FACT SHEET

The Effect of Changing Irrigation Strategies on Biodiversity

Introduction

Irrigation farming has changed significantly in the past 25 years. Policy and climatic changes have seen the amount of water available to irrigators reduced which has driven greater water use efficiency at both farm and regional levels. With further policy changes ahead and climate change experts predicting significant reductions in water availability across the Murray Darling Basin there will be continued change in irrigation landscapes. Water is as significant a resource for native plants and animals as it is for people and in key irrigation regions irrigation significantly influences the availability of water across the landscape therefore these changes will also have implications for biodiversity.

Research recently completed by CSIRO Ecosystem Sciences aimed to identify likely changes to irrigation practices, the potential implications for native biodiversity in irrigation landscapes, and strategies to help reduce any negative impacts for biodiversity. The three year project used the irrigation districts of the New South Wales Riverina as a case study. The project was undertaken in collaboration with the Ricegrowers' Association of Australia Inc through their Environmental Champions Program and involved working with Murrumbidgee Irrigation, groups of local farmers and other professionals. It reviewed existing research and undertook new field research in black box woodlands. New research was undertaken specifically in the Murrumbidgee Irrigation Area referred to as the Midbidgee and the Lower Murrumbidgee Floodplain, referred to as the Lowbidgee (Figure 1).

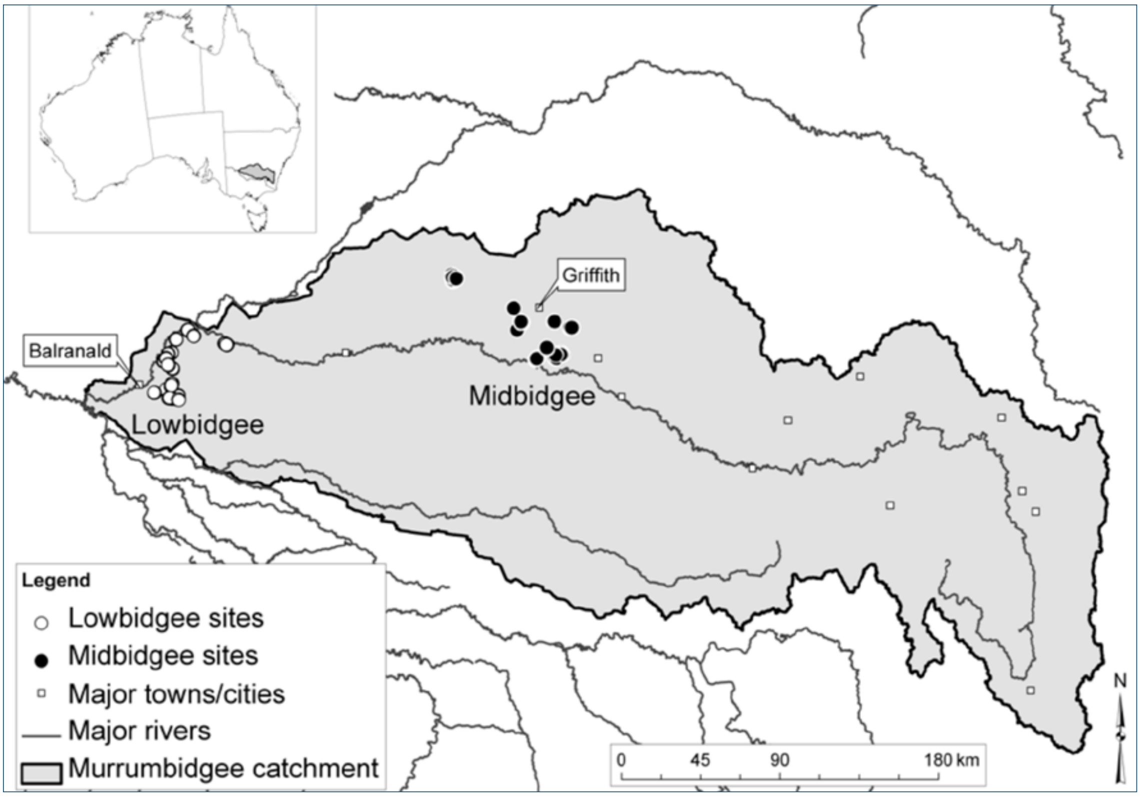

Figure 1 - Location of study sites

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Background

Before irrigation development the Riverina was a semi-arid plain with a range of shrubland, grassland, woodland, forest and wetland vegetation. With the advent of the Snowy River Scheme, and the resulting establishment of the Murrumbidgee, Coleambally and Murray Irrigation Areas, new landscapes have been created incorporating irrigation infrastructure, intensive farming and significantly, a large change in the temporal and spatial availability of water.

Irrigated agriculture in the Riverina consists of a variety of industries - rice, cereal, pulse and oilseed production, horticulture, as well as livestock. Water use efficiency has significantly improved over the past 25 years at both on farm and in regional water distribution systems. This has been achieved through changes in irrigation layouts, improvements in technology, widespread adoption of more efficient infrastructure and technology, research and management changes.

The Midbidgee region is now dominated by irrigation with intensive cropping and grazing, elevated watertables, and low levels of connectivity between vegetation patches. Patches of remnant black box (*Eucalyptus largiflorens*) woodlands are common and river red gum (*E. camaldulensis*) forests remain along major waterways. Due to irrigation seepage groundwater levels were a problem for a significant period until the 'millennium drought' in the 2000's. Until recently, isolated remnant black box patches in the Midbidgee were also often used as destinations or storages for irrigation drainage or surplus water. In contrast, the Lowbidgee region is dominated by light grazing with irregular and relatively limited flood irrigation, relatively low and falling watertables, and high levels of vegetation connectivity.

In recent times there has been a focus on protecting and enhancing remaining biodiversity through Landcare, Land and Water Management Plans and industry initiatives such as the Rice Industry's Biodiversity Strategy and Plan. However the concern now is that future changes in farming and water management practices may put further pressure on biodiversity.

What might the future hold?

Climate change is expected to result in reductions in river stream-flows and impending policy changes are likely to see the proportion of water drawn from the river system for irrigation reduced. The need for even more efficient use of irrigation water at both farm and regional levels in the future is certain.

Examples of potential changes in water management

Farm level

- Improved irrigation layouts,
- Reduction or cessation of flooding of rice crops in favour of other irrigation techniques (this may also lead to increased herbicide use),
- Reductions and increased efficiency in the use of flood irrigation,
- Increased use of lateral move, centre pivot and drip irrigation,
- Changes in the mix of crops grown
- Reductions in the frequency of and area under irrigation
- Increased on-farm storage of water

Regional level

- Lining and piping of supply channels,
- Using improved technology to manage the distribution of water,
- The application of more efficient techniques may result in less drainage being received in regional wetlands.

Possible impacts on native biodiversity

These changes will result in a reduction in the amount of water available in constructed wetland habitats, such as irrigation channels, impoundments and flooded crop-growing areas such as rice bays. These habitats have provided significant resources to some wetland plants and animals, such as frogs, a tortoise and waterbird species and hence these reductions may have some negative consequences for these species locally. However, these species tend to be common, generalist and tolerant of human disturbance and also occur in natural wetland habitats. Hence, it is likely that changes to irrigation practices will not have large regional effects on these species.

A more significant issue is how future changes to irrigation practices will affect the remaining native vegetation, particularly floodplain woodlands, because many of the native fauna species in these regions are associated with this vegetation. Some of the changes that could impact on this vegetation include:

Reduced water available to floodplain (water-dependent) vegetation communities, particularly black box woodlands, unless management specifically targets them by watering

Clearing of mature trees in paddocks to allow increased use of lateral move and centre pivot irrigation. Isolated mature trees can provide significant and potentially irreplaceable benefits to wildlife in the landscape, including food, shelter and connectivity

Increased herbicide use in crops due to reduced flood irrigation controlling weeds, leading to impacts on surrounding native vegetation if not managed carefully

Black box woodlands

Black box communities comprise a large percentage of the remaining remnant vegetation in the Riverina and are generally the major remnant vegetation type on irrigated farms. Much of the native fauna in irrigated regions is associated with remnant native vegetation. Black box woodlands have a natural surface flooding regime of once every three to ten years and hence are affected by changes to water availability.

The field component of the study collected data from 33 sites of at least 10 hectares in area, 17 from the Midbidgee and 16 from the Lowbidgee (*Note: Data from the Lowbidgee were collected from a separate CSIRO internally funded project*.). Sites were also chosen so they had some of the key attributes known to be important for fauna species, e.g. hollows for hollow nesting species.

Sites in the Midbidgee reflected high, medium and low levels of irrigation intensity and sites in the Lowbidgee were all classed as very low irrigation intensity. With the assistance of landholders sites were also selected to represent a range of surface water histories. This included how often they received water in the past 30 years, time since they were last wet and time since the surrounding land was wetted.

Figure 2 - Black box in poor condition

Figure 3 - Flowering black box in good condition

Vegetation patterns and responses

Shrub and ground layer

Shrubs are important structural components of woodlands for fauna, providing nesting and foraging habitat and protection from predators. Woodlands with multiple vegetation layers including shrubs support greater fauna diversity and abundance than woodlands without such layers.

The shrubs and ground layers at the various sites reflected their grazing, clearing and wetting histories, with the Lowbidgee sites having more large shrubs such as nitregoosefoot and less of species that indicate higher grazing pressure such as barley grass.

Black box tree health

The study found that black box trees in the Lowbidgee were in significantly worse health than trees in the Midbidgee. There were also more dead trees in the Lowbidgee region than in the Midbidgee

Over the long term, the Lowbidgee has a lower annual rainfall than the Midbidgee however during the millennium drought (2000-2009) rainfall was similar between the two regions. During this period trees in the Midbidgee were probably buffered against the drought by access to high water tables, and in some areas relieved of stress by lowering of excessively high water tables.

In contrast, recovery of aquifers in the Lowbidgee has been impaired by increased groundwater extraction and reduced flooding over the same drought period reducing access to water for trees. Consequently the condition of black box communities in the Lowbidgee has been affected.

In the Lowbidgee tree flowering was also associated with wetting history indicating the importance of flooding for reproduction, particularly where trees do not have access to groundwater. The fall of seed coincides with the natural flood season and local rainfall and flooding are important for seedlings to survive.

Figure 4 - Black box in flower – where there is a lack of access to groundwater flooding is important for flowering.

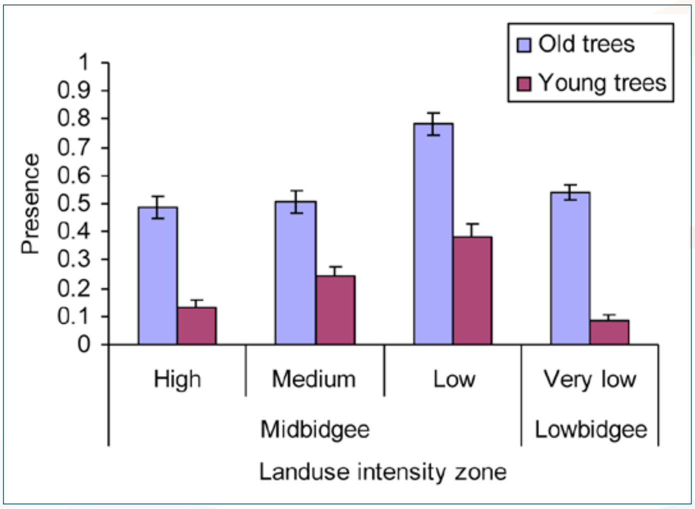

Figure 5 - The proportion of photos with old or young trees based on the surrounding irrigation intensity. Error bars show ± standard error.

As would be expected, the study confirmed that floodplain woodlands with flood histories closer to 'natural' are in better condition and have greater structural complexity. However it has also demonstrated that for black box woodlands this depends on the availability of groundwater.

In the absence of sufficient rainfall or accessible groundwater, flooding for vegetation condition becomes more important. Results indicate that flooding less than once every 10 years leads to tree decline, and regular flooding of about once every 1-2 years may be necessary during drought where water tables are not accessible to trees. Flood frequency is even more important in areas where salinity is a problem, because flooding flushes salts away from the root zone, reducing salt stress in trees. The depth and duration of flooding is also important with results indicating those remnants which had received deeper, longer flooding events were in better health. However, this is only true up to a point of tolerance beyond which the health of the trees is negatively affected.

Woodland birds

The woodland bird field component was undertaken in early and late spring 2009 and looked at 13 woodland bird species and how their abundance and breeding activity was influenced by flooding history and intensity of use of the surrounding land. The sites were specifically chosen to have certain attributes (i.e. greater than 10 ha in size and with hollow bearing trees). The species range from common species to some that are considered threatened or declining in New South Wales. The introduced starling was also included as they can compete with native woodland species.

Species studied:

- Australian magpie
- Brown treecreeper
- Apostlebird
- White-winged chough
- Striated pardalote
- Willy wagtail
- Noisy miner
- Yellow throated miner
- Rufous whistler
- Grey butcherbird
- Pied butcherbird
- Grey-crowned babbler
- Magpie lark.

Abundance

Sites in the Midbidgee had approximately double the densities of birds of sites in the Lowbidgee. There was a slight trend for lower densities in the highest irrigation intensity zone relative to the low and medium irrigation intensity zones (Figure 6). There was some evidence that the sites in the Midbidgee had higher species richness compared with the Lowbidgee (9 species vs. 7 species). There were no consistent responses to surface wetting history across regions, nor to any of the other habitat factors considered.

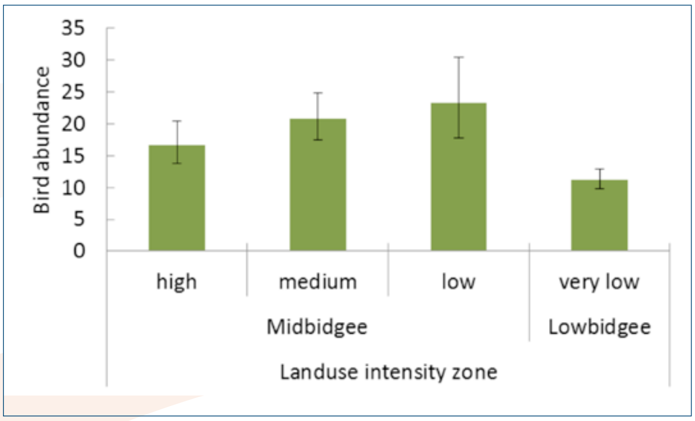

Figure 6. Abundance (number of birds per km of transect) of selected species at sites for regions and surrounding irrigation intensity. Error bars show ± standard error.

It is likely that the lack of flooding in the Lowbidgee over the drought led to greatly reduced food resources for woodland birds and hence lower densities. In contrast, birds in black box remnants in the low and medium irrigation areas may have benefited from higher water availability in the surrounding irrigated landscape, leading to higher food availability, and hence higher survival and reproductive success.

In the high intensity irrigation area in the Midbidgee, lower bird densities compared with the medium and low intensity zones may reflect the greater isolation of these sites from other woodland patches compared with the less intensive irrigation areas. Grazing intensity was also high in these patches and other studies have shown high grazing pressure to have a negative impact on woodland birds.

No strong relationships were found between woodland bird densities and patch water histories. This may reflect a dominance of the landscape-scale effect observed, but it could also reflect the high level of uncertainly about the water histories at the sites. Even though a landscape level effect of water in irrigated landscapes appears to benefit woodland birds, it is possible that within the Midbidgee within-patch surface watering will provide additional benefits. In addition, a range of other flora and fauna are likely to require within-patch watering to remain existent in these irrigated landscapes.

Breeding

In early spring 2009 there was little evidence of breeding, possibly due to the dry season and prolonged drought. In late spring 2009, there was some evidence that there were higher rates of breeding in the very low and high irrigation intensity zones. 2009 was a very dry year across all sites, with limited irrigation allocations as well as low rainfall. If this led to low food availability in all sites, then competition for food may have been lower in the sites with less birds, leading to the higher breeding activity. Another possibility is the patches with a greater density of birds have more younger birds, some which may be reproductively immature. In this study, density observations provide more valuable information as they reflect the longer term patterns of survival and recruitment of birds.

Figure 7 - Apostlebirds nesting

Responses of some individual species

Starlings

Starlings are an introduced species, which may impact on native species, either through competition for food or nesting sites. Starling counts were highly variable because they were sometimes seen in large flocks, however there was a trend towards higher counts with increasing irrigation intensity. This may have contributed to the lower densities of native woodland species in the high irrigation intensity areas.

Brown treecreepers and grey-crowned babblers (vulnerable species)

Brown treecreepers and grey-crowned babblers were only present in 8 and 14 of the 33 sites respectively. There was a trend towards higher presence in the low and medium surrounding irrigation intensity zones and less brown treecreepers were found where noisy miners were present. Understanding what drives noisy miner populations would contribute to developing management actions for conserving other native bird species.

Management Implications/recommendations

With the climate predicted to become increasingly hot and dry and irrigation water supply reduced and more variable, there will be increasing stress on farming and natural ecosystems. The predicted reduction of constructed aquatic habitats may affect the native species using them, however may not have a major adverse impact on biodiversity regionally because the species recorded in constructed habitats tend be abundant and widespread, and also occur in natural wetland habitats. Sensitive species that depend on native floodplain vegetation are at greater risk.

Remnant floodplain vegetation is critical to these species, so regional management should focus on retaining and improving the quality of remnant vegetation patches in irrigation landscapes. Improvements to habitat quality including restoring and maintaining a healthy ground and shrub layer, ensuring old hollow bearing trees are retained, maintaining woody debris, increasing the size of remnant patches and increasing the connectivity and where possible the area of vegetation patches. Retaining isolated paddock trees may also contribute to connectivity in these landscapes.

The impacts of changed irrigation practices on black box woodland communities should be mitigated through careful management in terms of surface flooding to ensure they remain healthy, reproduce successfully and have a healthy understorey. Indications are that flooding is needed at least every 2 to 10 years, especially in areas where water tables are low or salt levels are high. While this study did not find strong links between bird abundance and site flood history, there are flora and fauna species that clearly require and would benefit from managed flooding of remnant floodplain woodlands. There are opportunities for incorporation of woodland watering into public and private land management; however we recommend that managed flooding should always be undertaken with careful monitoring of the responses of and outcomes for both fauna and flora.



Where to get more details

Final project report

Arthur, A.D., McGinness, H.M., and McIntyre, S. (2011) The effect of changing irrigation strategies on biodiversity. Final report to the National Program for Sustainable Irrigation. CSIRO Ecosystem Sciences, Australia. www.npsi.gov.au

Published articles from this study to-date

McIntyre, S., McGinness, H. M., Gaydon, D. & Arthur, A. D. (2011) Introducing irrigation efficiencies: prospects for water-dependent biodiversity in a rice agro-ecosystem. Environmental Conservation, 38, 353-365.

McGinness, H. M., Arthur, A. D., Davies, M. & McIntyre, S. (2012 In press) Floodplain woodland structure and condition: the relative influence of flood history and surrounding irrigation landuse intensity in contrasting regions of a dryland river. Ecohydrology.

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