

Fortuitously, the field work for this project also coincided with a number of manual releases of water from Lake Coranderrk over the September/October 2019 period due to high rainfall and filling of Lake Coranderrk. The baffle structure that directs flows to drain to the siltation ponds was also was not functioning properly, and this contributed to high levels of water in the Lake. Figure 3 shows the extent of floodplain inundation that was surveyed on 18 September 2019 with some further comments on additional areas that were inundated by further releases in September/October 2019. Valuable information on the distribution and extent of floodplain inundation arising from these releases, the reactivity of the floodplain to wetting and the volume of water that is required to create these inundation events was gained through survey during an event, flow monitoring, hydrological analysis and hydraulic modelling.

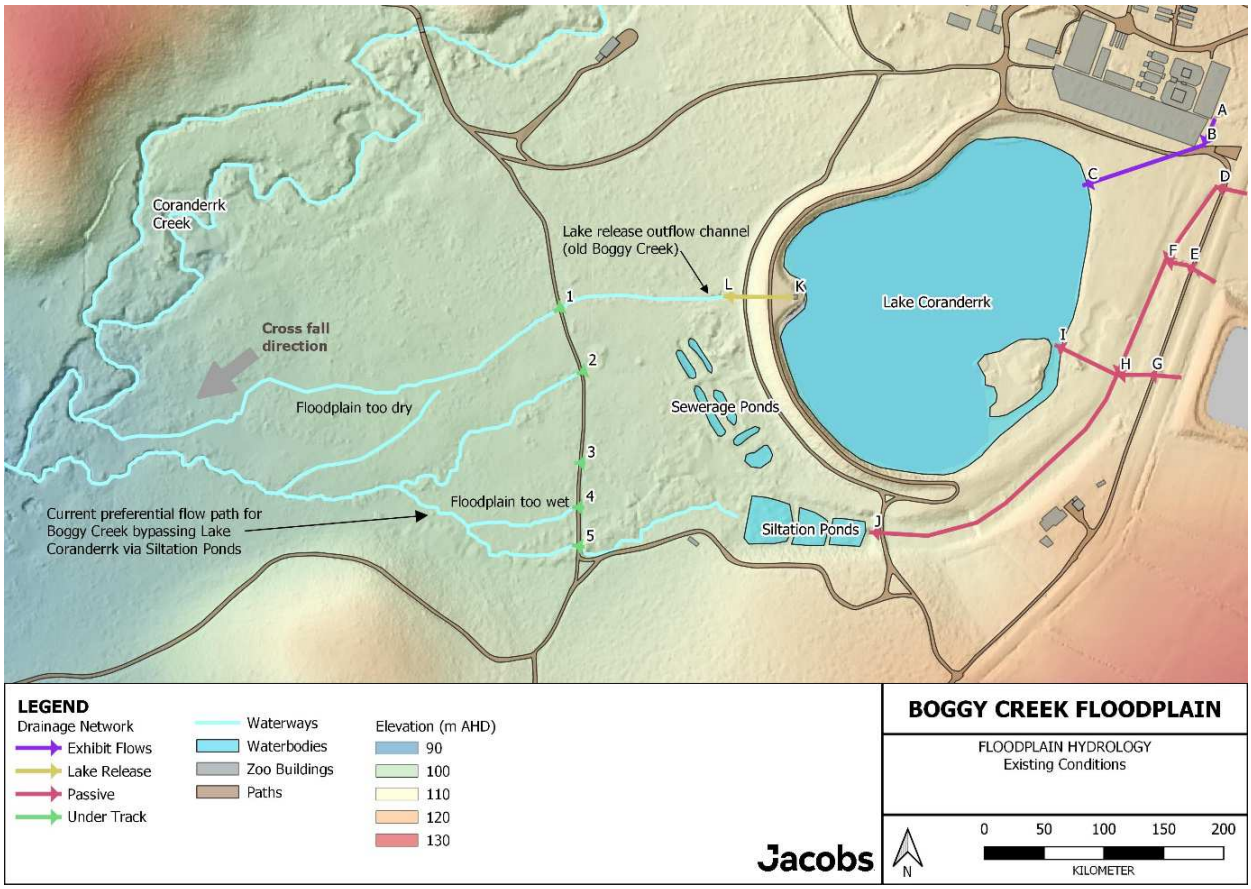

Figure 1. Map of Boggy Creek Floodplain and Lake Coranderrk System, highlighting key drainage features and infrastructure: ABC – Drainage from Healesville Sanctuary to Lake; DEFG – Drainage from farmland and catchment area west of lake; H – Drain with baffle that allows water to be directed into the lake at I; J – Drain to siltation ponds; K – Pit with inflow pipes that feed to pump and managed release of flow to an old course of Boggy Creek at L. Numbers 1-5 refer to location of culverts under a gravel vehicle track.

Swampy Woodland with *E. ovata,* flow breaking out of distributary channel onto the broader floodplain.

Sedgeland, shallow overland flow sheeting across the surface of the floodplain. Notable lack of overstorey.

Figure 2. Photographs taken on the 18 September 2019 of inundation of vegetation communities across the Boggy Creek Floodplain following a trial water release from Lake Coranderrk.

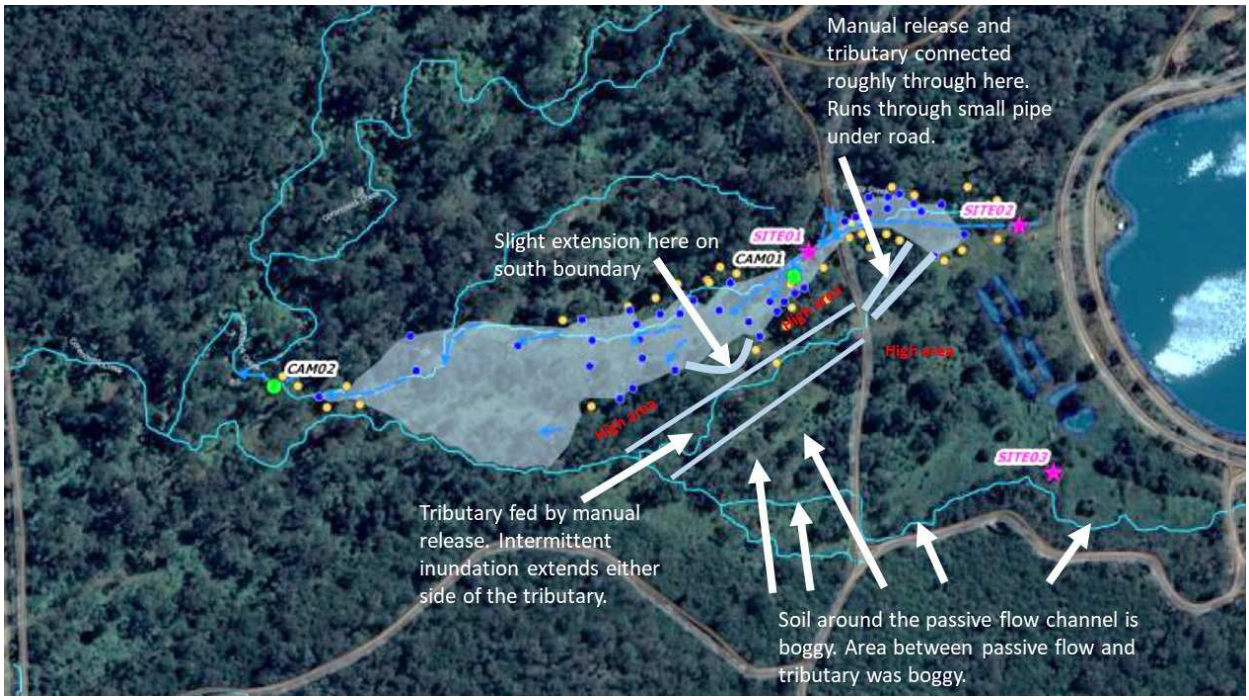

Figure 3. Surveyed inundation extent on 18 September 2019 with comments on extension of inundation/soil saturation with additional releases over the September/October 2019 period.

The monitoring showed that managed releases from Lake Coranderrk can be made into a channelised course of Boggy Creek to re-create a more natural inundation pattern across the floodplain. However, it is not possible with present infrastructure to vary the amount of flow that is released from this point, which it was determined through flow measurement to be 9 ML/Day. The Boggy Creek floodplain is highly responsive to these releases, with water inundating floodplain areas within 2-4 hours from its initial release and water draining from the floodplain within 12 hours, although soil moisture content would remain high in the floodplain.

To further understand the existing hydrological conditions and current flow paths, a 2D hydraulic model of the Boggy Creek floodplain was built. The hydraulic model has been used to model current conditions for lake releases as well as investigate the effectiveness of scenarios designed to determine the extent of flooding possible from bypass flows around the south side of the lake through the siltation ponds and then along a drainage line on the south side of the floodplain. The hydraulic modelling demonstrated that a lake release of 9 ML/Day produces similar extents and maximum depths for all release durations modelled (0.5, 1, 2 and 3 days). The introduction of bypass flows to inundate the southern section of the floodplain showed that the extents only buffered slightly from 1 ML/Day to 10 ML/Day, 20 ML/Day was the only flow that extended north.

The amount of water that can be released from Lake Coranderrk is limited by the capacity of the lake and the amount of water that flows into this storage. There is a steady input of flow (measured as 0.3 ML/Day) into the lake from flows diverted from Coranderrk Creek through Zoos Victoria exhibits. This is insufficient to balance a lake release (~9 ML/Day). To replenish a single day release of 9ML, it would take the recorded inflows from the Zoos exhibits of approximately 30 days. The volume of water currently flowing into the lake from the Zoo exhibits is unlikely to be able to support the required wetting of the Boggy Creek Floodplain (frequent and variable wetting from June/July to November /December), meaning lake drawdown would occur unless top up from catchment inflows occurs.

A rainfall runoff model was developed to estimate catchment inflows into the lake. Assuming all catchment available flows were diverted and stored in Lake Coranderrk, on average, a flow of 9 ML/Day could be

released for 133 days, based on an average annual catchment inflow of 1200 ML/year. The top up from catchment inflows relies on the available volume of catchment inflow and the ability to transfer water into Lake Coranderrk using aging infrastructure.

Water management objectives

The objective for Boggy Creek Floodplain is to create hydrological conditions suitable for the establishment of *E. camphora* Swamp Community and restore habitat for Lowland Leadbeater's Possum and Helmeted Honeyeater. Greet (2014) has specified the preferred regime for this community to comprise annual inundation to a depth of ~20 cm for 4–5 months from June–October followed by a drying phase to promote seed germination and seedling establishment prior to the next inundation phase (Figure 4).

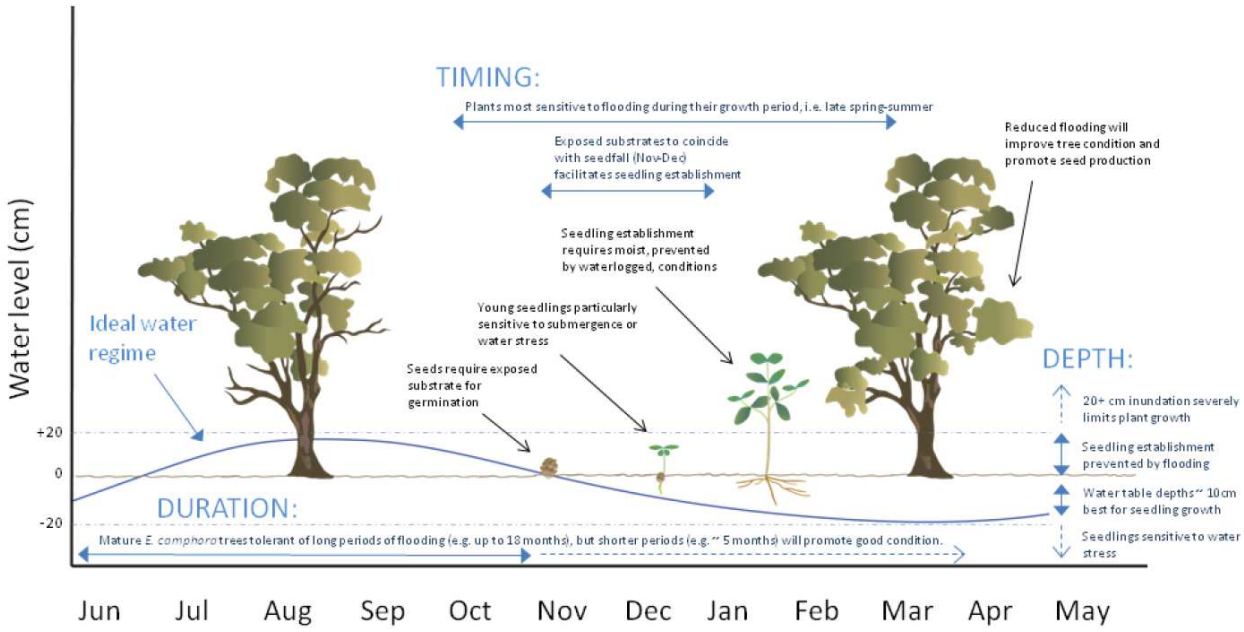

Figure 4. Environmental watering objectives for *E. camphora* swamp forest at Yellingbo NCR (Greet 2014).

The hydrological analysis indicates that inundation of Boggy Creek floodplain areas is possible through manual releases from Lake Coranderrk which inundate the northern areas of the floodplain and bypass flows which inundate the southern section of the floodplain. The floodplain is highly responsive to flows modelled, and once flows cease, water drains from the floodplain within 12 hours, although the soil moisture content would remain high in the floodplain. Leakage from the manual release point also appears to be assisting in maintaining good soil moisture levels for extended periods following a manual release (pers comm Lisa Stuart, Zoos Victoria, June 2020). This indicates that a smaller amount of water released during more frequent events may be enough to achieve the required flooding regime.

To meet the watering requirements of *E. camphora* Swamp Community, repeated inundation events through the Winter/Spring period are likely to be needed to maintain the overall desired inundation of floodplain inundation (i.e. 4–5 months). To maximise the extent and duration of inundation events, management options that block the channels and assist in extending the inundation and retaining the water on the floodplain for longer are recommended.

Water management options

Boggy Creek floodplain areas are connected to a series of channels that traverse the Coranderrk Bushland Reserve. There are two potential ways to increase the duration of time that water inundates these floodplain areas:

- Option 1 - Increase the frequency and duration of time in which water inundates the floodplain areas via managed releases from Lake Coranderrk and bypass flows.

  Repeated inundation of the floodplain through Winter/Spring (4–5 months), followed by a drying phase in Summer/Autumn) is required to create the hydrological conditions suitable for the restoration of vegetation on Boggy Creek Floodplain. During Winter/Spring, inflows to Lake Coranderrk and available water in the lake storage would be used for watering floodplain areas. The timing and duration of releases will need to be managed to maximise the extent of floodplain inundation and wetting of floodplain soils. No releases of water from Lake Coranderrk would occur over the Summer/Autumn period. The intent would be to capture as much flow as possible in the Lake over the Summer/Autumn period to provide for floodplain watering events in Winter/Spring. If the Lake storage capacity is reached during Summer/Autumn period, excess water should be preferentially diverted to the southern bypass.

- Option 2 - Increase the extent of inundation and the ability of the floodplain to hold water for longer periods.

  Increasing the extent of inundation and ability of the floodplain to hold water for longer periods could be achieved by placement of structures in the bottom of channels to help pond water on the upstream side and create points where flow breaks out of the channel and inundates the floodplain. A number of options are available for the installation of structures to help block channels and pond water upstream. These include, earthen or block banks (essentially small dam walls) or coir logs. The former may require significant earth works while the later are easy to install and can be removed/modified to optimise outcomes.

  Small weir structures have been installed at two locations along a channelised section of Macclesfield Creek within the Yellingbo Nature Conservation Reserve. Their purpose was to reengage disconnected floodplain areas and improve vegetation condition in areas supporting lowland Leadbeater's Possums. The scale of the weirs was considered small, and the structures temporary, low risk, and easily constructed using sandbags (Jacobs 2018). A three-year monitoring program was established by The University of Melbourne to assess potential floodplain watering and vegetation benefits. Both weirs were successful in diverting large volumes of water from the channel and flooding large extents of the Maccclesfield Creek floodplain. This flooding had multiple benefits, including increased tree seedling germination, increased growth of planted seedlings and extant trees, and the triggering of seedfall (Fischer *et. al.* 2021). Given the likelihood of further benefits, it was recommended that the weirs be modified as necessary to ensure their structural integrity and longevity, and additional weirs be strategically introduced into the channelised sections of the Macclesfield Creek to promote further floodplain engagement.

  The placement of structures on Macclesfield Creek with good preliminary results provide us with confidence that similar benefits could be achieved at Coranderrk.

Recommended water management

It is recommended that Zoos Victoria proceed with a trial of managing the available water in Lake Coranderrk and delivery of a seasonal watering regime to Boggy Creek Floodplain (Option 1). The objective is inundation to a depth of ~20 cm for ~4 months for the July-October period. The duration of manual flow releases from Lake Coranderrk needs to be long enough to allow for extension of water across the floodplain. The results from our monitoring and hydraulic modelling indicate that delivering 9 ML/Day for half a day is all that is required for water to reach maximum extent of flooding across the floodplain, however if this release is then stopped water will then drain from the floodplain within 12 hours, with soil moisture content remaining high

in the floodplain. The operating regime should be trialed to determine a suitable release strategy that meets the desired water regime.

In addition to Option 1, it is recommended that Zoos Victoria install small weir structures/block banks (using core logs and sand bags) in the channels to create shallow ponding (Option 2). This will enhance the outcomes of the recommended flow release regime by spreading flows across the floodplain and extending the duration of inundation. Coir logs and sand bags could be installed at several points along the channel to create a series of shallow wetland areas and help spread the area of inundation. Coir logs have been successfully used in peat swamp restoration in NSW and are often used for erosion control (BMCC 2010). They are easy to install by laying on the ground and securing with star pickets or timber stakes. Ends can be buried into the channel banks if necessary, and they can be stacked more than one log high if required to increase the depth of inundation. Zoos Victoria have commenced work implementing some of these structures (Figure 5).

Coir logs (inset) and an example of their use for spreading flow along a drainage line (BMCC 2010).

Works in progress at Coranderrk Reserve using sand bags and coir logs to block the channel and enhance watering of the floodplain.

Figure 5. Photographs demonstrating use of coir logs (left) and works in progress at Coranderrk Reserve using sand bags and core logs to enhance floodplain connectivity.

Conclusions

Current conditions, including water regimes, were documented for the Boggy Creek floodplain in Coranderrk Bushland Reserve. The condition of the floodplain and its hydrological regime have been significantly modified by clearing and the construction of Lake Coranderrk system. The original Boggy Creek drainage line appears to have been channelised in the past and conveys little, if any flow unless releases are made directly from the lake, which is a rare occurrence. Parts of the floodplain traversed by Boggy Creek are not receiving flow and are too dry to support the preferred vegetation communities. The floodplain vegetation is highly degraded, historical changes in land use and water regime has altered its vegetation composition with low levels of canopy cover and structural diversity.

The objective for Boggy Creek Floodplain is to create hydrological conditions suitable for the establishment of *E. camphora* Swamp Community and restore habitat for Lowland Leadbeater's Possum and Helmeted Honeyeater. To meet the watering requirements of *E. camphora* Swamp Community repeated inundation events through the Winter/Spring period are likely to be needed to maintain the overall desired inundation of floodplain inundation (i.e. ~4 months). To maximise the extent and period of inundation events, management options that block the channels and assist in extending the inundation and retain the water on the floodplain for longer are recommended. It is recommended that Zoos Victoria proceed with a trial of managing the available water in Lake Coranderrk and delivery of a seasonal watering regime to Boggy Creek Floodplain . It is also recommended that Zoos Victoria continue with the trial installation of coir log and sand

bag structures in the channels to create shallow ponding and enhance the outcomes of the recommended flow release regime by spreading flows across the floodplain and extending the duration of inundation. Monitoring of the effects of the weir installation on enhancing flood extent should be undertaken.

Acknowledgments

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