

Cockatoo Swamp Hydrology Improvement Project

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Key points

- As a result of historical changes to Cockatoo Creek and water distribution in the Yellingbo Nature Conservation Reserve, dieback of ecologically significant swamp forests has occurred.
- Substantial research and modelling work was undertaken to investigate the causes of the dieback and potential solutions.
- A levee removal and pumping project has been undertaken to improve the distribution of floodwaters and to trial the dewatering of Cockatoo Swamp.
- Ongoing monitoring of vegetation, surface water and groundwater levels have allowed for an adaptive management approach to this project. The data will be utilised going forward as we consider a longer-term solution for the site.

Abstract

Cockatoo Swamp is a part of Yellingbo Nature Conservation Reserve (YNCR), a protected area near Yellingbo in the Upper Yarra Valley region of Greater Melbourne. Both the Helmeted Honeyeater and the lowland Leadbeater's Possum are only found in the YNCR, where they rely on floodplain forest dominated by Mountain Swamp Gum (*Eucalyptus camphora*) in the Cockatoo Swamp.

Historical changes to waterways and the construction of levee banks in the 1950s has changed the natural distribution of water in the area, with some sections of the swamp now being too dry and some sections being too wet. As a result, there has been significant dieback of *E. camphora* swamp forests.

Initial research indicated that inappropriate water regime is one of the main threats to the persistence of swamp forests within the Cockatoo Swamp. Further research was then undertaken to determine an appropriate water regime for the swamp forests, and a detailed monitoring program was established. A hydraulic model was also developed and used to test the likely outcomes of various potential management interventions.

In December 2017, sections of old levees were removed to improve the distribution of floodwaters, and a temporary pipeline and pumps were installed to trial the dewatering of sections of the swamp that are too wet. Water is being pumped from the swamp and released further downstream to maintain low water levels during the vegetation growth period and when recruitment is most likely to occur.

Melbourne Water and our partners worked collaboratively on the pumping project and are also now looking at other longer-term solutions for the site.

Keywords:

Cockatoo Swamp, vegetation restoration, hydrology improvement, endangered species, floodplain, Leadbeater's Possum, Helmeted Honeyeater

Introduction

Cockatoo Swamp is a part of Yellingbo Nature Conservation Reserve (YNCR), a protected area near Yellingbo in the Upper Yarra Valley region of Greater Melbourne. Both the Helmeted Honeyeater and the lowland Leadbeater's Possum are only found in the YNCR, where they rely on floodplain forest dominated by Mountain Swamp Gum (*Eucalyptus camphora*) in the Cockatoo Swamp. Both species are State faunal emblems of Victoria and are listed as Critically Endangered under the EPBC (Environmental Protection and Biodiversity Conservation) Act.

Historical changes to waterways and the construction of levee banks in the 1950s has changed the natural distribution of water in the area with some sections of the swamp now being too dry and some sections being too wet (Greet 2012; Boon 2016). As a result, there has been significant dieback of *E. camphora* swamp forests. Melbourne Water, in

collaboration with Parks Victoria, University of Melbourne, Zoos Victoria, and Friends of the Helmeted Honeyeater, have been undertaking a project to understand and restore a more natural hydrological regime within Cockatoo Swamp; this is crucial to stopping dieback and encouraging regeneration of this critical habitat.

The hydrology works program represents the culmination of extensive research, hydrologic modelling, and stakeholder consultation.

Initial Steps

Research was undertaken over many years to ascertain the cause of the vegetation dieback in the swamp. Investigation of the causes suggested that an inappropriate watering regime is one of the main threats to the persistence of wetland forests within the Cockatoo Swamp (Greet 2012; Boon 2016). Prolonged inundation was driving the dieback of mature *E. camphora* wetland forest in parts, and a lack of appropriate wetting and drying was preventing its regeneration (Greet 2012) (Figure 1).

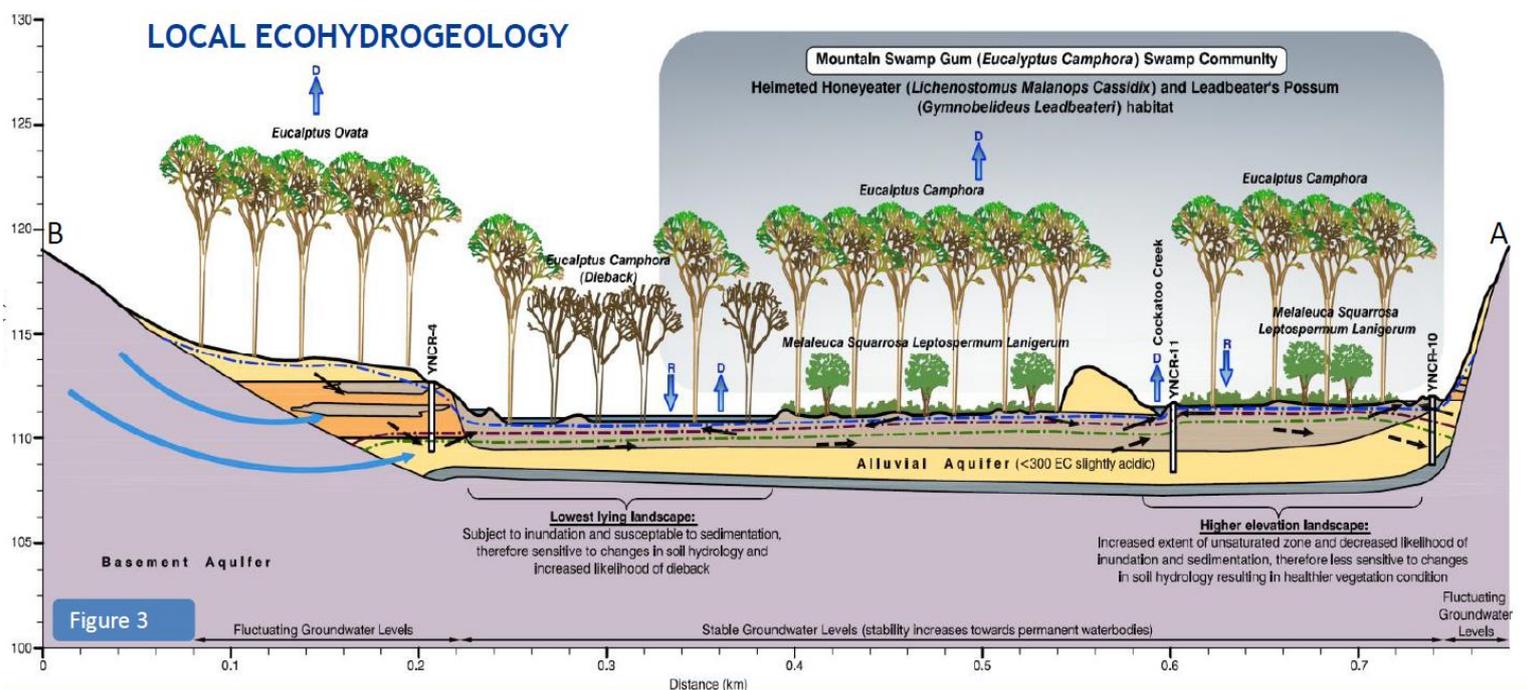


Figure 1. Hydro-eco-geological conceptual model for Yellingbo (SKM 2014).

A hydraulic model informed by high-resolution LiDAR was developed for the Cockatoo Swamp (Water Technology 2013). This model was used to test the likely outcomes of various potential management interventions (e.g. entire levee bank removal versus removal of partial levee sections, pumping of excess water from different sections of swamp etc.) on the water regime of the swamp (Jacobs 2015a; Jacobs 2015b; Jacobs 2015c; Jacobs 2016). The water regime outcomes of the various management actions were assessed against how well they aligned with environmental watering objectives for *E. camphora* swamp forest (Greet 2014; Greet 2015).

A detailed monitoring program was established to capture groundwater, surface water, water quality and vegetation condition data. The monitoring program was designed to assess the efficacy of the hydrology works in reinstating more natural patterns of wetting and drying.

Specific vegetation response variables are being monitored for each of the important life-history stages of the vegetation. They include mature tree and stand condition (using The Living Murray Method and hemispherical photography, respectively); seed production (using seedfall traps); and seedling germination and recruitment (using three permanent 5m x 5m quadrats at each site) (Figure 2). Additionally, changes in vegetation structure at the whole-of-swamp scale are being assessed using high-definition multi-level LiDAR data captured using a drone (Greet 2015).

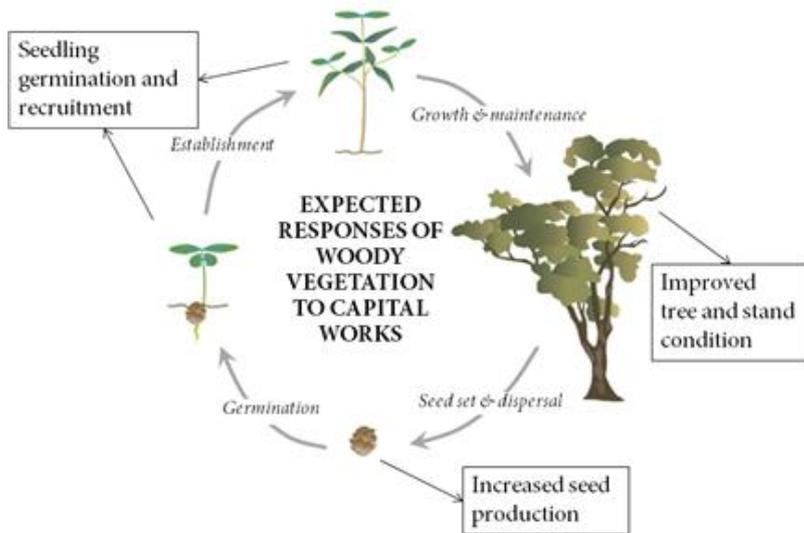


Figure 2. Expected responses of critical woody vegetation at different life-history stages to water regime changes resulting from the Melbourne Water capital works program at the Cockatoo Swamp (Greet 2015).

Implementation of works

Equipped with the necessary data, a combination of approaches were initiated to address the vegetation dieback. Sections of old levees were removed to improve the distribution of flood waters in drier parts of the swamp, and a temporary pipeline and pumps were installed to trial the dewatering of sections of the swamp that are too wet.

Levee removals

From Nov 2017–Jan 2018, several sections were removed from a levee alongside the Cockatoo Creek. These were covered with mulch, jute matting and planted with Sterile Rye for stabilisation (Figure 3). This was undertaken to improve the distribution of overbank flows over the floodplain into disconnected dry areas of the swamp.

Floodplain engagement via levee breaks

Since construction, there has been minimal engagement through the more upstream breaks. Break 1 regularly inundates where the Cockatoo Creek is less incised. Apart from the absence of large floods, the incised nature of the channel in the vicinity of the levee breaks limits overbank flows and thus the engagement of disconnected floodplain areas via the levee breaks (Greet 2020). Further work will need to be undertaken to address channel incision through this reach.



Figure 3. Sections of the levee bank removed in 2017/2018 and photo of levee Break 6 taken 6/12/2017 (Jacobs 2017)

Pumping trial

The pumping trial aimed to reduce the water levels in the swamp in the area that was too wet. The water in the swamp is pumped out and re-entered back into Cockatoo Creek 700m further downstream below the choke point of the swamp. Due to the considerable cost of a permanent pipe, it was decided to conduct a pumping trial for four months of the year (January to April) for four years to study the potential benefits before implementing a permanent solution.

Installation of two temporary pumps and pipes were undertaken between December 2017 and March 2018 (Figure 4). Two initial pumping events were conducted in 2018. Both events were of short duration (days) and were conducted to refine operational rules.

Since 2018, pumping has been carried out between January and April for three years (2018/19, 2019/20, 2020/21). A target of 20ML of water pumped per day was set for reducing the water levels in the swamp to appropriate levels. This was reviewed every year and during the pumping periods with a stakeholder group involving Melbourne Water and the University of Melbourne.



Figure 4. Pumps on site (left photo) and inlet site with gauge board visible (right photo).

Effectiveness of the pumping trial

The pumping has allowed us to trial an adaptive management approach to lowering water levels in key areas of the swamp. As a result, we have learnt about our capacity to influence water levels and have significant data from monitoring to consider the vegetation response.

Several factors have hampered the pumping trial's success and therefore, its effectiveness is difficult to determine. The first full season of pumping was particularly dry, and as a result, the pumps were unable to pump. The two following years have been very wet (2019/20 and 2020/21), with inflows exceeding an average of >40ML/ day from November to April. With the pumps pumping an average of between 10–15ML of water per day out of the swamp, higher inflows mean that their capacity to reduce water levels is limited.

After the 2019/20 pumping season, the pumps were taken off site and fully stripped and reconstructed as they were not achieving the expected pumping capacity. Additional pipes were also installed in 2020.

Another aspect not initially foreseen was that while the water levels can be influenced immediately at the pump inlet location, our ability to influence them beyond this location is limited. This is likely due to a combination of groundwater inflows, sediment build up in the swamp, and the limitations of the pumps.

Vegetation monitoring initially indicated a positive response. Against the backdrop of a drying trend, field assessments between 2015–2019 revealed there have been increases in tree crown extent and stand condition within dieback-affected sites (Greet 2019) (Figure 5). It was noted at the time that the positive responses observed were likely attributable to climatic trends, and the contribution of the pumping trial to these changes was likely to have been minimal. This has been further indicated with recent vegetation monitoring data collected following two wet years showing a decline in *E. camphora* tree condition within dieback-affected areas (Greet 2020).



Figure 5. Hemispherical photographs taken at one of the dieback-affected monitoring sites in 2015 (left photo) and 2019 (right photo). There is a clear increase in woody plant cover over that period (Greet 2019).

Learnings/ Reflections

The installation of the temporary pumps and pipes was initiated to trial the application of pumping water out of the swamp to lower water levels and improve the condition of the vegetation. A successful outcome would have led to a more permanent solution being constructed at a significantly greater cost. The trial has enabled us to learn from doing and avoided over-investment in a solution that may have only provided limited benefits.

An adaptive management approach was used during the trial, which meant that we were looking at and considering what the data was telling us before engaging in pumping for the following year. This approach was necessary for this project as the circumstances for each year were quite different.

We have learnt that our capacity to influence water levels at this site may be limited given the large amount of water captured in the swamp area during wet periods and the significant alterations made to the geomorphology and sediment dynamics of Cockatoo Creek and Cockatoo Swamp.

While several factors have hampered the trial, the monitoring data collected and knowledge garnered are important tools that will be utilised going forward as we look for alternative solutions for the site. Further works are being considered for disconnected dry areas of the swamp (instream structures to reduce hydraulic capacity and promote overbank flows), which will be complementary to the levee removals.

The outcomes of these works will continue to be monitored to help deliver a long-term management solution for the waterlogged areas and improve the habitat of Victoria's critically endangered faunal emblems.

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