Riparian restoration of lowland streams in the Southern Murray- Darling Basin

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SUMMARY

The restoration of riparian zones across Australia is motivated by increasing stream degradation and the understanding that stream condition is intimately linked with the condition of riparian zones. These efforts cost millions of dollars annually and involve substantial inputs by agricultural landholders, however, the ecological outcomes of this restoration are rarely documented. This project centres around five riparian revegetation sites managed by four different CMAs in the Murray-Darling catchment, spanning two states (Victoria and NSW). In this case, the restoration works are fully integrated into a research-based monitoring program funded by the MDBA (Murray Darling Basin Authority) and is designed to inform both implementation and monitoring of riparian restoration works across the southern Murray- Darling Basin. Resources for the monitoring have been assured for at least 10 years following restoration works. Restoration techniques used in this project are considered typical of those used throughout the Murray-Darling area and involve livestock removal and replanting of riparian zones adjacent to degraded lowland stream. While prolonged drought has affected recovery and has even worsened the condition of stream biodiversity, it is evident that fencing has enabled natural regeneration of the dominant tree species and planted vegetation and weed control are having a positive effect on the terrestrial zone.

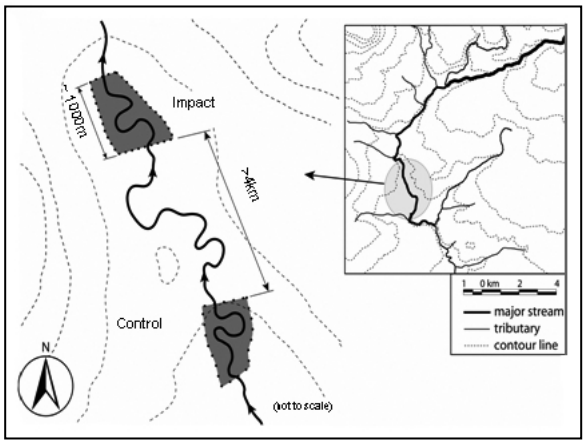
INTRODUCTION

Ecological rehabilitation and restoration works have been facilitated on private agricultural land in the Murray-Darling Basin over the last two decades in response to generally declining terrestrial and aquatic biodiversity values in the catchment. These projects have been largely facilitated by revegetation NGOs and regional Catchment Management Authorities (CMAs), with varying but improving ecological rigour. Measuring success has also historically been patchy, with few projects having the resources to apply empirical methodology to the monitoring challenge.

In this project, five sites were selected in the lowland tributary streams in the southern Murray-Darling Basin, dominated by River Red Gum *(Eucalyptus camaldulensis)* which represents one of the most widespread and abundant stream types in southern Australia. The riparian area restored at each of the five sites ranges from ~4ha to 9ha (in total ~30ha), typically extending for 1km of steam length. This area is within the typical range of sizes targeted by

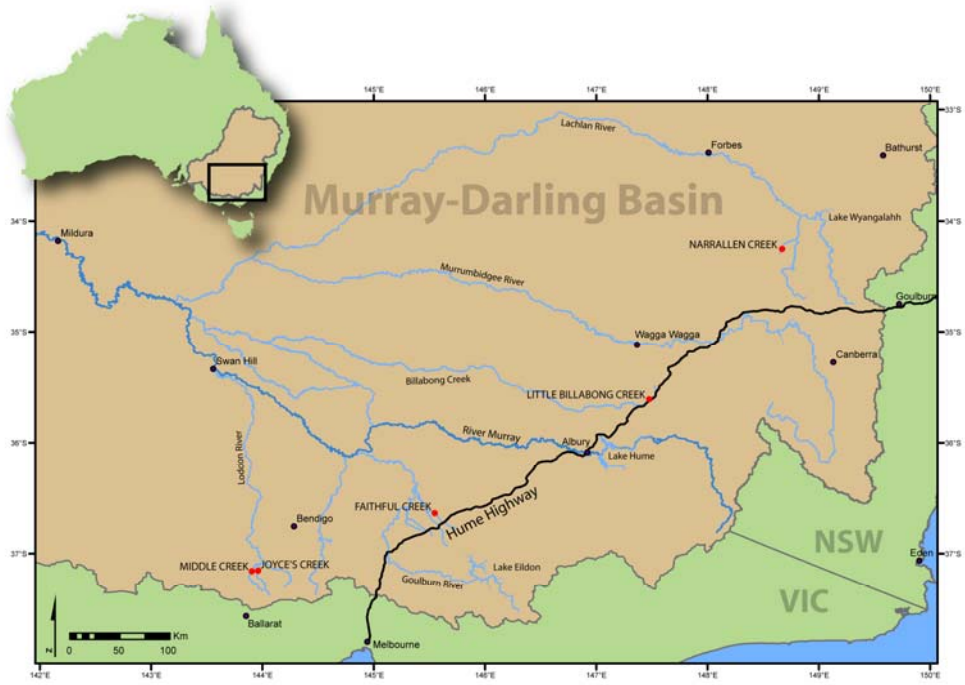
Faithful Creek, Victoria. A degraded zone, typical of small creeks throughout southeastern Australia

waterway managers for riparian restoration works on lowland tributary streams. Sites along three Victorian creeks (Faithful Creek in the Goulburn catchment - and Joyces Creek and Middle Creek in the Loddon catchment) were established in 2005. Additional sites on two NSW creeks (Narrallen Creek in the Lachlan catchment and Little Billabong Creek in the Murray catchment) were established in 2006 and 2007, respectively.



Experimental Design Layout: This design illustrates the location of control and impact sites

The overall objective of the monitoring is to apply optimal empirical techniques to document long-term ecological responses (both in-stream and terrestrial) resulting from the on-ground riparian restoration. The impacts of restoration activities are monitored using a MBACI (Multiple, Before, After, Control and Impact) experimental design. Following extensive reconnaissance, during which 98 sites on 39 Victorian streams were assessed, it was evident that intact reference sites, against which restoration success could be assessed, were not available on lowland streams of this type (Anderson *et al.* 2005). Thus each restoration site is paired with a control site upstream, and data are gathered before and after restoration. Monitoring is linked to specific ecological indicators that were identified at the outset using a conceptual model that outlined the key responses to riparian restoration. Monitoring of each indicator is also linked specifically to the anticipated time frame of responses in the short (1-3 yrs), medium (3-8 yrs) and long- term (10+yrs).



Map outlining the location of the five sites within this project

STAKEHOLDERS AND BUDGET

The Murray- Darling Basin Authority is funding the scientific output and knowledge transfer components of the project. Four regional catchment management authorities, Goulburn Broken, North Central, Lachlan and Murray CMAs, are responsible for funding and implementing restoration works at specific sites and fostering interaction between scientists, landholders and the wider community. The research is undertaken by researchers, Dr Paul Reich, Dr Tim Cavagnaro and Prof. Sam Lake from Monash University, School of Biological Sciences. The Environmental Protection Agency Victoria is responsible for collecting data to document changes in aquatic macroinvertebrates at sites in Victoria. Landholders will actively participate in the ongoing maintenance of restored sites and provide data on historical and current land use. New South Wales Department of Natural Resources (NSW DNR), Victorian Department of Sustainability and Environment (VIC DSE), & South Australian Research and Development Institute (SARDI) also guide the management related scientific outputs of the project.

ECOSYSTEMS AND IMPACTS

Prior to European settlement all sites supported a River Red Gum dominated, grassy woodland riparian community. Tree clearance for agriculture occurred throughout the late 1800s and early 1900s, dramatically altering these systems. A narrow strip of trees was often left along streams and rivers. Unrestricted access of livestock into riparian areas for over 100 years has led to soil compaction, the proliferation of weeds and a subsequent reduction in native plant species richness. The absence of a shrub layer, and poor or limited over-story recruitment, are now common to all sites. Livestock access onto the banks and into the stream channel has also led to severe erosion, poor water quality and the decline of many species of aquatic fauna and flora. In some cases coarse wood has also been removed from the stream channel, reducing the available in-stream habitat for aquatic biota. The application of herbicides to control weed species and fertilizers for increased crop yields or improved pasture, has also reduced water quality.

Aerial view of Faithfuls Creek, Victoria showing the extent of clearing

RESTORATION AIM AND GOALS

The general aim of the restoration works is to reinstate the structure and function of pre-existing riparian vegetation, to levels that existed prior to European settlement. The general strategy for restoring the native vegetation involves the removal of disturbance by livestock and the active planting of native riparian plant species, followed by management of competition from weed species.

The notional restoration target at sites is essentially based on pre-european or unimpacted conditions as unfortunately, analogous reference sites on small, lowland streams were not available to guide restoration targets. In Victoria, for example, information from the pre-1750 statewide Ecological Vegetation Class (EVC) was used to guide the species planted and provides a target for the plant community. The plant community at the Faithful Creek site is considered to be previously classified as EVC68: Creekline grassy woodland (Victorian riverina bioregion) with River Red Gum as the dominant overstorey species. In NSW, target plant communities were developed individually by each regional agency. The restoration goals for many of the other ecological indicators were developed using historical distributions, published records and data collected from best available locations nearby. For aquatic invertebrates, integrated statewide community metrics such as SIGNAL and AUSRIVAS provide a broad target against which to gauge the success, or otherwise, of restoration. Similar approaches are used to set appropriate targets for other biota such as fish and birds, as well as abiotic parameters such as water quality and coarse wood loading.

Faithful Creek treatment site in November 2006 just after planting.

Faithful Creek treatment site in April 2008 showing vegetation establishment

PROJECT IMPLEMENTATION

The underpinnings of this restoration project are scientific and draw upon the knowledge of local management agencies to ensure the outcomes are in line with current policy practices. Riparian zones at the five sites have been fenced off and replanted with native vegetation following regional riparian restoration best practice guidelines. Each site comprises approximately 1km of stream length and restoration works have been carried out on both sides of the stream to a minimum width of ~20 m from the stream channel.

CMA field staff with appropriate skills identified regional vegetation type (based on statewide or regional protocols) and appropriate planting densities and coordinated site plantings using tube-stock grown from seed with local provenance. All livestock were excluded from sites with the erection of new fences and the provision of off-stream watering where required. Local CMAs were responsible for ensuring best practice at these sites as well as engaging with local landholders to gain access to sites as well as landholder expectations and participation. Planting of tubestock was undertaken by a mixture of participants including CMA staff, landholders and contractors. Areas underwent additional re-planting where tubestock mortality was very high. One goal of the project is to document the implementation activities undertaken at each site. This includes monitoring the growth and survivorship of tubestock and recording any site preparation such as soil tillage or herbicide application.

MONITORING AND RESEARCH LINKS

Researchers from Monash University's School of Biological Sciences are the primary research partners in the project, measuring a range of parameters to assess the effectiveness of Riparian Restoration in the Murray-Darling Basin (Experimental design is described in the Introduction). These researchers are working with the Environmental Protection Agency, Victoria who are responsible for collecting data to document changes in aquatic macroinvertebrates at sites in Victoria.

The project has been running since 2005 and has a further three years of monitoring by the Monash University team in place, with the vision that the 10 year agreement between landholders, researchers and local management authorities will optimise potential for both the restoration and scientific goals to be achieved.

PROGRESS TO DATE

At least one year of pre-restoration data have been collected from each site on a range of ecological variables (e.g. terrestrial vegetation, in-stream macrophytes, fish, birds, channel geometry, soil nutrients, leaf litter & water quality). These data have also been collected at an equivalent site ~4-5km upstream of each restoration site that acts as a control. The survivorship and growth of new plantings have been documented at each restoration site. Mortality of planted tube-stock has varied between sites from ~10 to ~50% and has been differentially affected by the drought conditions that continue to impact south eastern Australia. Preliminary results show that in the three years following livestock removal bare ground has decreased by ~20% and

natural regeneration of the dominant tree River Red Gum at fenced sites has been marked, with densities of up to 14 400 seedlings /ha along Faithful Creek. An examination of the soil seed bank at a subset of sites representing a range of riparian conditions showed that exotic weeds dominated and most pre-european taxa were absent. A steady decline in the abundance and diversity of macrophytes and aquatic fauna at our sites has been evident due to drought conditions. Data collected to benchmark pre-restoration conditions across all sites have revealed some clear relationships between aspects of riparian condition and some key response variables. For example, riparian canopy cover greater than ~50% is required before leaf litter consistently accumulates in the stream channel. This litter has subsequently been shown to form the major resource base structuring aquatic food webs in these systems.

ONGOING CHALLENGES

It is becoming increasingly apparent that many of the anticipated short-term ecological responses to riparian restoration at our sites are being constrained and/or delayed by the ongoing drought. This provides an excellent opportunity to document the impacts of drought on these systems and monitor their potential recovery once the drought breaks. However, the sampling effort and resources required to detect the impacts of drought and monitor recovery are substantial. For instance, the frequency and duration of sampling for most ecological variables (e.g. birds, fish, macrophytes) has exceeded that originally proposed to detect responses to livestock removal and replanting. Much of the intra- and inter-annual variation evident across most of our ecological data is due largely to the drought and provides essential context from which to assess any responses, or otherwise, to riparian restoration. As such we will continue with many of these measurements for longer than initially proposed. The expectations of the timeframes and magnitudes over which responses to riparian restoration are anticipated (particularly in the short-term) will probably need to be revised for many of our ecological indicators if dryer than average conditions persist.

Apart from drought, the capacity of the research efforts to evaluate the restoration efforts is likely to depend upon the co-operation of landholders and CMA involvement. In addition, the area surrounding these sites is also heavily impacted by agriculture and will continue to influence riparian areas via the export of weeds, sediment and nutrients. Further degradation of these sites will hopefully be prevented for the duration of the agreements entered into by landholders.

COMMUNICATION OF RESULTS

This project seeks to provide managers with protocols to monitor restoration success and guide expectations. A document that outlines the methods used in the project has been assembled and is available to anyone planning or implementing riparian restoration works. In addition, a document has been produced which presents the likely direction, rate, timing and magnitude of each ecological indicator with restoration. These anticipated responses form a collection of conceptual models that are based on available data and current understanding, and

will be refined as information is gathered throughout the project. These conceptual models will ultimately provide managers with a better basis for catchment planning and for managing expectations arising from restoration activities. Restoration sites will also be used by the MDBA and local CMAs as demonstration sites to communicate the benefits and difficulties of riparian restoration to landholders and catchment managers.

Communication between the research teams outputs and management has increased since 2008 with research outcomes converted to management flyers. The vision is to have scientifically based messages translated into policy terms to aid management within the local CMA's and government agencies. These flyers are available on http://www.mdbc.gov.au/rre

FURTHER READING

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