



Victorian Environmental Water Holder
Environmental watering
in Victoria 2015-16



The Victorian Environmental Water Holder acknowledges the contribution of its partners, particularly waterway managers, in managing environmental water to improve the health of rivers, wetlands and floodplains.

Acknowledgement of Country

The Victorian Environmental Water Holder acknowledges Aboriginal Traditional Owners within Victoria, their rich culture and their spiritual connection to Country. The contribution and interests of Aboriginal people and organisations in the management of land and natural resources is also recognised and acknowledged.

Aboriginal and Torres Strait Islander people are warned that this document may contain images or names of deceased persons.

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Emma Coats from the VEWB with Murray cod, by Rachel Wood.

foreword

A theme you will notice in this year's *Reflections* is the excitement about waterbirds breeding—an event taken for granted a hundred years ago is now cause for celebration.

The number of breeding waterbirds in eastern Australia is at an all-time low and if it wasn't for environmental watering at 73 wetlands in 2015–16, it could be even lower.

2015–16 marked the fifth year for the Victorian Environmental Water Holder (VEWH). This edition of *Reflections* proudly demonstrates how life-saving water has been provided to Victoria's most vulnerable and threatened plants and animals. We also show the critical importance of environmental watering to protect Australia's dwindling bird populations under climate change.

It was a challenging year in some parts of the state: 2015–16 was the first year the VEWB had to manage prolonged dry conditions and low water allocations.

The western and northern parts of Victoria bore the brunt of the dry weather. On average, water storage levels across northern Victoria were 35 percent lower in June 2016 than the previous year.

Western Victoria experienced some of the driest conditions on record with allocations for the Wimmera and Glenelg systems ending the year at just 16 percent. Sections of the Wimmera and Glenelg rivers were reduced to pools.

In planning ahead, the VEWB had prepared for low early-season allocations and actions that protected plants and animals. In most systems, we significantly reduced watering and environmental watering objectives in line with the dry conditions and our seasonal watering plan.

In many regions, we used water that had been carried over from the previous year to bolster low water allocations. This carryover water played a vital role. In northern Victoria, it provided sufficient environmental water in winter and spring to maintain many wetlands which would otherwise have been left dry. The wetlands watered across the Victorian Murray region provided an essential mosaic of habitat for native birds (such as the egret, shown on the cover) in an otherwise dry landscape.

We know that our climate varies naturally over seasonal, annual and longer cycles. The effects of climate change will be superimposed on this natural variability, increasing the frequency of extreme weather (floods and drought) and the degree of uncertainty facing all water managers, water users and the community.

As we move into 2016–17 and face floods in many parts of Victoria, the VEWB continues to evaluate how it manages environmental water and prioritises watering within a changing climate.

As always, many thanks to the Commonwealth Environmental Water Holder and Office, the Living Murray program and Victorian communities who work with us to improve the state's rivers, floodplains and wetlands.

I'd also like to express our ongoing appreciation to our partners, the waterway, storage and land managers who are critical to the environmental watering program's success.



Chairperson



*Yellow-billed spoonbill at the
River Murray, by Mallee CMA.*

introduction

The Victorian Environmental Water Holder (VEWH) is an independent statutory authority set up under the *Water Act 1989* to manage Victoria's environmental water entitlements to benefit Victoria's rivers, wetlands and floodplains and the plants and animals that rely on them.

The role of the VEWH is to:

- make decisions about the most effective use of the environmental water entitlements including use, carryover and trade
- commit water and authorise waterway managers to implement watering decisions
- work with storage managers and other water holders to coordinate and maximise environmental outcomes from the delivery of all water
- commission projects to demonstrate the ecological outcomes of environmental watering at key sites and to help improve environmental water management
- publicly communicate environmental watering decisions and outcomes.

Why is environmental watering important?

Rivers and wetlands are Victoria's lifeblood, so we must protect them.

Healthy rivers and wetlands support vibrant and healthy communities. They sustain people by supplying water for towns, farms and businesses. They also contribute to local farming, fishing, real estate and tourism activity.

Healthy rivers and wetlands make cities and towns more liveable and support the physical and mental wellbeing of communities. They provide places for people to play, relax and connect with nature and sustain Aboriginal communities who have a continuing connection to Country.

Rivers and wetlands cannot provide these benefits unless their health is protected and maintained. Environmental watering is crucial to achieving this.

Mapping Aboriginal cultural values, by Murray-Darling Basin Authority.



Cowanna bushwalk, by Mallee CMA.





Rivers and wetlands provide water and land that is important to towns, industry and farms. As a result, many of Victoria's rivers and wetlands have become highly modified.

For example, instead of water flowing across the landscape naturally, water is captured in storages by dams and weirs; diverted via pipelines, levees and constructed channels; and used for towns, cities, industry and farming.

Some of our rivers give up more than a third, and sometimes up to a half, of their water for homes, farms and businesses. Instead of flowing naturally, with high flows in winter and low flows in the hotter summer months, rivers now run higher when water needs to be delivered for farming and urban use.

These changes have interrupted many of the natural river and wetland processes that native plants and animals need to survive, feed and breed.

In rivers, environmental water is often delivered to mimic some of the flows that would have occurred naturally, before the construction of dams, weirs and channels. This is vital for maintaining the physical, chemical and biological health of rivers.

Environmental water managers generally focus on returning some of the small and medium-sized river flows that are essential for native plants and animals. These flows can move sediment and nutrients through river systems, connect habitats and improve water quality.

The timing, duration and volume of water delivery is designed to support the plants and animals that rely on those flows. For example, Australian grayling rely on an increase in river flows in autumn to signal them to migrate downstream for spawning.

Many wetlands are now disconnected from the rivers that once filled them naturally; others are permanently connected to rivers or channels. This means that some wetlands do not get enough water and others get too much.

In wetlands, environmental water managers focus on mimicking the natural wetland wetting and drying cycles that so many plants and animals have evolved to depend on for their diversity and long-term resilience. For example, where wetlands and floodplains have been cut off from natural river flows, environmental water can be used to reconnect these areas, sometimes via irrigation infrastructure (such as pumps, channels and regulators).

Carryover and trade

The VEWH uses carryover water (saved, unused, allocated water to use the following season) and water trade (buying, selling or exchanging water) to enable environmental water to be used when and where it is most needed.

In 2015, the following carryover and trade activities were used to effectively and efficiently manage its environmental water portfolio:

- 500 ML of Goulburn allocation was transferred to the Broken system to water Moodie Swamp to encourage plant growth.
- The VEWH transferred 1,970 ML from the Yarra River to the Thomson River to deliver summer/autumn freshes (small pulses of water) in the Thomson system to help young Australian grayling fish migrate upstream.
- 3,000 ML was transferred from the Goulburn for carryover in the Campaspe to provide Campaspe River flows under expected continuing dry conditions in 2016–17.

In some systems, carryover rules allow the VEWH to retain unused water in storage at the end of the year. This can then be used to meet environmental watering priorities in future years.

At the end of 2015–16, 414,232 ML were carried over for 2016–17, subject to carryover rules and conditions (for example, evaporation and potential loss to storage spills).

This water was carried over in preparation for forecast dry conditions and potentially low water allocations, which was the situation towards the end of 2015–16.

Some sites (such as wetlands and River Murray floodplains) may need more environmental water under average-to-wet conditions, which could be provided using carryover.

Water donations

About 28 ML of water was generously donated to the VEWH by Mallee landholder Christiane Jaeger in 2015–16, contributing to wetland watering in the region. Thank you Christiane! You can read more about why she has donated water over the past 12 years on page 14.

Partnerships

Working with program partners is critical to the efficient and effective delivery of the environmental watering program.

Waterway managers—Victoria's catchment management authorities (CMAs) and Melbourne Water—and storage managers have a key role in the local planning and implementation of watering.

The VEWH also works with other water holders including the Commonwealth Environmental Water Holder (CEWH) and the Murray-Darling Basin Authority (through the Living Murray program) to negotiate and coordinate the use of water in Victorian waterways.

Funding research and river improvements

A large body of scientific and community knowledge about rivers and wetlands is used to measure the success of environmental watering and improve the use of the water.

The VEWH funds a range of monitoring and technical investigations (such as better understanding of hydrology) and community engagement and infrastructure (such as water metering) projects across Victoria.

In 2015–16, we funded CMAs to do 26 projects including water-flow monitoring on the Campaspe and Goulburn rivers, bird, frog and plant surveys at Moodie Swamp and angler engagement in the Glenelg and Wimmera regions.

These projects complement other similar projects funded by the Department of Environment, Land, Water and Planning and by Melbourne Water.

highlights of environmental watering in Victoria

Victoria is benefitting from a successful history of environmental watering, which was strengthened by the establishment of the Victorian Environmental Water Holder (VEWH) five years ago. We have seen environmental watering protect and re-establish threatened species, re-invigorate declining rivers and creeks, and safeguard and boost internationally important wetlands. It also helps protect Victorian wildlife from the effects of climate change including more intense droughts, fires and floods.

Top 10 achievements

These are the top 10 things Victoria's environmental watering program has achieved.

➤ **Prevented the extinction of the Murray hardyhead, a threatened species, in Victoria.** Emergency watering in 2007 at the peak of the Millennium drought helped protect the few remaining Murray hardyhead populations in Victoria. Water deliveries every year since have stabilised the species, and we are moving closer to recovery and self-sustaining populations.

➤ **Helped fight the decline of waterbird populations in south-east Australia by providing a mosaic of wetland habitats in an otherwise drought-affected landscape (as explained on page 10).**



➤ **Successfully nurtured one of Victoria's most threatened fish species, the Australian grayling.** Environmental watering now ensures that adequate flows provide adult Australian grayling with the time and distance needed to migrate and reach spawning areas.

➤ **Helped re-establish platypus populations following a drastic decline in numbers during the Millennium drought.** Flows are essential for platypus breeding, and environmental watering helped secure new populations of platypus in rivers statewide including in the Wimmera, Tarago and Campaspe rivers.

➤ **Safeguarded six internationally important wetlands at Hattah-Kulkyne, Gunbower Forest, Kerang, Bellarine Peninsula, Barmah Forest and Gippsland Lakes.** Australia committed to protect these sites under the Ramsar convention, a global intergovernmental treaty which drives international cooperation for the conservation and wise use of important wetlands.

➤ **Averted the local extinction of moira grass at Barmah Forest, an internationally important Ramsar wetland and iconic Murray site.** Moira grass is a foundation of the forest's ecosystem. It provides a major nutrient source for floodplain life and recycles organic and inorganic matter back into living matter, providing food and habitat for water fowl and other birds, turtles, frogs and other animals. Before environmental water deliveries, only 4 percent of the area of moira grass that existed 80 years ago remained.

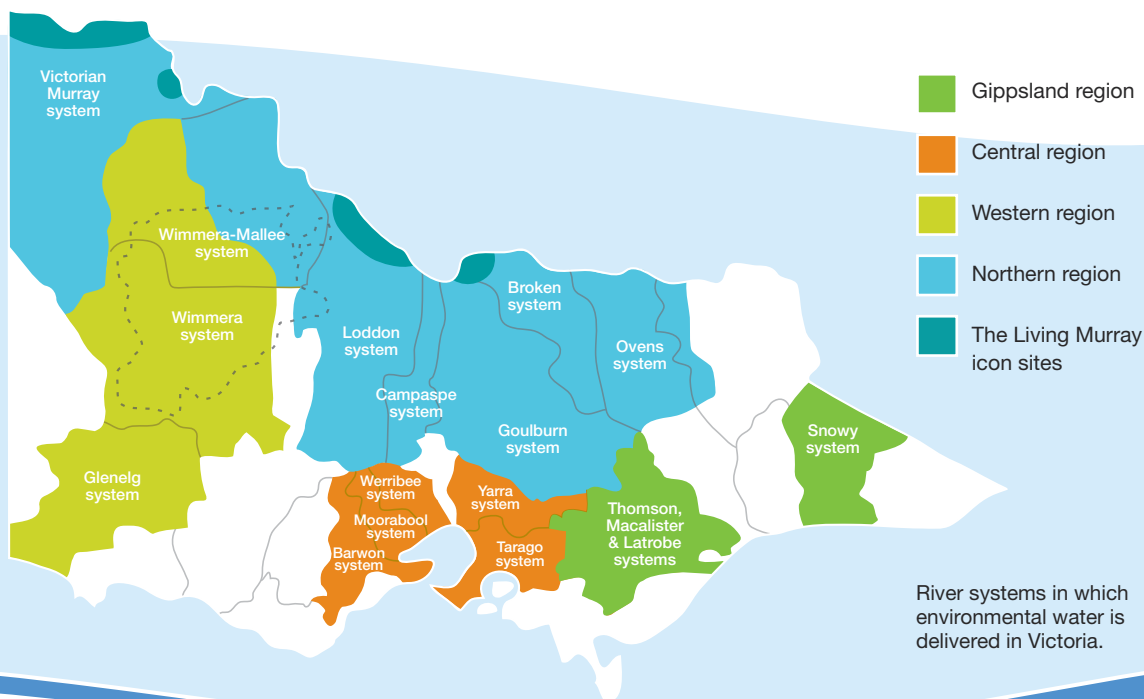
highlights of environmental watering in Victoria

➤ **Improved flows in six Victorian heritage rivers, rivers protected for their significant recreation, nature conservation, scenic or cultural heritage attributes.** Environmental water is regularly delivered to the Glenelg, Wimmera, Goulburn, Snowy, Thomson and Yarra heritage rivers.

➤ **Complemented river and wetland restoration works (such as revegetation, fencing and removal of fish barriers).** For example, fish travelled more than 300 km in the Glenelg River, thanks to improved river flows and removal of fish barriers.

➤ **Helped rivers and wetlands recover from devastating bushfires including the Goulburn-Broken wetlands.** This helped river red gums and other vegetation recover, bringing waterbirds back to roost, feed and breed.

➤ **Provided emergency watering for hundreds of drought refuge pools in northern and western rivers, enabling fish and other aquatic animals to survive through the hottest, driest parts of summer.** This also provided watering holes for birds and animals trying to survive extremely dry conditions.



Shared community benefits

As well as protecting Victoria's rivers and wetlands and safeguarding plants and animals for future generations, environmental watering is also providing many benefits for people.

Environmental watering increases opportunities for fishing, birdwatching, kayaking, bushwalking, cycling, camping, yabbing, swimming and picnicking on or around rivers, wetlands and floodplains. It also increases amenity and people's enjoyment: 92 percent of those surveyed in the *My Victorian Waterways* survey visit waterways to enjoy the scenery.

Environmental watering helps support sustainable bird populations by providing suitable habitat and by increasing feeding and breeding opportunities.

There are 23 sites in state game reserves that can receive environmental water, 14 of those received environmental water in 2015–16. They were:

- central Murray wetlands: Johnson Swamp, Lake Elizabeth, and Richardsons Lagoon
- Boort wetlands: Lake Meran
- Goulburn-Broken wetlands: Moodie, Black and Doctors swamps
- lower Latrobe wetlands: Heart Morass
- lower Barwon wetlands: Hospital Swamps and Reedy Lake
- Wimmera-Mallee wetlands: Crow, Mutton, Sawpit and Wal Wal swamps.

Healthy rivers help sustain recreational fishing in Victoria

Of the top 50 Victorian recreational fishing reaches, 28 can receive environmental water. Twenty-four (86%) of these reaches received environmental water in 2015–16: four could not, due to limited availability. If the expected favourable conditions eventuate, in 2016–17 all 28 reaches will receive environmental water.

The numbers ...

Environmental water has been delivered to **188 river reaches and wetlands** since July 2011, including an average of **63 river reaches each year**, far exceeding Victoria's goal of 39.

The total volume of environmental water deliveries in Victoria increased from **22,555 ML** in 2007–08 to **544,526 ML** in the VEWH's first year, hitting a peak of **1,167,830 ML** in 2013–14.

The VEWH oversaw delivery of about **3,760,000 ML** of environmental water since 2011. This is equivalent to about one-seventh of the water in Port Phillip Bay.

The VEWH's entitlements increased from a long-term average yield of about **230,000 ML in 2011** to about **650,000 ML today**, resulting from water recovery projects.

In 2015–16, **96 %** of environmental water delivered in northern Victoria was also re-used to meet downstream environmental water targets. To increase efficiency, environmental water is also piggybacking on water delivered for drinking and farming.

protecting waterbirds



Environmental water is playing a critical role in fighting the decline of waterbird populations in Australia's south-east.

In December 2015, bird lovers were greeted with sobering news: a University of New South Wales study found that the number of waterbirds in eastern Australia had fallen to the second-lowest level on record. Around 60 percent of wetlands surveyed were dry and the number of breeding waterbirds was the lowest ever recorded.

The findings were ominous: as study author Professor Richard Kingsford noted, the low waterbird numbers recorded were partially due to drought conditions, resulting in birds dying or failing to breed. Worse news, however, was that breeding rates had been down

since 2011–12. This continues the trend of a collapse in waterbird abundance since the 1980s of 80 percent, as explained by Professor Kingsford in BirdLife Australia's 2014 report *Birds of the Murray-Darling Basin*.

In Victoria, the western and northern parts of the state were dealing with prolonged dry conditions. Water storage levels across northern Victoria were on average 35 percent lower in June 2016 than a year previously. Western Victoria experienced some of the driest conditions on record, with allocations for the Wimmera and Glenelg systems ending the year at just 16 percent. Both the Wimmera and Glenelg rivers were reduced at times to chains of pools.

Positively, environmental water managers were hard at work watering wetlands, primary habitat for Australian and migratory waterbirds. Aside from the four icon Living Murray sites—Barmah Forest, Hattah Lakes,

Cygnet in swan nest at Steamer Plain, Barmah, by Keith Ward.

in climate change

Lindsay Wallpolla and Gunbower Forest—12 wetlands were watered in the lower Murray, six in north-central Victoria, five in the Goulburn-Broken area and 40 small wetlands in the Wimmera-Mallee area. Further south where conditions were not as dry, the lower Barwon and Latrobe wetlands, both very important for birdlife, continued to receive restorative drinks.

The watering provided a mosaic of habitat in what was (in the north and west of the state) an otherwise extremely dry landscape. As intended, birds flocked to the sites to feed and breed. Many rare and threatened species were observed including three egret species (great, intermediate and little) and the very shy and endangered Australasian bittern (as explained on page 13).

The importance of environmental watering in climate change

“Environmental watering is critical for birds in dry times,” says Paul Sullivan, Chief Executive Officer of BirdLife Australia.

Paul heads up the nation’s largest organisation devoted to the future of native birdlife. For over 100 years, members of BirdLife Australia have been powerful advocates for native birds and the conservation of their habitats, working to address the threats to vulnerable bird populations. It sees climate change, and the extreme weather patterns associated with it, as one of the key risks and considers environmental watering can be a mitigating factor.

“Habitat is vital for waterbirds to survive and breed,” Paul says. “With the flows of so many rivers now regulated with dams and weirs and with so much water extracted from the streamflow, many river wetlands are now almost never filled, leading to a huge loss of biodiversity. Environmental water ensures that birds have somewhere to go for food, nesting and raising their young.



“Birds usually breed when there is best chance for their chicks to survive, usually when there is abundant water and therefore food.

“Rainfall and floods boost macroinvertebrate (waterbug) populations and result in plants (such as eucalypts) germinating and flowering. In turn, this feeds frogs and fish which are lunch for many of our larger waterbirds. So, water in wetlands is extremely important for breeding.”

During widespread droughts, many wetlands across Australia will dry out, limiting the food habitat available for waterbirds to feed and breed. This decline in the availability of wetlands, as both their extent and locations decline, is exacerbated by the extraction of water from the system to meet human needs. “With the onset of climate change and the extreme weather events that is likely to bring, environmental watering is playing a critical role in conserving our bird populations and is likely to be the key to survival in drought.”

Straw-necked ibis, by Andrew Silcocks.

protecting waterbirds

They still call Australia home

In 2015–16, environmental watering was extremely successful across many regions.

In the Goulburn-Broken wetlands, magpie geese (another threatened species) were recorded at Black Swamp for the first time and at Kinnaird Wetland for only the second time. This prompted Goulburn Broken CMA to ask for environmental water to maintain water levels at Kinnaird Wetland to help the geese feed, roost and breed.

Birds also made the most of the wetlands watered in north-central Victoria. Environmental Water Officer with the North Central CMA, Bree Bisset, says, “At Round Lake, most waterbirds recorded at the wetland were deepwater foragers (such as Eurasian coot and black swan). While low numbers of diving and dabbling ducks were recorded, we did observe the blue-billed duck and vulnerable musk duck, both of which are threatened species.

“It was a similar story at Lake Elizabeth. The abundance and number of species were lower than previous years but we still recorded around 1,400 birds and 18 different species. Grey teal, black swan and Eurasian coot were particularly abundant. Threatened species (such as freckled duck, Ballion’s crake, whiskered tern and Australasian shoveler) were commonly recorded. We also counted 104 sharp-tailed sandpipers, a species listed under a number of international migratory agreements.”

The annual aerial survey of waterbirds in eastern Australia, conducted under the guidance of Professor Richard Kingsford from the University of New South Wales, has shown significant declines over more than 30 years in many waterbird species across eastern



Australia and the Murray-Darling Basin – including Australasian shoveler, glossy ibis and straw-necked ibis. The latter was seen in unusually significant numbers in the Wimmera-Mallee wetlands in October 2015, when hundreds were observed at Corack Lake.

“Straw-necked ibis are a rare site at this wetland,” Amy Russell, Environmental Water Officer at the North Central CMA confirms. “We think they came to the wetland because of a lack of water elsewhere in the landscape. This demonstrates just how important environmental watering can be in north-west Victoria in drier times.”

Environmental watering provided a mosaic of habitat in what was (in the north and west of the state) an otherwise extremely dry landscape.

Magpie geese at Black Swamp, by Goulburn Broken CMA.

in climate change



Once bittern, twice shy

One of the more exciting observations made after environmental watering this year was the presence of several endangered Australasian bittern at Moodie Swamp. This shy, reclusive species inhabits shallow and freshwater wetlands in south-east Australia. Australasian bitterns are extremely difficult to detect as they hide among tall vegetation. Luckily, they can be monitored acoustically; their presence is signalled by a booming call made by the male birds.

Unfortunately, this species is in decline. BirdLife Australia reports that there was a decline of more than 50 percent in Australasian bitterns between the late 1970s and early 2000s, undoubtedly exacerbated by the Millennium drought.¹

Australasian bitterns prefer shallow ephemeral wetlands with dense emergent vegetation. Many of these wetlands have been lost due to river regulation and water diversion for human needs.

Over the last four years, BirdLife Australia has been assessing the value of rice crops in the Riverina (in south-western New South Wales) for Australasian bittern and has confirmed that a large population of bitterns moved into rice crops, with some breeding

activity occurring. The Bitterns in Rice Project also tracks a number of birds to find out where they travel during and after breeding.

In 2015–16, Robbie, the first Australasian bittern to be tracked, made his way to Victoria and headed south-west to the mouth of the Glenelg River, eventually arriving at Long Swamp. He stayed there for months before starting his journey home to the Riverina. In May 2016, Neil, another tracked bittern, left the Riverina and took a 450 km journey east. He was eventually tracked to Moodie Swamp, a Goulburn-Broken wetland which is an important environmental watering site.

“It’s great to see Neil arrive at Moodie Swamp,” says Jo Woods, Environmental Water Project Officer at Goulburn Broken CMA.

“Interestingly, we’d provided Moodie Swamp with water back in May 2014, primarily to promote the growth of southern cane grass which is excellent habitat for Australasian bittern. We then managed to acoustically record bittern calls the following September. Off the back of this, Moodie Swamp received environmental water in the summer of 2014–15 and again in late autumn of 2016, coinciding with Neil arriving at Moodie Swamp. The fact that Neil chose to head to Moodie Swamp this year gives us an excellent signal that the watering is doing its job!”

Neil, an Australasian bittern, was tracked to Moodie Swamp, giving us an excellent signal that environmental watering is doing its job.

The VEW, water managers and BirdLife Australia will continue to work together to find ways to use environmental water more effectively to protect Australia’s diverse birdlife for future generations.

Australasian bittern, by Andrew Silcocks.

¹ Silcocks, Webster & Herring, cited in *Birds of the Murray Darling Basin*, 2014, BirdLife Australia.

people making a splash

Conservation takes on many forms. For some people it's about planting trees or removing rubbish. For others it's about making the most basic of life's needs—water—available.

Here you will meet someone who has generously donated thousands of dollars' worth of water, and a couple who have moved heaven and earth to recreate the oasis that was.

Donating water

Imagine camping beside a wetland knowing it has as much water as it has because of you? Avid bushwalker and landholder Christiane Jaeger can do just that.

Over the past 12 years, she has donated a total of 50 ML of water to the environment. In 2008, 3 ML of the water was used to keep 300 and 500-year-old red gum trees alive.

"I put my money where my mouth is. It gives me a sense of integrity to live my values," says Christiane who lives and works in the Mildura region in north-west Victoria where she holds about 20 ML of water shares.

"I know I'd be better off financially if I put the water on the market. My ethical conscience is very high and environmental watering is important for enhancing biodiversity on floodplains."

It's a modest water entitlement and previously she used it to grow cut flowers and stone fruit on her 2.5 ha block. Now she works away from the farm and with only a couple of ponies to support she has water left over each year.

The VEWH has accepted regular water donations from organisations during its five-year history but Christiane is the only individual who has donated.

In 2015–16, she donated 28 ML, which included water she carried over from the previous year. At the time she donated it, the water was worth about \$7,000. Some of the donated water has been delivered to wetlands near Christiane including the Butlers Creek system and Brickworks Billabong. They're part of the lower Murray wetlands which span more than 700 km of floodplain along the River Murray. The vast area makes the wetlands regionally significant.

The dominant tree species are river red gum and black box, providing habitat for birds and reptiles (such as lace monitors) and mammals (such as bats). Brickworks Billabong is a permanent saline wetland providing habitat to the critically endangered Murray hardyhead fish.

The lower Murray is a popular spot with campers, anglers and bird watchers. Aboriginal culture is strongly linked to the floodplains, which were an abundant food source.

Christiane developed an affinity for the Australian bush after migrating from Germany in 1981 and working as a jillaroo and later living and working in a central Australian Aboriginal community.



Her conservation efforts don't stop at donating water. She has also purchased land under a Trust for Nature conservation covenant to permanently protect remnant vegetation. The land also contains Bullock Swamp, which had environmental water delivered to it in 2014–15.

She says, "I think it's my ethical obligation to respect, look after and care about other forms of living.

"Besides the ethical reasons, a narrow focus on human needs has real-world harmful effects on people. In the riverine environment, unwillingness to share the available water with the whole ecosystem of which we are part destroys the riverine ecosystems. Yet, research has shown that we need exposure and contact with a healthy natural environment for psychological health and wellbeing. I guess it's a legacy of our evolution as human beings."

Christiane canoeing in her favourite wetlands, courtesy Christiane Jaeger.

people making a splash

From farmland to wetland

Looking across the expanse of sheep paddocks, it's hard to imagine the landscape dotted with wetlands. But that's how it was before it was turned into farms.

The locals who developed the Kerang district back in the mid-1900s can tell you exactly where the wetlands started and finished. It's all in the slight dips in the land, the grasses and sedges. These same people are now changing the landscape again, to bring the wetlands back.

One by one the wetlands are returning, thanks to environmental watering and the tireless efforts of landholders like Jill and Ken Hooper. Thirty-two hectares of wetlands on their property were flooded with environmental water for the first time in 2015. The wetlands, collectively called Wirra-Lo wetland complex, are some of the last wetland remnants that once meandered across the floodplain of the Loddon and Murray rivers, naturally flooding when water flowed through the landscape. Levee banks on the Loddon River are one reason the wetlands don't naturally flood anymore.

The Wirra-Lo wetland complex is regionally significant. It's home to a variety of waterbirds and was also once home to the vulnerable growling grass frog. With better watering regimes and consequently increased habitat, it's hoped they'll come back.



Ken says it's taken three years to organise environmental water to be delivered to the wetland. He and Jill have achieved this in collaboration with the North Central CMA, the Department of Environment, Land, Water and Planning and the VEWH.

"It's been an absolute joy and privilege to work with the North Central CMA and the VEWH to get to this stage.

"Over 100 bird species have been recorded on Wirra-Lo, with 83 recorded from September 2015 to March 2016 as part of the environmental watering monitoring program. The wetland has goannas and lizards and at least 45 native water-dependent plant species including a variety of nardoo, water milfoil and pond weed species. It's an incredibly valuable drought refuge in dry years."

Ken Hooper (centre) showing visitors a map of the wetlands, by Kathy Cogo.



Other parts of the Hooper's property could eventually become part of the Wirra-Lo wetland complex. The aim is to rotate the watering regimes so some are drying, as they would have naturally, and others have water in them. This means there will always be water somewhere for animals (such as the growling grass frog). The drying is just as important as the wetting because it allows plants to seed and provides food for mud-loving wader birds.

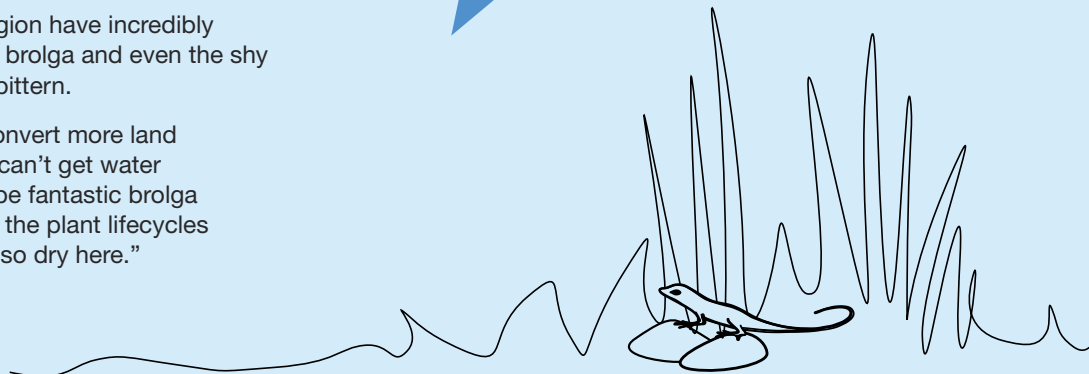
Established wetlands in the region have incredibly diverse wildlife – turtles, frogs, brolga and even the shy and endangered Australasian bittern.

Ken says, "We would like to convert more land to wetlands but we physically can't get water everywhere. This wetland will be fantastic brolga habitat. The objective is to get the plant lifecycles going again because it's been so dry here."

*Planting out Brolga swamp,
by Jill and Ken Hooper.*

Did you know?

Aquatic plants don't always need a lot of water, they need high and low levels at different stages of their life. Environmental water can provide this variability.





Swan nest at Sale Common, by David Stork.

Gippsland region

Environmental water was delivered to the Snowy, Thomson, Macalister and Latrobe rivers and to the lower Latrobe wetlands, making a big difference to plants and animals.

- West Gippsland achieved its first recorded breeding of Australian grayling fish.
- Kayakers, canoers and rafters enjoyed increased river heights caused by environmental water in the Thomson River.
- A whitewater river rafting business noticed more people using the Snowy River, and it also noted the river has a sense of being alive since environmental watering began five years ago.



Environmental watering in the Latrobe River in 2015–16 aimed to replicate conditions in 2014–15, prompting the first recorded breeding of the Australian grayling.

“Monitoring findings available in late 2015 found that the delivery of environmental water in autumn 2015 resulted in the first recorded breeding event of the Australian grayling, a vulnerable species, in this system,” said West Gippsland CMA’s David Stork.

“These results were based on larval and egg sampling done immediately after the environmental water release.” Larval and egg sampling involves picking up and counting fish eggs in the water to determine the extent of fish breeding.

Environmental watering also improved water quality in the lower Latrobe River and enabled water to enter Heart Morass, an important part of the lower Latrobe wetlands.

“While waterbird numbers have been low in the region due to drier conditions, a significant number of swans took advantage of the increased food supplies in Heart Morass as a result of the environmental water delivery,” David said.

“Heart Morass, Dowd Morass and Sale Common were successfully allowed to dry over summer to allow vegetation to grow. Heart Morass was watered in autumn and Sale Common in June. Very high water levels in Lake Wellington filled Dowd Morass in May.”

Shared community benefits

In March 2016, with the support of surrounding landholders and the CMA, the VEWL authorised the first watering of a community wetland.

Heart Morass, near Sale, was replenished with environmental water diverted from the Latrobe River. The watering mimicked natural flows into the system to provide feeding habitat, particularly for waterbirds, and supported plants.

Following the watering, a large number of swans were seen grazing on plants in the wetland.

The Latrobe River and lower Latrobe wetlands are very important to the local community.

The wetland has undergone more than a decade of community-funded restoration work. This has included removing 20 tonnes of carp, planting more than 50,000 indigenous trees and collecting seed from 50 plant species for regeneration.

The land for the 1,349 ha wetland reserve was purchased with funds from the Hugh D.T. Williamson Foundation. The rehabilitation of the reserve is a joint initiative by a group of stakeholders consisting of Field & Game Australia, Bug Blitz, Watermark Inc. and the West Gippsland CMA.



Waterway manager:

West Gippsland CMA

Storage manager:

Southern Rural Water

Sites delivered in Latrobe system

Latrobe River (3,750 ML)

Heart Morass¹

¹ Volumes delivered to Heart Morass are not measured.



*Top: Water testing, by David Stork, West Gippsland CMA.
Right: Swans at Heart Morass, by West Gippsland CMA.*

thomson river

The ideal breeding conditions for the iconic Australian grayling fish in the Thomson River were put to the test in 2015–16.

While we know that Australian grayling are more likely to breed when there is more flow in a river, it's important to test the actual volume and rate of environmental water that should be delivered to get the best breeding results.

In 2015–16, the West Gippsland CMA, in conjunction with fish researchers from the Arthur Rylah Institute, tested whether the Australian grayling would breed with a lower magnitude of environmental water than has been delivered to the river previously.

“The results indicated that very little breeding had occurred with this lower volume of water,” said the CMA’s David Stork.

“This is an important finding. We now know that to get a good breeding event, we need to aim for the higher magnitude of environmental water.”

Annual fish surveys in 2015–16 highlighted an improvement in the health of native fish in the Thomson River as a result of environmental watering. The surveys, conducted as part of the Victorian environmental flows monitoring and assessment program show improvements (such as an increasing population) of Australian grayling in particular.

“Australian grayling are highly dependent on flows in the river, and our environmental watering is therefore targeted towards their breeding, migration and survival,” David said.



Shared community benefits

Landholders along the Thomson River also expressed appreciation after environmental water partially filled billabongs on their properties in 2015–16, providing important habitat for waterbirds, frogs and platypus.

Keen kayakers, canoers and rafters also took advantage of increased flows in the Thomson River created by the environmental watering, which attracted visitors to the area.

Thomson River drift sampling, by West Gippsland CMA.



Waterway manager:

West Gippsland CMA

Storage manager:

Melbourne Water, Southern Rural Water

Site	Volume delivered in 2015–16 (ML)
Thomson River	12,251

Did you know?

Environmental watering can target the needs of particular fish and provide the triggers these species require to breed and mature.

"We now know that to get a good breeding event, we need to aim for the higher magnitude of environmental water."

David Stork, West Gippsland CMA.

Canoeing on an environmental water release in the Thomson River, by Jolyon Taylor.

macalister river

Environmental watering in the Macalister River in 2015–16 flushed waterholes and provided habitat for plants and animals, including platypus.

Sightings of platypus in 2015–16 are an encouraging sign of the benefits of environmental watering.

Fish surveys in 2015 found nine species of native fish: Australian smelt, flat-headed gudgeon, short- and long-finned eels, Australian bass and grayling, tupong, southern pygmy perch and common galaxia. Australian grayling spawned in the lower Thomson River in response to combined flows from the Macalister and Thomson rivers.

Despite these positive results, a blue-green algal bloom in the Macalister River was an unfortunate side effect of the warmer and drier conditions.

This highlights the vulnerability of these systems in a warming climate and the importance of environmental watering in helping to protect and preserve these important riverine environments for the benefit of future generations.

Did you know?

Environmental water can help provide the high and low river levels platypus need at different stages of their breeding cycles.



Shared community benefits

The improvements in the Macalister River have created a haven for local birdwatchers and wildlife enthusiasts.

West Gippsland CMA has a community-based Environmental Water Advisory Group. Duncan Fraser, a member of the group, recently discovered a rare native damselfly species in the Bellbird Corner Reserve. Duncan is also a member of the Bellbird Corner Reserve Management Committee.

“Damselflies are medium-to-large flying insects similar to dragonflies. They are often seen flying rapidly over water bodies. They need water to breed and can therefore be an important indicator of river health,” Duncan said.

“The sighting of the rarely seen orange threadtail and bronze needle damselflies was an exciting discovery.”

Orange threadtail damselfly at Bellbird Corner, Macalister River, by Duncan Fraser.



Waterway manager:

West Gippsland CMA

Storage manager:

Southern Rural Water

Site	Volume delivered in 2015–16 (ML)
Macalister River	12,796

“The sighting of the rarely seen orange threadtail and bronze needle damselflies was an exciting discovery.”

Duncan Fraser, West Gippsland CMA
Environmental Water Advisory Group.

Macalister River at Lanigans Bridge during low flows in winter, by Minna Tom.

Snowy river

Environmental watering in the Snowy River aims to rehabilitate river reaches below Jindabyne Dam by moving sediment, establishing plants and boosting carbon.

To achieve this, environmental water is released every day of the year. There are bigger releases in winter and spring to recreate flows that would have resulted from rainfall or snowmelt.

The East Gippsland CMA, along with scientists from the Arthur Rylah Institute, has undertaken research to determine whether environmental watering can benefit the growth and breeding of estuary perch and Australian bass in the Snowy River estuary.

“Our research is telling us that environmental watering in spring may benefit the growth of young fish of both species,” said the CMA’s Liz Brown.

“We also know that when the estuary is open, the flows assist to keep the estuary open longer than might otherwise be the case, benefiting recreational anglers and local tourism operators.”



Shared community benefits

Lynton Hill runs whitewater rafting tours on the Snowy River. He has noticed the increased environmental watering during the past five years has had a positive effect on the river.

“We see consistency of water, increased water clarity, reduction of stagnant pools, reduction of silt and algae on the banks, reduction of stream bed vegetation and a deepening and more defined river channel,” said Lynton.

He said the river now looks like how older locals remember it. “The river has a more natural flow, with increased spring releases mimicking what happened before the dam.”

As a result of environmental watering, there are more recreational activities along the river including camping, fishing, paddling, swimming and sightseeing. “The river now has a sense of being alive,” said Lynton.

In recognition of the five Aboriginal groups associated with the Snowy Mountains rivers, the five winter/spring releases were named Djuran (running water), Waawii (water spirit), Billa Bidgee Kaap (big water season), Wai-Garl (river black fish) and Bundrea Nooruun Bundbararn (waterhole big lizard).

Estuary perch, by Lauren Dodd.



"The river has a more natural flow, with increased spring releases mimicking what happened before the dam."

Lynton Hill, business owner.

Waterway manager:

New South Wales Office of Water (NSW),
East Gippsland CMA

Storage manager:

Snowy Hydro Limited

Site	Volume delivered in 2015–16 (ML)
Snowy River ¹	147,884

¹ Environmental water deliveries to the Snowy River are managed by the NSW Department of Primary Industries using water made available by Victoria and New South Wales. Deliveries are aimed at achieving outcomes in the New South Wales reaches of the river and also provide some downstream benefits to the Victorian reaches.

Did you know?

All fish need water but the timing, speed and temperature of water flowing in a river may suit one species and not another.

Lynton Hill on a tour of the Snowy River, courtesy Lynton Hill.

case study *australian grayling*

Environmental watering gives
threatened fish a brighter future



Adult Australian grayling from Thomson River, by Arthur Rylah Institute.



Environmental watering over the last five years has initiated migration of the threatened Australian grayling to spawn in the lower Thomson River. One fish was recorded travelling up to 140 km.

Australian grayling are prompted by increased river flows and possibly lower water temperature to migrate downstream to spawning sites in the lower reaches of the Thomson River in late April to early May.¹ Following spawning, eggs and larvae drift downstream to the sea and young fish travel back into freshwater river habitat 4–6 months later.²

Acoustic telemetry (an important scientific method where transmitters are implanted into fish and receivers are placed intermittently along the river) was used to track the movement of adult Australian grayling in the Thomson River in response to environmental watering that increased the flow rate and height of the river for several days in 2012 and 2013.³ Fish were found to move long distances, from 62–140 km, during the flows.

The fish migrated downstream during environmental watering, near to where the Thomson River meets the Latrobe River, where they spawned.

Spawning was detected using drift nets to collect fish eggs 6–10 km upstream from where the Thomson River meets the Latrobe River.

The peak in egg collection occurred simultaneously with environmental watering, as Figure 1 shows.⁴

A valuable lesson was learned in 2016 when the peak flow of environmental water changed from 800 ML a day to 600 ML a day to investigate whether the same response could be generated using less water.

No eggs were captured that year, indicating that 600 ML a day is too low for successful spawning. This demonstrates the need to provide river flows of sufficient magnitude and duration to allow adult fish to reach spawning areas. It is also important to maintain river flows and connectivity so they can return to their home range.

At times when the flows are not quite right and fish are presumed to stop migrating to the spawning area, multiple water releases may be provided to get the fish moving again, if environmental water is available. Alternatively, suitable natural flows could prompt fish to move again.

The recovery potential of Australian grayling is determined by multiple factors including marine larval stocks, river flows, food and habitat availability; and these interactions are complex.⁵

case study Australian grayling

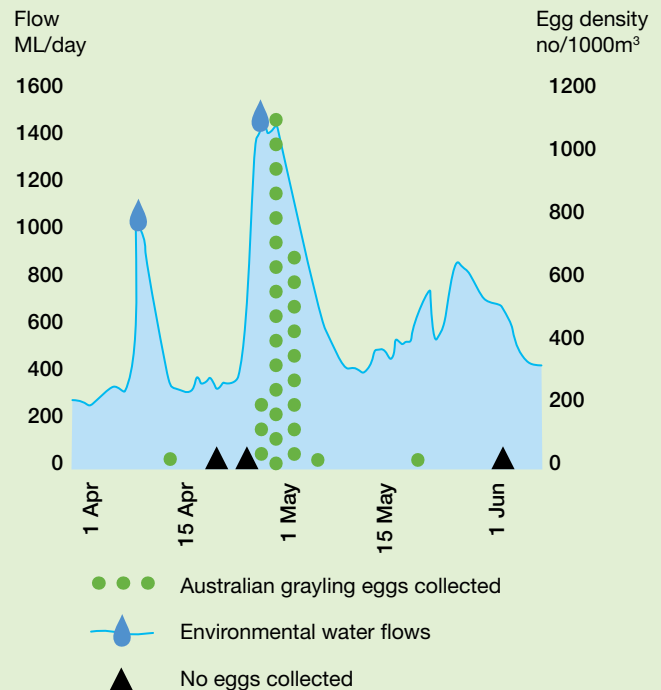
Environmental watering gives threatened fish a brighter future

In the last five years, fish ecologists have improved sampling and learned how water volumes affect Australian grayling spawning in the Thomson River.⁶ This knowledge is being applied to environmental water management.

In time, knowledge will increase further and environmental water secured for the Thomson River will be used more effectively to give Australian grayling a brighter future.

Figure 1 shows the average density of Australian grayling eggs collected in the lower Thomson River. Black triangles show drift sampling events when no eggs were captured. Grayling spawning is stimulated by an increase in river flows. Large quantities of eggs collected from the river coincided with environmental water releases.

Figure 1: Average density of Australian grayling eggs collected in the lower Thomson River 2012.

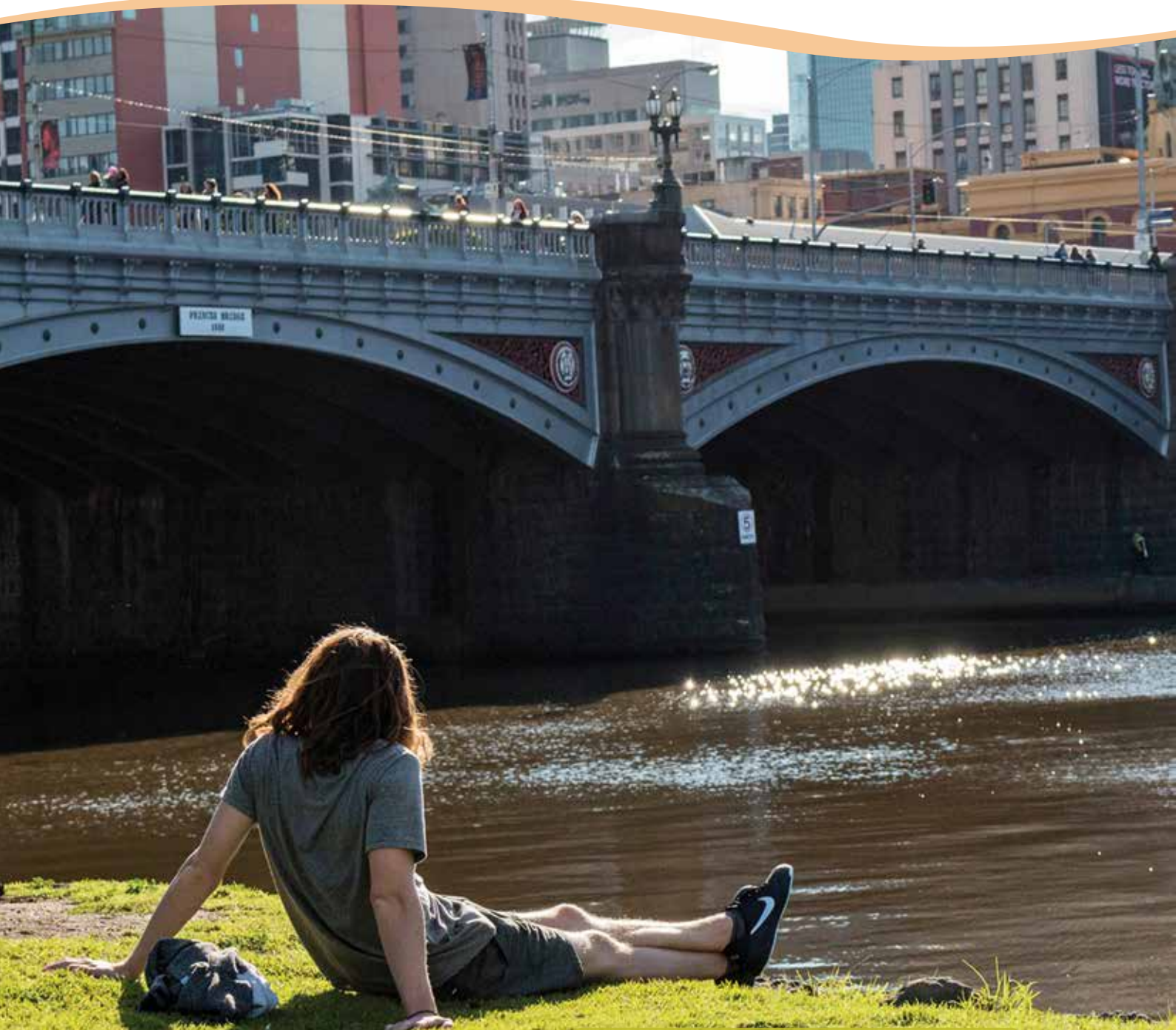




- ¹ W. Koster, D. Dawson and D. Crook, 2013, Downstream spawning migration by the amphidromous Australian grayling (*Prototroctes maraena*) in a coastal river in south-eastern Australia, *Marine and Freshwater Research*, 64:31-41.
- ² D. Crook, J. Macdonald, J. O'Connor and B. Barry, 2006, Use of otolith chemistry to examine patterns of diadromy in the threatened Australian grayling *Prototroctes maraena*. *Journal of Fish Biology*, 69: 1330-1344.
- ³ F. Amtstaetter, J. O'Connor and A. Pickworth, 2016, Environmental flow releases trigger spawning migrations by Australian grayling, *Prototroctes maraena*, a threatened diadromous fish, *Aquatic Conserv: Mar.Freshw.Ecosyst.* 26: 35-43.
- ⁴ F. Amtstaetter, J. O'Connor and L. Dodd, 2015, Thomson and Macalister rivers environmental flows monitoring and assessment program: 2015 survey results, Arthur Rylah Institute for Environmental Research Unpublished client report for the West Gippsland Catchment Management Authority, Department of Environment, Land , Water and Planning, Heidelberg, Victoria.

- ⁵ D. Schmidt, D. Crook, J. O'Connor and J. Hughes, 2011, Genetic analysis of threatened Australian grayling *Prototroctes maraena* suggests recruitment to coastal rivers from an unstructured marine larval source population. *Journal of Fish Biology*: 78, 98-111.
- ⁶ F. Amtstaetter, D. Dawson and J. O'Connor, 2015, Improving our ability to collect eggs of the threatened Australian grayling, *Prototroctes maraena*. *Marine and Freshwater Research*, 66: 1216-1219.

Young Australian grayling captured at Bunyip River, by Tarmo A Raadik.



Central region

Environmental watering provided relief to plants and animals during drier conditions across rivers and wetlands in greater Melbourne, Ballarat and Geelong.

- Environmental watering improved oxygen levels and reduced water temperatures in the Yarra River.
- Young Australian grayling are migrating into the Yarra River and Macquarie perch numbers are increasing.
- Environmental watering increased Australian grayling spawning in the Tarago River.
- The parts of the Werribee River that received environmental water had significantly more frogs, fish and waterbugs than other areas.
- Environmental watering helped flush out blue-green algae, improving conditions for visitors and anglers in the Werribee system.
- Environmental watering improved water quality for fish, waterbugs and platypus in the Moorabool River.

yarra system

Environmental watering in the Yarra River in 2015–16 focused on protecting the health of the system under dry conditions.

Environmental watering maintained habitat for fish and waterbugs and allowed movement between habitats. It also concentrated on minimising the risks associated with poor water quality in the deep pools in the lower Yarra River.

“A combination of warm weather and low flows in the river can cause dissolved oxygen levels to fall, which can be harmful to fish and other aquatic species,” explains Melbourne Water’s Helen Clarke.

“Water quality monitoring in the Dights Falls weir pools showed that environmental watering improved the levels of dissolved oxygen and reduced the temperature of the water.”

Research projects are showing evidence of juvenile Australian grayling migrating into the river, along with an increase in the number of juvenile Macquarie perch. There is evidence that spawning was aided by environmental watering. In 2014–15, monitoring collected higher numbers of Australian grayling eggs than in previous surveys, improving our understanding of spawning flows required for the river.

“These research projects help us improve our understanding of how to manage environmental water to achieve our ecological objectives,” Helen said.



Shared community benefits

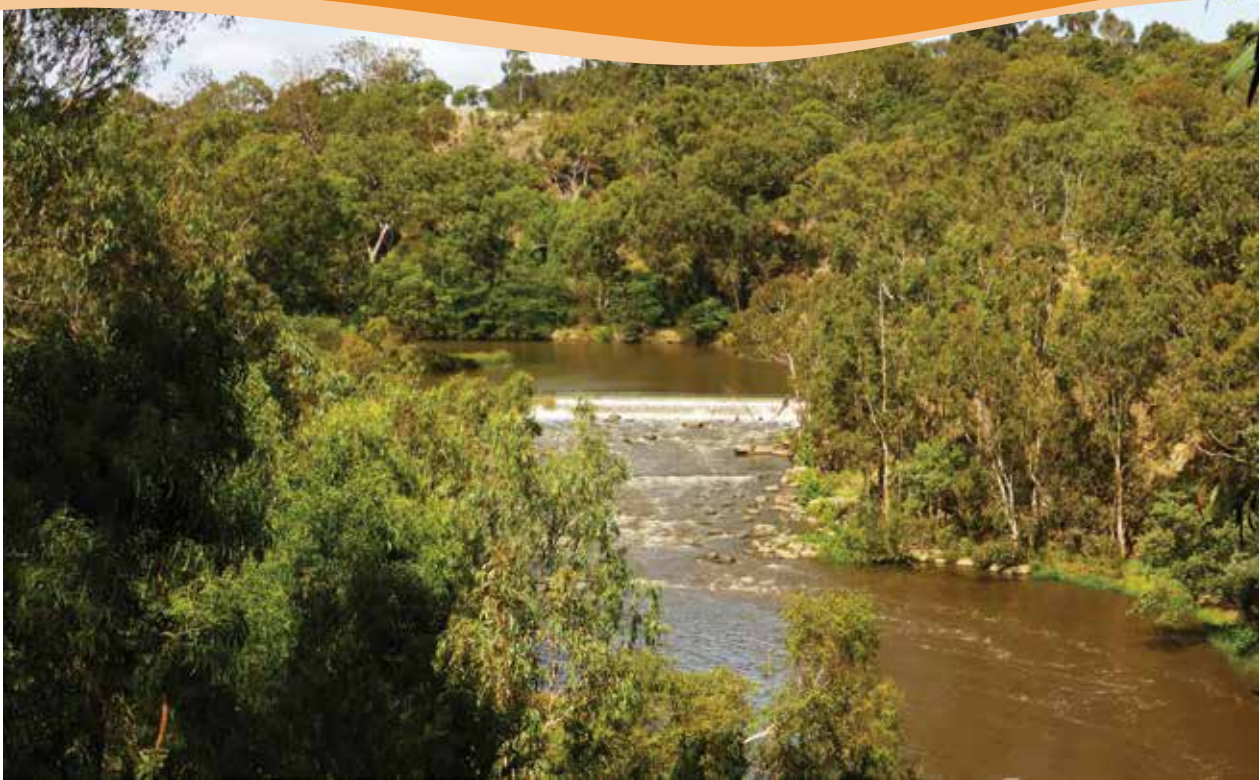
The VEWB and Melbourne Water began a cultural values mapping project in 2015–16, in collaboration with the Wurundjeri Tribe Land Compensation and Cultural Heritage Council. The project will improve the responsiveness of environmental water managers to Traditional Owners’ aspirations in the future.

In 2015–16, environmental watering in the Yarra River also improved recreational opportunities along the river by improving water quality during periods of very low flows.

A Melbourne icon, the river is the focus for many key community events including the Moomba festival, rowing regattas, the Melbourne Festival and the Melbourne International Dragon Boat Festival.

The banks of the river have barbecue and picnic facilities, fishing platforms and jetties. There are also trails and paths for cyclists, walkers and joggers.

Juvenile Macquarie perch, by Zeb Tonkin.



Waterway manager and storage manager:

Melbourne Water

Site	Volume delivered in 2015–16 (ML)
Yarra River	8,817

“Water quality monitoring in the Dights Falls weir pools showed that environmental watering improved the levels of dissolved oxygen and reduced the temperature of the water.”

Helen Clarke, Melbourne Water.

Yarra River at Dights Falls, Abbotsford, by Melbourne Water.

tarago system

Australian grayling showed a great response to environmental watering in the Tarago River in 2015–16 after a drier-than-average late summer and autumn.

Environmental watering in April 2016 aimed to trigger Australian grayling breeding, flush fine sediment and organic material from the river bed and maintain habitat for waterbugs and fish life.

“Egg and larval sampling is how we determine whether or not a fish species has spawned or produced eggs,” said Melbourne Water’s Sarah Gaskill.

“Early indications are that there was strong spawning by Australian grayling in response to environmental watering during April 2016.”

Survey results also show more grayling in the river following the increase in flows generated by environmental watering. Young fish also migrated.

Australian grayling breed in the lower freshwater reaches of the system before the eggs and larvae drift out to sea. The young fish spend about six months in the sea before they migrate upstream.

The timing of Australian grayling migration is measured by undertaking chemical analysis of their ear bone to determine when they moved from the marine environment into freshwater reaches.

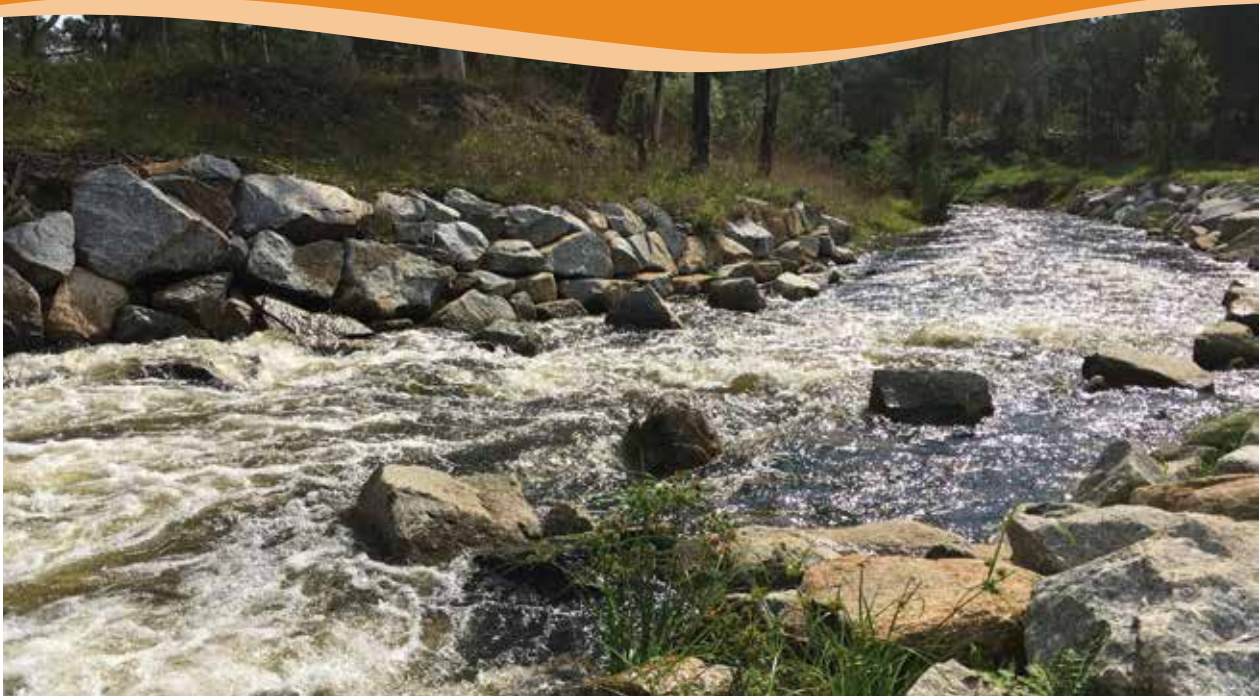
Water quality also improved following environmental watering, moving fine sediment in the river to create habitat suitable for fish, frogs and platypus.



Platypus showed an encouraging response to environmental watering, with monitoring indicating a slight increase in platypus numbers in the river. There were also sightings of young platypus.

“The environmental flows released by Melbourne Water from Tarago Reservoir over the last few years have brought a lot of activity into the Tarago River,” said Jeff Smythe, Coordinator of Friends of Robin Hood Reserve. “We’ve seen large schools of native grayling, many ducks and waterfowl and the odd freshwater crayfish crawling about. And of course the local platypus are very happy.”

Caught during platypus monitoring, Tarago River, April 2015, by Keith Chalmers.



Shared community benefits

Environmental watering improves the health of rivers and increases recreational opportunities for people living beside or visiting the Tarago River.

Melbourne Water's Sarah Gaskill said, "There is a very popular caravan park along the river and the picnic spots make wonderful stopping-off points for people along the Tarago. Fishing is also a popular recreational activity with many eager anglers awaiting a bite."

Waterway manager and storage manager:

Melbourne Water

Site	Volume delivered in 2015-16 (ML)
Tarago River	2,117

Tarago River at Robin Hood Reserve, Drouin, by Sarah Gaskill.

Maribyrnong system

Significant populations of platypus and a range of fish (including migratory short-finned eels, galaxias and flathead gudgeon) call the Maribyrnong River home.

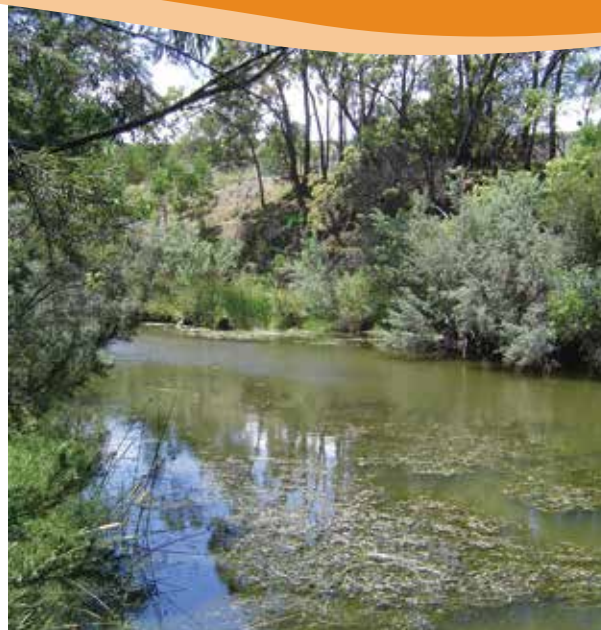
The Maribyrnong has suffered from a decline in rainfall and run-off. Without environmental water, it would continue to decline.

As there are no environmental water entitlements for the river, the VEWH and Melbourne Water have purchased unused water to maintain river quality for plants and animals over the last three years.

In 2015–16, 302 ML was bought and delivered over two releases when the river was especially low: one in January and one in March. These provided much-needed relief for fish, waterbugs and other animals by restoring oxygen levels, particularly in the upper sections of the system at Jacksons Creek. They also helped keep terrestrial plants from encroaching into the river channel.

Shared community benefits

The Maribyrnong River runs through the western suburbs of Melbourne before meeting the Yarra River. The river's proximity to the city makes its parklands popular for boating, fishing, cycling, walking and picnicking.



Waterway manager:

Melbourne Water

Storage manager:

Southern Rural Water

Site	Volume delivered in 2015–16 (ML)
Upper Jacksons Creek	300 ¹

¹ In 2015–16, water allocations copurchased by Melbourne Water and the VEWH contributed to the delivery of 300 ML of environmental water to meet objectives in upper Jacksons Creek in the Maribyrnong system, where no permanent environmental water holdings are currently held.

Jacksons Creek at Sunbury, by Melbourne Water.



*Family picnic at Maribyrnong River, by Chris Kapa.
Image courtesy of Melbourne Water.*

werribee system

Environmental watering provided much-needed drought relief for fish, frogs and waterbugs in the Werribee River after a hot, dry start to the summer.

In 2015–16, environmental water was released into the upper reaches of the river: they would otherwise have been a series of disconnected pools.

Ongoing monitoring shows that the parts of the river that were watered had significantly more frogs, fish and waterbugs than the parts of the river that can't receive environmental water.

"This is clear evidence that environmental watering really is very important in providing critical drought refuge habitat," said Melbourne Water's Bill Moulden.

"These creatures move to where there are suitable water levels, where they can take refuge until conditions improve.

"Environmental watering also ensures that native plants along the river bank receive enough water when the river is otherwise low."

Environmental water was also released into the lower reaches around Werribee, to improve water quality and flush a blue-green algal bloom.

"Water testing indicated that water quality improved after the summer release of environmental water and was successful in completely flushing a blue-green algal bloom, an unfortunate side effect of prolonged periods of hot weather," Bill said.

"This improved conditions for native fish and frogs, with the added benefit of improving water quality for recreational fishers in the lower reaches of the river and the estuary."

Environmental water is sometimes used to manage blue-green algae when the outbreak is small and the system is small and isolated.

Shared community benefits

The lower reach of the Werribee River flows through an important recreational centre in western Melbourne.

Each year, thousands of people visit and use the facilities along this part of the river: Werribee Park (including Werribee Open Range Zoo, Werribee Mansion and hotel, Werribee Park Golf Club and Werribee Park National Equestrian Centre) and Werribee South Boat Ramp.

Environmental water improves the quality of water in the Werribee system, improving the appearance of the river and generally making it better for visitors and fishing.

Waterway manager:

Melbourne Water

Storage manager:

Southern Rural Water

Site	Volume delivered in 2015–16 (ML)
Werribee River ¹	324
Pyrites Creek	326

¹ Deliveries to the Werribee River included some reuse of return flows. They include use of 141 ML of allocation made available for use by Melbourne Water.



Top – Before: Lower Werribee River with blue-green algal bloom before environmental watering on 11 March 2016, by Melbourne Water. Bottom – After: Lower Werribee River after environmental watering on 16 March 2016, by Melbourne Water.

moorabool system

Environmental watering provided drought refuges for fish, waterbugs, frogs and waterbirds in the Moorabool River during a dry 2015–16. Drought refuges (refuge pools) are sections of a river that hold water through long dries.

Drought conditions have continued to inflict high levels of stress on the Moorabool River, which needs catchment inflows and fresh water to support habitat for plants and animals.

“Due to dry conditions, only a small amount of environmental water was available in 2015–16, so the aim of environmental watering was to maintain water quality and top-up habitat refuge pools that support life in the river,” said Corangamite CMA’s Saul Vermeeren.

Ongoing drought and lack of river water created a dry riverbed in the lower reach of the river. Environmental watering in 2015–16 was also able to fill the channel and reconnect the Moorabool with the Barwon River, providing a link for animals to move between habitats.

Water quality monitoring at habitat refuge pools in some sections of the river indicated that environmental watering improved water quality conditions and supported fish, waterbugs and platypus.



Shared community benefits

In wetter years, when more environmental water is available, the delivery of environmental water to Moorabool River provides social benefits (such as bushwalking, camping, recreational fishing and canoeing).

Healthy plants in the Moorabool River gorge, by Chloe Wiesenfeld.



Waterway manager:

Corangamite CMA

Storage manager:

Central Highlands Water

Site	Volume delivered in 2015-16 (ML)
Moorabool River	240

Did you know?

Shorebirds need shallow water for foraging. Ideal depth differs from species to species - up to 15 cm for long-legged birds such as black-winged stilts, less than 5 mm for short-legged birds such as stints. Environmental water can help provide this diversity.

Moorabool River, by Chloe Wiesenfeld.

lower barwon wetlands

An all-important drying regime was implemented at the Hospital Swamps wetland in 2015–16, improving the health of wetland plants and attracting the majestic brolga.

Some wetlands, like Hospital Swamps, need both wet and dry periods to remain healthy and continue to provide habitat for fish, frogs, waterbugs and waterbirds.

Environmental watering protects some of Victoria's rarest and most charismatic species (such as the brolga, orange-bellied parrot, Australasian bittern and growling grass frog), and subtropical and temperate coastal saltmarsh plants.

"A successful drying regime occurred at Hospital Swamps this year, which improved soil salinisation and provided suitable growing conditions for the wetlands' significant environmental values, including nationally threatened coastal saltmarsh plants," said Corangamite CMA's Saul Vermeeren.

"Implementing the natural wetting and drying regime also provided wading habitat, which attracted the seasonal return of brolga to the site."



Shared community benefits

Keeping the lower Barwon wetlands healthy through the environmental watering program benefits everyone including the many thousands who visit and value the site each year for its intrinsic beauty, ecological significance and recreational opportunities.

In particular, the wetlands are used regularly by Geelong Field and Game and Geelong Field Naturalists for conservation activities, events, birdwatching, game hunting and other recreational activities.

"Geelong Field and Game acknowledges the long-term outcomes of environmental watering. Our club continues to be a strong advocate of a watering regime that contains noxious weeds (such as cumbungi) and noxious fish (such as European carp), and supports the biodiversity of the lower Barwon wetlands," said David La Ferla of Geelong Field and Game.

"Our club is very active in designing and actively deploying leading conservation programs and acknowledges that our wetlands serve as important refuges during periods of drought. For example, in early 2015 and early 2016 many of our members recorded the breeding activities of colonial nesting birds including royal spoonbill and Australian white ibis."

Coastal saltmarsh, Hospital Swamps, by Saul Vermeeren.



Waterway manager:

Corangamite CMA

Sites delivered in Lower Barwon wetlands¹

Reedy Lake

Hospital Swamps

¹ Water delivered to the wetlands is not measured.

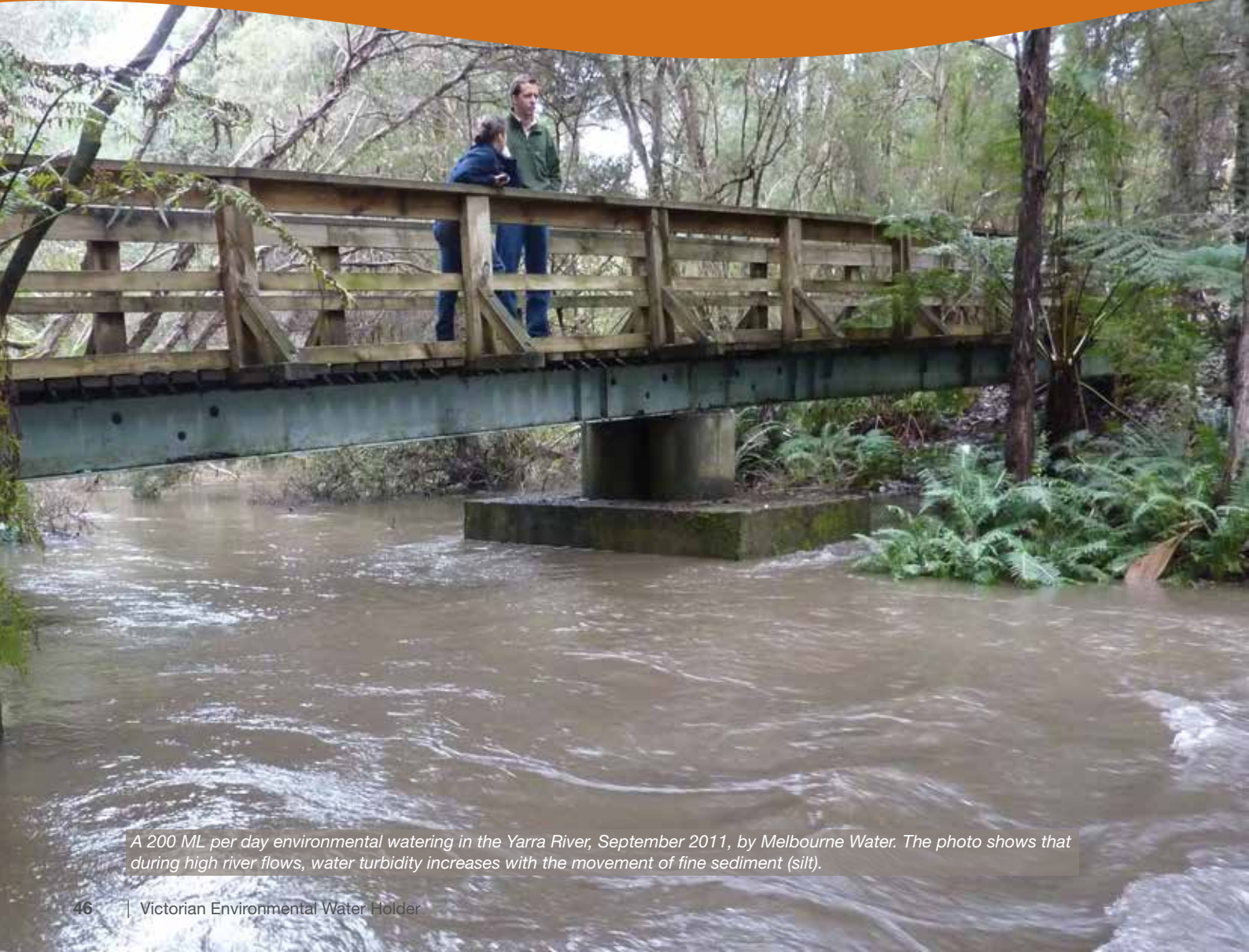
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David La Ferla, Geelong Field and Game.

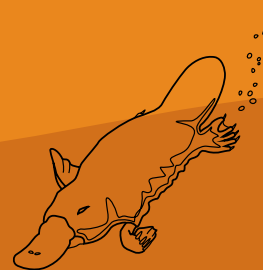
Lower Barwon wetlands from Lake Connewarre, by Saul Vermeeren.

case study yarra river

Less silt and more habitat in the Yarra River



A 200 ML per day environmental watering in the Yarra River, September 2011, by Melbourne Water. The photo shows that during high river flows, water turbidity increases with the movement of fine sediment (silt).



Environmental watering has scoured sediment from pools in the Yarra River, improving habitat for fish, waterbugs and platypus.

Fine sediment (silt) is important for a waterway but too much can be a problem¹. Without the flow variability provided by natural floods or large environmental water releases, sediments can build up, smothering rocks and snags and preventing the growth of algae that is the foundation of the food chain. Over a long period of time, the build-up of sediment can also reduce the size and depth of pools that are refuges for fish, invertebrates and platypus during droughts².

Floods or fast-flowing water dislodges and moves sediment to deepen pools and improve the diversity of habitat on the bottom of the river. Since 2011, environmental watering has helped maintain the river channel by moving sediments downstream.

In September 2011 and July 2012, environmental water (200 and 300 ML a day respectively) was released by Melbourne Water to improve habitat downstream of the Upper Yarra Reservoir. Each release lasted about three days. In part of a surveyed pool, these water releases eroded up to 98 percent of the bed sediment, as Figure 1 shows.

Between the large 2011 and 2012 water releases, smaller environmental water releases, of less than 60 ML a day, further reduced sediment and created in-stream habitats by providing a mixture of river flow rates and depth essential to fish, plants and waterbugs. This highlights that even small environmental water releases scour the channel.

When water levels recede, the river flows slowly again, allowing sediments to redeposit. Regular environmental watering is important in the Yarra River to help maintain a continuous process of sediment scouring and deposition.

Environmental watering since 2011 has increased the availability of pools and riffles (shallow sections of rivers with a rapid current) for fish and waterbugs, helping reduce terrestrial vegetation encroachment and helping maintain the dimensions of the river channel. This benefits a wide range of plants and animals including waterbugs, native fish (such as river blackfish and Macquarie perch) and platypus³.

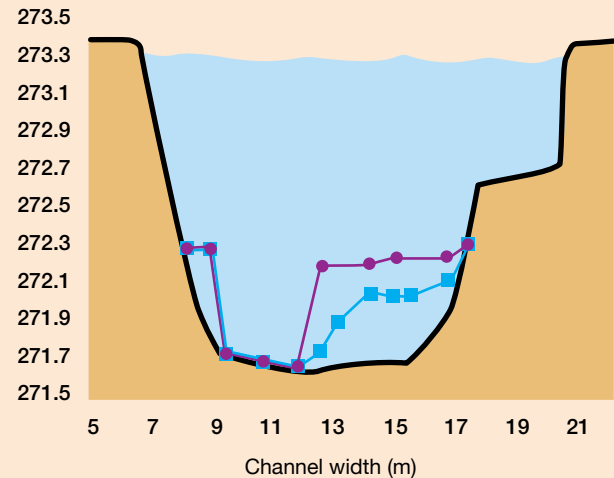
case study yarra river

Less silt and more habitat in the Yarra River



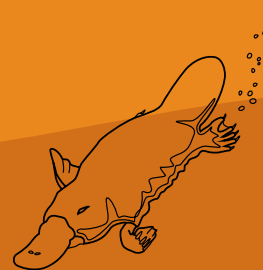
Figure 1: Pool cross-section before and after freshes in 2011 and 2012. In 2011 the profile was narrowed by sediment, or silt. By August 2012 environmental water helped move some of this sediment and provide more channel space.

Elevation above
Australian Height
Datum (m)



- Cross-section of original bed
- Profile at August 2012
- Profile at June 2011

Inspecting rocks at Yarra River, by Chris Kapa. Image courtesy of Melbourne Water.



¹ P. Prosser, I. D. Rutherford, J. M. Olley, W. J. Young, P. J. Wallbrink & C. J. Moran, 2001, Large-scale patterns of erosion and sediment transport in river networks, with examples from Australia. *Marine and Freshwater Research* 52: 81-99.

² Bond, R. Nicholas and Barbara J. Downes, 2003, The independent and interactive effects of fine sediment and flow on benthic invertebrate communities characteristic of small upland streams. *Freshwater Biology* 48: 455-465.

³ Z. Tonkin, J. Kearns, J. O'Mahony and J. Mahoney, 2015, Spatio-temporal spawning patterns of two riverine populations of the threatened Macquarie perch (*Macquaria australasica*). *Marine and Freshwater Research*.

Leisure time by the Yarra, by Chris Kapa. Image courtesy of Melbourne Water.



Fisher on the Glenelg River at Yat Nat, by Chloe Wiesenfeld.

Western region

Environmental watering was the difference between life and death for many water-dependent animals in 2015–16.

- It helped maintain fish diversity in the Glenelg River.
- It connected parts of the Glenelg River, enabling estuary perch and tupong to travel 330 km in total.
- Freshwater catfish survived in the Wimmera River in drought refuge pools maintained by environmental water.
- The critically endangered western swamp crayfish was found in the Wimmera River for the first time.
- Young platypus are surviving and maturing in the Wimmera River despite extended dry conditions.



glenelg system

Native fish have withstood one of the worst droughts on record in the Glenelg River thanks to environmental watering in 2015–16.

Fish monitoring shows that fish diversity remains high in the Glenelg River despite extremely dry conditions, during which much of the river was reduced to a series of large-but-disconnected refuge pools between November and May.

“The biggest threat through the last year was that water quality in refuge pools would deteriorate to the extent that stranded fish die. Environmental watering aimed to protect fish from poor conditions,” explains Bryce Morden from Glenelg Hopkins CMA.

“Environmental water delivered over summer improved conditions in refuge pools in the upper Glenelg River through to Dergholm. This also provided a short-term connection for fish to move between the pools.”

In a surprise find, estuary perch and tupong were found this year as far upstream as Fulham Reserve near Balmoral. This is a distance of 330 km upstream from where they start life in the estuary at Nelson.

Did you know?

Native fish numbers are about 10 percent of what they were 200 years ago. Victoria's environmental watering program is helping to protect native fish species.



“The Glenelg River is the best I’ve seen it for 50 years.”

Lachie Turner, Harrow sheep farmer.

Lachie Turner at Harrow Field Day, by Emma Coats.



Shared community benefits

“The Fulham Streamside Reserve is a very popular camping area with bush running to the edge of several long, deep pools. The reserve now has a new drawcard, with estuary perch a native fish species popular with anglers,” Bryce Morden from Glenelg Hopkins CMA says.

The importance of protecting refuge pools during drought years was highlighted to over 100 people who attended angler engagement field days along the Glenelg River.

Community and local angling club members aged from three to 80 watched CMA and research staff demonstrate how they monitor fish. They then discussed the benefits of environmental watering for native fish with representatives of the CMA, the VEWB and Austral Research and Consulting.

Waterway manager:

Glenelg Hopkins CMA

Storage manager:

Grampians Wimmera Mallee Water

Site	Volume delivered in 2015–16 (ML)
Glenelg River	2,970

Electrofishing demonstration on the Glenelg River at Harrow, by Chloe Wiesenfeld.

Wimmera system

Recent environmental watering has provided important habitat for native fish, plant, waterbug and other species during dry times by filling up key drought refuge pools.

“A resilience survey we undertook in 2016 highlighted the ability of the Wimmera River to withstand the stresses of drought due to environmental watering from 2010–14,” explains the Wimmera CMA’s Greg Fletcher.

“Carp numbers are down compared with previous years. Surveyors found small native fish like common galaxias and good numbers of flathead gudgeons.”

Despite dry conditions, freshwater catfish continued to be found in the Wimmera River due to the drought refuges provided by environmental watering.

Another significant find in 2016 was a western swamp crayfish, a critically endangered species found for the first time near Mokepilly in Mount William Creek, a refuge pool that received environmental water in 2015 and 2016.

CMA monitoring shows platypus also continue to do well on the adjoining MacKenzie River, despite the dry conditions. Two platypus, one adult female and one juvenile male, were captured during surveys in March 2016.

The juvenile is the fifth juvenile recorded in the last three years after no juveniles were found between 2006–13. The female was first captured as a juvenile the previous year, confirming young platypus are surviving and successfully maturing.

Jeparit Angling Club president Rick Day said, “The river makes the town. The river is the town.”



Shared community benefits

A giant golden perch, fondly named Spotted Bess, made an appearance at a local fishing competition on the Wimmera River in 2016, highlighting the benefits of environmental watering for native fish.

Named for the large black spot on her side, Spotted Bess was caught and released at the 2016 Horsham Fishing Competition, which attracted over 2,000 people and raised more than \$12,000 for community projects. Horsham local Adam Shields won the first prize, a new car, for catching her on the Sunday of the Labour Day weekend. The next competition is on the Labour Day weekend in 2017. For information about it, visit horshamfishingcomp.com.au.

The large female fish was first discovered during electrofishing surveys in 2012 and 2014 and continues to thrive in the Wimmera River thanks to environmental watering.

Catfish at Horseshoe Bend on Wimmera River, by Chris Bloink.



Waterway manager:

Wimmera CMA

Storage manager:

Grampians Wimmera Mallee Water

Site	Volume delivered in 2015–16 (ML)
Wimmera River	3,890
MacKenzie River and Burnt Creek	1,010
Upper Mount William Creek	100

Did you know?

Environmental water can maintain critical habitat, water quality and refuge habitat, particularly during low flow periods. When rivers stop flowing and dry, native fish seek refuge in deeper pools, scattered throughout the river system.

Zoologist and TV presenter Chris Humfrey, who ran river wildlife education sessions at the competition, next to a tank holding Spotted Bess, photo by Adele Rohde.

Wimmera-mallee wetlands

Environmental water was delivered to 40 of the 51 Wimmera-Mallee wetlands in 2015–16, providing refuge for plants and animals during one of the driest years on record.

Environmental watering created pockets of water across a very dry landscape, improving conditions for native plants and animals including lace monitors, straw-necked ibis, kangaroos and a range of waterbirds.

Environmental watering in wetlands in the Wimmera region provided much-needed refuge for some baby wood ducks at Pinedale and a fledging wedge-tail eagle at Harcoans.

In the Mallee, Greens Wetland, Barbers Swamp and Rickard Glenys Dam provided vital watering holes for local wildlife, attracting an extraordinary number of birds, reptiles and mammals.

In 2015–16, some of the Wimmera-Mallee wetlands were investigated as potential surrogate refuge sites for the endangered Murray hardyhead. Surrogate refuge sites are sites with a secure water source that don't have any hardyhead predators. They are used as breeding locations to provide a range of source populations for the larger Murray hardyhead sites. They are usually small sites, which means that the fish can be easily caught for translocation into larger sites. The investigation was part of a larger Murray hardyhead recovery project funded by the Victorian Government's Threatened Species Protection Initiative.

Shared community benefits

Many of the Wimmera-Mallee wetlands are on private land. Environmental water managers regularly meet landholders on-site to share knowledge about environmental water.

Wimmera-Mallee wetlands are also in areas of Aboriginal cultural significance. The North Central CMA continues to work with the Barengi Gadjin Land Council which has a representative on the Wimmera-Mallee Environmental Watering Advisory Group. The group provides advice and feedback on environmental watering activities from a community perspective. The group participated in a field trip in 2015–16 to see first-hand the environmental benefits of watering at three wetlands in the region.

Waterway manager:

Wimmera, Mallee and North Central CMAs

Storage manager:

Grampians Wimmera Mallee Water

Did you know?

Waterbirds fly long distances and are excellent at finding new wetlands, even those that flood after being dry for years.



Crow Swamp received almost 5 ML of environmental water in 2015-16, photo by Chloe Wiesenfeld.

Wimmera-mallee wetlands



Did you know?

Waterbugs (aquatic macroinvertebrates) are food for platypus, fish, turtles, frogs and birds. We provide environmental water to maintain healthy species populations.

Wimmera-Mallee Environmental Watering Advisory Group (EWAG) for North Central CMA. The group provides advice and feedback on environmental watering from a community perspective. Photo by Chloe Wiesenfeld.

Site	Volume delivered in 2015–16 (ML)
Barbers Swamp	17.3
Broom Tank	1.5
Bull Swamp (Bulls Swamp)	3.4
Challambra Swamp	3.2
Chiprick	4.0
Chirrup Swamp	2.1
Clinton Shire Dam	2.9
Cokum Bushland Reserve ¹	8.1
Considines ¹	4.8
Corack Lake	2.7
Creswick Swamp	2.7
Cronomby Tanks	13.0
Crow Swamp	4.9
D Smith Wetland	0.9
Davis Dam	1.0
Falla Dam	2.7
Fieldings Dam	1.3
Greens Wetland	3.7
J Ferrier Wetland	3.0
Jeffcott Wildlife Reserve	2.9
Jesse Swamp	3.9
John Ampt	3.9

Site	Volume delivered in 2015–16 (ML)
Krong Swamp	2.9
Lake Danaher Bushland Reserve	2.0
Mahoods Corner	1.4
Morton Plains Reserve	2.0
Mutton Swamp	3.9
Newer Swamp (Round Swamp)	3.5
Part of Gap Reserve (Stephen Smith Dam)	1.5
Paul Barclay	2.6
Pinedale	4.0
Poyner ¹	3.3
R Ferriers Dam	7.8
Rickard Glenys Dam	4.9
Roselyn Wetland/Reids Dam	6.3
Sawpit Swamp	9.0
Shannons Wayside	1.3
Tarkedia Dam	1.8
Towma (Lake Marlbed)	4.1
Wal Wal Swamp	2.1

¹ Water delivered to these Wimmera-Mallee wetlands was made available by Grampians Wimmera Mallee Water.

case study wimmera river

Building a strong Wimmera River



The Jeparit Waterwatch group which has provided some of the data in the long-term study of the effect of environmental watering on the Wimmera River. Photo by Joel Boyd.



The resilience of the Wimmera River has increased over the last five years, thanks to environmental watering.

Delivering environmental water to the Wimmera River has been essential to protect ecosystem health and the diversity of riverbank plants and animals (such as waterbugs and small fish).

Waterway managers aim to build resilience to help the river withstand the impact of floods and drought. Resilience is measured by the ability of a river to retain its structure and functions under stressful conditions (such as having little-to-no water flows and poor water quality).

During drought, watering aims to protect important refuge pools, in the deeper parts of the river. In average-to-wet years, watering is needed to increase the duration or magnitude of river flows that improve river connectivity.

An assessment of the riparian and in-stream condition of the Wimmera River over the last five years, from 2011–16, shows its resilience has strengthened with environmental watering.^{1,2}

Indicators like salinity and water levels show how much the river is changing, with surveys of aquatic plants and waterbugs measuring the ecosystem response.

The 2011 floods released the Wimmera River from the effects of drought. Since then, annual environmental watering has been essential to maintaining suitable salinity levels and improving water clarity and oxygen levels, which has resulted in improvements for aquatic plants. Early surveys, starting in 2011, recorded one dominant species of water ribbons. Five years later, in 2016, there was more diversity, with a high abundance of algae and water milfoil that have taken advantage of lower salinity levels.

The three photos also show the drought condition of aquatic and fringing vegetation at Jeparit in 2006 and post-drought recovery in 2011 and 2016. These plants create habitat for waterbugs and small fish.

Reeds and sedges are also starting to grow. They provide habitat and take up nutrients, reducing the likelihood and severity of blue-green algal blooms.

At Jeparit, floods and environmental watering have increased the level and improved the water quality and waterbug diversity of the Wimmera River. Figure 1 explains this further.

However, in the middle-to-lower reaches of the river, rising salinity is still a threat due to groundwater intrusion and evaporation after a series of dry years from 2013–15. In 2015–16, there were insufficient flows for the river. This was most apparent downstream of Dimboola and sites like Jeparit gradually became more isolated and saline.

case study wimmera river

Building a strong Wimmera River



The local community is monitoring water quality, weir pool levels, fish and birds. Jeparit Waterwatch volunteer Jeanie Clark says salinity is increasing. “Up until the last six months, the river had mostly been below 6,500 EC (electrical conductivity) units. That is better than most of the last 21 years we have recorded at Jeparit. However, with such dry conditions in the last year, the river’s salinity has been going up monthly.”



While environmental watering has topped-up pool levels and maintained water quality at many sites along the Wimmera River, in drier times reduced flows and environmental watering will compromise the resilience of the river.

Environmental watering has been used in the Wimmera catchment to support fish, plants, platypus, waterbugs and birds that depend on refuge pools. It has been essential to give plants and animals their best chance to bounce back from drought.



A resilient river also helps build resilience in the community. Fish in the river bring anglers to town for the annual fishing competition.

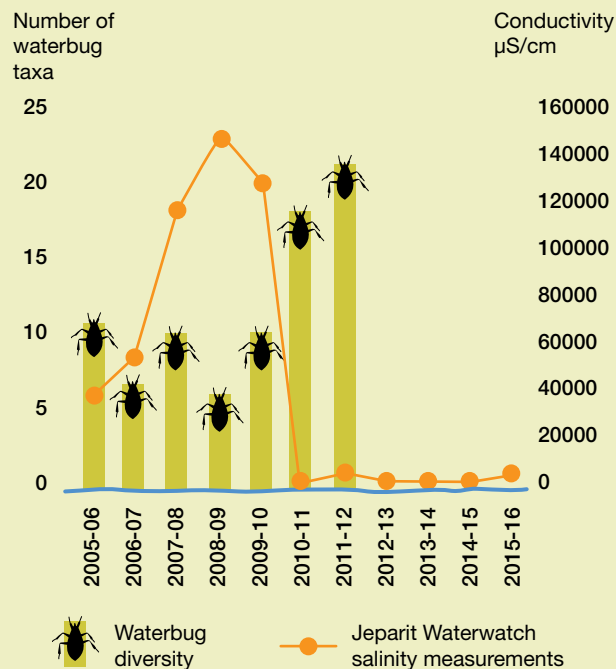
Post-drought recovery and expansion of aquatic and fringing vegetation at Jeparit from 2006–16.



The Wimmera CMA works with agencies and community members and groups (such as Jeparit Waterwatch and Jeparit Anglers Club) to deliver a watering program that protects the resilience of the river as much as possible.

Figure 1 shows the average yearly salinity (measured as conductivity $\mu\text{S}/\text{cm}$) and waterbug diversity (measured as the number of waterbug taxa) of the Wimmera River at Jeparit. Waterbug diversity rose as salinity levels fell in response to increased inflows and spring and autumn freshes. No waterbug survey data was available between 2011–12 and 2015–16.

Figure 1: Yearly salinity and waterbug diversity, Wimmera River at Jeparit.



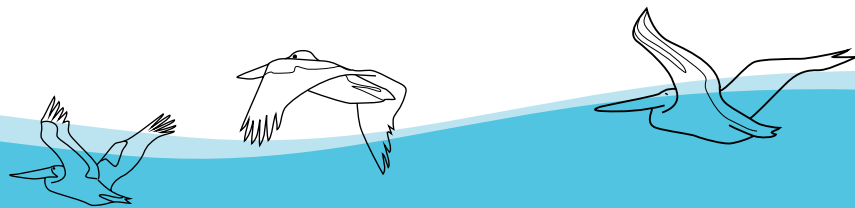
¹ Brooks, S. and C. Madden, 2016, Environmental Water Contribution to Ecosystem Functions and Resilience in the Wimmera River. Unpublished report to Wimmera CMA, Horsham, Vic.

² Personal communications with Shane Brooks (see footnote 1).

Wimmera River at Jeparit, by Deirdre Murphy.



Neds Corner watering, by Mallee CMA.



Northern region

Environmental water managers kept a close eye on conditions across northern Victoria to use water as efficiently as possible and at critical times.

- River red gums improved in the parts of Gunbower Forest that received environmental water.
- Over 25,000 waterbirds flocked to the central Murray wetlands after the delivery of environmental water. The endangered Australasian bittern bred at the wetlands.
- Environmental watering improved water quality in the Broken system.
- The Goulburn-Broken wetlands have significantly improved, attracting birds not seen for years.
- The critically endangered Murray hardyhead is repopulating the lower Murray wetlands.

goulburn system

Flexible, responsive environmental water management in the lower Goulburn River was particularly important during 2015–16, with the timing of environmental watering adjusted in response to weather and river conditions.

The annual spring delivery of environmental water was released slightly earlier than the previous year's October flow to improve the chances of seed germination and plant growth on the river banks before the forecast hot weather arrived.

"After losing a lot of bank vegetation during the 2010–11 floods, rushes, herbs and grasses tolerant of fluctuating water levels have re-established on the river banks," Goulburn Broken CMA's Meegan Judd said. "Flow variation is important to provide soil moisture to the bank and build the populations of these plants along river banks. Flows also provided a moisture store in the river bank to maintain these plants going into what was forecast to be a hot, dry summer."

A second release of environmental water was considered for November to provide cues for golden perch breeding and migration, but it didn't go ahead due to low water allocations.



"As is the case with all water entitlement holders, environmental water holders are affected by seasonal allocations. Given allocations on the Goulburn system were at 75 percent, [limited environmental water availability meant] we did not proceed with a second spring flow," Meegan said.

"Fortunately, the previous two years had seen good golden perch breeding in the Goulburn River and consequently the November release of environmental water was not one of the highest priorities for 2015–16."

A small environmental watering occurred in March 2016 to maintain recently established plants on the lower river banks.

Having fun at the Goulburn River, Murchison, by Tony Kubeil.



Shared community benefits

The Goulburn River is popular for recreational activities, particularly fishing, which benefits the regional economy.

During environmental water releases in 2015-16 the higher river levels were good news for anyone heading to the river to boat, fish or swim during Easter and the school holiday period. They also provided additional downstream environmental benefits.

Waterway manager:

Goulburn Broken CMA

Storage manager:

Goulburn-Murray Water

Site	Source of water and volume delivered in 2015-16 (ML)			
	VEWH	Living Murray	CEWH	Total
Goulburn River	10,000	27,680	190,563	228,243

Checking bank condition at Goulburn River near McCoys Bridge, by Goulburn Broken CMA.

broken system

Native fish in the lower Broken Creek proved remarkably resilient to a dry winter, low oxygen levels and azolla and blue-green algal outbreaks during 2015–16.

The Broken Creek's flows have been significantly altered over the past 100 years by the extraction of water for households, industry and farming. Rather than the creek having naturally low or no flows during summer and autumn, its water levels are maintained to supply water for irrigation, domestic and stock use. In winter, water levels would be higher under natural conditions but flows are now reduced as the irrigation season comes to an end.

Given the regulated flow pattern, in order to improve water quality and habitat for native fish and waterbugs, environmental watering is timed to piggyback on water delivered for irrigation, domestic and stock uses between August and May.

"2015–16 was particularly dry and long stretches of the creek below Nathalia were blanketed by azolla, a small aquatic floating fern. It can form a dense carpet and block sunlight and oxygen from reaching aquatic plants, fish and other aquatic wildlife," said Goulburn Broken CMA's Simon Casanelia.

"Water from the Goulburn water quality allowance, which is water specifically set aside for maintaining water quality in the Goulburn River, was delivered along the creek in August 2015 to help dilute and flush connected channels. This had the added benefit of flushing azolla through the system."



Low allocations and the dry spring and summer led to high temperatures which, coupled with a blue-green algal bloom, resulted in extremely low oxygen levels at Rice's Weir near Barmah. Low oxygen levels in waterways can result in the death of fish and other aquatic species.

Goulburn Broken CMA staff then implemented a careful fish rescue to move native fish out of harm's way. "To avoid fish deaths, native fish were moved from Rice's Weir and released further along the creek," Simon said.

"Just 15 native fish were caught and released including 13 Murray cod and two golden perch, indicating that most fish had already moved further along the creek. The fish that were caught appeared to be in good condition, with no visible signs of stress."

Fishing and boating were not affected by the blue-green algal and azolla outbreaks.

Large Murray cod caught during electrofishing surveys, by Jim Castles.

Shared community benefits

Environmental watering supports recreational activities including in townships and areas of the Broken-Boosey State Park.

Gavin Parkinson, secretary of the Numurkah Fishing Club, said his club is pleased to see environmental water being used in the lower Broken Creek system.

“Environmental water improves water quality, gives sufficient water levels and flows to fill habitat pools and provides safe passage for fish throughout the creek and fish ladders in our local waterway. We feel this is even more important during times of low winter flows and as we approach the spring breeding season.

“The use of environmental water, in conjunction with improved in-stream habitat from habitat restoration projects, has improved recreational fishing in the local area and will continue to do so in the future.”

Waterway manager:

Goulburn Broken CMA

Storage manager:

Goulburn-Murray Water

Did you know?

In some waterways, environmental water can lessen the chance of blue-green algae occurring, depending on the size and nature of the waterway. It may do this by reducing the periods of low flow and water temperatures, generally providing conditions that are less suitable for algae to take hold.

“The use of environmental water, in conjunction with improved in-stream habitat from habitat restoration projects, has improved recreational fishing in the local area and will continue to do so in the future.”

Gavin Parkinson, Numurkah Fishing Club.

Site	Source of water and volume delivered in 2015–16 (ML)		
	VEWH	CEWH	Total
Lower Broken Creek	800	29,520	30,320

Goulburn Broken Wetlands

Environmental watering in Kinnairds Wetland and Black Swamp near Numurkah in late 2015 attracted birds not seen in the area for many years.

Good feeding habitat has flourished in response to environmental watering. Surveys found three egret species that are of conservation concern in Victoria—the great egret, intermediate egret and little egret—are using the wetlands. Magpie geese were seen at the wetlands for the first time in 10 years. Water nymph, a rare wetland plant, was also recorded for the first time at Black Swamp.

“Reports of these species in the area are great indicators that environmental watering in these wetlands is achieving our objectives of increasing the plant diversity that provides food and shelter for native animals,” said Goulburn Broken CMA’s Jo Wood.

While environmental water was being delivered to the two wetlands, and to Reedy Swamp near Shepparton, more than 1,600 aquatic plants were planted to further boost the wetland’s biodiversity. Planting was undertaken with the support of Moira Shire, Parks Victoria and Rakali Ecological Consulting.

Environmental watering in Moodie Swamp near Katamatite in April and May 2016 promoted cane grass growth and protected the nationally threatened rigid water milfoil that grows there; it is one of the largest populations in Victoria.



Brolga have been spotted scoping the area for breeding in recent years. In May, Neil, an Australasian bittern tagged and monitored as part of the Bitterns in the Rice project, was recorded stopping over at Moodie Swamp.

This year, environmental water was delivered for the first time to Doctors Swamp near Murchison, one of the most intact red gum swamps in Victoria. The red gums and other plants responded positively to the watering with large numbers of egrets, herons and ibis observed at the site.

Great egrets at Black Swamp, by Catarina Gregson.

Shared community benefits

Visitors to the Goulburn-Broken wetlands enjoy a range of recreational activities including birdwatching, picnicking, bike riding, walking and camping. Doctors Swamp, Moodie Swamp and Black Swamp are state game reserves used by hunters.

Waterway manager:

Goulburn Broken CMA

Storage manager:

Goulburn-Murray Water

Site	Volume delivered in 2015–16 (ML)	
Goulburn wetlands	Doctors Swamp	594
	Reedy Swamp	356
	Black Swamp	80
Broken wetlands	Kinnairds Wetland	689
	Moodie Swamp	500



Top right: Brolga at Moodie Swamp, by Jo Wood.
Right: Dragonfly at Moodie Swamp, by Fiona Lloyd.

Campaspe system

Monitoring shows the Campaspe River is gradually climbing back to health following the Millennium drought and the floods of 2011, which wiped out much of the river's plants.

Environmental watering in summer and winter helped maintain habitat for fish, waterbugs, platypus and water rats, and continued the rehabilitation of aquatic and fringing plants.

"Latest monitoring demonstrates the gradual return of aquatic and fringing vegetation in the Campaspe River since the 2013 survey," said North Central CMA's Darren White. "The environmental water delivered to the river since the 2011 floods has likely helped this positive response."

A small release of environmental water to the Coliban River in summer 2016 helped improve conditions for platypus. The release was made in line with scientific flow recommendations to maintain in-stream and bank plants, cue fish movement, mix water in the river and inundate snag habitat.



"There have been a lot of people in here. A lot of kids jumping in the river, a few people with kayaks and rubber dinghies and there have been a few fishing."

Andrea Disher, camper at Campaspe River.

Campers Ron and Andrea Disher at Aysons Reserve, by North Central CMA.

Shared community benefits

The community has reported more frequent platypus sightings in the Campaspe River near Goornong following environmental watering. Rainbowfish numbers also continue to increase in the system.

While environmental watering specifically aims to achieve environmental benefits, it also provides additional benefits for communities.

“Environmental water for the Campaspe River is held in Lake Eppalock. In 2015–16, there was an opportunity to adjust the magnitude and timing of environmental flows to coincide with deliveries to irrigators and other consumptive users,” Darren said.

“Those actions reduced the call on environmental water, which meant more water was held in Lake Eppalock where it helped support recreational activities like boating, fishing and camping.”

“More broadly, environmental watering provides greater recreational benefits for towns along the Campaspe. These activities can result in economic returns for the local community.”

Environmental watering in the Campaspe River made it an appealing camping spot, with campers venturing into Elmore and Rochester to buy groceries and lunch.

Mount Gambier couple Ron and Andrea Disher were among hundreds of campers at Aysons Reserve (near Elmore) over the Melbourne Cup long weekend. “There have been a lot of people in here. A lot of kids jumping in the river, a few people with kayaks and rubber dinghies and there have been a few fishing,” Andrea said. “I reckon over the weekend there were more than 100 vans here, and tents as well. This place and this river are really good.”



Waterway manager:

North Central CMA

Storage manager:

Goulburn-Murray Water, Coliban Water

Site	Source of water and volume delivered in 2015–16 (ML)				
	VEWH	Living Murray	CEWH	Other	Total
Campaspe River	10,336	63	3,259	-	13,658
Coliban River	-	-	-	826 ¹	826

¹ Under entitlement rules in the Coliban system, the VEWB and the storage manager can agree to temporarily reduce passing flows and release the withheld volume at a later date. These rules allow some flexibility in the timing of passing flow delivery, which can help increase environmental outcomes without affecting other water users.

Campers by the Campaspe, by Victoria Penko.

central murray wetlands

Over 25,000 waterbirds flocked to wetlands in the central Murray wetland complex following environmental watering in 2015–16.

Environmental watering in Johnson Swamp, Richardsons Lagoon and the Wirra-Lo wetland complex helped rehabilitate wetland plants and encouraged waterbird feeding and breeding.

“Recent fauna surveys identify successful breeding of the Australasian bittern, Australian little bittern and brolga at Johnson Swamp in response to the delivery of environmental water,” said North Central CMA’s Bree Bisset.

“Vegetation surveys also recorded a high diversity and abundance of land and wetland plants at Johnson Swamp and Wirra-Lo wetland after environmental water was delivered.”

Environmental watering in Round Lake and Lake Elizabeth occurred to provide habitat for the critically endangered Murray hardyhead fish. Environmental watering helps protect the Murray hardyhead fish from extinction, explained Bree.

“Murray hardyhead can tolerate water salinity levels of between 25,000–40,000 EC (electrical conductivity) units, which is ideal for management as it enables the exclusion of competition from other species such as gambusia (mosquito fish).”

“Environmental watering allows us to maintain these few remaining refuges for Murray hardyhead and provides the conditions they need to survive and breed.”



Shared community benefits

Environmental watering of the central Murray wetlands supports recreational activities including bushwalking, birdwatching and duck hunting, which generate tourism and provide economic benefits to local communities.

Brolga, Johnson Swamp, by Damien Cook.



Waterway manager:

North Central CMA

Storage manager:

Goulburn-Murray Water

“Environmental watering allows us to maintain these few remaining refuges for Murray hardyhead and provides the conditions they need to survive and breed.”

Bree Bisset, North Central CMA.

Site	Volume delivered in 2015–16 (ML)
Johnson Swamp	2,890
Lake Elizabeth	1,070
Richardsons Lagoon	1,309
Round Lake	576
Wirra-Lo wetland complex	369

Australian little bittern, Johnson Swamp, by Simon Starr.

lower murray wetlands

In 2015–16, 11 important wetlands along the lower Victorian Murray received environmental water: Brickworks and Cowanna billabongs, Butlers Creek, Powell and Carpul lakes, Nyah and Vinifera floodplains, Neds Corner, Burra Creek North, Cardross Lakes and Lake Hawthorn.

Environmental watering focused on restoring aquatic plants and improving the condition of floodplain plants. It also aimed to provide habitat for carpet pythons, bats, lace monitors, sugar gliders, catfish and Murray hardyhead fish, and to promote breeding and roosting habitat for waterbirds.

Many rare and threatened species with state and national conservation listings benefited from environmental watering this year. The endangered Murray hardyhead is doing well at Brickworks Billabong (near Mildura) with 2015–16 sample catches recording more than 500 fish since translocation in January 2014. This is a good indication that Brickworks is a successful refuge site for the fish.

At Powell and Carpul lakes, regent parrots, blue-billed ducks, freckled ducks and Australasian shovelers were observed.



Shared community benefits

Environmental watering in the lower Murray wetlands presented a range of recreational and educational opportunities in 2015–16.

The Mallee CMA focused on sharing the community benefits of environmental watering with locals. “This included everything from birdwatching and bushwalking events to the introduction of a new education program for Year 9 students focused on environmental watering in River Murray wetlands,” said Mallee CMA Chair Sharyon Peart. “This unique in-field program has been delivered to more than 350 Year 9 students in the Mallee region, teaching them about everything from riparian health to environmental watering.”

A canoeing activity at Powell and Carpul lakes attracted over 30 people who enjoyed canoeing on the environmental water and birdwatching.

The 2016 Mallee Wetlands photo competition also attracted more than 100 entries and helped capture the beauty of the lower Murray wetlands.

Birdwatching at Lake Powell, by Mallee CMA.

Waterway manager:

Mallee CMA

Storage manager:

Goulburn-Murray Water

Site	Volume delivered in 2015–16 (ML)		
	VEWH	CEWH	Total
Brickworks Billabong	200	200	400
Burra Creek North	277	-	277
Butlers Creek ¹	103	-	103
Cardross Lake	477	477	953 ³
Cowanna Billabong	125	125	250
Lake Carpul	1,842	-	1,842
Lake Hawthorn	459	-	459
Lake Powell	2,158	-	2,158
Lock 15 wetlands ²	-	-	-
Neds Corner East and Central	250	-	250
Nyah Floodplain	790	-	790
Vinifera Floodplain	400	-	400



¹ Water delivered to Butlers Creek included 28 ML of allocation donated to the VEWB by a landholder in the Mallee region.

² Environmental watering at wetlands associated with lock 15 was facilitated through the manipulation of River Murray lock 15. Environmental water was used to account for the losses associated with raising the lock above normal operating range to achieve environmental outcomes. Environmental water use was accounted for by NSW.

³ Total use differs from the sum of the use per source due to rounding.

Early stages of environmental water delivery at Nyah Floodplain, by Mallee CMA.

Loddon system

Environmental watering provided relief to the Loddon River during a dry 2015–16.

Like the Campaspe River, the Loddon is on the road to recovery following the prolonged drought and the floods of 2011.

Environmental watering is important for this recovery, maintaining habitat for fish, waterbugs, platypus and water rats and helping to re-establish in-stream and fringing plants.

“Monitoring results show an increase in the distribution and number of Murray rainbowfish over the past four years, which is a promising result,” said North Central CMA’s Phil Slessar.

“River red gums are also showing signs of improved health and in-stream vegetation continues to recover.”

Healthy plants provide important habitat for native fish and the waterbugs that fish, waterbirds, water rats and platypus feed on.

A survey of Lake Meran also identified that hatchlings and juvenile Murray River turtles are in greater numbers than adult turtles, indicating successful breeding.

“This is a significant finding as exotic predators like foxes that prey on turtle eggs have significantly reduced the successful breeding of all freshwater turtle species, with adults recorded in greater numbers than juveniles throughout much of the Murray-Darling Basin,” Phil said.

“Therefore, the population of Murray River turtles at Lake Meran could be regionally significant if young turtles can recolonise the rest of the Loddon system during times of flood.”



Shared community benefits

“A healthy river delivers benefits to the environment, the local community and the economy,” Phil said.

Recreational fishing is popular in the upper Loddon River and Serpentine Creek. Laanecoorie Reservoir is inhabited by Murray cod and golden perch, and Serpentine Creek has annual sightings of golden perch.

Other recreational activities around the Loddon include waterskiing, boating, swimming, canoeing and walking along riverside tracks.

Environmental watering also improves water quality including water then used for irrigation.

Loddon River near Fernihurst, by Phil Slessar.



Waterway manager:

North Central CMA

Storage manager:

Goulburn-Murray Water

Site	Volume delivered in 2015–16 (ML)		
	VEWH	CEWH	Total
Loddon River and Tullaroop Creek	5,235	1,477	6,712
Lake Meran	2,000	-	2,000

Did you know?

There are three turtle species in Victoria – the broad-shelled turtle, the Murray River turtle and the Eastern long-necked turtle – and each need different water levels. Eastern long-necked turtles are most affected by regulated rivers as their habitats – wetlands, small ponds and floodplains – are more likely to dry. Environmental water can provide a lifeline for this species.

Murray River turtle, by North Central CMA.

the living murray icon sites

Waterway manager:

Goulburn Broken, Mallee and North Central CMAs

Storage manager:

Goulburn-Murray Water, Lower Murray Water, Murray-Darling Basin Authority (River Murray Operations)

The Living Murray program is one of Australia's most significant long-term river restoration projects. It aims to achieve a healthy, working River Murray system for all Australians. Four sites in Victoria have been identified as icon sites for restoration under the Living Murray program: Hattah Lakes; Lindsay, Wallpolla and Mulcra islands; Gunbower Forest; and Barmah Forest.

Hattah Lakes

Semipermanent lakes within the Hattah-Kulkyne National Park were topped up with environmental water in 2015–16, providing an opportunity for native fish to move freely between the lakes and the River Murray.

Native fish (such as golden perch and gudgeons) use the Hattah Lakes as safe refuges to breed and grow, before returning to the main river channel.

Black box trees in the northern Hattah Lakes system also received a boost as a result of past environmental watering.

“A report looking at the influence environmental watering has on the reproduction and health of floodplain black box in the northern lakes system of Hattah showed that due to past environmental watering, there was an increase in seed release and fruit abundance for black box,” said Mallee CMA Chair Sharyon Peart.

“This is great news as black box trees were hit very hard during the drought and have only started to recover over the last few years. The black box trees at Hattah are one of only a few intact communities left of this species in Victoria.”

A report evaluating the effect of environmental watering on the plants of Lake Bitterang found it helped increase native plant richness and abundance.

Surveys done over three years from 2013–15 also show regent parrots are nesting near infrastructure used to deliver environmental water at Messengers and Oatey's Bend.





Shared community benefits

The Hattah Lakes are a popular place for camping, kayaking, bushwalking, recreational fishing, birdwatching and photography.

In 2015–16, the Mallee CMA launched a children's activity book, *Wildlife Detectives*, based on local plants and animals. The book is available for free at the Hattah-Kulkyne National Park information centre. Environmental watering of the lakes helps to support recreational and educational activities, which contribute to the local community.

The lakes are greatly valued by Traditional Owners in the region, who have a continuing connection to the land. The area contains more than 1,000 registered Aboriginal sites including burial sites, scar trees and shell middens.

Site	Source of water and volume delivered in 2015–16 (ML)		
	VEWH	CEWH	Total
Hattah Lakes ¹	1,493	5,347	6,840

¹ Deliveries to Hattah Lakes included some reuse of return flows.

Birdwatching at Hattah Lakes, by Mallee CMA.

the living murray icon sites

Lindsay, Wallpolla and Mulcra islands

Native fish in the Mullaroo Creek and upper Lindsay River are on the move thanks to environmental watering and new environmental infrastructure.

In 2015–16, small pulses of water were delivered through these important anabranches at Lindsay, Mulcra and Wallpolla islands, providing ideal conditions for native fish spawning and recruitment.

Watering also partially filled Lake Wallawalla, improving the health of plants on the bed of the lake and supporting waterbird populations.

Recently constructed water-regulating structures on Lindsay River and Mullaroo Creek aim to restore flows and flooding to the Chowilla Floodplains (an icon site in South Australia) and the Lindsay–Wallpolla–Mulcra islands icon site. They also removed barriers to fish movement.

Research by the Arthur Rylah Institute into how native fish use the regulators recorded Murray cod, golden perch, silver perch, bony herring and Australian smelt moving frequently between the different habitats within anabranches and the River Murray. The investigation used telemetry receivers placed along Mullaroo Creek, Potterwalkagee Creek, the Lindsay River and the River Murray. Fish with telemetric trackers swimming past the receivers were able to show how fish navigated through the structures. “Telemetric trackers were attached to 135 fish including Murray cod, golden perch and freshwater catfish,” said Mallee CMA Chair Sharyon Peart. “These tracking devices showed increased movement of native fish into the creeks over spring and early summer for breeding.”



One golden perch was tracked travelling from Mullaroo Creek to lock 11 near Mildura, an ultramarathon distance of more than 180 km.

Shared community benefits

Discussions with the Mallee CMA's Aboriginal Reference Group and several on-Country visits have happened across the region to inform Aboriginal stakeholders about environmental watering and to improve the CMA's understanding of Aboriginal aspirations. This will help the CMA to carry out environmental watering that is mutually beneficial.

Lake Wallawalla, by Courtney Johnson.



Site		Source of water and volume delivered in 2015–16 (ML)			
		VEWH	Living Murray	CEWH	Total
Lindsay Island	Lake Wallawalla ¹	8,000	-	-	8,000
	Lindsay River and Mullaroo Creek ²	-	-	2,739	2,739
Mulcra Island	Potterwalkagee Creek ²	-	-	-	-
Walpolla Island	Wallpolla East	-	600	-	600

¹ Deliveries to Lake Wallawalla included some reuse of return flows.

² Environmental watering in Lindsay River, Mullaroo Creek and Potterwalkagee Creek was facilitated through the manipulation of River Murray locks 7, 8 and 9. Environmental water was used to account for the losses associated with raising the locks above their normal operating ranges to achieve environmental outcomes. Environmental water use in the Lindsay River and Mullaroo Creek was accounted for in Victoria, with deliveries in Potterwalkagee Creek accounted for by NSW.

Lindsay and Mulcra islands, by Mallee CMA.

the living murray icon sites

Gunbower Forest

Environmental water was provided to 2,840 hectares of Gunbower Forest in 2015–16 including to 95 percent of the forest's impermanent wetlands. Environmental watering also benefited 14 percent of the forest's river red gum trees.

“Vegetation surveys in watered wetlands and under river red gums demonstrate strong aquatic plant growth, especially in areas where plants were protected from carp,” said North Central CMA's Kathryn Stanislawski.

“There is healthy growth and improved condition of river red gums in parts of the forest that received environmental water. The condition of river red gum trees in parts of the forest not watered is comparatively poor.

“Fish surveys also identify mass recruitment of small-bodied fish in floodplain wetlands that received environmental water.”

Environmental water is also provided to Gunbower Creek to support a diverse native fish population. “We maintained moderate-to-high flows through the creek in spring and summer to support Murray cod spawning (when fish release fertilised eggs), recruitment and survival. Low flows were maintained through winter to provide habitat for Murray cod and other native species outside the irrigation season,” Kathryn said.

“Fish surveys recorded Murray cod of mixed ages for the first time in 10 years, including ‘young-of-year’ [fish under one year old]. This indicates recent strong recruitment and fish surviving to maturity.”

Murray cod, Dixie Patten, Gunbower Creek by North Central CMA.



Shared community benefits

Gunbower Forest is very important to the local community for recreational, social and economic reasons. It is of particular importance to the Barapa Barapa and Yorta Yorta Traditional Owners.

Yorta Yorta and Barapa Barapa have established a self-determined monitoring program focused on cultural values. In 2015–16, Barapa Barapa and Yorta Yorta Traditional Owners, North Central CMA staff and vegetation and fish ecologists joined forces to examine how the forest had responded to environmental watering and to share the results of cultural health site surveys, fish surveys and plant surveys.

Traditional Owner and North Central CMA team leader Sharnie Hamilton said, “Water is a key element for our cultural sites, not only our cultural sites but the environment. The environment is what makes our cultural sites. We need water to these places so we can bring back food and medicine plants, because these plants are becoming very rare out here.”



Site ¹	Source of water and volume delivered in 2015–16 (ML)			
	VEWH	Living Murray	CEWH	Total
Gunbower Forest	13,692	15,000	-	28,692
Gunbower Creek	2,691	-	13,606	16,297

¹ Deliveries to Gunbower Creek and Forest included some reuse of return flows.

“Water is a key element for our cultural sites, not only our cultural sites but the environment. The environment is what makes our cultural sites. We need water to these places so we can bring back food and medicine plants, because these plants are becoming very rare out here.”

Sharnie Hamilton, Traditional Owner and North Central CMA.

Gunbower Forest, by North Central CMA.

the living murray icon sites

Barmah Forest

Environmental watering in the Barmah-Millewa wetlands in 2015–16 boosted native grasses, fish and bird populations before the water flowed back into the Murray to benefit downstream river users, wetlands and communities.

Goulburn Broken CMA Project Officer Lisa Duncan said about 17 percent of the Barmah-Millewa floodplain was inundated this season.

“About 20 percent of the environmental water delivered over the five-month period stayed in the wetlands, while the rest flowed back into the Murray where it was then re-used to water wetlands further downstream (such as Gunbower and Hattah),” Lisa said. “Waterbugs were flushed back into the Murray, providing more food for fish, which made for good fishing.”

Native birds also responded well to the environmental water. “Little pied cormorants nested in at least two locations in Barmah and up to 60 male Australasian bitterns were heard calling in wetlands on both sides of the river,” Lisa said. “We suspect the Australasian bitterns were breeding, which is great news as they are a nationally endangered species; but because of their cryptic nature we weren’t able to confirm this.”

The vulnerable river swamp wallaby-grass responded well to the watering while moira grass growth was varied. “Good growth occurred despite not reaching the depths or duration of flooding we’d normally aim for. Moira grass was found to be putting out new roots at the nodes when the water drew down. This will form new plants.”



Barmah Forest has the most extensive areas of moira grass plains in Victoria and is an important breeding ground for ibis, swans, ducks, cormorants, herons, spoonbills, crakes and rails.

Ongoing monitoring at Barmah continues to measure how environmental watering affects water quality; bird, fish, frog and waterbug breeding and numbers; and plants. “This helps us understand the effectiveness of environmental watering and tweak future timing and flow rates to get the best outcomes,” Lisa said.

“We’ve been doing this for a number of years now, and we’re seeing some great results. For example, the percentage of native fish caught in creeks and wetlands was much higher (40 percent) in 2015–16 than in 2014–15 when it was just five percent. That’s why it’s so important for us to continue supplying environmental water to these critical drought refuges throughout the forest.”

Blue damselfly at Hut Lake, Barmah, by Keith Ward.



Shared community benefits

Environmental watering has helped sustain and grow Barmah Forest's significant natural values, which in turn has added to social and recreational enjoyment. Increased canopy, in-stream plant growth and invigorated moira grass plains have all added to the fishing, birdwatching and bushwalking experience.

A river cruise through the wetlands provides visitors with examples of stable biodiversity.

White ibis chicks at Boals site, by Keith Ward.

Site	Source of water and volume delivered in 2015–16 (ML)			
	Living Murray	CEWH	Other	Total
Barmah Forest and River Murray ¹	10,000	258,594	134,700 ²	403,294
Boals Deadwood	10,592	-		10,592

¹ Commonwealth deliveries in the River Murray support environmental objectives in the Barmah Forest and downstream in the River Murray.

² This comprises Living Murray and CEWH water released from the New South Wales share of the Murray water storages.

Ovens system

Environmental watering in the King and Buffalo rivers during autumn 2016 aimed to benefit native fish. The King and Buffalo rivers are part of the Ovens system.

“Commonwealth environmental water was released into the King and Buffalo rivers to provide some variability in flows and inundate new habitats for native fish,” said North East CMA’s Catherine McInerney.

“Environmental watering allows connection between different habitats, which enables native fish species to flourish, and provides a range of new food resources and habitats for waterbugs.”

“Environmental water was released when flows were low and didn’t contribute to minor flooding the catchment has since experienced.”

The Ovens River system supports a wide range of native fish including Murray cod, trout cod, golden perch and fly-specked hardyhead. The Buffalo River is important for large fish species during part of their breeding cycle, while trout cod are found as far up the King River as Whitfield.

Fish movement throughout the system relies on unimpeded access that requires adequate flows and the removal or modification of barriers (such as weirs).

The North East CMA is in the process of providing fish passage on all remaining weirs in the Ovens system below Lake Buffalo and Lake William Hovell.

The Ovens system has also seen a successful recovery project for trout cod, and efforts to reintroduce Macquarie perch are currently underway. Frogs (such as the giant bullfrog and growling grass frog) are abundant in the lower Ovens River and associated wetlands and in the King River upstream of Cheshunt.

Shared community benefits

Environmental water released into the Ovens has helped improve its health. This healthier river attracts people engaged in fishing, boating, kayaking, waterskiing, swimming and bushwalking.

Waterway manager:

North East CMA

Storage manager:

Goulburn-Murray Water

Site ¹	Source of water and volume delivered in 2015–16 (ML)		
	VEWH	CEWH	Total
To the King River ¹ from Lake William Hovell	-	50	50
To the Buffalo River ¹ from Lake Buffalo	-	20	20

¹ The King and Buffalo rivers are major tributaries of the Ovens River.



Did you know?

For all fish, environmental flows can be important in connecting habitats and enabling fish to move up and downstream. This movement is important for breeding and feeding.

Kayaker on Ovens River, by North East CMA.

case study barmah waterbirds

Barmah wetlands alive with waterbirds



Surveys over five years at Barmah Forest show a connection between environmental watering of the wetlands and waterbird fledging success.

Barmah Forest's shallow wetlands provide breeding habitat for colonial waterbirds. These are birds that nest in groups (such as the Australian white ibis, straw-necked ibis and royal spoonbill).^{1,2} If wetlands are flooded for 3–4 months, they create ideal conditions for the birds to nurture their young from egg to flight, a life stage known as fledging.

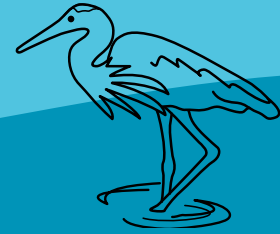
The Goulburn Broken CMA has monitored nesting behaviour in response to environmental watering since 2011.² Aerial surveys, site visits and remote cameras have tracked water depth and bird response.

One wetland, Boals Deadwood, has been home to most of Barmah Forest's waterbirds in the last five years, as Figure 1 shows. In a successful breeding season, two or three birds may fledge from each nest.

Environmental watering in Boals Deadwood maintained a depth of 0.5 m for 3–4 months, emulating more natural conditions. While how much environmental water is delivered each year varies according to rainfall and natural inflows, sufficient water is necessary for waterbirds to breed.^{3,4}

In four of the last five years (between 2011–15), the number of nests in Boals Deadwood was highest when it was flooded for 3–4 months, as Figure 2 shows.

White ibis chicks at Boals Deadwood wetland, by Keith Ward.



While the right triggers for nesting—early-season flooding, water temperature and day length—occur most years naturally, environmental watering has been essential to achieve the 3–4 month flooding needed for fledging.⁵

Goulburn Broken CMA Project Officer Lisa Duncan says the one year the forest didn't receive environmental water had a significant effect on breeding.

"We saw 500 ibis nests abandoned in 2014 when seasonal conditions changed in the wetland and we were unable to arrange delivery of environmental water in time."

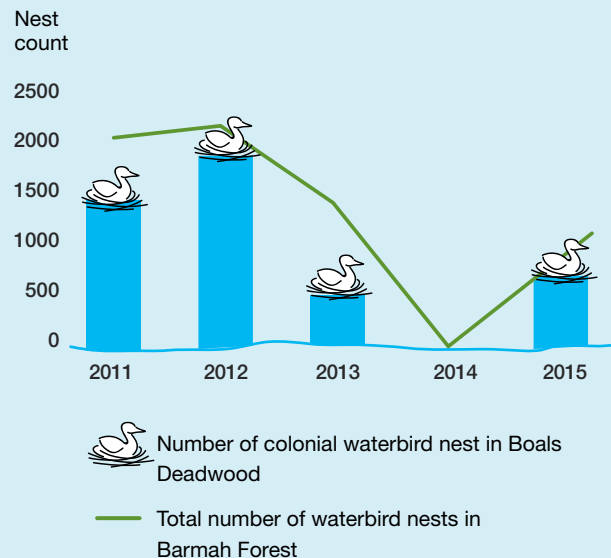
White ibis, straw-necked ibis and royal spoonbill represent half-to-all of the total population of nesting waterbirds throughout the forest.^{1,2}

By knowing the number of nesting waterbirds and monitoring fledging, environmental water managers can respond to changes regularly. For example, they might adjust the volume of water delivered to avoid nests being inundated or abandoned.

Birds are an important part of wetlands and environmental water maintains the range of plants and animals needed to sustain their habitat and foraging grounds. Environmental watering over the past five years has supported thousands of waterbirds to fledge successfully.⁶

Figure 1 shows that colonial waterbird nests in Boals Deadwood each spring/summer breeding season comprise most, and in 2013 all, of the waterbird nests in Barmah Forest.

Figure 1: Colonial and other waterbird nests, Boals Deadwood and Barmah Forest.

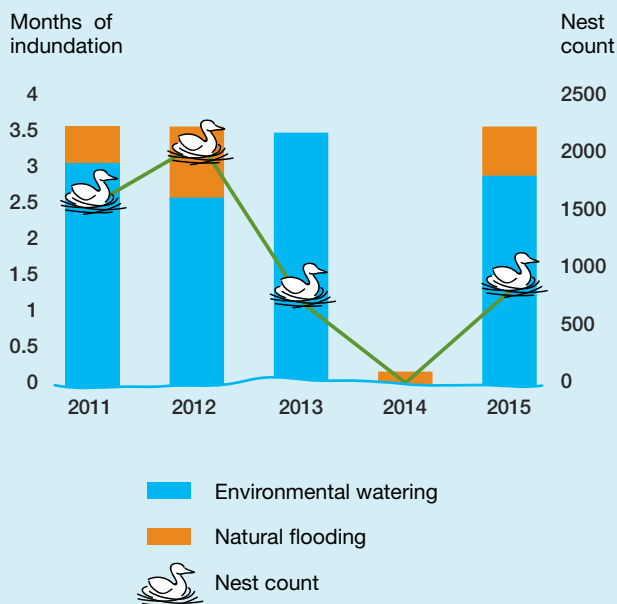


case study barmah waterbirds

Barmah wetlands alive with waterbirds

Figure 2 shows the number of nests recorded in Boals Deadwood wetland (the green line) and the number of months of flooding. Blue represents environmental water and orange represents natural flooding. The nest count is represented by the number of breeding pairs. The extended periods of inundation by environmental water allows chicks to fledge (from early October to late January).

Figure 2: Nests and months of flooding, Boals Deadwood.



¹ Unpublished data reports, Goulburn Broken CMA.

² D. J. Leslie, 2001, Effect of river management on colonially-nesting waterbirds in the Barmah-Millewa Forest, South-Eastern Australia. Regulated Rivers: Research and Management 17: 21-36.

³ A. D. Arthur, J. R. Reid, R. T. Kingsford, H. M. McGinness, K. A. Ward & M. J. Harper, 2012, Breeding flow thresholds of colonial breeding waterbirds in the Murray-Darling Basin, Australia. Wetlands, 32(2), 257-265.

⁴ K. A Ward, 2015, Environmental Water Allocations in the Barmah-Millewa wetlands. Floodplain Ecology Course.

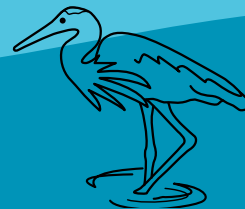
⁵ R. T. Kingsford, J. L. Porter & A. Wetlands, 2012, Survey of waterbird communities of the Living Murray icon sites, November 2011. Australian Wetlands and Rivers Centre, University of New South Wales, Report to Murray-Darling Basin Authority.

⁶ GB CMA & OEH, 2016, Barmah-Millewa Forest Seasonal Watering Proposal 2016-2017. Prepared 14 April 2016. Goulburn Broken CMA, Shepparton, and NSW Office of Environment & Heritage, Moama.

Remote cameras monitored successful fledging of white ibis chicks, by Keith Ward.

case study lake elizabeth

Rehabilitating Lake Elizabeth to its former glory



Environmental watering is sustaining the habitat necessary for the survival of one of Australia's most threatened fish, the Murray hardyhead.

Lake Elizabeth was once a freshwater wetland, but land-use change and water management have caused salinity to increase. Fortunately for Murray hardyhead, they can tolerate very high salinity, which gives them an advantage over other fish in salty wetlands.

Before the Millennium drought, Lake Elizabeth north-west of Kerang, had a vibrant population of Murray hardyhead: there are currently only 10 populations recorded in Australia. During the Millennium drought, the lake dried out and all its Murray hardyhead died.

In recent years, North Central CMA has undertaken a rehabilitation program to make water quality, habitat and food at Lake Elizabeth suitable for the reintroduction of Murray hardyhead. This enabled 50 fish to be translocated to it in 2016.

Environmental watering keeps the salinity in Lake Elizabeth between 25,000 and 40,000 EC (electrical conductivity in micro siemens or $\mu\text{S}/\text{cm}$), which is roughly half as salty as the sea. This is helpful for Murray hardyhead because it excludes less salt-tolerant fish that prey on them or compete with them for food, such as carp, redfin and gambusia. The salinity range is also good for sea tassel, an aquatic plant that provides habitat for Murray hardyhead to reproduce, and for some zooplankton, small crustaceans which are the ideal food source for small fish¹.

Delivering environmental water to Lake Elizabeth, by North Central CMA.

case study lake elizabeth

Rehabilitating Lake Elizabeth to its former glory

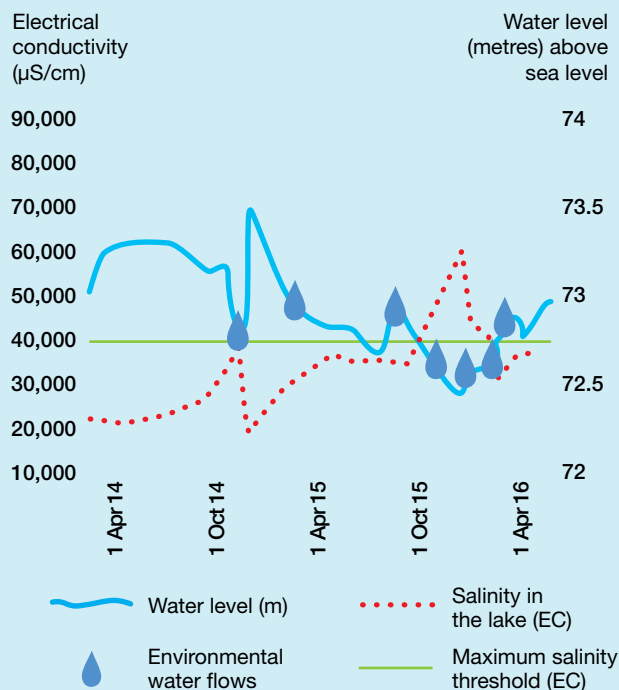
Aquatic plant surveys show dramatic improvements in Lake Elizabeth since the first environmental watering in 2014. Plants such as stonewort, sea tassel and watermat have re-established and now cover about 80 percent of the lake bed². There is now sufficient habitat for Murray hardyhead to spawn.

The abundance and diversity of zooplankton was assessed in Lake Elizabeth in 2015³ and 2016⁴ to determine the availability of food for Murray hardyhead. The results were compared to nearby Round Lake, a favoured habitat of Murray hardyhead. Zooplankton is more abundant at Lake Elizabeth than Round Lake, indicating that the lake has enough food for the newly-introduced population to establish. The additional food available also benefits birds and there has been a 36 percent increase in wetland bird species diversity since environmental watering began at Lake Elizabeth².

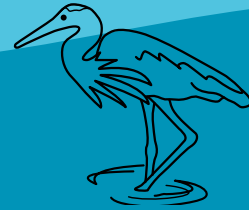
In this establishment phase, North Central CMA does regular monitoring to ensure that environmental watering achieves the best possible water quality, food and habitat for Murray hardyhead, as Figure 1 shows.

While the success of the Murray hardyhead translocation program will be determined through ongoing surveys, the lake has been primed by environmental watering to provide another valuable niche for this threatened species⁵.

Figure 1: Lake Elizabeth water levels, salinity and environmental watering, April 2014–16.



The salinity of Lake Elizabeth is managed by adding environmental water⁶. As the water level drops, the lake receives more saline groundwater resulting in a rise in salinity, monitored by electrical conductivity measurements. Waterway managers have reduced the intrusion of groundwater by delivering environmental water when water levels drop. The viability of the ecosystem depends on keeping electrical conductivity below 40,000 EC and preferably between 25,000-35,000 EC.



- ¹ G. Backhouse, J. Lyon, B. Cant, 2008a, National Recovery Plan for the Murray Hardyhead *Craterocephalus fluviatilis*. Department of Sustainability and Environment, Melbourne.
- ² Aquatic vegetation survey of Lake Elizabeth, April 2015, Rakali Ecological Consulting, unpublished client report.
- ³ I. Ellis and R. Petrie, 2015, Zooplankton in Lake Elizabeth, winter 2015: identifying food resource availability for future translocated Murray hardyhead, Final report prepared for the North Central CMA by The Murray-Darling Freshwater Research Centre, MDFRC publication 79/2015, June 8, 8 pp.
- ⁴ R. Petrie, 2016, Zooplankton in Lake Elizabeth, Round Lake and Woorinen North Lake, winter 2016: identifying food resource availability for Murray hardyhead. Draft Report prepared for the Department of Environment, Land, Water and Planning by the Murray-Darling Freshwater Research Centre, MDFRC publication 111/2016, May, 7pp.
- ⁵ I. M. Ellis, D. Stoessel, M. P. Hammer, S. D. Wedderburn, L. Suitor & A. Hall, 2013, Conservation of an inauspicious endangered freshwater fish, Murray hardyhead (*Craterocephalus fluviatilis*), during drought and competing water demands in the Murray-Darling Basin, Australia. Marine and Freshwater Research, 64(9), 792-806.
- ⁶ Lake Elizabeth hydrogeology, salt and water balance and adaptive management summary, North Central CMA, unpublished.



Murray hardyhead, by Emma Coats.

glossary

Carryover – Allows entitlement holders to retain ownership of unused water into the following season, according to specified rules.

Catchment management authority – A statutory authority that manages river health, regional and catchment planning, waterways, floodplains, salinity and water quality.

Commonwealth Environmental Water Office – The federal agency that manages water entitlements recovered by the Australian Government through a combination of investments in water-saving infrastructure, water purchases and other water recovery programs. The entitlements are held by the Commonwealth Environmental Water Holder (CEWH).

Electrical conductivity (EC) units – the measure of the ability of water that contains salt to conduct electricity, usually measured in microSiemens per centimetre ($\mu\text{S}/\text{cm}$) which is most commonly expressed as EC units.

Environmental water entitlement – An entitlement to water used to achieve environmental objectives. The entitlement can be an environmental entitlement, an environmental bulk entitlement, a water share, a section 51 licence or a supply agreement.

Estuary – A partially enclosed body of water along the coast where fresh water from rivers and streams meets and mixes with salt water from the ocean.

Fish ladder – A series of pools built like steps to enable fish to travel through a particular waterway, dam or waterfall.

Freshes – Small or short-duration, peak-flow events which exceed the baseflow and last for one or several days.

Groundwater – Water held underground in the soil or in pores and crevices in rock.

Hydrology – The science dealing with the properties of water and its movement in relation to land or under the earth's surface.

Lock – River or channel infrastructure that changes the water level.

Macroinvertebrates – Animals that have no backbone and can be seen with the naked eye, including worms, snails, mites, waterbugs, beetles, dragonflies and freshwater crayfish.

Megalitre (ML) – One million (1,000,000) litres.

Pulse – A gradual increase in the flow of water, typically to replicate optimal conditions for water species (such as fish) to travel and spawn.

Reach – A stretch or section of a river, generally defined in an environmental flows study.

Riparian – The area that is the interface between the land and a river.

Seasonal allocation – The volume of water allocated to a water share in a given season, expressed as a percentage of entitlement volume.

Spawning – When fish release eggs for fertilisation. Spawning sites are the sites where they release the fertilised eggs.

Storage manager – Appointed by the Minister for Environment, Climate Change and Water to operate a major water storage in a particular river basin to deliver to entitlement holders.

The Living Murray – An intergovernmental program that holds an average of 500,000 ML of environmental water a year for use at six icon sites along the River Murray.

Unregulated entitlement – An entitlement to water declared during periods of unregulated flows in a river system: that is, flows that cannot be captured in storages.

Waterways – Includes rivers, wetlands, creeks, floodplains and estuaries.

Water entitlement – The right to a volume of water that can (usually) be stored in reservoirs and taken and used under specific conditions.

Waterway manager – An agency responsible for the environmental management of catchments and waterways, including CMAs and Melbourne Water.

Summary of environmental water delivery 2015–16

Site			VEWH (ML)	Living Murray (ML)	CEWH (ML)	Other (ML) ¹	Total (ML)
Gippsland region							
Latrobe system	Latrobe River		3,750	-	-	-	3,750
	Lower Latrobe wetlands	Heart Morass	Water delivered ²				
Thomson River			12,251	-	-	-	12,251
Macalister River			12,796	-	-	-	12,796
Snowy River ³			-	-	-	147,884	147,884
Gippsland region total			28,797	-	-	147,884	176,681
Central region							
Yarra River			8,817	-	-	-	8,817
Tarago River			2,117	-	-	-	2,117
Maribyrnong River	Upper Jacksons Creek ⁴		300	-	-	-	300
Werribee system	Pyrites Creek		326	-	-	-	326
	Werribee River ^{5, 6}		324	-	-	-	324
Moorabool River			240	-	-	-	240
Lower Barwon wetlands	Reedy Lake		Water delivered ²				
	Hospital Swamps		Water delivered ²				
Central region total			12,124	-	-	-	12,124
Western region							
Glenelg system	Glenelg River		2,970	-	-	-	2,970
Wimmera system	Wimmera River		3,890	-	-	-	3,890
	MacKenzie River and Burnt Creek		1,010	-	-	-	1,010
	Upper Mount William Creek		100	-	-	-	100
Wimmera-Mallee wetlands			142.1	-	-	16.2 ⁷	158.3
Western region total			8,112.1	-	-	16.2	8,128.3

Summary of environmental water delivery 2015–16

Site			VEWH (ML)	Living Murray (ML)	CEWH (ML)	Other (ML) ¹	Total (ML)
Northern region							
Victorian Murray	Barmah	Barmah Forest and River Murray ⁸	-	10,000	258,594	134,700 ⁹	403,294
		Boals Deadwood	-	10,592	-	-	10,592
	Gunbower	Gunbower Creek ⁶	2,691	-	13,606	-	16,297
		Gunbower Forest ⁶	13,692	15,000	-	-	28,692
	Central Murray wetlands	Johnson Swamp	2,890	-	-	-	2,890
		Lake Elizabeth	1,070	-	-	-	1,070
		Richardsons Lagoon	1,309	-	-	-	1,309
		Round Lake	576	-	-	-	576
		Wirra-Lo wetland complex	369	-	-	-	369
	Hattah Lakes ⁶		1,493	-	5,347	-	6,840
	Lower Murray wetlands	Brickworks Billabong	200	-	200	-	400
		Burra Creek North	277	-	-	-	277
		Butlers Creek ¹⁰	103	-	-	-	103
		Cardross Lake	477	-	477	-	953 ¹¹
		Cowanna Billabong	125	-	125	-	250
		Lake Carpul	1,842	-	-	-	1,842
		Lake Hawthorn	459	-	-	-	459
		Lake Powell	2,158	-	-	-	2,158
		Lock 15 wetlands ¹²	-	-	-	-	-
		Neds Corner East and Central	250	-	-	-	250
		Nyah Floodplain	790	-	-	-	790
		Vinifera Floodplain	400	-	-	-	400

Summary of environmental water delivery 2015–16

Site			VEWH (ML)	Living Murray (ML)	CEWH (ML)	Other (ML) ¹	Total (ML)
Northern region							
Victorian Murray	Lindsay, Wallpolla and Mulcra islands	Lake Wallawalla ⁶	8,000	-	-	-	8,000
		Lindsay River and Mullaroo Creek ¹³	-	-	2,739	-	2,739
		Potterwalkagee Creek ¹³	-	-	-	-	-
		Wallpolla East	-	600	-	-	600
Ovens River			-	-	70	-	70
Goulburn system	Goulburn River		10,000	27,680	190,563	-	228,243
	Goulburn wetlands	Doctors Swamp	594	-	-		594
		Reedy Swamp	356	-	-		356
Broken system	Broken wetlands	Black Swamp	80	-	-	-	80
		Kinnairds Wetland	689	-	-	-	689
		Moodie Swamp	500	-	-	-	500
	Lower Broken Creek		800	-	29,520	-	30,320
Campaspe system	Campaspe River		10,336	63	3,259	-	13,658
	Coliban River ¹⁴		-	-	-	826	826
Loddon system	Loddon River and Tullaroop Creek		5,235	-	1,477	-	6,712
	Loddon wetlands	Lake Meran	2,000	-	-	-	2,000
Northern region total			69,761	63,935	505,977	135,526	775,198
Total water use			118,794.1	63,935	505,977	283,426.2	972,131.3

¹ 'Other source' refers to water that is either delivered outside of Victoria or delivered in Victoria but not accounted for under the environmental water holdings.

² The VEWHS environmental entitlements in the lower Latrobe and lower Barwon systems allow the diversion of unregulated flows from the Latrobe and Barwon rivers into the wetlands at any time when specific river heights are met. The entitlements are not held in storage and do not consist of a set volume. The volume of water diverted into the wetlands is not measured.

³ Environmental water deliveries to the Snowy River are managed by NSW Department of Primary Industries using water made available by Victoria and New South Wales. Deliveries aim to achieve outcomes in the New South Wales reaches of the river and also provide some downstream benefits to the Victorian reaches.

- ⁴ In 2015–16, water allocations co-purchased by Melbourne Water and the VEWH contributed to the delivery of 300 ML of environmental water to meet environmental objectives in Upper Jackson Creek in the Maribyrnong system, where no permanent environmental water holdings are currently held.
- ⁵ Water delivered to the Werribee River included 141.3 ML of allocation made available for use by Melbourne Water.
- ⁶ Delivery to these systems included some reuse of return flows.
- ⁷ Water delivered to these Wimmera-Mallee wetlands was made available from Grampians Wimmera Mallee Water.
- ⁸ Commonwealth deliveries in the River Murray contributed to environmental objectives in the Barmah Forest and further downstream in the River Murray.
- ⁹ This comprises Living Murray and CEWH water released from the NSW share of the Murray water storages.
- ¹⁰ Water delivered to Butlers Creek included 28 ML of allocation donated to the VEWH by a landholder in the Mallee area.
- ¹¹ Total use at Cardross Lakes differs from the sum of the use of water from different Water Holders due to rounding.
- ¹² Environmental watering at wetlands associated with Lock 15 was facilitated by manipulating River Murray lock 15. Environmental water was used to account for the losses associated with raising the lock above normal operating range to achieve environmental outcomes. Environmental water use was accounted for by NSW.
- ¹³ Environmental watering in the Lindsay River, Murrumbidgee Creek and Potterwalkagee Creek was facilitated by manipulating River Murray locks 7, 8 and 9. Environmental water was used to account for the losses associated with raising the locks above their normal operating ranges to achieve environmental outcomes. Environmental water use in the Lindsay River and Murrumbidgee Creek were accounted for in Victoria, with deliveries in Potterwalkagee Creek accounted for by NSW.
- ¹⁴ Under entitlement rules in the Coliban system, the VEWH and the storage manager can agree to temporarily reduce passing flows and release the withheld volume at a later date. These rules allow some flexibility in the timing of passing flow delivery, which can help increase environmental outcomes without affecting other water users.

Canoeing at Lake Carpul, by Mallee CMA.



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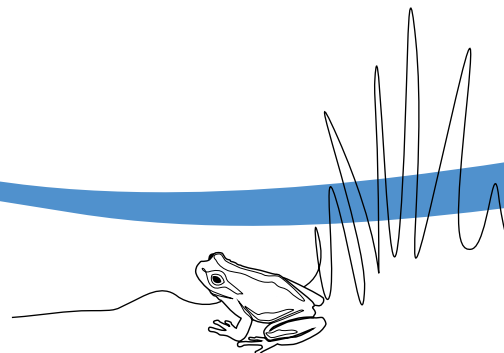
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Front cover: Little egret, by Ian Colley.

Inside cover: Enjoying the Yarra at Princes Walk, by Zarleen Blakeley.

Back cover: Camping at the Campaspe River, by Victoria Penko.





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