

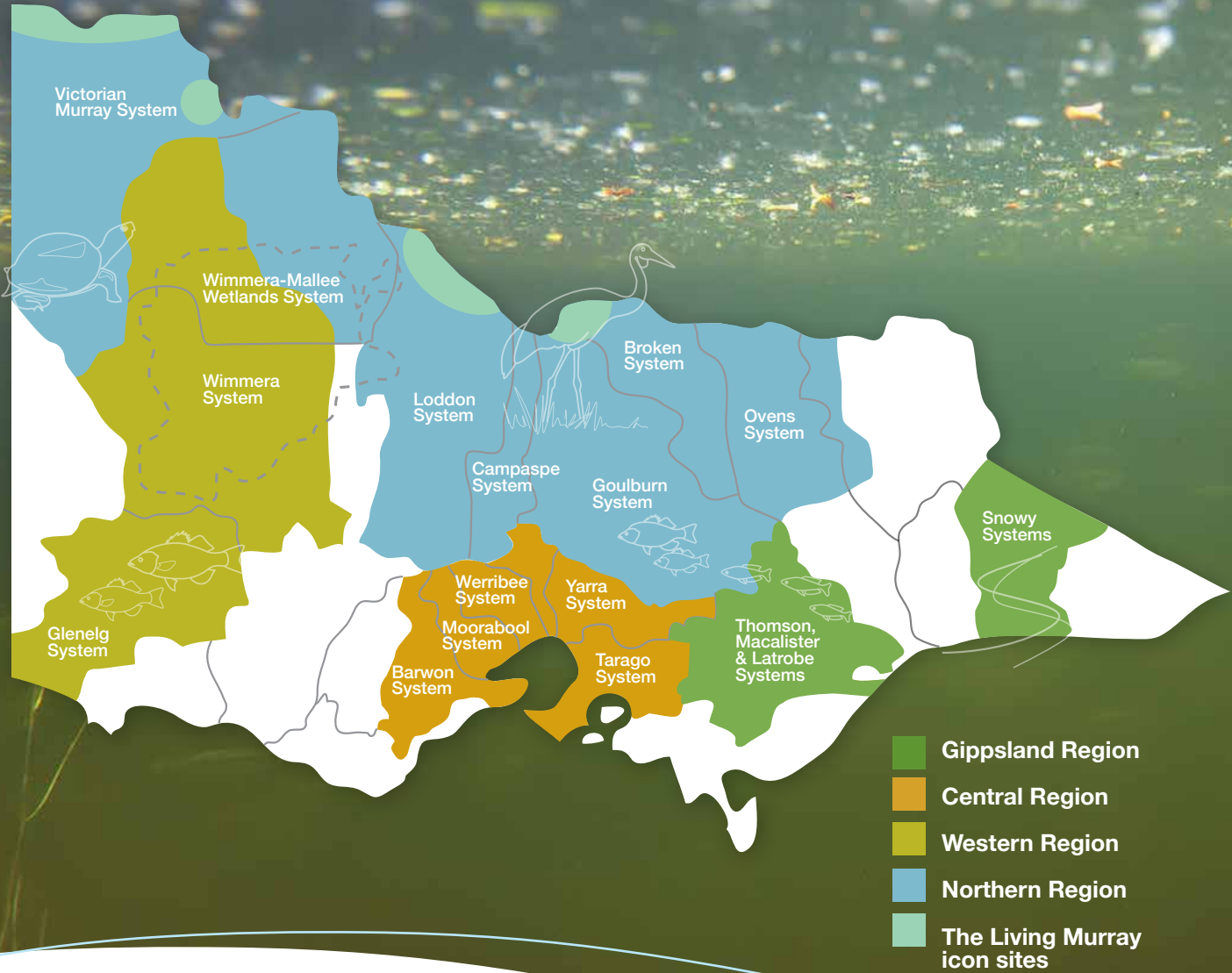
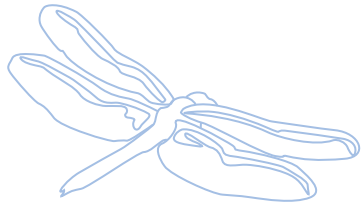
Victorian Environmental Water Holder

Reflections

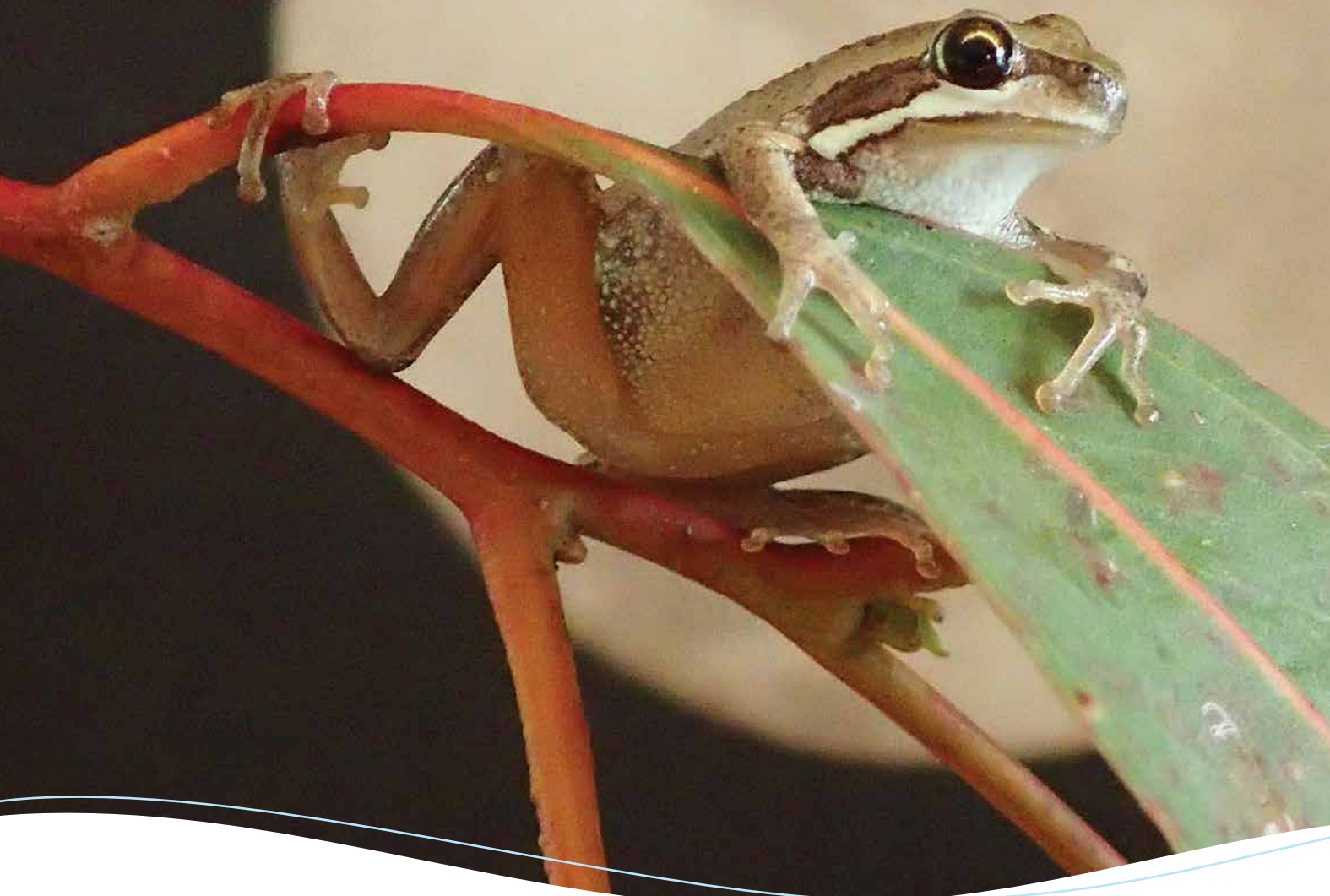
Water for the Environment
in Victoria 2016–17

contents

Foreword	1	Northern Victoria	59
Introduction	3	Goulburn system	61
Why do we water when it's wet?	9	Broken system	63
Gippsland Region	15	Goulburn Broken wetlands	64
Latrobe system	17	Campaspe system	65
Thomson system	19	Central Murray wetlands	67
Macalister system	20	Lower Murray wetlands	69
Snowy system	21	Loddon system	71
Bumper year for Tupong in Southern Victoria	23	Ovens system	73
Shared community benefits	25	Living Murray icon sites	75
Central Region	27	Hattah Lakes	76
Yarra system	29	Lindsay, Mulcra and Wallpolla islands	77
Tarago system	31	Gunbower forest	78
Maribyrnong system	32	Barmah Forest	79
Werribee system	33	Rivers without borders	81
Moorabool system	35	Shared community benefits	84
Lower Barwon wetlands	37	Glossary	87
Watering for Melbourne's environment	39	Summary of environmental water delivery 2016-17	89
Shared community benefits	43		
Western Region	45		
Glenelg system	47		
Wimmera system	49		
Wimmera-Mallee wetlands	51		
Yarns on the western rivers	53		
Shared community benefits	55		



foreword



Despite meteorologists predicting that 2016–17 might see a repeat of the prolonged dry conditions of the previous year, the heavens opened across the state, bringing flooding across western and northern Victoria.

2016 was Victoria's wettest year since the flood year of 2011, with rainfall 19 percent above average. We experienced our wettest September on record, with the Glenelg, Wimmera and Loddon rivers experiencing major flooding. Later, most of December's rain fell in one day — 29 December 2016 — which delivered the highest summer rainfall on record and triggered flash flooding in several places across the state.

While Victorian communities struggled with the floods, a great deal of water that was planned to be released for the environment in spring and summer was not delivered, either to reduce the flood risk or because it was not needed as sites had been watered naturally.

Sometimes, river and wetland managers were able to make the most of the wet weather and add water to natural flows, creating the deep, long drinks that some of our wetlands and waterways need every few years. These soakings replenished trees (such as red gum and black box), rejuvenated floodplain lands and returned food and nutrients to the river for fish and other water animals like platypus and turtles.

We know our climate varies naturally over seasonal, annual and longer cycles. The effect of climate change is now magnifying this variability, increasing the frequency of extreme weather — flood and drought — and with it the degree of uncertainty facing Victorian communities. The increasing variability of our weather means that those of us who manage water for Victoria's environment must continue to plan ahead each year for all climate scenarios — from drought through to very wet — to provide the best-possible waterway environments for Victorian communities.

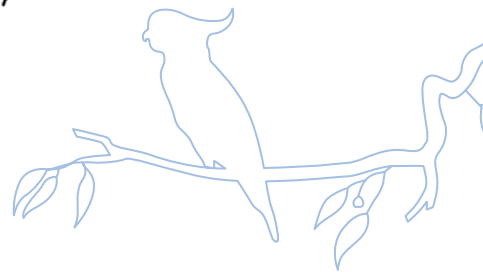
A plains tree frog at Kialla, by Keith Ward, Goulburn Broken CMA

The stories in *Reflections* this year show the many benefits of water for the environment. There are stories of fish species returning to rivers in which they were previously extinct, birds flocking to watered wetlands, trees thriving, river banks stabilising and the landscape coming to life.

Waterways are being restored in the heart of Victorian communities, delighting anglers, kayakers, birdwatchers and even remote-control boaters! Some of these Victorians tell their stories in the following pages, reminding us that water for the environment is ultimately water for everyone.

Denis Flett

Denis Flett
Chairperson



introduction



As Victoria's population has grown, many rivers and wetlands have continued to be modified to provide water for communities to grow and thrive.

In some rivers, up to half of the water that would have naturally flowed in them is removed each year to provide water for farms, homes and industry.

As a result, these waterways cannot function as they would naturally and we must actively manage how water flows through them. These managed flows are called 'water for the environment'.

Water for the environment is set aside in storages and released into rivers, wetlands and floodplains to support them, the plants that grow in them and the native animals that live, feed and breed in them.

By improving the health of these waterways, water for the environment also provides benefits to communities. Healthy waterways sustain people by supplying water for towns, farms and businesses. They contribute to local agriculture, fishing, real estate, recreation and tourism activity. They 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 are important to Aboriginal communities who have a continuing connection to Country.

Rivers, wetlands and floodplains cannot provide these benefits unless their health is protected and maintained.

About the Victorian Environmental Water Holder

The Victorian Environmental Water Holder (VEWH) is an independent body, established by the Victorian Government in 2011, responsible for managing Victoria's water for the environment.

Set up under the *Water Act 1989*, the VEWB manages environmental water entitlements — the legal right to access a share of water available at specified locations to improve the environmental values and health of Victoria's rivers, wetlands and floodplains, and the plants and animals that rely on them.

The role of the VEWB is to:

- make decisions about the most effective use of the environmental water entitlements, including whether to use carryover or 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.

The VEWB works with local waterway managers to ensure water for the environment achieves the best environmental outcomes.

A turtle at Gunbower Forest,
by Hugh McGregor



How does water for the environment work?

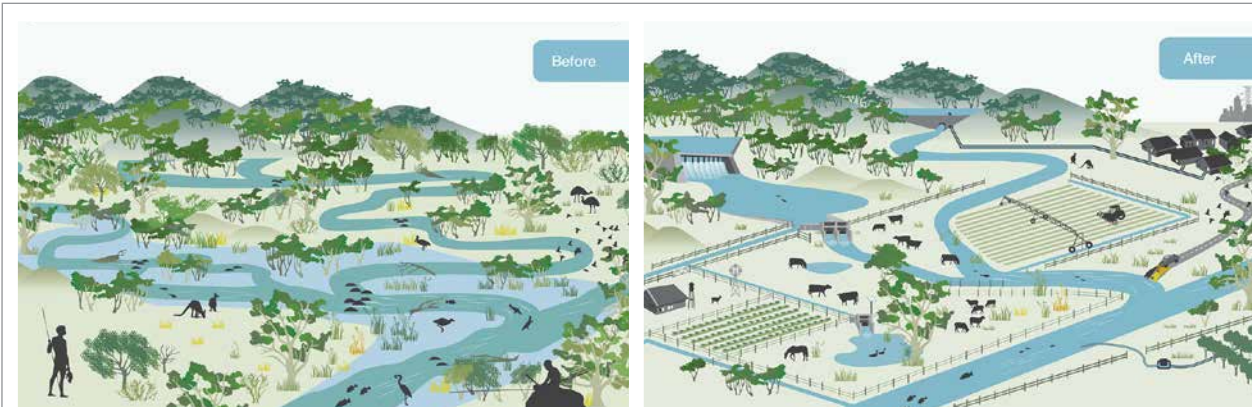
Water for the environment is released into rivers to mimic some of the flows that would have occurred naturally before the construction of dams, weirs and channels. This is vital to maintain the physical, chemical and biological health of rivers.

Environmental water managers generally prioritise returning some of the small and medium sized river flows that are essential in the life cycles of 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 for the environment is designed to support the plants and animals that rely on it. For example, fish such as Australian grayling rely on an increased river flow in autumn as it signals them to migrate downstream for spawning — when fish release eggs.

Many wetlands are now either disconnected from the rivers that used to naturally fill them or 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 aim to mimic the natural wetland wetting and drying cycles on which many plants and animals depend for their diversity and long-term resilience. For example, where wetlands and floodplains have been cut off from natural river flows, water for the environment can be used to reconnect these areas, sometimes via irrigation infrastructure (such as pumps, channels and regulators).



Before and after the development of dams, weirs and channels

Rivers and wetlands provide water and land that is important to farms, towns, and industry. As a result, many of Victoria’s rivers and wetlands have been 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 half, of their water for farms, homes, and businesses. Instead of flowing naturally, with high flows in winter and low flows in the hotter summer months, many rivers now run higher when water needs to be delivered for farming and urban use.

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

Carryover and trade

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

The success of environmental watering in a waterway relies on the timing, magnitude and frequency of flow – just as agriculture requires water to be applied at the right time and in the right amount. For benefits to occur – such as triggering fish to move to feed and breed – water must be released at a particular time, in a certain amount, for an adequate number of days. Carryover is an essential tool to maximise the outcomes of water for the environment.

Carryover rules allow for the flexible management of water between seasons. Irrigators and environmental water holders rely on carryover to manage differences between water supply and demand in wet years versus dry years.

At the end of 2016–17, there were 336,230 megalitres carried over for potential use in 2017–18, subject to carryover rules and conditions (for example, evaporation and potential loss to storage spills) for winter and spring environmental watering actions. In 2016–17, the VEWH used water trades to effectively and efficiently manage its environmental water portfolio.

For example:

- in the Central region, Melbourne Water and the VEWH jointly funded the purchase of 304 megalitres to allow the Maribyrnong system to receive water for the environment
- in the Northern region, the VEWH sold 20,000 megalitres of water in the Murray and Goulburn systems
- in the Western region, the VEWH purchased 5,000 megalitres in the Wimmera–Glenelg water supply system.

Water donations

In 2016–17, there were no donations of water into the VEWH accounts.

Partnerships

The efficient and effective delivery of the water for the environment program requires the VEWH to work closely with our program partners.

Waterway managers — Victoria’s catchment management authorities (CMAs) and Melbourne Water — and storage managers are central to the local planning and implementation of environmental watering.

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

Left to right: Birdwatchers at Lake Powell, by Mallee CMA; A pelican and its reflection on the river, by Emma Coats



Funding research and river improvements

In 2016–17, the VEWH coordinated the delivery of water for the environment to 76 river reaches and 51 wetlands, totalling 127 sites. We use scientific and community knowledge about rivers and wetlands to measure our success and improve the use of the water.

The VEWH also funds monitoring and technical investigations (for example, research to better understand hydrology) and community engagement and infrastructure projects (such as projects to meter water) across Victoria.

In 2016–17, the VEWH funded CMAs to monitor native fish, vegetation and water quality. A monitoring project to study native fish at Cardross Lakes, Brickworks Billabong and Lake Koorlong provided a better understanding of the ecology, habitat and status of the Murray hardyhead, one of the most threatened vertebrate species in Australia. Knowledge from the project will inform the environmental watering program, so we can improve the recovery of this threatened fish species.

Shared community benefits

Water for the environment provides shared benefits to the community: that is, additional Aboriginal cultural, social, economic and recreational benefits.

Water for the environment is for everyone. It provides benefits including fishing, birdwatching, kayaking, bushwalking, cycling, camping, yabbing, swimming and picnicking. These activities are all enjoyed on or around Victoria’s rivers, wetlands and floodplains.

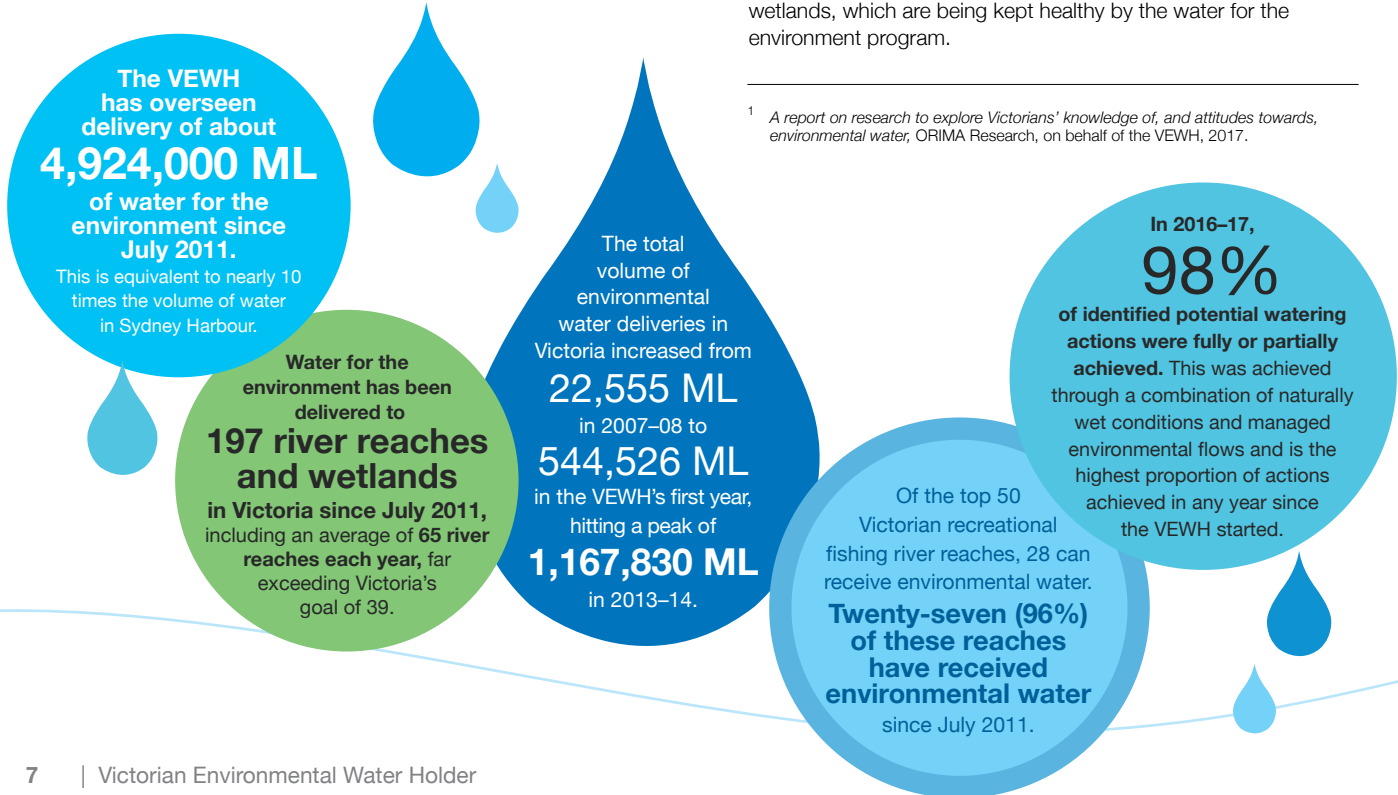
The beauty of the waterways brings a sense of joy to the community. In a recent survey, 90 percent of Victorians said they visited waterways to relax, rest and enjoy the scenery¹.

Healthy rivers help sustain recreational fishing in Victoria. Of the top 50 Victorian recreational fishing river reaches, 28 can receive water for the environment.

River tour operators and canoe clubs have been enjoying healthier rivers, getting out on environmental flows and benefiting from an interest in paddling on waterways.

The case studies about shared community benefits throughout this report show how Victorians are enjoying their rivers and wetlands, which are being kept healthy by the water for the environment program.

¹ A report on research to explore Victorians’ knowledge of, and attitudes towards, environmental water, ORIMA Research, on behalf of the VEWH, 2017.



Upper Latrobe River, by Rachael Millar, West Gippsland CMA

Why do we water when it's wet?

It's raining, it's pouring and nature is filling rivers and wetlands during a plentiful wet season. So should we still put water into the environment when nature is delivering it on tap?

In drought years, it's easy to understand the need to deliberately release water into rivers and wetlands for animals, plants and the environment: parched wetlands, drying river beds and stagnant pools are visibly in need of water. But in wet years, it's not as easy to understand the need for water for the environment: If the river already has water in it, why do we need to send down more? Why do we need water for the environment when it rains?

The artificial drought

Rain or shine, many of Victoria's rivers, floodplains and wetlands constantly experience an artificial drought:

Victoria's waterways have continued to be modified as the population has grown, to provide water for food production towns and industry. The water in rivers is now pooled up in water storages and its flow controlled by weirs and other mechanisms. In some rivers, up to half of the water that would have naturally flowed in them is removed each year for farms, homes and businesses. Even in a wet year, most rivers are still in drought compared to their natural condition. The program to deliver water for the environment was established to help ease some of the impacts of this high level of water extraction.

Rivers rely on a pattern on flow

Rivers are meant to have a seasonal pattern. The volume, timing, speed, duration, frequency, quality and range of river flows are all essential for the ecosystem. Each part of a river's flow pattern has its own job to do, whether it's a high flow in spring to prompt fish to move and breed or an overbank flow to give a drink to river red gum and black box forests.

Most of the water we usually see travelling down a river is not water for the environment but water released from a water storage for farms, homes and industry. In fact, water specifically managed to help plants and animals makes up less than a quarter of the water released into Victoria's rivers.

Water for the environment breathes life back into our river systems, creating highs and lows where and when they are naturally needed. We use environmental flows to make sure the right amount of water is in the right place at the right time to trigger feeding, breeding, fledging or migration for fish, birds, turtles and other animals, as well as to water trees and other vegetation and refresh the floodplain.

Even if it is a wet year, water for the environment might be required to help mimic some of the natural seasonal flow patterns the river landscape and its wildlife need.

“ Even in a wet year, most rivers are still in drought compared to their natural condition. ”



An autumn flow of water for the environment in the Thomson River at Coopers Creek, by West Gippsland CMA

“ Rain or shine, many of Victoria’s rivers, floodplains and wetlands constantly experience an artificial drought. ”

Flood water can’t always reach wetlands because of constructed barriers

Before European settlement, when rivers flooded, water would flow over river banks and cross the floodplain to soak natural wetlands. Today when floods occur, dams, levee banks, weirs, roads and other structures stop water from reaching some wetlands. This is why today, even when it rains, water still needs to be pumped to these wetlands so that plants and river animals get the drinks they need to thrive.

Flood marks on trees in Broken Creek, by Keith Ward Goulburn Broken CMA



Watering for a wet 2016–17

Victoria had an extremely wet year in 2016–17. In July 2016, rainfall was 200 percent above the average in the Goulburn, Kiewa and Ovens river catchments, and there was flooding along many River Murray floodplains. We had our wettest September on record, with major flooding of the Glenelg, Wimmera and Loddon rivers. Later, most of December’s rain fell in one day — 29 December — delivering the highest summer rainfall on record and triggering flash flooding of several places across the state.

Interestingly, the 2016–17 deluge had not been predicted: meteorologists had forecast that 2016–17 might repeat the prolonged dry conditions of the previous year. Fortunately, waterway managers plan for all weather.

“Weather conditions change and we need to be responsive,” said VEWH Co-Executive Officer Trent Wallis.

“We know that our climate varies naturally over seasonal, annual and longer cycles. We also know that climate change is now increasing the frequency of extreme weather — flood and drought — and with it the degree of uncertainty facing Victorian communities.

“The unpredictability of our weather means that those of us who manage water for Victoria’s environment have to plan ahead each year for all weather scenarios.”

Each year, local waterway managers develop seasonal watering proposals based on scenarios for drought, dry, average and wet-to-very-wet conditions. There is no one-size-fits-all year-to-year, so these scenarios provide options for watering rivers and wetlands, based on the seasonal climate conditions and water availability for the year.

Trent explained, “In drought, the focus may be on avoiding the loss of species such as fish, platypus or waterbirds. During average and wet-to-very-wet conditions, water for the environment aims to recover and enhance waterways.”

This includes:

- improving ecological health and resilience
- reconnecting rivers to floodplains and wetlands
- improving and enhancing opportunities for populations of key animal and plant species to grow and strengthen.

“Sometimes, we have to think of environmental flows as preventative medicine,” said Trent.

“Watering when it’s wet enables rivers and wetlands and their animal populations to become stronger and more resilient if conditions turn dry again.”

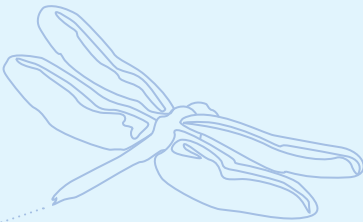
Some of the water planned to be released for the environment in 2016–17 was not delivered. For example, when heavy rain hit the west of the state in winter and spring, waterway managers carefully monitored the Wimmera and Glenelg rivers and decided not to release any water from Rocklands Reservoir until late November 2016, when the threat of destructive flooding had subsided. Meanwhile, the Goulburn Broken wetlands did not need any ‘managed’ water for the environment in 2016–17: rain and natural flooding in late winter and early spring filled the wetlands earmarked for a drink. Summer rainfall then kept them wet until early autumn 2017.

However, many river and wetland managers were able to make the most of the wet weather and add water for the environment to natural flows, creating the deep, long drinks some of our wetlands and waterways need every few years. These soakings replenished trees (such as red gum and black box), rejuvenated floodplains and returned food and nutrients to the river for fish and other water animals (like platypus and turtles).

“As we are learning, it’s hard to predict what weather 2017–18 will bring us,” Trent said.

“But without doubt, our waterway environments are in a better condition to deal with whatever is on the horizon, thanks to the soaking we’ve been able to give them this year.”

“ Watering when it’s wet enables rivers and wetlands and their animal populations to become stronger and more resilient if conditions turn dry again. ”





Baby birds benefit from watering when it's wet

* Waterbirds certainly appreciated the water for the environment that was delivered on the back of the largest flood in Barmah Forest since 1993.

This water helped maintain shallow water around the waterbirds' nests in the wetlands until February, which meant the baby birds could grow their feathers ready for flight.

Without water for the environment on the back of the flood, adult ibis and spoonbills would have abandoned their nests in response to the dropping water levels, before their young could fly.

For the full story, see page 79.

Figure 1: Examples of environmental watering objectives under different planning scenarios

Drought	Dry	Average	Wet to very wet
Main objective: PROTECT	Main objective: MAINTAIN	Main objective: RECOVER	Main objective: ENHANCE
<ul style="list-style-type: none">▶ Avoid critical loss▶ Maintain key refuges▶ Avoid catastrophic events	<ul style="list-style-type: none">▶ Maintain river functioning with reduced reproductive capacity▶ Maintain key functions of high priority wetlands▶ Manage within dry-spell tolerances	<ul style="list-style-type: none">▶ Improve ecological health and resilience▶ Improve recruitment opportunities for key animal and plant species	<ul style="list-style-type: none">▶ Restore key floodplain and wetland linkages▶ Enhance recruitment opportunities for key animal and plant species

Living with extremes

* Victoria's climate has been following a drying and warming trend for several decades, and 15 of the 16 hottest years in Australia have occurred this century.

It is now clear that this trend is a result of human-induced climate change, and most climate models forecast that Victoria will become hotter and drier.

Modelling now forecasts that streamflows could reduce by around 50 percent in some Victorian catchments by

2065. This has serious consequences for everyone and everything — agriculture, households, industry, recreation, Aboriginal cultural values, liveability, waterway health and native plants and animals.

We may still have years when rainfall during the cooler months is higher than average, but these will occur less often.

A royal spoonbill with its chicks, by Keith Ward, Goulburn Broken CMA

Gippsland region

Environmental flows triggered huge wildlife breeding events in Gippsland.

- » Water for the environment helped trigger the largest breeding event of black swans in a decade at Sale Common.
- » A project in the Thomson River tested if endangered Australian grayling would spawn at lower flows.
- » A wet winter and spring resulted in Lake Glenmaggie spilling from July to November and the first bankfull flows in the Macalister River since 2012, which helped breeding among important native fish species.
- » Over 130,000 megalitres of water for the environment was delivered to the Snowy River to improve habitat for native plants, waterbirds and aquatic animals.



A Tupong, by Glenelg Hopkins CMA

latrobe system

In 2016, majestic black swans at Sale Common had the biggest breeding boom in a decade as water for the environment flowed into reed beds and swamps.

Water was provided to the lower Latrobe wetlands of Sale Common and Dowd Morass during 2016–17. These wetlands are a vital part of the internationally recognised Gippsland Lakes Ramsar site and provide habitats for a variety of birds.

“Environmental flows in June 2016 slowly filled the Sale Common, providing clear water that prompted good growth of aquatic plants,” said West Gippsland CMA Waterways Project Manager David Stork.

“Plant growth was also helped by the low numbers of carp, which were screened from the wetland,” he said.

“Then in July, natural flooding filled the wetland with more turbid water and unfortunately lots of carp, but this flow, combined with water previously delivered, triggered the black swan breeding event. This was a spectacle for locals and visitors and great for the environment.”

A constant stream of sightseers enjoyed the Sale Common River Heritage and Wetlands Trail, taking in the spectacle of the swans. The 15-kilometre walk provides an immersive experience in the wetlands.

The boardwalk winds its way through a variety of habitats, starting from the edge of the swamp, through deeper water, past islands and through a small reed bed, with a bird hide located near the eastern end of the boardwalk.

Keeping Sale Common healthy through the water for the environment program benefits everyone. Its environmental values, natural beauty and recreational opportunities are enjoyed by the many visitors to the Common each year.

The Heart Morass wetland, also in the lower part of the Latrobe system, is once again brimming with life after a decade of restoration works followed by the delivery of environmental water in early 2016. Last year’s watering helped provide a burst of growth for wetland plants and food for the waterbirds.

Waterway manager: West Gippsland CMA
Storage manager: Southern Rural Water

Site	Volume delivered in 2016–17 (ML)
Latrobe River	3,713
Heart Morass ¹	No active deliveries
Sale Common ¹	Water was diverted into Sale Common from the Latrobe River
Dowd Morass ¹	Water was diverted into Dowd Morass from the Latrobe River

¹ The VEWH’s environmental entitlement in the lower part of the Latrobe system allows the diversion of water from the Latrobe River into Heart Morass, Dowd Morass and/or Sale Common at any time when specified river heights are met. The volume of water diverted into the wetlands is not measured.



Swan at the lower Latrobe wetlands,
by David Stork West Gippsland CMA

thomson systemmacalister system

In late 2016–17 the Victorian Government finalised a commitment to provide extra water to the heritage-listed Thomson River, to protect its environmental and community values.

The river will now receive an extra eight gigalitres of water for the environment annually, adding to the ten gigalitres already available. This will help the West Gippsland CMA provide water for threatened Australian grayling, improving their habitat for breeding and growth.

Water for the environment in autumn 2017 helped the river endure dry conditions and provided an opportunity to discover more about optimal breeding conditions for native fish.

“It provided an opportunity to test whether Australian grayling would spawn at different flow rates,” said West Gippsland CMA’s Minna Tom.

“Our monitoring gave us a good overview of the flow rates fish prefer, so we can adjust flows where necessary to give the native fish the best chance to breed.”

This year’s autumn flow had an added bonus: it was timed to coincide with the weekend lead-up to Anzac Day, a prime time for those who like to get out for a paddle.

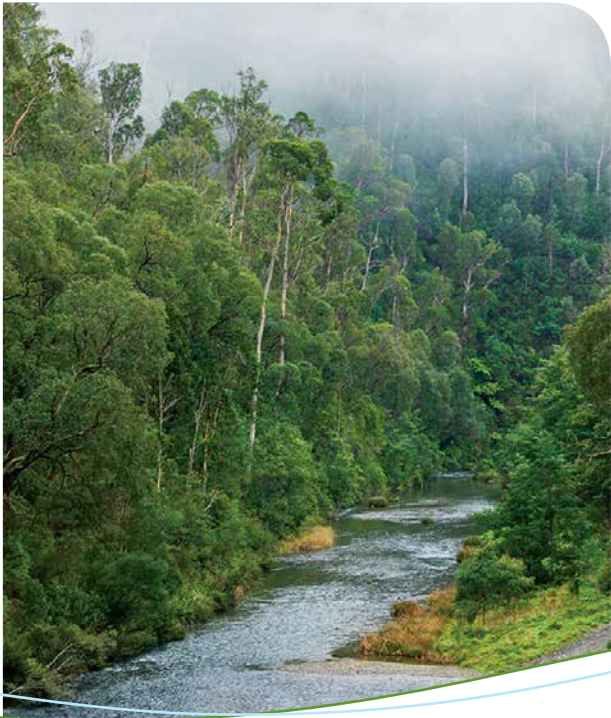
The extra water provided excellent conditions for kayakers and canoeists in the upper Thomson River. Whitehorse Canoe Club took to the water, with almost 30 people enjoying the increased river flows.

(See page 25 for full story).

The Thomson River,
by Rachel Millar, West Gippsland CMA

Waterway manager: West Gippsland CMA
Storage manager: Melbourne Water, Southern Rural Water

Site	Volume delivered in 2016–17 (ML)
Thomson River	10,326



The recovery of the Macalister River and its native fish was helped along by water for the environment and rainfall in 2016–17, following two years of lower than average rainfall.

Heavy rainfall in winter and spring 2016 resulted in spills from Lake Glenmaggie from July to November, with two bankfull flows into the Macalister River for the first time in four years. High river flows in winter are important to trigger the movement of Australian bass and tupong to breed.

“It was fantastic to see, because the high flows of water are so important for plants on the river bank,” said West Gippsland CMA’s Minna Tom.

“The floods also inundated floodplains, providing food and breeding opportunities for turtles, frogs and waterbirds.”

In autumn 2017, water for the environment was used to increase success of breeding among important native fish species.

A maintenance of low flows throughout the year provided connectivity between waterways for fish movement.

Waterway manager: West Gippsland CMA
Storage manager: Southern Rural Water

Site	Volume delivered in 2016–17 (ML)
Macalister River	6,599



Left to right: The Macalister River at Lanigans Bridge in winter, by West Gippsland CMA; Lake Glenmaggie, by West Gippsland CMA

Snowy system

The Snowy River was given a new lease on life in 2016–17 with over 130,000 megalitres of environmental water creating a food chain bonanza for the river’s plants and animals.

Originating on the high plateaus of Mt Kosciusko in the Snowy Mountains of New South Wales, the Snowy River is an Australian icon immortalised by Banjo Paterson’s poem *The Man from Snowy River*. Since then, this once-mighty river has changed: much of its natural flow has been diverted for the Snowy Mountains Hydro-electric Scheme, which was constructed over 50 years ago.

“Floods, land clearing and reduced flows have contributed to changes in the Snowy River over time,” said East Gippsland CMA Program Manager Bec Hemming.

“The river is now wider, straighter and shallower, particularly in the lower floodplains areas. The build-up of sediment in the river bed has resulted in a loss of habitat for native plants, waterbirds and aquatic animals. The East Gippsland CMA has worked closely with the community to rehabilitate the river by planting trees, controlling willows and other weeds and excluding stock from the river.”

To help the river recover, environmental water is released every day of the year. Bigger releases in winter and spring recreate flows that would have previously resulted naturally from rainfall or snowmelt.

“We had pretty wet conditions in spring 2016, which coincided with planned high-flow deliveries of water for the environment, so we rescheduled environmental watering for later in 2016 to give the river a much-needed summer drink,” said Bec.

Paddle steamer on the Snowy River, by East Gippsland CMA

To further investigate the effect of environmental flows in the Snowy River, researchers at the Arthur Rylah Institute are looking at the extent to which these flows deliver nutrients to the river estuary. Nutrient cycles are a vital component of the estuary food web and a functioning river system. Preliminary results of this monitoring are expected in 2018.

Waterway manager: New South Wales Department of Primary Industries, Water and East Gippsland CMA
Storage manager: Snowy Hydro Limited

Site	Volume delivered in 2016–17 (ML)
Snowy River	132,300

Environmental water deliveries to the Snowy River are managed by the New South Wales Department of Primary Industries, using water made available by Victoria and New South Wales.



Tulloch Ard Gorge on a Snowy River environmental flow, by East Gippsland CMA

bumper year for tupong in southern Victoria

The catch of tupong in the Thomson River using electrofishing in 2017 was the highest observed in 13 years.

Scientists setting their sights on learning more about the influence of river flows on native fish in Victorian waterways recorded a boom season for tupong across southern Victoria.

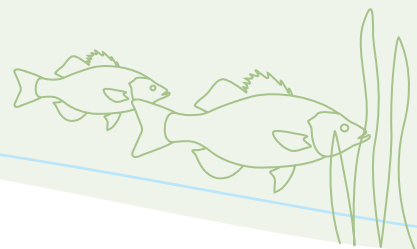
Tupong were recorded in significant numbers across southern coastal rivers, from the far west of the state, where tupong were reported for the first time in more than 60 years in upstream areas of the Glenelg River, to Gippsland, where monitoring found some of the highest numbers of tupong in the Thomson River in 13 years.

Why has this been such a bumper year for tupong? In part, it's to do with river flow. Tupong, also known also as congolli, are common in southern Victoria, but belong to a group of fish about which we don't know much.

"They're diadromous, meaning they spend parts of their lives in saltwater and parts in freshwater," explained Arthur Rylah Institute Research Scientist Frank Amtstaetter.

"We know there are several factors that influence the presence of tupong and other diadromous species, primarily spawning, immigration into rivers and their ability to survive," Frank said.

"We're working on finding out more about how tupong respond to environmental conditions, particularly flows in the rivers – how flows affect their lifecycle and that of other diadromous species," he said.



The importance of flow

Young tupong migrate into streams from the sea in spring and summer. Conversely, adult tupong migrate from freshwater downstream to the sea in autumn and winter to breed.

"There is evidence that adult spawning migrations are triggered by increases in river flows," Frank said.

“For example, adult tupong implanted with acoustic transmitters migrated 40 kilometres downstream during a pulse in river flows. We are investigating the link between movements of that sort and flow pulses.”

Frank said studies were also continuing on the effects of river flows on the migration of juvenile tupong into rivers and on their survival rates.

"Based on the first year of sampling using netting and trapping last spring, numerous tupong were captured migrating into freshwater during late spring in rivers such as Gippsland's Thomson and Tarwin rivers.

"The catch of tupong in the Thomson River using electrofishing in 2017 was the highest catch rate observed in 13 years of monitoring on this river," Frank said.

"More than 80 percent of the tupong captured in 2017 were less than one year old, indicating that tupong are successfully spawning, migrating to freshwater and surviving," he said.

Survival

"The upstream dispersal of juvenile tupong can allow them to take advantage of additional habitats for feeding, growth and survival, which may be important to growing the population," Frank said.

"There are a couple of mechanisms for this dispersal. First, increases in river flows can stimulate the upstream movement of these fish. Second, maintaining suitable flows enables fish to move to feed and breed. For example, if flows drop to a point where the river becomes a series of disconnected pools, then the fish cannot migrate upstream."

*Adult tupong migrate from freshwater downstream to the sea in **autumn** and **winter** to breed, triggered by increased river flows.*

Water for the environment

Environmental watering for diadromous fish occurs during autumn and winter to trigger spawning migrations, during spring to attract fish into coastal streams, and during summer to trigger migration.

"In addition, summer base flows are maintained in a number of rivers to provide river connectivity, which allows tupong to migrate upstream," Frank said.

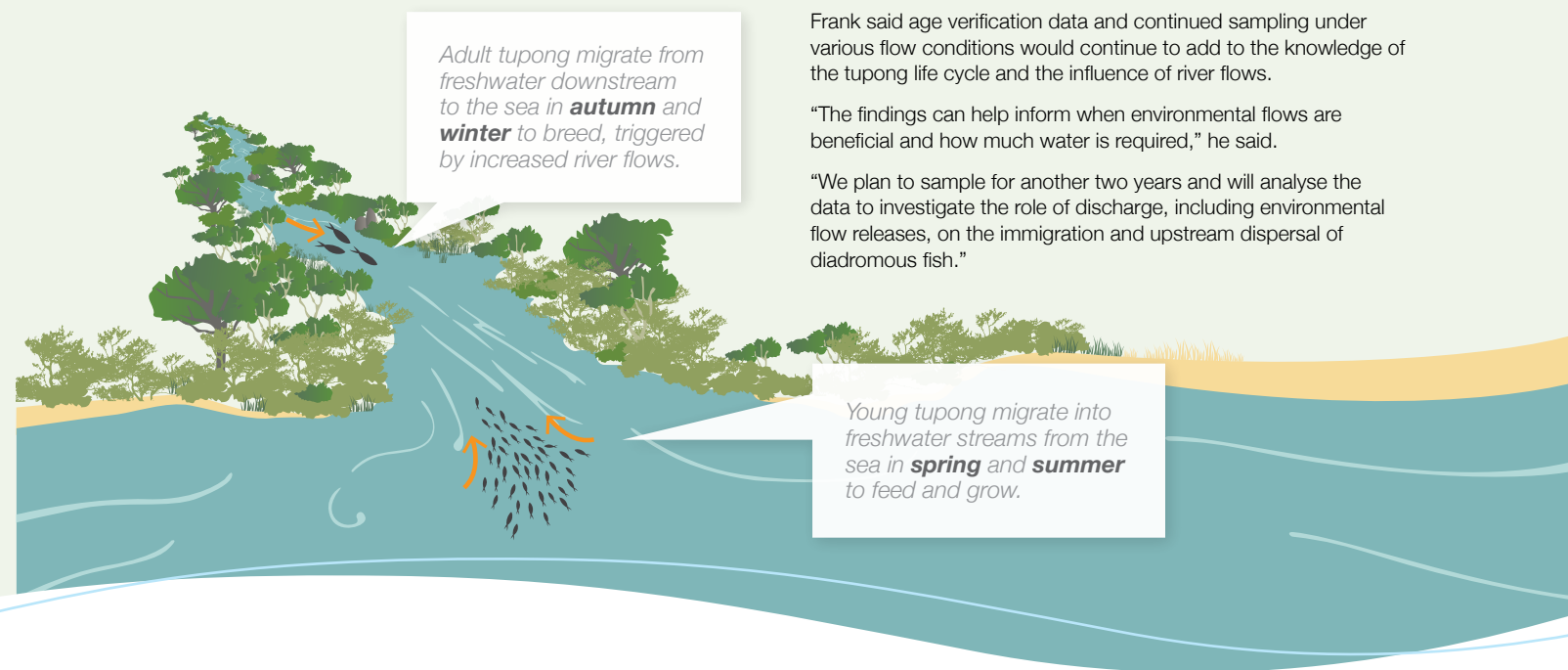
"For example, in 2017 in the Thomson River, tupong dispersal upstream was possible during the summer with higher baseflow conditions. Similarly, juvenile tupong migrated to the upstream portion of the middle reaches of the river by early February."

Frank said age verification data and continued sampling under various flow conditions would continue to add to the knowledge of the tupong life cycle and the influence of river flows.

"The findings can help inform when environmental flows are beneficial and how much water is required," he said.

"We plan to sample for another two years and will analyse the data to investigate the role of discharge, including environmental flow releases, on the immigration and upstream dispersal of diadromous fish."

*Young tupong migrate into freshwater streams from the sea in **spring** and **summer** to feed and grow.*



Shared community benefits



Paddlers riding a wave

Water for the environment is providing more recreational opportunities along Victoria's rivers, including for canoeing and kayaking.

Whitehorse Canoe Club is among the groups making good use of local waterways during environmental flows.

The club took to the water on the Thomson River during a flow timed for the Anzac Day long weekend. Almost 30 people joined the club's fun on the water, with an environmental flow providing perfect conditions for paddling.

Whitewater rafting tour operator Lynton Hill is also noticing that water for the environment has had a positive effect on the Snowy River.

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

"The river now looks like how older locals remember it. It has a more natural flow, with increased spring releases mimicking what happened before the dam. The river now has a sense of being alive."

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



Whitehorse Canoe Club members canoeing the Thomson River, by Mike Flavel

Whitehorse Canoe Club members canoeing the Thomson River, by Mike Flavel

Central region

Water for the environment boosted the health of rivers and wetlands, creating refuges for plants and animals in the densely populated areas of greater Melbourne, Ballarat and Geelong.

- » Water delivered to the Tarago River triggered a baby boom of threatened Australian grayling.
- » The largest spring flow to date was released to the Werribee River to stimulate fish breeding and support native vegetation.
- » The environmentally diverse Yering Backswamp and the Banyule Billabong on the Yarra River bounced back, with more frogs and birds and fewer weeds.
- » A successful summer drying regime reinvigorated Reedy Lake in the internationally important lower Barwon wetlands.
- » Fresh flows in the Maribyrnong River in autumn improved water quality for waterbugs, fish and platypus, as well as recreational users.
- » New research improved our understanding of how deep pools in the Moorabool River provide refuge for plants and animals when the river stops flowing.



*The Moorabool River at Dog Rocks,
by Andrew Sharpe, VEVH*

yarra system

Melbourne’s iconic Yarra River is becoming an ecological wonderland for frogs, birds, platypus and fish, as water for the environment improves the health of the river.

The Yarra system received its second-largest-ever volume of water for the environment in 2016–17 with the delivery of over 21,000 megalitres. This water is key to the survival of the river’s endangered aquatic inhabitants (such as Australian grayling, Macquarie perch, river blackfish, platypus and waterbugs).

“Environmental flows complemented wet conditions during the year, providing a much-needed top-up to improve the health of the Yarra. While it may seem unusual that water is released in wet periods, it is the ideal time to mimic natural processes.” said Melbourne Water’s Cheryl Edwards.

“Dams have altered natural flows and reduced habitat and food availability for native aquatic animals, so the release of this water is very important to improve the Yarra’s health.”

Over time, the lower Yarra River has been straightened, widened and cleared of debris as Melbourne has grown around its banks. The earliest recorded European modifications to the course of the river date back to 1879. The program to deliver water for the environment aims to reinstate flows that support the environment along the length of the river.


In the Yarra system, Yering Backswamp (5 kilometres south-west of Yarra Glen) and Banyule Billabong (at Viewbank) received environmental water in 2016–17, and the health of these areas improved noticeably. There were more native frogs and birds and fewer weeds.

As well, works to lower the bank of Spadoni’s Billabong (at Yering) allowed this waterway to fill naturally for the second time since the project’s completion in 2013.

Over one-third of Victoria’s population lives in the Yarra catchment, which has an area of about 4,000 square kilometres. Water for the environment is improving environmental outcomes and the highly prized recreational values of the river, benefiting everyone who enjoys the Yarra.

Waterway manager: Melbourne Water
Storage manager: Melbourne Water

Site	Volume delivered in 2016–17 (ML)
Yarra River	21,478
Banyule Billabong	60
Yering Backswamp	6


Click here to watch the Melbourne Water video about environmental water for the Yarra River, or watch it at <https://youtu.be/2zALXkrFJDU>

* It’s been a big year for the Wurundjeri people, Traditional Owners of the Yarra River.

In June 2017, Minister for Planning Richard Wynne joined Wurundjeri elders in Victorian Parliament to introduce the *Yarra River Protection (Wilip-gin Birrarung murron) Bill 2017*. In September, the Bill passed in Parliament.

In an Australian first, the Act identifies the Yarra River and the many hundreds of parcels of public land it flows through, as one living, integrated natural entity for protection.

The Act combines the ‘Caring for Country’ wisdom of Traditional Owners with the most modern river management expertise. In a Victorian first, it is co-titled and part of its preamble is written in Woi-wurrung, assuring Traditional Owners a permanent voice in the governance and protection of the Yarra River.

The Wurundjeri people are involved in an increasing number of projects related to the Yarra and its tributaries, including a project with VEWB and Melbourne Water that aims to use water for the environment to achieve cultural objectives.

The Yarra River at Templestowe, by Sarah Gaskill, Melbourne Water

tarago systemmaribyrnong system

The threatened Australian grayling fish underwent a baby boom in 2016–17, triggered by water releases into the Tarago River.

The releases improved river health for native fish, other animals (such as platypus) and plants, and in the process made the river a better place for the community to enjoy.

Populations of threatened Australian grayling benefited greatly from the water released by Melbourne Water from the *Tarago/Bunyip Environmental Entitlement*, with high counts of grayling eggs and larvae showing the positive response of these fish to water for the environment.

A survey of fish populations in the Tarago and Bunyip rivers also recorded the iconic river blackfish and other native fish species including spotted galaxias, pouched lampreys and hooded lampreys.




“We were excited to also find a baby Australian mudfish as part of our monitoring,” Melbourne Water Senior Environmental Water Resources Planner Sarah Gaskill said. “It’s a critically endangered species and has only been recorded in a handful of locations before.”

There is however still some concern about the river blackfish, which will be the subject of future research.

“Our research over many years has helped us to fine-tune how we release water for the environment, so we can provide the specific river conditions needed for breeding by species such as the Australian grayling,” Sarah said. “But the needs of river blackfish are less well known, so we will need to do some more work to understand their water flow and habitat requirements in detail.”

Waterway manager: Melbourne Water
Storage manager: Melbourne Water

Site	Volume delivered in 2016–17 (ML)
Tarago River	1,952

 **Click here** to watch the Melbourne Water video about environmental water for the Tarago River, or watch it at <https://youtu.be/1Pzy1lwaQl8>

Top to bottom: The Tarago River, by Sarah Gaskill, Melbourne Water; a young grayling in the Bunyip River, by Tarmo A Raadik, Arthur Rylah Institute

A fresher and healthier Maribyrnong River is the result of environmental flows that are protecting one of Melbourne’s most-valued and frequently used waterways.

Jacksons Creek and Deep Creek join to form the Maribyrnong River, which runs south through Yarraville in the heart of Melbourne’s inner suburbs.

There are no formal environmental water entitlements available to deliver flows through the river, so the VEW and Melbourne Water have bought unused water from irrigators for the last three years, to maintain the river’s water quality.

“Dry conditions since 2012 have meant reduced flows in the Maribyrnong River system, and this has put pressure on river health and aquatic habitats,” explained Melbourne Water Senior Environmental Water Resource Planner Simon Catzikiris.

There has been much less run-off to the system over the last few years including in Jacksons Creek and Deep Creek. Despite the return of wetter conditions this year, there was still not enough water making its way into the Maribyrnong River system.

“Conditions dried again over summer and autumn, so water for the environment was delivered from Rosslynne Reservoir to Jacksons Creek in March and May 2017. A total of 304 megalitres provided the fresh flows needed to help support the health and sustainability of the river’s ecosystem,” Simon said.

Populations of platypus and fish including migratory short-finned eels, galaxias and flathead gudgeons call the Maribyrnong River home. Water for the environment refreshed pools, improved fish passage and supported aquatic plants.

Without this water, the condition of the animals and plants in Jacksons Creek would have continued to decline. An added

bonus of the water for the environment is a cleaner, healthier river for the community to enjoy for recreation.

Waterway manager: Melbourne Water
Storage manager: Southern Rural Water

Site	Volume delivered in 2016–17 (ML)
Upper Jacksons Creek	304 ¹

¹ In 2016–17, water allocations copurchased by Melbourne Water and the VEW contributed to the delivery of 304 ML of environmental water to meet objectives in upper Jacksons Creek in the Maribyrnong system, where no permanent environmental water holdings are currently held.

Maribyrnong River at Brimbank Park in Keilor, by Simon Catzikiris, Melbourne Water



Werribee system

The Werribee River received a boost in late 2016 — its largest ever single environmental flow — in a bid to encourage native fish to breed.

Melbourne Water Senior Environmental Water Planner Bill Moulden said the larger flow this year aimed to encourage migratory fish to move into the river from the estuary.

“Water for the environment gives nature a boost. We use it to replicate the conditions native fish, frogs and platypus require to reproduce, and it helps to flush out sediment and improve water quality,” Bill said.

“A sign of the improved river health was the discovery of an Australian grayling — a nationally-threatened fish — for the first time ever in the Werribee River. In June 2017, a young Australian grayling adult was sighted upstream near the town centre. Its age and location implied that it would have migrated during the previous spring.”

Bill said the installation of a fish ladder in 2015 was also enabling Australian grayling and other fish species to migrate and breed.

Monitoring funded through the Victorian Government’s *Water for Victoria* plan, which underpins a major investment in catchment and waterway health, found large numbers of common galaxias moving into the river after water for the environment was released. This was another sign of improved waterway health.

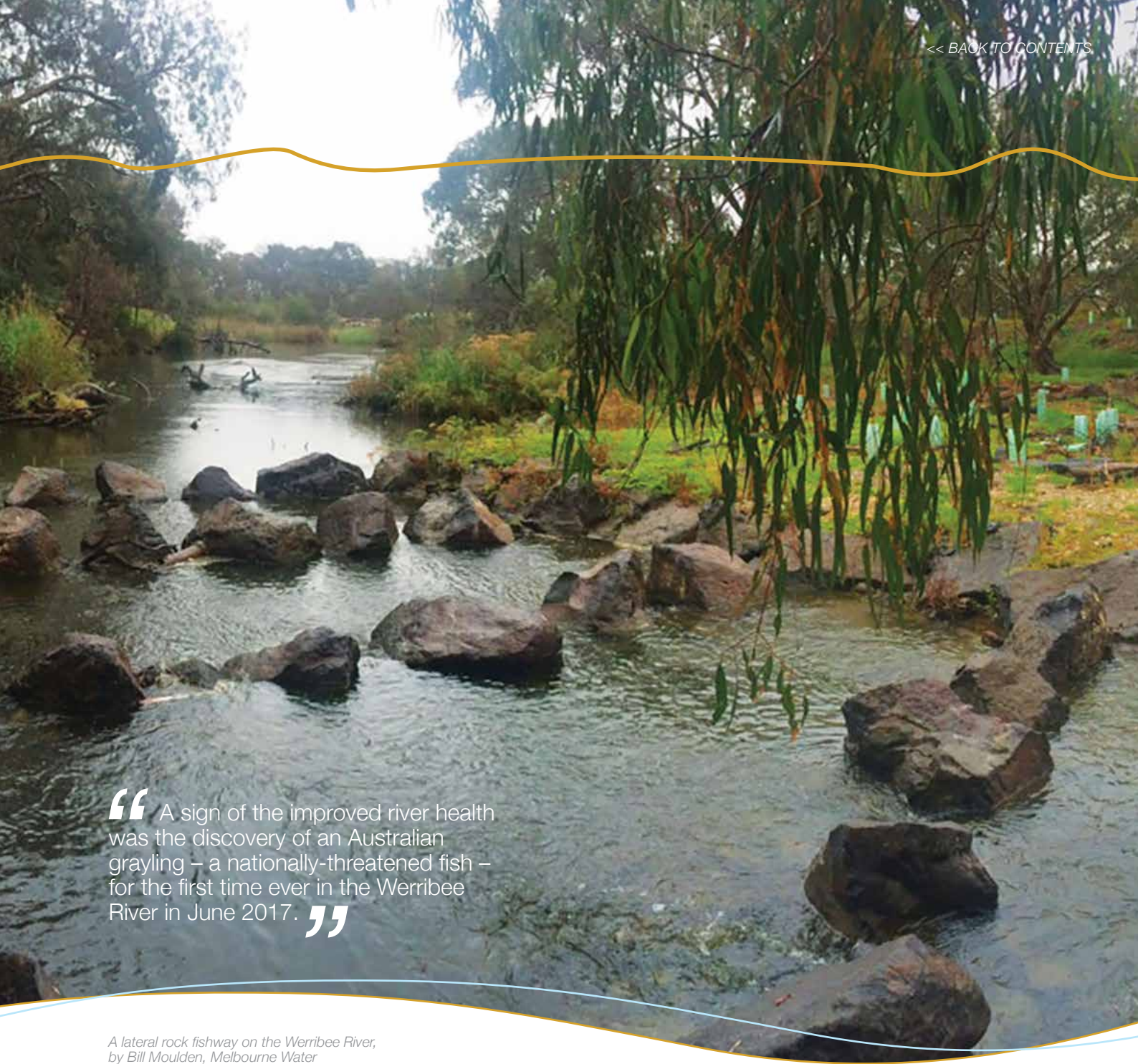
The 1,122 megalitres of environmental water delivered to the Werribee River in 2016–17 is helping to bring the river back to optimum health.

Waterway manager: Melbourne Water
Storage manager: Southern Rural Water

Site	Volume delivered in 2016–17 (ML)
Werribee River	1,122 ^{1, 2}
Pyrites Creek	954

1 Deliveries to the Werribee River included some reuse of return flows.
2 Includes use of 896.4 ML of allocation made available for use by Melbourne Water.

Australian grayling, by Arthur Rylah Institute



“ A sign of the improved river health was the discovery of an Australian grayling — a nationally-threatened fish — for the first time ever in the Werribee River in June 2017. ”

A lateral rock fishway on the Werribee River, by Bill Moulden, Melbourne Water

moorabool system

Animals that live in the Moorabool River, like fish and platypus, are thriving after water for the environment deliveries in summer and autumn 2016–17 added to the flows of a wet spring to improve the river’s health.

Following the end of dry conditions, river flows increased and the Lal Lal Reservoir overflowed with high rainfall in spring 2016. Waterway managers capitalised on the wet conditions by delivering water to the environment during summer and into autumn. This protected refuge pools and helped plants and animals recover from the dry period in 2015–16.

Refuge pools are deep pools in a river channel that provide habitat for fish, frogs, waterbirds and aquatic plants. These pools often hold water through long, dry periods and provide somewhere for aquatic animals to live until flows return, connecting the river again. Deep pools along a river are often the last refuge for river life when flows are low.

Research this year helped us better understand how refuge pools in the river function and how they provide sanctuary for plants and animals when the river stops flowing. The research identified and prioritised which pools to target with environmental water deliveries, to maximise their effectiveness as places of refuge.

“This new information is particularly important for waterway managers when we are in drought and have only a very limited amount of water available to protect environmental values,” Corangamite CMA Environmental Water Coordinator Saul Vermeeren said.

“Conditions were very dry in the Moorabool River in 2015–16, which meant we aimed to maintain water quality and top-up habitat refuge pools. This year the river reconnected due to the

wetter conditions and we’re working to keep it as connected as possible with the limited water we have available. The research carried out this year has also confirmed just how important the refuge pools are in helping plants and animals survive during dry times so they can flourish in wet times.”

Waterway manager: Corangamite CMA
Storage manager: Central Highlands Water

Site	Volume delivered in 2016–17 (ML)
Moorabool River	1,965

“ Water for the environment this year helped plants and animals recover from the dry period in 2015–16. ”



The Moorabool River at Dog Rocks,
by Andrew Sharpe, VEWH

lower barwon wetlands system

Managing water for the environment isn't always about adding more water. One of the success stories of 2016–17 was the lowering of the water levels of an internationally important wetland.

Healthy wetlands need varying water levels, because their wide variety of plants and animals have differing water needs. Until this year, Reedy Lake — a wetland in the lower Barwon river system — suffered from having too much water for too long. The lake's water levels had been high for over a decade, allowing reeds to choke the lake and crowd out other important plants and animals. This loss of habitat threatened endangered coastal saltmarsh communities and the number and diversity of internationally important migratory waterbirds the wetland supports.

The wetland had literally had too much to drink and needed a good drying-out. Corangamite CMA worked with local community members, the Lower Barwon Advisory Committee, Department of Environment, Land, Water and Planning, Parks Victoria and the VEWI to put in place a plan to lower water levels at the lake.

"If we don't act, one of the last remaining areas of endangered coastal saltmarsh communities in the Corangamite Region will be lost, the dominant reeds will choke the wetland, carp will multiply and the wetland will no longer be able to provide a haven for a range of internationally important birds," explained Corangamite CMA Chair Alice Knight.

"Lowering water levels at Reedy Lake is an important management action that we believe will mitigate threats to the system and ensure all user groups can continue to use and cherish the lake into the future."

A low-water-level regime began at Reedy Lake in 2016–17. As explained in the VEWI's Seasonal Watering Plan 2016–17, levels at the lake will be lowered each summer for the next two years, with full water levels maintained in the fourth year of the cycle.

Corangamite CMA, with the support of the VEWI, is keeping a close eye on the lake to see how it responds to the new approach. Monitoring of the lake is already showing signs that the regime is working, with clear evidence that the extent of reeds is reducing.

The monitoring also identified environmental improvements including better wader habitat for migratory shorebirds and restored coastal saltmarsh habitat, and it also found that the new regime did not generate acid sulfate soils.

Water levels at Hospital Swamps, another lower Barwon wetland, were also managed throughout 2016–17.

Waterway manager: Corangamite CMA



Click here to watch the Corangamite CMA video about environmental watering at Reedy Lake, and **here** to watch the video about environmental watering at Reedy Lake and Hospital Swamps, watch them at <https://youtu.be/ZVADTKm9gcM> and https://youtu.be/S_jsY2uch6Q



“ If we don't act, one of the last remaining areas of endangered coastal saltmarsh communities in the Corangamite Region will be lost. ”

Lignum swamp and coastal saltmarsh at Reedy Lake, by Saul Vermeeren, Corangamite CMA

Watering for Melbourne's environment

Melbourne's rivers, estuaries and wetlands are the foundation of a vibrant natural environment and a key contributor to the city's productivity and liveability.

The community loves its waterways, and our deep connections to the rivers and their surrounding landscapes form part of the region's liveability. Environmental water is important for keeping these rivers and landscapes healthy.

"As Melbourne and the surrounding region have grown over the past two centuries, the city has relied heavily on our rivers to supply water for growing food, drinking and industry use," Melbourne Water's General Manager Integrated Planning Chris Williams said.

Melbourne Water, as the waterway manager, works with the VEWH to carefully plan and target the release of water for the environment to help native plants and animals cope with the pressures of urbanisation. Species that call Melbourne's Yarra, Maribyrnong, Tarago and Werribee rivers home include platypus, dozens of frog species and important and endangered native fish populations.

The strategically timed release of water for the environment helps increase platypus and frog populations and encourages native fish to migrate and spawn.

"Water for the environment gives nature a boost. We use it to create the conditions native fish, frogs and platypus need to reproduce, and it helps to flush out sediment and improve water quality," Chris said.

"Given the pressures of climate variability and population growth likely to be experienced in Melbourne, it's never been more important to find ways to help nature deal with these stresses."

"Working with the VEWH and other stakeholders, we want to ensure these important native species of aquatic animals and vegetation thrive. Our focus is on finding a balance that supports community and commercial needs, for the benefit and liveability of Melbourne now and for future generations."

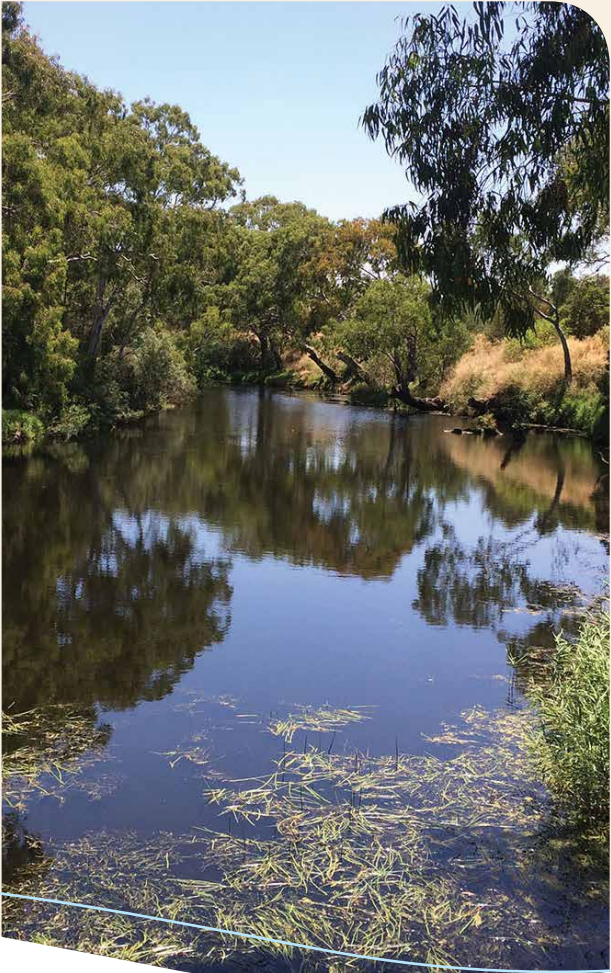
Fish recovery

Fish populations are benefiting from the delivery of water for the environment. For instance, during the Millennium Drought from 1997–2009, there were concerns about Australian grayling in the Yarra River. Flows to the Yarra and Tarago rivers in autumn — known as freshes — are timed to support the breeding requirements of Australian grayling. They provide the natural cue for the fish to migrate downstream to spawn.

"Australian grayling spawn in the freshwater reaches of the system before their eggs and larvae drift out to sea. The juveniles then spend about six months in the sea before migrating back upstream," Melbourne Water Senior Environmental Water Resources Planner Cheryl Edwards said.

Water for the environment delivered in the region in 2016–17 included the largest-ever release in the Werribee River in November, which resulted in Australian grayling being detected in the Werribee River for the first time.

Australian grayling are not the only fish to benefit from the flows. River blackfish also respond well, and the flows in the Yarra help Macquarie perch to breed by clearing debris from its spawning grounds — pebble beds known as riffle habitats.



Left to right: Maroondah reservoir, by Bob Padula;
Watering at Banyule Billabong, by Keith Chalmers;
Werribee River, by Melbourne Water

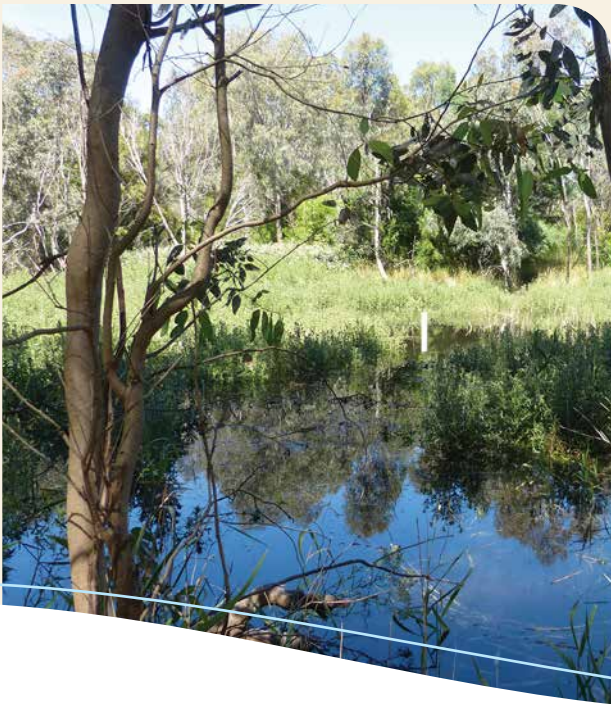


“ You never heard so many happy frogs! Common froglets, pobblebonks and some clicks from, I think, striped marshfrogs.” ”

Platypus

The local platypus population suffered greatly during the Millennium Drought. Environmental water releases in subsequent years have improved water quality for macroinvertebrates — the platypus’ main food source — and have stimulated platypus to explore new habitat and expand their range.

“We work with the VEWH to plan and release environmental water, which enables platypus to move around the river and put on the weight they need to be healthy enough to reproduce during the summer breeding season,” Cheryl said.



Frogs bouncing back

Rivers and wetlands in the central region also support several frog species, which are highly dependent on water to provide habitat at particular stages of their life cycle.

Frogs are highly sensitive to changes in the environment and we use this knowledge to plan the delivery of environmental water to rivers and wetlands to replicate the conditions frogs need to reproduce. Monitoring shows that frog populations in rivers and creeks that receive environmental water are larger than those that don’t.

A symphony of frogs serenaded visitors to Banyule Billabong, when environmental water in late spring 2016 provided spectacular benefits for those who frequent the area. The billabong lies along one of Melbourne’s most popular recreational trails in Viewbank, near Heidelberg.

The Banyule Billabong has one of the most diverse populations of regionally and locally significant wildlife of all the Yarra Valley parkland billabongs. A Melbourne Water investigation of its long-term needs prompted an environmental watering regime to help ensure its ecological future.

The month-long trial helped determine the amount of water needed to rehabilitate the billabong’s rich ecosystem, which is home to species like the growling grass frog and to threatened plant species (such as river swamp wallaby grass and ferny azolla). The monitoring showed a rapid response response from frogs and improvements in plant growth.

Banyule Billabong after watering in 2016, by Anthea Fleming of the Warringal Conservation Society

Banyule resident Anthea Fleming, also of the Warringal Conservation Society, witnessed this first hand: “You never heard so many happy frogs! “ she reported. “Common froglets, pobblebonks and some clicks from, I think, striped marshfrogs.”

Melbourne Water General Manager of Integrated Planning Chris Williams said that under natural conditions the Banyule Billabong would have been flooded annually. However, with our rivers supplying water to drink, grow food and meet industry needs, the billabong is flooded less frequently, and water for the environment is essential to its future.

Left to right: A growling grass frog, by East Gippsland CMA; An echidna at Banyule Billabong, by Anthea Fleming, Warringal Conservation Society; Tawny frogmouths at Banyule Billabong after watering, by Anthea Fleming, Warringal Conservation Society.



“We delivered water to the site to simulate what should occur naturally, and we were really pleased to see that the frogs responded by returning to the area almost immediately,” Chris said.

“The billabong is also a popular recreational area for enjoying nature, walking and cycling along the Yarra trail, so we want to ensure the site is rehabilitated for the benefit and liveability of the community and for future generations. Water delivered from the Yarra River to help this unique environment survive and thrive is crucial to achieving this rehabilitation.”

Shared community benefits



Paddling in 'the backyard'

As well as boosting waterway health for native plants and animals, water for the environment delivered to the iconic Yarra River is providing a playground for paddlers.

The Yarra River is Sean Marler's little slice of paradise in Melbourne's high-rise landscape. Sean's been paddling the Yarra River since he was 19 years old.

He said the peaceful surrounds of the river and diverse wildlife made it easy to forget Melbourne is a city that more than four million people call home.

"I've paddled on rivers all over the world but nothing quite beats what you've got in your own backyard," Sean said.

"The Yarra River is my main playground. I go bushwalking, birdwatching and paddling there, and I'm constantly amazed by the biodiversity I see," he said.

It's an appreciation being shared by a growing number and diversity of people.

"There's a huge age range. I know people in their 70s who get out here and I take kids as young as three down the river, too," Sean said.

Environmental flows create a healthier waterway for native plants and animals and a Yarra River for everyone to enjoy.

“ I know people in their 70s who get out here and I take kids as young as three down the river too. ”

Paddling on the Yarra River during an environmental flow, by Melbourne Water

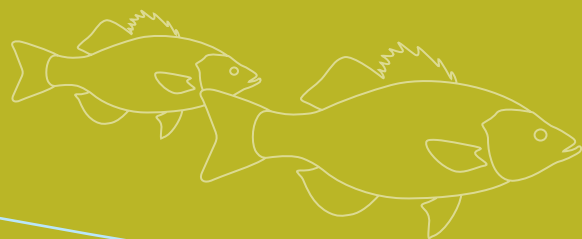


Sean Marler enjoys paddling on the Yarra River, by Melbourne Water

Western region

2016–17 saw the region's waterways recover after three dry years, with a wet winter providing more water to help us achieve many of our winter watering objectives.

- » High natural flows in winter 2016 reconnected many parts of the Glenelg River, providing ideal breeding conditions for native fish.
- » Platypus and native fish in the Wimmera River continued to recover, thanks to high natural flows and water for the environment.
- » Water for the environment was delivered to 31 of the 51 Wimmera–Mallee wetlands.
- » Two Aboriginal water projects in the Wimmera and Glenelg rivers helped reconnect Traditional Owners to many parts of Country and built cross-cultural relationships.
- » Water for the environment was delivered to the Glenelg River to coincide with the Johnny Mullagh Memorial Cup, an annual cricket competition celebrating the first Australian Test team, who were all Aboriginal men from the area.
- » Scientists and anglers collaborated using environmental DNA monitoring to reveal how native fish in Wimmera waterways respond to environmental flows.



*The Wimmera River at Horsham,
by Greg Fletcher, Wimmera CMA*

glenelg system

This year, the Glenelg River system received some much-needed relief from the dry conditions of recent years, with heavy rainfall in winter and early spring.

Last year, drought was tough on the Glenelg system: inflows were among the lowest ever and the river was reduced to a series of ponds along some stretches.

But heavy rain in winter 2016 was substantial enough to inundate the floodplain in many parts of the catchment and provide riparian vegetation with much-needed water.

The heavy rain and subsequent high river flows reconnected different parts of the river, providing ideal breeding conditions for some native fish species and enabling migratory species to disperse and recolonise the system. Flows in the river were carefully managed, particularly in summer and autumn, to capitalise on the benefits of the wet winter.

“We have fish like estuary perch and tupong moving back into their old range, more than 270 kilometres upstream from where they were just seven years ago,” said Glenelg Hopkins CMA Water Resources Manager Bryce Morden.

“Blackfish numbers have doubled and numbers of critically endangered variegated pygmy perch have increased tenfold. Water for the environment in 2016–17 was also really beneficial for the endangered Glenelg spiny freshwater crayfish, which suffered in the recent drought.”

Plants and animals can withstand all sorts of conditions, but they all have their limits. Bryce said the flooding scoured and in some cases uprooted drought-stressed riparian and in-stream vegetation.

“While we can’t prevent some of the damage of the seasonal extremes we’ve been experiencing, we can use water for the environment to help river plants and animals bounce back from tough conditions, ensuring healthy and resilient populations into the future,” he said.

Waterway manager: Glenelg Hopkins CMA
Storage manager: Grampians Wimmera Mallee Water

Site	Volume delivered in 2016–17 (ML)
Glenelg River	2,765

Water birds on the lower Glenelg River, by Chloe Wiesenfeld



A spiny crayfish at Dartmoor, by Glenelg Hopkins CMA

Wimmera system

The Wimmera River system’s native fish and platypus showed signs of recovery and growth in 2016–17, demonstrating the importance of careful environmental water management.

Heavy rain in winter and spring marked the end of an extended dry period. As a result, the waterways flowed naturally, reducing the need for environmental water and achieving many environmental outcomes naturally. The heavy rain meant there was more water in the bank to build the resilience of the plants and animals that rely on rivers and protect them in future dry years.

Water for the environment in 2016–17 capitalised on the wet conditions in winter and early spring to ensure low flows and some variable higher flows occurred in spring, summer and autumn.

Water for the environment also continued to support plants and animals to recover from the extended Millennium Drought. During the drought, rivers and creeks in the Wimmera system dried out everywhere, except for a handful of small waterholes.

In December 2016, the Arthur Rylah Institute undertook fish monitoring as part of the Murray–Darling Basin Authority’s Fish Survey. It found there were healthy native fish populations in the MacKenzie River and that the number of native fish compared to the number of non-native fish was high.

Researchers also found platypus numbers were steadily rising, as the current population continued to breed and disperse into areas that would have dried out without water for the environment.

When surveying in the MacKenzie River at Zumsteins, researchers saved the life of a juvenile female platypus they nicknamed Maddie. Wildlife ecologist Josh Griffiths, working with Wimmera CMA, discovered Maddie with a hair tie wrapped around her neck:

it would have killed her within weeks. Josh removed the hair tie and released Maddie back into the wild, so she can grow and hopefully breed in the future.

Waterway manager: Wimmera CMA
Storage manager: Grampians Wimmera Mallee Water

Site	Volume delivered in 2016–17 (ML)
Wimmera River	7,116
MacKenzie River and Burnt Creek	3,429
Lower Mount William Creek	155

The Wimmera River at Dimboola, by Chloe Wiesenfeld



Maddie the platypus, by Paul Carracher, The Weekly Advertiser

Wimmera mallee wetlands

A network of wetlands in dry north-western Victoria is proving a valuable natural asset for communities.



The Wimmera Mallee Pipeline, completed in 2010, was one of the largest water infrastructure projects in Australia, replacing 17,500 kilometres of inefficient open channels with over 9,000 kilometres of pipeline. The pipeline greatly reduced water losses from dam and channel evaporation and seepage. However, it also meant that much less water was available for plants and animals.

These days, to help mitigate the effects of water loss in the landscape, the Wimmera–Mallee wetlands are rejuvenated with water for the environment sent through the pipeline.

“Coming off the back of a very dry year, the plan in 2016–17 was to drip-feed the landscape with environmental water, just to keep some water in it,” said North Central CMA Environmental Water Team Leader Louissa Rogers.

“But with good rain, we were lucky enough to have some wetlands completely inundated naturally.”

Learning about wetland ecology at Corack Lake, by Chloe Wiesenfeld, VEWH

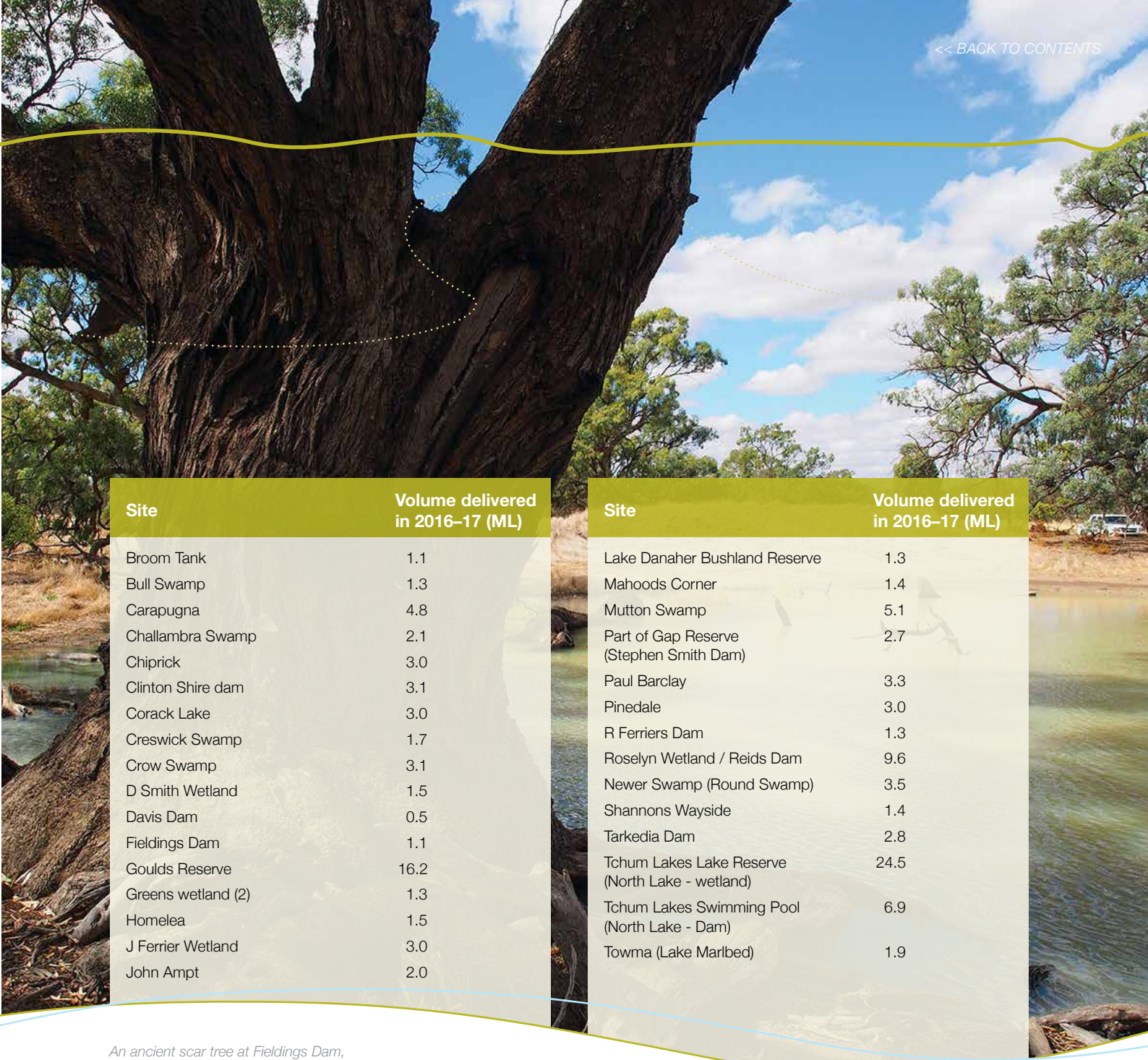


In 2016–17, 31 of the 51 wetlands received water for the environment. As a result, people have spotted mountain ducks, grey teals, pink-eared ducks, freckled ducks, Eurasian coots, masked lapwings, black-winged stilts, red-kneed dotterels, curlew sandpipers and black swans. Many animals like kangaroos, wallabies, turtles, snakes and lizards are regularly seen using these wetlands, too.

Broad-scale improvement in the condition of plants has also been observed, with healthier trees and shrubs reported at many wetlands.

Communities are making the most of the improved environmental conditions at these wetlands and are using them for social and recreational pursuits. Walking, birdwatching, boating, picnicking, duck-hunting and yabbing are popular activities on the wetlands. They are also good sites for organised events (such as meetings and community days).

Waterway manager: Wimmera, North Central and Mallee CMAs.
Storage manager: Grampians Wimmera Mallee Water



Site	Volume delivered in 2016–17 (ML)
Broom Tank	1.1
Bull Swamp	1.3
Carapugna	4.8
Challambra Swamp	2.1
Chiprick	3.0
Clinton Shire dam	3.1
Corack Lake	3.0
Creswick Swamp	1.7
Crow Swamp	3.1
D Smith Wetland	1.5
Davis Dam	0.5
Fieldings Dam	1.1
Goulds Reserve	16.2
Greens wetland (2)	1.3
Homelea	1.5
J Ferrier Wetland	3.0
John Ampt	2.0

Site	Volume delivered in 2016–17 (ML)
Lake Danaher Bushland Reserve	1.3
Mahoods Corner	1.4
Mutton Swamp	5.1
Part of Gap Reserve (Stephen Smith Dam)	2.7
Paul Barclay	3.3
Pinedale	3.0
R Ferriers Dam	1.3
Roselyn Wetland / Reids Dam	9.6
Newer Swamp (Round Swamp)	3.5
Shannons Wayside	1.4
Tarkedia Dam	2.8
Tchum Lakes Lake Reserve (North Lake - wetland)	24.5
Tchum Lakes Swimming Pool (North Lake - Dam)	6.9
Towma (Lake Marlbed)	1.9

An ancient scar tree at Fieldings Dam, by Chloe Wiesenfeld, VEWH

yarns on the western rivers

Victoria's river systems flow through landscapes which are culturally significant to Traditional Owner groups, whose ancestors have lived along these rivers for tens of thousands of years.

In 2016–17, two projects in western Victoria provided the opportunity for Traditional Owners to reconnect with the Glenelg and Wimmera rivers and to talk with water managers about their aspirations for how water is managed along the rivers. The Traditional Owners were represented by the Gunditj Mirring Traditional Owner Aboriginal Corporation and the Barengi Gadjin Land Council.

The Towards Cultural Flows project focuses on the Glenelg River and is a partnership between the Glenelg Hopkins CMA, Gunditj Mirring and Barengi Gadjin, while the River Yarns project focuses on the Wimmera River and is a partnership between the Wimmera CMA and Barengi Gadjin.

Glenelg Hopkins CMA staff Jane Walker and Ryan Jones by the Glenelg River working on the Towards Cultural Flows project, by Glenelg Hopkins CMA



Benefits for Aboriginal people from environmental flows

Both projects are seeking to find out more about the story places and plant and animal species along the rivers that are significant for Traditional Owners, so these values can be supported using environmental flows.

Glenelg Hopkins CMA Project Officer Jane Walker said this information will be incorporated into environmental watering plans for the Glenelg River in future.

"The purpose of the Towards Cultural Flows project is to see what is significant about the river system for Traditional Owners and to look at where the CMA can potentially support their interests in the Glenelg River through environmental flows," Jane said.

In March 2017, the Glenelg Hopkins CMA did just that. In a first for Victoria, the timing of an environmental flow was tweaked to support environmental outcomes as well as Aboriginal values along the Glenelg River.

Each year, a team of Aboriginal cricketers and a local cricket team vie for the Johnny Mullagh Memorial Cup, an annual event that celebrates the first Australian Test team. The team toured England in 1868 and was made up of Aboriginal men from the Harrow area, one of whom was Mullagh, who continued to play Test cricket. Water was released from Rocklands Reservoir between 21 February and 1 March to coincide with the cup match on the March long weekend at Harrow. People at the match enjoyed more flow in the river, better quality water for swimming and a pleasant place to camp and play.

As well as freshening the water for native plants and animals and improving the river's useability and amenity for the cricketers, spectators and others, the environmental flows resulted in many other benefits including support for cultural heritage values (such as scarred trees and native plants, which are sources of traditional foods and medicines).

The benefits flow on

Wimmera CMA Aboriginal Water Officer Ben Muir said one of the most significant benefits for Traditional Owners of the River Yarns project was the opportunity to reconnect with many parts of their Country.

"The elders had not been to some of these places for a long time. It was very emotional to go back there," Ben said.

The river trips and community gatherings drew out memories and stories that have not been shared for decades.

Jane Walker said another benefit had been building cross-cultural understanding about the Glenelg and Wimmera rivers.

"Part of the journey is learning about the river system, learning about the knowledge Traditional Owners have about the river and about the history of the river, and combining that with modern management approaches and western science," she said.

A key benefit of both projects has been the opportunity to build relationships that will provide the foundation for longer-term projects. Through Towards Cultural Flows and River Yarns, Gunditj Mirring and Barengi Gadjin have developed relationships with the CMAs as well as with other water and land agencies, other Aboriginal organisations, community groups, ecologists and archaeologists.

"We had fantastic feedback from everyone involved," Wimmera CMA Community Delivery Manager Joel Boyd said.

"It is really just the start of ongoing discussions with the local community to build partnerships and work together to create opportunities."

From little things, big things grow

Stories from the River Yarns project are now being shared at gatherings and through performances, films and an interactive online story map. The Towards Cultural Flows project team have been having similar gatherings to tell their story, and they have presented their knowledge at conferences.

Gunditj Mirring and Barengi Gadjin hope that projects like these will ensure local Aboriginal values and customary uses are better linked to water planning and river management.

For a long time, Aboriginal groups have been calling for water rights and meaningful participation in water management across Australia. These projects respond to Traditional Owner rights and interests in waterway management and they are generating many opportunities to improve the health of Aboriginal people and Country.

Traditional Owners getting involved in the Towards Cultural Flows project on the Glenelg River, by Glenelg Hopkins CMA



Shared community benefits

Wimmera anglers get involved

Cutting-edge technology is revealing the behavioural patterns of native fish in Wimmera waterways, helping us to better understand how environmental flows benefit the fish.

The Wimmera CMA was an early adopter of environmental DNA (eDNA) technology to monitor platypus movements. It is now using the technology to better understand fish populations in a joint project between Wimmera Anglers Association and Wimmera CMA.

eDNA is DNA collected from water or soil, rather than directly sampled from plants or animals. It is a non-invasive way to test for the presence or absence of particular plants or animals.

Volunteer anglers took eDNA samples from more than 17 kilometres of the lower Wimmera River near Dimboola. This allowed them to measure the presence or absence of species including golden perch and catfish and to measure the effects of water for the environment on those fish. Along the way, they also noted some good fishing spots!

"It's really fascinating," said Wimmera Anglers Secretary Barry Williams. "You can give the CMA 100 millilitres of water and what they can get out of that sample with this eDNA is mind-blowing."

The encouraging sampling results were backed up at the 2017 Horsham Fishing Competition, where for the first time more native fish were caught than carp.

Top to bottom: Angling is a way of life on the Wimmera, by Wimmera CMA; Greg Fletcher of Wimmera CMA with Kelvin Robinson of Horsham Angling Club taking part in the river environmental DNA sampling, by Wimmera CMA

“ You can give the CMA 100 millilitres of water and what they can get out of that sample with this eDNA is mind-blowing. ”



Riding the flow

Knowing when environmental water was to be released along the Glenelg River meant George Turner could plan the adventure of a lifetime with his family on a rarely paddled stretch of the Glenelg.

George knows the lower Glenelg well. Originally hailing from the Coleraine area, he estimates he's canoed from Dartmoor to Nelson at least a dozen times in his life.

Now Adelaide-based and with family in tow, the 44-year old surveyor's fondness for the Glenelg River remains. That's why when he was planning his Christmas holidays last year, his thoughts turned to canoeing along the Glenelg with his family — his partner Sue and two sons aged 10 and 12.

He thought, maybe given the wet winter in 2016, they might be able to canoe beyond the usual Glenelg River canoeing route into the area north of Dartmoor.

But before he planned the trip, he wanted to be certain there'd be enough water to paddle on. "I wanted to know how canoeable different sections of the river would be," he said.

He figured if they could time their adventure with an environmental flow, they'd be assured a clear passage. Wanting to find out more about the river's condition and planned environmental flows, he contacted Glenelg Hopkins CMA. After talking with Water Resources Manager Bryce Morden, he was able to plan a 40-kilometre trip upstream of Dartmoor around the timing of a flow.

Using river height data, they estimated when the flow would reach the area of river his family was hoping to paddle.

"It's always going to be better, from a canoeing perspective, jumping in your boat when there is extra water around," George said.

"Knowing what is happening on the water is very helpful. It's useful for knowing if the trip is viable and for managing any threats and risks to the trip," he said.

In late December 2016, George and his family enjoyed the benefits of the environmental flow as they navigated a rarely canoed stretch of the Glenelg River north of Dartmoor.

George said he was impressed by the range of wildlife they saw along the river. "The wildlife was pretty amazing. We saw platypus, wedge-tailed eagles, koalas, emus, kangaroos and snakes."

He said finding sandy spots along the Glenelg to pitch a tent was easy, and the kids loved every minute.

Bryce Morden said part of the reason for releasing water into the Glenelg from Rocklands in early December was so it could benefit holiday-makers along the lower reaches later in the month. He said it was gratifying to be able to help people like George and his family enjoy some of what the Glenelg has to offer.

"Water for the environment supports more than just plants and animals, it's for people too. It's good that message is getting out there about environmental flows and people like George are taking up the opportunity to speak with us to help them plan recreational activities like canoeing."

“ It’s always going to be better, from a canoeing perspective, jumping in your boat when there is extra water around. ”



Preparing for a day of paddling, by George Turner



* In 2017, more than 437,000 people visited the 24 waterways in the Wimmera Southern Mallee region — the municipalities of Hindmarsh, Horsham, Northern Grampians, West Wimmera and Yarriambiack — and their total economic contribution was an estimated \$27.5 million.

As importantly, participating in recreational activities on the region’s waterways had a combined annual physical and mental health value estimated to be \$8.6 million.

It just goes to show that keeping waterways healthy is important for our wellbeing and lifestyle.

(From Wimmera Southern Mallee: Socio-Economic Value of Recreational and Environmental Water 2017, Wimmera Development Association)

The Wimmera River, by Greg Fletcher, Wimmera CMA

Northern region

Despite the forecast of a dry year, rain storms and natural flooding across most of northern Victoria created super-wet conditions in rivers and wetlands.

- » Flows were coordinated across three major rivers in an effort to woo native fish hundreds of kilometres from the River Murray into Victorian waterways.
- » The banks of the Goulburn River stood up to erosion and slumping in a flood, in part due to earlier use of water for the environment.
- » Water for the environment was used to improve water quality in the Goulburn River, after natural flooding caused a blackwater event.
- » The central Murray wetlands became a haven for waterbirds in 2016–17 with the return of rare Australasian bitterns as well as magpie geese thought to be extinct in this region since 1913.
- » Monitoring found the Campaspe River had good numbers of silver perch for the first time in 10 years, and numbers of juvenile Murray cod were at their highest levels since monitoring began in 2007.
- » The threatened Murray–Darling rainbowfish bounced back, with significant numbers recorded in the wetlands of the Gunbower Forest.
- » Water for the environment in Hattah Lakes provided a refuge for aquatic animals, following a natural blackwater event that occurred in the River Murray after rain storms.
- » Floodplain vegetation, fish and frogs were thriving in the Barmah Forest, prompting a waterbird breeding boom.
- » Deliveries of water for irrigation in the Ovens River were coordinated to simulate a summer fresh flow to the downstream reaches.



*A spoonbill at Steamer Plain, Barmah,
by Keith Ward, Goulburn Broken CMA*

goulburn system

Although the Goulburn River flooded naturally in late 2016, the river’s banks experienced less erosion and slumping than in previous floods, due in part to the earlier use of water for the environment.

Regular use of water for the environment has helped stabilise the riverside vegetation and strengthened the banks of the lower Goulburn, making it more resilient to floods.

“The annual monitoring we’ve conducted shows that using environmental water to top-up water delivered to irrigators and other users at this time of the year has helped bank-stabilising plants establish along the lower Goulburn,” Goulburn Broken CMA Environmental Water and Wetlands Manager Simon Casanella explained.

“Because of this vegetation, we saw far less bank slumping and erosion during the natural flooding we experienced late last year than we did during 2010 to 2012.”

Winter and spring rainfall provided the second-largest overbank flood in the lower Goulburn River in the past 20 years. The flooding triggered native fish to breed, and monitoring found good numbers of golden and silver perch spawning.

“We planned an environmental flow in November to stimulate golden perch migration and spawning, but we cancelled it due to the high natural flows,” Simon said.

“It was great news that nature ran its course and triggered a fish spawning event, and it provided ideal conditions for the further recovery of vegetation as well.”

Waterway manager: Goulburn Broken CMA
Storage manager: Goulburn-Murray Water

Site	Volume delivered in 2016–17 (ML)			
	VEWH	MDBA	CEWH	Total
Goulburn River	27,500	20,000	182,253	229,753

Regular environmental water deliveries have helped re-establish vegetation on the banks of the lower Goulburn River, by Goulburn Broken CMA



Managing blackwater

* Water for the environment was used to lessen the effects of blackwater which developed in the Goulburn River in summer 2016, following an extreme and rare summer storm.

Up to 100 millimetres of rain fell across parts of the catchment on one day – 29 December 2016 – and run-off from Castle, Pranjip and Seven creeks entered the Goulburn River near Shepparton.

Water from the creeks, containing decaying leaf litter and other debris, made its way into the Goulburn River. When a large amount of leaf litter enters a waterway, the micro-organisms that break it down use oxygen. If the oxygen is consumed faster than it can be replenished, oxygen levels in the water can drop to such low levels that deaths of fish and other river life may occur. The water looks blackish, hence the name.

During the Goulburn blackwater event, water for the environment was used to increase flows along the Goulburn to help replenish dissolved oxygen levels and disperse the blackwater, providing relief for native fish and other river life.

▶ **Click here** to watch this video from North Central CMA about the causes and effects of blackwater: <https://youtu.be/OyKhsKCvIqw>

Goulburn River near swing bridge Shepparton, by Goulburn Broken CMA

broken system

goulburn broken wetlands

The return of wet conditions to the Broken system in 2016–17 meant that most of the flows needed to keep the river healthy were provided naturally.

Rain storms across the catchment in winter and spring 2016 resulted in bankfull and overbank flows along the Broken River and Broken Creek. These flows provided the floodplain and wetland habitats along these waterways with a much-needed drink, helping the many native plants and animals that call them home.

Broken Creek showed itself to be remarkably resilient. The River Murray experienced major flooding, with a peak flow of over 196,000 megalitres a day from Yarrowonga Weir. As a result, poor-quality water from the River Murray backed up the lower Broken Creek, lowering dissolved oxygen levels for about a week. The water quality improved once flows in the River Murray dropped and environmental flows were delivered down the creek. No reports of ill effects to aquatic animals or fish deaths were recorded.

To try to reset the balance, water for the environment was delivered in winter to lower Broken Creek for the first time, to enable native fish to pass along the creek outside the irrigation season.

Water for the environment is yielding excellent results: fish monitoring shows Murray cod numbers are at a 10-year high in the Broken River.

Waterway manager: Goulburn Broken CMA
Storage manager: Goulburn-Murray Water

Site	Volume delivered in 2016–17 (ML)		
	VEWH	CEWH	Total
Lower Broken Creek	-	36,364	36,364

Flood marks on trees in Broken Creek, by Keith Ward, Goulburn Broken CMA



High rainfall filled the Goulburn Broken wetlands naturally in winter and spring 2016–17, and summer rainfall prolonged the inundation.

Black Swamp, Kinnairds Wetland and Moodie Swamp all filled naturally. Moodie Swamp was still holding water and supporting large numbers of waterbirds into autumn 2017.

For the first time, researchers recorded both musk ducks and greater crested grebes at Moodie Swamp. At Black Swamp, bird surveys recorded rare freckled ducks for the first time as well as large numbers of wading birds (such as herons, egrets and spoonbills). Royal spoonbills and pied cormorants bred at Kinnairds Wetland, and endangered blue-billed ducks were observed.

The wetlands are also being listened to, as well as observed visually. When environmental water was delivered, Goulburn Broken CMA Wetlands and Environmental Water Project Officer Jo Wood headed out into the wetlands with her acoustic recorders.

Jo put the recorders out for 48 hours, recording for 30 seconds at 30-minute intervals. As a result, Jo recorded many different frog species including Sloane’s froglet, which was heard for the first time at Doctors Swamp.

“The response after water is delivered is nearly instant. Frogs start calling and some waterbirds such as ducks and swans have been recorded calling within 24 hours of the delivery,” Jo said.

“Earlier this year, we heard magpie geese at Kinnairds Wetland at Numurkah. The wetland was drawing down but when we recorded the geese we were able to deliver more water to help them feed and roost over the warmer months. If we hadn’t put the recorders out, we would never have realised they were there.”

Waterway manager: Goulburn Broken CMA
Storage manager: Goulburn-Murray Water

“The response after water is delivered is nearly instant. Frogs start calling and some waterbirds such as ducks and swans have been recorded calling within 24 hours of the delivery.”

A magpie goose and spoonbills at Black Swamp, by Goulburn Broken CMA



Campaspe system

Animals in the Campaspe River enjoyed near-ideal river flows in 2016–17, with the river receiving the right amount of water flowing through it at the right times to meet its environmental needs.

For the first year since the 1990s, the river enjoyed its full complement of recommended flow throughout the year. This was thanks to a combination of high rainfall and careful planning by water agency partners.

While the river will never return to its pristine condition before it was altered to provide water for homes, farms and businesses, North Central CMA works to provide the river with the best flows possible to keep it healthy and to sustain its animals and plants.

Staff of North Central CMA worked with Goulburn-Murray Water for the third year in a row to manage irrigation flows downstream of Lake Eppalock to help fish, platypus and native water rats survive the summer. Environmental flows are sometimes piggybacked on irrigation water deliveries, to maximise efficient use of water and benefits for the river.

They also collaborated with Goulburn Broken CMA and the Murray–Darling Basin Authority, and were guided by fish ecologists from the Arthur Rylah Institute, to deliver a successful fish migration flow in March (see ‘Rivers without borders’, pages 81–84).



The flows triggered the migration of golden and silver perch from below the Torrumbarry Weir near Echuca into the Campaspe and Goulburn rivers.

“Monitoring found good numbers of silver perch in the Campaspe for the first time in 10 years and juvenile Murray cod at their highest levels since monitoring began in 2000,” said North Central CMA Environmental Water Manager Darren White.

“The river is in good shape. Murray–Darling rainbowfish, recorded only once in the catchment before 2013–14, are now the dominant species downstream of the Campaspe Weir.”

Darren White, North Central CMA.

Waterway manager: North Central CMA
Storage manager: Goulburn-Murray Water

Site	Volume delivered in 2016–17 (ML)
Campaspe River	5,551

A Murray–Darling rainbowfish, by Gunther Schmida



The Campaspe River, by North Central CMA

Central murray wetlands

The central Murray wetlands became a haven for waterbirds in 2016–17, with a return of rare Australasian bitterns as well as magpie geese previously thought to be extinct in this region since 1913.

Despite heavy rainfall and flood conditions across northern Victoria, water for the environment was still needed to boost the central Murray wetlands. The water was necessary to replenish important wetlands that remained isolated from natural flooding due to barriers such as channels, roads and levees.

Several top-up flows were delivered to Round Lake and Lake Elizabeth to maintain suitable conditions for the Murray hardyhead, a threatened fish species.

Richardson’s Lagoon, McDonalds Swamp, Hird Swamp and the Wirra-Lo wetland complex flourished after top-up flows through the year.

Dusk at Brolga Swamp at the Wirra-Lo wetland complex, by Jill and Ken Hooper



A major win was the ability to water Lake Cullen, which had been dry since 2012. Lake Cullen is an intermittent saline lake that provides food and habitat to a large number and variety of waterbirds.

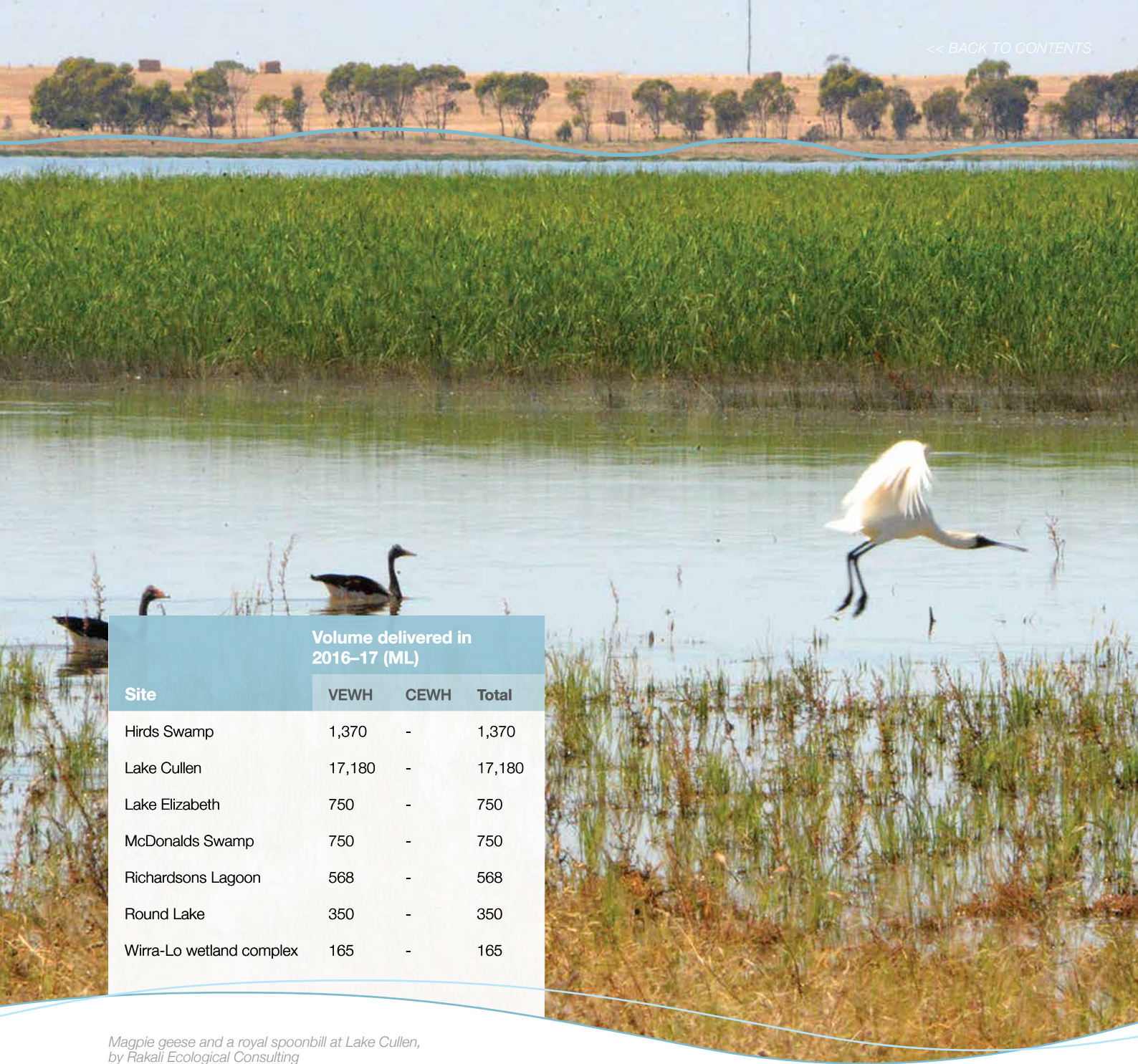
Lake Cullen was due for watering in 2016–17, but due to potential groundwater interactions it was only proposed to top-up the lake if the nearby Avoca marshes and Lake Bael Bael filled first naturally. Heavy rainfall in September and October 2016 saw the Avoca River then Lake Bael Bael flood, allowing water for the environment to be used to partially fill Lake Cullen in spring and topped up in summer and autumn.

The floodwater and water for the environment provided feeding and breeding habitats for birds including nationally endangered Australasian bitterns, Australian little bitterns, brolgas and magpie geese.

The presence of magpie geese at Lake Cullen and other central Murray wetlands this year is especially exciting as the species has been extinct in this area since 1913 due to predation by foxes and habitat destruction — river regulation and the draining of wetlands. The return of magpie geese is a great sign that we are getting things right and that the species is recolonising some of its old sites.

Additionally, Australasian bitterns were recorded in large numbers during autumn, at least 16 in one sighting. This is very significant as there could be as few as 1,000 adults left in the world.

Waterway manager: North Central CMA
Storage manager: Goulburn-Murray Water



Site	Volume delivered in 2016–17 (ML)		
	VEWH	CEWH	Total
Hirds Swamp	1,370	-	1,370
Lake Cullen	17,180	-	17,180
Lake Elizabeth	750	-	750
McDonalds Swamp	750	-	750
Richardsons Lagoon	568	-	568
Round Lake	350	-	350
Wirra-Lo wetland complex	165	-	165

Magpie geese and a royal spoonbill at Lake Cullen, by Rakali Ecological Consulting

lower murray wetlands

The planned environmental watering of many wetlands in the lower Murray was set aside in 2016, as large, natural floods moved through the region late in the year.

The floods, which inundated the wetlands and the broader floodplains, highlighted the importance of keeping environmental water planning flexible and adaptable. Mallee CMA adjusted its plans to make the most of the natural flows.

Only one wetland — Heywood Lake — received water for the environment in 2016–17. The lake received natural floodwater but not enough to fill it, so environmental water was used to inundate the fringing vegetation (such as blackbox trees).

As the flood progressed, Mallee CMA removed obstacles to natural inflows entering the floodplain. This maximised the inundated area and connected most of the wetlands originally set to receive environmental water and areas to which environmental water cannot normally being delivered.

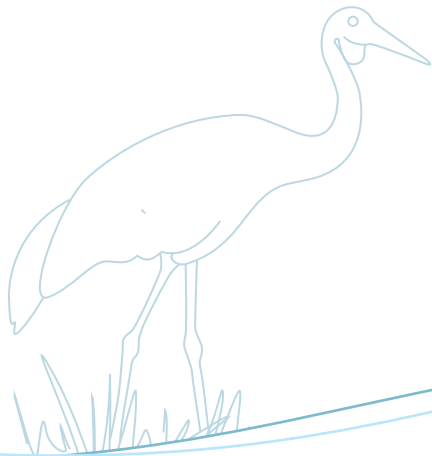
The natural flood caused a flourish of plant growth as the water receded, providing waterbugs, fish and birds with food.

Natural connections between the wetlands (such as Brickworks Billabong and Koorlong Lake near Mildura) provided an opportunity for endangered Murray hardyhead populations to move, complementing the work being done to protect and increase the populations of these native fish.

Waterway manager: Mallee CMA
Storage manager: Goulburn-Murray Water

Site	Volume delivered in 2016–17 (ML)		
	VEWH	CEWH	Total
Heywood Lake	3,000	-	3,000
Lock 15 wetlands ¹	Water levels managed		

¹ Environmental watering at wetlands associated with lock 15 was facilitated by manipulating River Murray lock 15. There was no environmental water use attributed to this management in 2016–17.



Heywood Lake,
by Jane White, Mallee CMA

loddon system

In June 2016, with water storages in the Loddon system drying up, water managers were heading into drought mode and had reduced environmental flows into the Loddon River to a trickle.

Then the heavens opened. Heavy rain in the second half of 2016 delivered one of the biggest floods ever recorded in the Loddon River system. This event watered everything naturally, including the Boort wetlands and Birchs Creek, improving the condition of the aquatic and floodplain plants.

In December 2016, the extra availability of water enabled water for the environment to be released to Serpentine Creek for the first time. Serpentine Creek is home to native river blackfish and is a popular canoe trail.

Serpentine Creek is also a culturally important waterway for the Dja Dja Wurrung people, who have been connected to it for over 40,000 years. Culturally significant scarred trees and ring trees are found along the creek.

The Loddon River system has been heavily modified and is mainly used to supply irrigators. In April and May 2017, North Central CMA, Goulburn-Murray Water and the VEWH performed a delicate balancing act to provide environmental flows to coax native fish to disperse.

Fish monitoring found good numbers of golden perch, silver perch and bony herrings at Kerang Weir and at the chute fishway on the Loddon River. Murray cod, golden perch and silver perch were recorded in the fish lock at Kow Swamp, and fish tagged in the River Murray were detected moving through the various fishways in the system.

The environmental flows supported North Central CMA's Native Fish Recovery Plan, which aims to improve water flows, habitat and the connectivity of waterways.

Waterway manager: North Central CMA
Storage manager: Goulburn-Murray Water

Site	Volume delivered in 2016–17 (ML)		
	VEWH	CEWH	Total
Loddon River and Tullaroop Creek	11,789	1,582	13,371
Serpentine Creek	373	96	469
Pyramid Creek	924	-	924

Serpentine Creek, which received environmental water for the first time in 2016, by North Central CMA



The Loddon River, by North Central CMA

Ovens system

A little bit of water for the environment can go a long way, with a little bit of help from our friends.

North East CMA has 70 megalitres of water available to help keep the Ovens River in good environmental condition. Fifty megalitres comes from Lake William Hovell along the King River, which runs into the Ovens River, and 20 megalitres from Lake Buffalo in the Ovens' upper reaches.

"The system doesn't have enough environmental water to meet the demands of all parts of the river, so it's vital we deliver the water that is available in the most beneficial and effective way we can," said North East CMA Environmental Water Resource Officer Catherine McInerney.

In 2016–17 the CMA worked with Goulburn-Murray Water to successfully create a larger fresh flow to the lower Ovens River.

"Goulburn-Murray Water let us know they were releasing over 5,000 megalitres of water from Lake Buffalo to allow infrastructure works to take place at the lake," Catherine explained. "So, we added 20 megalitres of environmental water from Lake William Hovell to the water being released from Lake Buffalo.

"We delivered the water to reinvigorate the food chain from the bottom up. A flow of this size scours and resets the biofilms — these are slimy films made up of algae, bacteria and fungi living on the rocks and other surfaces in the waterway — which provide food and habitat for water bugs, which are great fish food!"

The Ovens River system is home to several threatened and endangered native fish species, including the newly re-established trout cod population and Macquarie perch that are currently being reintroduced.

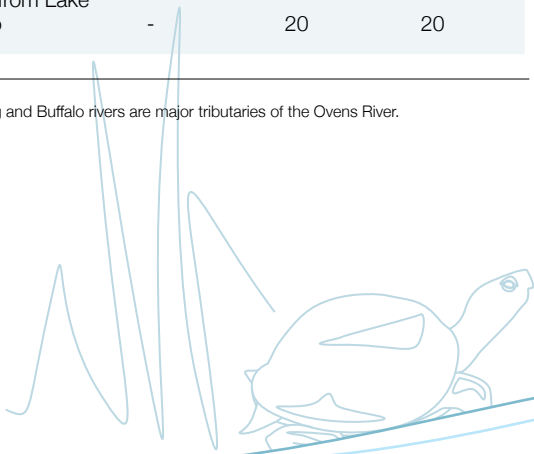
"By fostering the health and growth of the system on a micro level, we're helping to support the endangered fish populations," Catherine said.

The Ovens River system also enjoyed naturally wet conditions in the winter and spring of 2016, resulting in the largest spring flows in the past five years.

Waterway manager: North East CMA
Storage manager: Goulburn-Murray Water

Site	Volume delivered in 2016–17 (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.



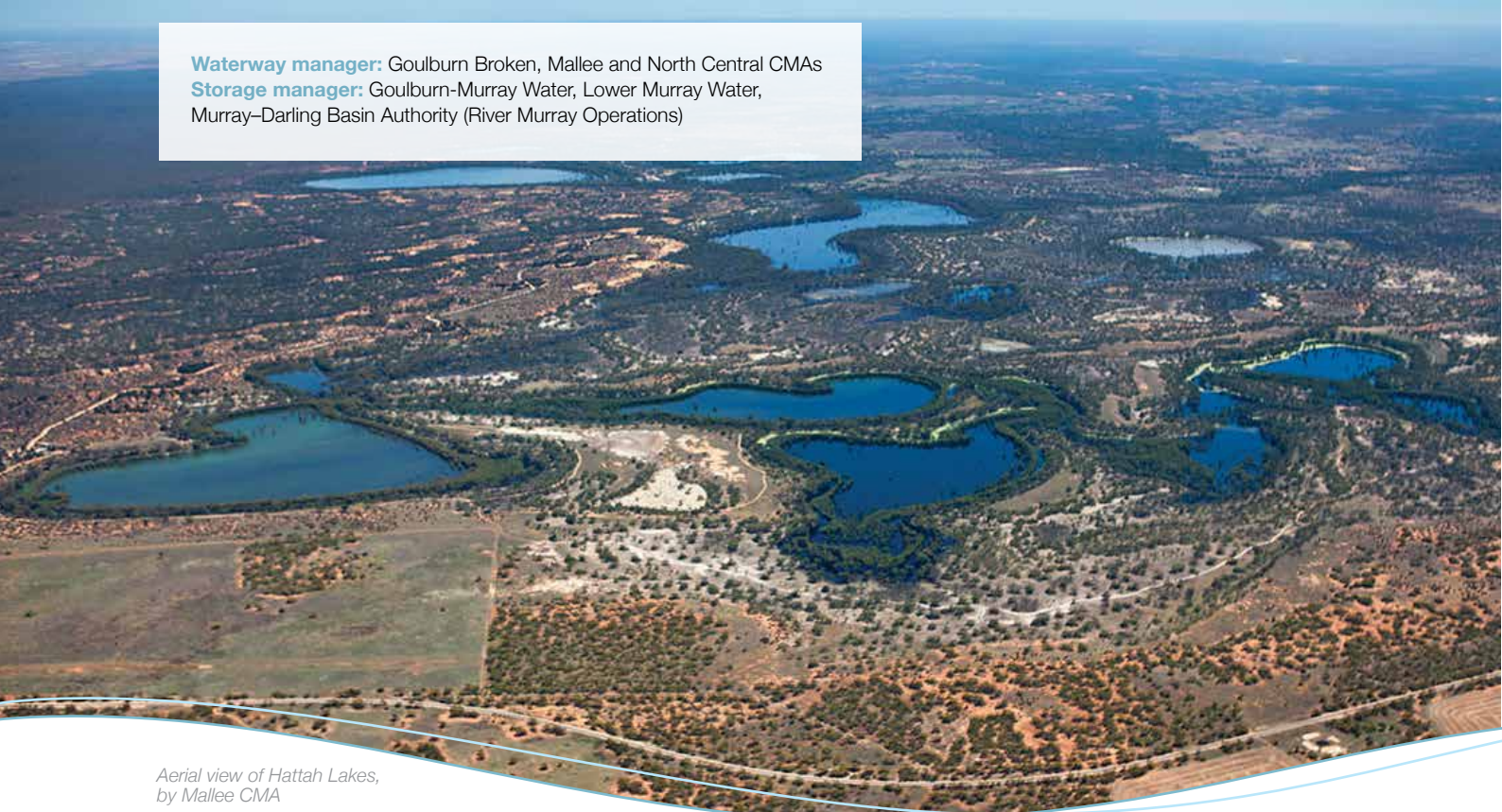
Buffalo River downstream of Lake Buffalo at Osbourne's Bridge – Nug Nug North, by North East CMA

living murray icon sites

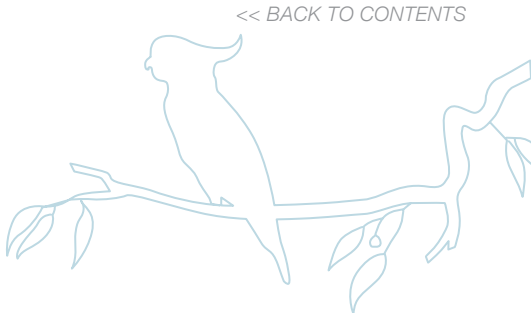
The Living Murray program is one of Australia’s most significant long-term river restoration projects.

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, Linsday-Walpolla and Mulcra islands, Gunbower Forest and Barmah Forest.

Waterway manager: Goulburn Broken, Mallee and North Central CMAs
Storage manager: Goulburn-Murray Water, Lower Murray Water, Murray-Darling Basin Authority (River Murray Operations)



Aerial view of Hattah Lakes, by Mallee CMA



Hattah Lakes

Hattah Lakes became a safe-haven for fish to escape potential blackwater during the Spring storms of 2016.

The wettest September on record led the River Murray to flood in October and November, shifting the focus of environmental watering to building on the benefits of natural flows.

Mallee CMA primed Hattah Lakes, pumping them with more than 31 gigalitres of water for the environment which, combined with natural flooding, provided a deep drink to black box woodlands on the lower terraces of the floodplain.

The positive effects are now on display: much-improved black box canopy densities, abundant flowering and the best seed fall since monitoring started.

During the flooding, some Murray tributaries (such as the Edward–Wakool River system and the Murrumbidgee River in New South Wales) suffered from widespread blackwater and fish deaths.

Before the main flooding in November, the waterway manager used the pumps at Hattah to fill the lakes on the floodplain with water. This meant the water in the lakes had relatively high concentrations of dissolved oxygen, compared to the water in the main river channel. Had the blackwater threat materialised, the lakes would have provided a refuge for aquatic animals.

As the water receded, there was abundant understory growth, better conditions for plants and animals in the lakes and more bird activity. This drew many visitors to enjoy the bushwalking, photography, kayaking and birdwatching opportunities.

Site	Volume delivered in 2016–17 (ML)		
	VEWH	MDBA	Total
Hattah Lakes	31,522	325	31,847

Hattah Lake, by Mark Toomey, VEWH



Lindsay, Mulcra and Wallpolla islands

Natural flooding in 2016–17 provided an opportunity to add to the floodwaters to benefit native fish and black box woodlands.

Deliveries of water for the environment were planned for the Lindsay, Mulcra and Wallpolla islands in 2016–17 to help native large-bodied fish to move and breed, to provide habitat for aquatic species and to improve floodplain conditions for plants and animals.

Not all goes to plan in nature. The large, natural flood in the Murray during spring brought more water than the environmental watering program would have delivered, overtaking the plans and filling the wetlands at the icon site.

In response, the environmental watering program was adapted to capitalise on the natural flows, with 457 megalitres of water delivered to Sandy Creek at Walpolla Island.

The natural flooding, supported by the additional environmental water, resulted in substantial golden perch spawning. It also resulted in overbank flooding that inundated the black box woodlands on the higher terraces of the floodplain. This provided the opportunity to monitor the effects of inundation on those black box woodlands that can't be watered with current infrastructure built under The Living Murray program.

Monitoring results show that areas of the floodplain that received water during both the 2016 and 2010–11 floods are in much better condition, and have more prolific seedlings, than those that didn't similarly benefit from flooding.

		Volume delivered in 2016–17 (ML)		
Site		VEWH	CEWH	Total
Lindsay Island	Lindsay River and Mullaroo Creek ¹	Water levels managed		
Mulcra Island	Potterwalkagee Creek ¹	Water levels managed		
Walpolla Island	Sandy Creek	457	-	457

¹ Environmental watering in Lindsay River, Mullaroo Creek and Potterwalkagee Creek was facilitated by manipulating River Murray locks 7 and 8. There was no environmental water use attributed to this management in 2016–17.

Lake Wallawalla,
by Jane White, Mallee CMA



Gunbower Forest

Natural flooding in the Murray system led to water entering parts of Gunbower Forest that had been dry for more than four years.

Rainfall as much as 200 per cent above average in the Goulburn, Kiewa and Ovens river catchments in July 2016, led to overbank flooding of many River Murray floodplains including Gunbower Forest.

North Central CMA Gunbower Forest Project Manager Anna Parker said these flows presented a rare opportunity to use additional environmental flows to improve the forest's long-term health.

"Without river modification, the natural floodwaters would have been higher for longer, and modelling shows water would have been in the forest from early June," she said.

"Even so, natural floods are always better for the forest and we need to take advantage of them when they happen. The high river triggered natural cues which led fish to swim onto the floodplain to feed and breed.

"Nature gave us a flood. We used water for the environment to open up the forest and connect the River Murray to Gunbower Creek. This put an indelible stamp on the health of the forest," Anna said.

"The water that came naturally from north-east Victoria was full of nutrients, having travelled across floodplains to get to Gunbower. Washing this water through our system and back out into the Murray provided plants, fish and other animals with a feast, helping them to boost their numbers."

River red gum responded with a flush of new growth and are now in better condition than before. Black box communities on the higher floodplains were inundated for several weeks, helping the many aquatic understorey species including common nardoo to flourish.

Fish surveys provided a welcome surprise: significant numbers of threatened Murray–Darling rainbowfish were found in the forest wetlands. These fish haven't been found in the forest in years. The return of these rainbowfish indicates environmental water is making a big difference to the rehabilitation of the forest wetlands, especially the permanent wetlands where aquatic plants are thriving.

Meanwhile, year-round flows in Gunbower Creek were again used to support native fish through their life cycles. Winter flows helped maintain habitat and food for juvenile fish in the creek: usually, the creek is drawn down to a series of deep pools at the end of the irrigation season.

Environmental flows provided cues for fish to spawn, supported adult fish to nest and gave juvenile fish the best chance to survive the colder winter months. Fish populations, especially of Murray cod, are thriving in the better conditions. Fish surveys show that the fish are not only breeding, but that more juvenile fish are surviving and becoming a more-resilient population.

Site	Volume delivered in 2016–17 (ML)			
	VEWH	MDBA	CEWH	Total
Gunbower Forest	196	2,894	-	3,090
Gunbower Creek ¹	-	-	23,563	23,563

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

A turtle at Gunbower Creek,
by North Central CMA



Barmah Forest

Water for the environment in 2016–17 built on the benefits of the largest flood in Barmah Forest since 1993.

Floodplain plants, fish and frogs responded well, and conditions were ideal for a waterbird breeding boom.

More than 4,200 bird nests were counted in one 20-hectare area in the forest, mostly of rufous night-herons (also known as nankeen night-herons). Another similar-sized area supported over 2,000 white ibis and straw-necked ibis nests. A significant number of endangered Australasian bitterns and little bitterns was also recorded.

Barmah Forest was the only known nesting site in Victoria for great egrets and intermediate egrets this year, and it hosted one of the state's few nesting events for night-herons.

Water for the environment was delivered to complement the wet conditions to maintain water around nesting waterbirds until February, so they could fledge their young.

“Water releases from Hume Reservoir helped maintain some shallow inundation of key wetlands,” said Goulburn Broken CMA Environmental Water Manager Keith Ward.

“Without it, the adult ibis and spoonbills would have abandoned their nests in response to the dropping water levels before their young could fly.”

Monitoring of native fish also showed Murray cod, silver perch and golden perch spawned in spring.

Larval Murray crayfish were found in the River Murray below Barmah Lake. This was an important finding as crayfish became extremely uncommon in this area of the river after a 2010–11 blackwater event.

Another unusual finding was a platypus recorded in a Barmah Forest wetland, adjacent to the river.

Site	Volume delivered in 2016–17 (ML)			
	VEWH	MDBA	CEWH	Total
Barmah Forest floodplain	91,472	10,000	10,033	111,505
Boals Deadwood	2,687	-	-	2,687

“ Without it, the adult ibis and spoonbills would have abandoned their nests in response to the dropping water levels before their young could fly. ”



Steamer Plain at Barmah, by Keith Ward

Rivers without borders

Coordinating environmental flows across three major rivers wooed native fish hundreds of kilometres into Victorian waterways in 2017.

Native fish such as golden and silver perch can be found across a large area of the River Murray and its tributary rivers. However, breeding often occurs at ‘hot-spots’ – where conditions are just right for a large successful breeding event. This results in very large numbers of juvenile fish in one area that are looking for triggers to move to new homes right across the river system.

In 2016-17, monitoring of native fish in the mid-River Murray showed large numbers of juvenile golden and silver perch. Waterway managers, scientists and river managers set

themselves a challenge to encourage these fish to migrate from the River Murray and set up home in the Goulburn and Campaspe rivers. They also wanted to learn more about how to increase fish populations throughout the Murray–Darling Basin.

First, they delivered water for the environment down the River Murray to stimulate golden and silver perch to move upstream through the fishway on Torrumbarry Weir. They then delivered water for the environment to the Goulburn and Campaspe rivers to encourage the fish in the Murray to move up into those rivers.

The plan worked. Monitoring showed that juvenile golden and silver perch tagged at Torrumbarry Weir moved up into the Victorian rivers directly in response to the flows delivered. While some fish eventually returned to the Murray, others stayed put to hopefully call the Goulburn or Campaspe rivers home.

Goulburn Broken CMA Environmental Water and Wetlands Manager Simon Casanelia said the project provided lots of information to help improve native fish management with environmental water.

“The movements into the Goulburn generally coincided with river flow increases, and movements back out into the Murray tended to coincide with flows falling,” said Simon.

“This would indicate that rising river levels and flows in the Goulburn are cues to fish to move in. That information will help us to continue to fine-tune the timing of environmental flows so we get the best outcomes for native fish,” he said.

VEWH Environmental Water Coordinator Keith Chalmers said there were people working across the southern Murray–Darling Basin to make the project a success.

“Fish in the Murray–Darling Basin don’t respect state borders: they use all of our waterways for their homes,” he said. “Building healthy fish populations in one river can ultimately help increase native fish numbers through the basin, and that’s our ultimate goal.”

Boosting fish numbers, year after year

Next year, the interstate team will set its sights again on helping native fish populations across the Murray–Darling Basin.

“Large native fish such as Golden Perch and Silver Perch breed in large numbers only in years when conditions are good. New South Wales waterway managers capitalised on high natural flows in spring 2016 and used environmental water allocations to deliver well-timed environmental flows to support successful fish spawning and recruitment in the Lower Darling River and Darling Anabranch,” Keith explained.

“The flows provided a connection between the River Murray and Menindee Lakes – a key nursery habitat for golden and silver perch – which enabled substantial numbers of juvenile golden perch to again move into the River Murray system.

“In the coming year, it’s planned to again deliver flows through Victorian tributaries of the Murray to help encourage and assist these new juvenile fish, that originated in the Darling system, to

migrate into the Goulburn and Campaspe rivers, building on this year’s results,” Keith said.

Arthur Rylah Institute Principal Research Scientist Jarod Lyon said the work was revealing important information about how to help repopulate other rivers in the southern Murray–Darling basin.

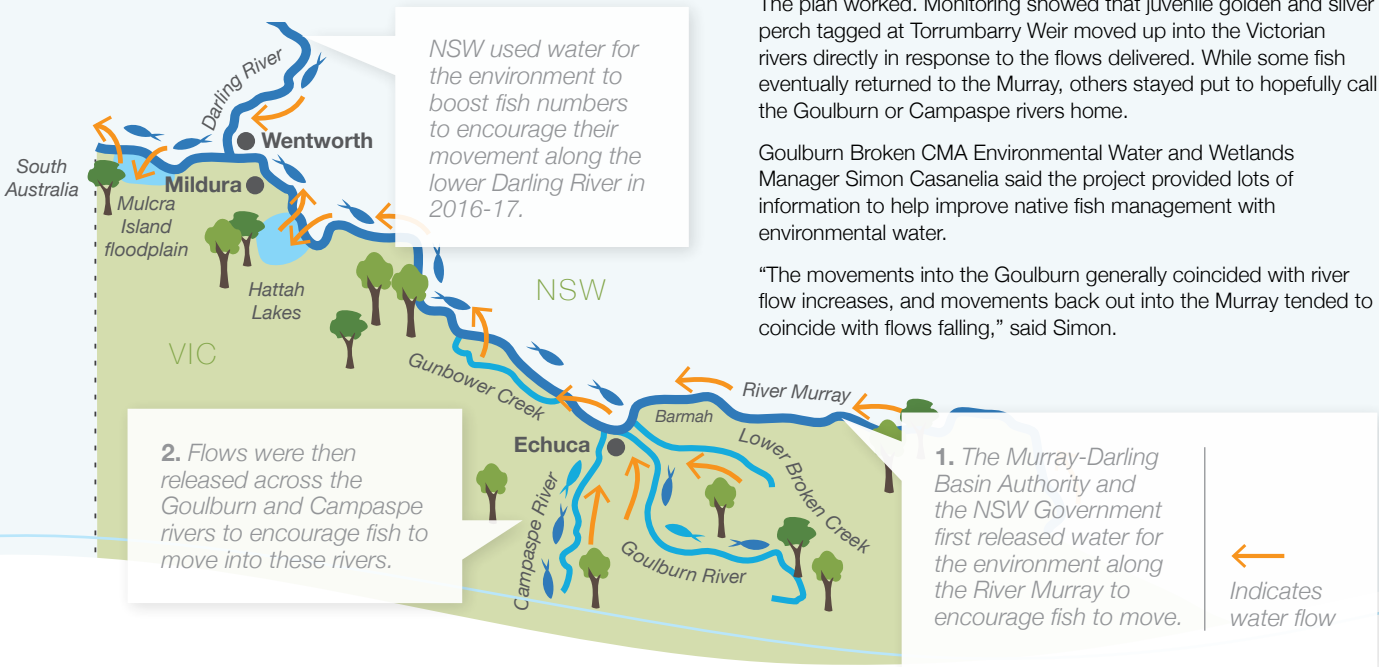
“This is a great example of learning by doing, working together to improve how we plan and manage environmental water,” he said.

* Jewels of the Murray–Darling Basin

Golden and silver perch are much-loved fish in the southern Murray–Darling Basin.

Golden perch – known as yellowbelly – are anglers’ favourites. Unfortunately, there are now far fewer of the fish in the wild: dams and weirs block their movement along rivers, and they don’t like cold water releases from water storages, preferring warm, slow moving, turbid streams.

The much-smaller silver perch is classed as critically endangered under Victoria’s *Flora and Fauna Guarantee Act 1988*. They were once widespread and abundant throughout most of the Murray–Darling Basin but have now declined to low numbers and disappeared from much of their native range. In Victoria, silver perch have been recorded in 12 river basins and most recordings are from the Goulburn River, Loddon River, Murray–Riverina region and the Mallee.



Shared community benefits

Who was involved

- » In Victoria, Goulburn Broken CMA led the coordination effort with input from North Central CMA.
- » The Arthur Rylah Research Institute provided advice about what flow patterns were needed to ensure the fish would be happy travellers. They also tagged the fish and followed their movements to monitor the results.
- » Goulburn-Murray Water helped plan how Torrumbarry Weir was operated to get the best possible response from native fish, while still meeting their irrigator customer demand.
- » The Murray-Darling Basin Authority and the New South Wales Office of Environment and Heritage delivered the River Murray pulse.
- » The VEWB and CEWH provided environmental water in the Murray and Goulburn rivers. Environmental water wasn't needed in the Campaspe River — Goulburn-Murray Water was transferring water from Lake Eppalock to the Murray at the time, so it 'shaped' the delivery as an environmental flow to get the right response from the fish.

A golden perch,
by Gunther Schmida

Riding the flow

Water used to support a healthy Goulburn River is also providing opportunities for adventure and nature tourism in the region. Fishing, kayaking, bushwalking, bike riding and camping are all popular activities in and around the river, its tributaries and wetlands.

Tour operator Rob Asplin established his canoeing business in the 1990s and now takes groups of paddlers along the river.

"There are beautiful routes from Mooropna to Daintons Bridge, which take about an hour, and from the Belstack Strawberry Farm to Daintons Bridge, which take a day," Rob said.

A considerable amount of river flow is water for the environment, delivered specifically to improve conditions for native fish and vegetation and to provide homes for platypus, birds and other animals.

"People just love that there are 300 species of birdlife here, great fishing and beautiful trees, and it's all based around the river," Rob continued.



Left to right: Tour operator Rob Asplin, by Shepparton News; Red-necked stilts and red-capped plovers at Lake Cullen, by North Central CMA

Breakfast with the birds

In February, nature enthusiasts and birdwatchers enjoyed a symphony of taste, colour and sound at the Breakfast with the Birds event in the central Murray wetlands.

Heavy spring rain created a unique opportunity to deliver water for the environment to Lake Cullen, an important waterbird breeding habitat north-west of Kerang.

The result was a wetland brimming with life, and the North Central CMA took full advantage of it, using the lake as the location for its annual World Wetlands Day community Breakfast with the Birds.

"There were huge numbers of migrating wading birds as well as near-threatened magpie geese, endangered Australasian bitterns, pelicans, swans and black-winged stilts," North Central CMA Project Manager Adrian Martins said.

"It was a great opportunity for families and the community, as well as birdwatchers, to get a look at Lake Cullen and its amazing birdlife in all its glory."



“Working with local communities and Traditional Owners can bring about great results.”

Louissa Rogers, North Central CMA

Boating on the billabong

Cowanna Billabong at Merbein Common is a freshwater haven for waterbirds and native animals and, as it turns out, is also the perfect place for remote-control boat enthusiasts.

“It’s sheltered and shallow enough that if a boat gets into trouble, you can wade out and retrieve it,” said Peter, a remote-control boat owner.

On weekends, remote-control boats, from home-made craft to elite racers, are driven expertly on the long, narrow billabong as the pelicans look on from afar.

This beautiful, natural area is a perfect example of how one place can serve many purposes. With care, our natural waterways can

benefit the animals and the plants that call them home and the broader community looking to enjoy the environment.

Through the delivery of water for the environment, places like Cowanna Billabong are kept healthy, adding to the fabric of Mallee life and the community’s connection with the area’s unique natural environment.

Left and right: Peter, a remote-control boat enthusiast at Cowanna Billabong, by Mallee CMA



A small plant with a big message

A pilot project on the Campaspe River is discovering how well-timed environmental flows can bring back vegetation, and even revive threatened species, when riverbanks are protected from cattle grazing.

With the help of the Dja Dja Wurrung Clans Aboriginal Corporation and local landholders, two grazing exclusion plots were erected on the banks of the river at Strathallan and Rochester. One was in a cattle-grazing area and the other on a public reserve.

“It allowed us to see the impact environmental flows can have on vegetation in specific areas with other variables excluded, especially when we keep cattle and other stock off the waterways,” North Central CMA Environmental Water Manager Louissa Rogers explained.

“The big news was the discovery of a threatened plant species — the small scurf-pea — in one of the plots. It shows that working with local communities and Traditional Owners can bring about great results.”



Left and right: A small scurf-pea at the Campaspe River, by North Central CMA



glossary

Bankfull flow – A flow that reaches the top of the river bank, with little flow spilling onto the floodplain.

Baseflow – A relatively stable, sustained, low flow in a river, generally being its minimum natural level.

Blackwater – A natural occurrence caused by the breakdown of organic matter resulting in the water discolouring. The water turns black and can have very low dissolved oxygen levels, which can result in the deaths of fish and other animals that breathe underwater.

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

Catchment management authority (CMA) – A statutory authority established to do regional and catchment planning and to manage salinity, water quality and the overall health of rivers, other waterways and floodplains in its catchment.

Commonwealth Environmental Water Holder (CEWH) – Manages a large portfolio of environmental water – entitlements with annual allocations that are acquired through the Australian Government's investment in water-saving infrastructure and strategic water purchasing throughout the irrigation districts of the Murray-Darling Basin. The Commonwealth Environmental Water Holder's decisions about the best use of this water are guided by *The Water Act 2007* and the *Murray-Darling Basin Plan* (specifically, the environmental watering plan and the Basin-wide environmental watering strategy).

Environmental water entitlement – An entitlement to water to achieve environmental objectives in waterways including an environmental entitlement, environmental bulk entitlement, water share, section 51 licence or supply agreement.

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

Fish ladder – A series of pools built like steps so fish can travel through a waterway.

Fishway – See Fish ladder

Fledging – Bringing up a young bird until it can fly.

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

Gigalitre (GL) – One billion (1,000,000,000) litres.

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

Hydrology – The study of the properties of water and its movement in relation to land.

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

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

Millennium Drought – One of the worst droughts recorded in Australia since European settlement, it went from about 1996 to 2010.

Overbank flood or flow – Flow that exceeds the capacity of a river channel and inundates parts of the surrounding floodplain.

Pulse – A short duration increase in flow above the normal baseline flow levels.

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

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

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 Water to operate major water storages in a river basin to deliver to entitlement holders.

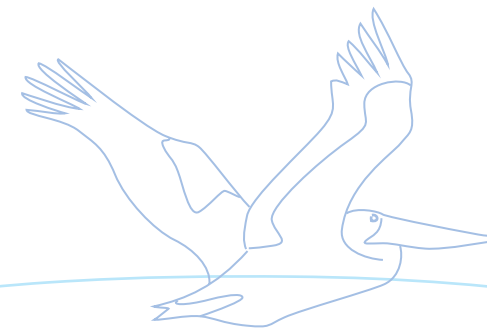
The Living Murray – An intergovernmental program, which holds an average of 500,000 ML of environmental water a year for use at six icon sites along the River Murray.

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

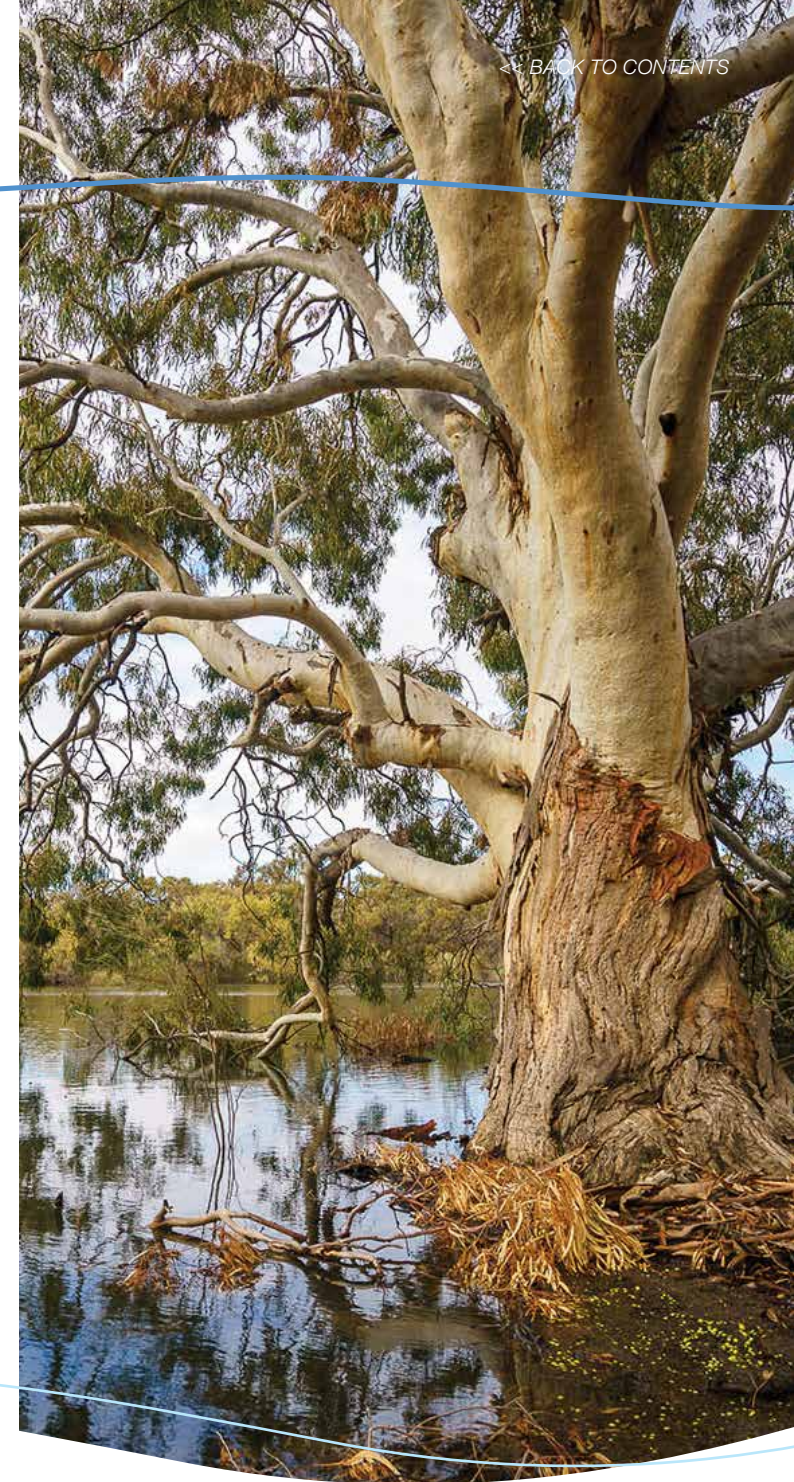
Waterways – Rivers, wetlands, creeks, floodplains and estuaries.

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.



Heywood Lake, by Mallee CMA



Summary of environmental water delivery 2016–17

Summary of environmental water delivery 2016–17				VEWH (ML)	MDBA (ML)	CEWH (ML)	Other (ML) ¹	Total (ML)
Gippsland Region								
Latrobe system	Latrobe River		3,713	-	-	-	3,713	
	Lower Latrobe wetlands ³	Heart Morass	No active deliveries					
		Sale Common	Water was diverted into Sale Common from the Latrobe River					
		Dowd Morass	Water was diverted into Dowd Morass from the Latrobe River					
Thomson River			10,326	-	-	-	10,326	
Macalister River			6,599	-	-	-	6,599	
Snowy River ³			-	-	-	132,300	132,300	
Gippsland region total			20,638	-	-	132,300	152,938	
Central Region								
Yarra system	Yarra River		21,478	-	-	-	21,478	
	Banyule Billabong		60	-	-	-	60	
	Yering Backswamp		6	-	-	-	6	
Tarago River			1,952	-	-	-	1,952	
Maribyrnong River	Upper Jacksons Creek ⁴		304	-	-	-	304	
Werribee system	Pyrites Creek		954	-	-	-	954	
	Werribee River ^{4,5}		1,122	-	-	-	1,122	
Moorabool River			1,965	-	-	-	1,965	
Lower Barwon wetlands ²	Reedy Lake		Water was diverted into Reedy Lake from the Barwon River					
	Hospital Swamps		Water was diverted into Hospital Swamps from the Barwon River					
Central Region total			27,841	-	-	-	27,841	
Western Region								
Glenelg system	Glenelg River		2,765	-	-	-	2,765	
Wimmera system	Wimmera River		7,116	-	-	-	7,116	
	Mackenzie River and Burnt Creek		3,429	-	-	-	3,429	
	Lower Mount William Creek		155	-	-	-	155	
Wimmera–Mallee wetlands			119	-	-	-	119	
Western Region total			13,584	-	-	-	13,584	

Summary of environmental water delivery 2016–17

Summary of environmental water delivery 2016–17			VEWH (ML)	MDBA (ML)	CEWH (ML)	Other (ML) ¹	Total (ML)
Northern Region							
Victorian Murray	River Murray ⁷		50,000	-	110,623	-	160,623
	Barmah Forest	Barmah Forest floodplain	91,472	10,000	10,033	-	111,505
		Boals Deadwood	2,687	-	-	-	2,687
	Gunbower	Gunbower Forest	196	2,894	-	-	3,090
		Gunbower Creek ⁶	-	-	23,563	-	23,563
	Central Murray wetlands	Hird Swamp	1,370	-	-	-	1,370
		Lake Cullen	17,180	-	-	-	17,180
		Lake Elizabeth	750	-	-	-	750
		McDonalds Swamp	750	-	-	-	750
		Richardsons Lagoon	568	-	-	-	568
		Round Lake	350	-	-	-	350
		Wirra-Lo wetland complex	165	-	-	-	165
		Hattah Lakes		31,522	325	-	-
	Lower Murray wetlands	Heywood Lake	3,000	-	-	-	3,000
		Lock 15 wetlands ⁸	Water levels managed				
	Lindsay, Walpolla and Mulcra islands	Lindsay River and Mullaroo Creek ⁹	Water levels managed				
		Potterwalkagee Creek ⁹	Water levels managed				
		Walpolla Island – Sandy Creek	-	457	-	-	457
		Ovens River		-	-	70	-
	Goulburn River		27,500	20,000	182,253	-	229,753
Lower Broken Creek		-	-	36,364	-	36,364	
Campaspe River		5,551	-	-	-	5,551	

Summary of environmental water delivery 2016–17

		VEWH (ML)	MDBA (ML)	CEWH (ML)	Other (ML) ¹	Total (ML)
Northern Region continued						
Loddon system	Loddon River and Tullaroop Creek	11,789	-	1,582	-	13,371
	Serpentine Creek	373	-	96	-	469
	Pyramid Creek	924	-	-	-	924
Northern Region total		246,147	33,676	364,584	-	644,407
TOTAL WATER USE		308,169	33,676	364,584	132,300	838,729

1. Other source refers to water that was not accounted for under the environmental water holdings.
2. The VEWH's environmental entitlements in the lower Latrobe and lower Barwon systems allow the diversion of water from the lower Latrobe and Barwon rivers into the wetlands at any time when specific river heights are met. The entitlements do not consist of a set volume and the volume of water diverted into the wetlands is not measured.
3. Environmental water deliveries to the Snowy River are managed by the New South Wales Department of Primary Industries using water made available by Victoria and New South Wales.
4. In 2016–17, water allocations copurchased by Melbourne Water and the VEWH contributed to the delivery of 304 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 896.4 ML of allocation made available for use by Melbourne Water.
6. Delivery to these systems included some reuse of return flows.
7. Environmental water use in the River Murray includes releases from Lake Hume, Lake Victoria (via the Rufus River) and Menindee Lakes (via the lower Darling River). This water was delivered to non-Victorian sites.
8. Environmental watering at wetlands associated with lock 15 was facilitated through the manipulation of River Murray lock 15. There was no environmental water use attributed to this management in 2016–17.
9. Environmental watering in Lindsay River, Mularoo Creek and Potterwalkagee Creek was facilitated through the manipulation of River Murray locks 7 and 8. There was no environmental water use attributed to this management in 2016–17.



Magpie geese at Black Swamp,
by Goulburn Broken CMA

© Victorian Environmental Water Holder 2017



This work is licensed under a Creative Commons Attribution 3.0 Australia licence. You are free to re-use the work under that licence, on the condition that you credit the Victorian Environmental Water Holder as author. The licence does not apply to any images, photographs or branding, including the Victorian Government logo and the Victorian Environmental Water Holder logo. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/3.0/au/deed.en>

Printed by Finsbury Green (October 2017)

ISSN 2202-9796 (Print)
ISSN 2202-980X (Online)

Disclaimer

This publication may be of assistance to you but the Victorian Environmental Water Holder and its employees do not guarantee that the publication is without flaw of any kind or is wholly appropriate for your particular purposes and therefore disclaims all liability for any error, loss or other consequence which may arise from you relying on any information in this publication.

Accessibility

If you would like to receive this publication in an alternative format, please contact the Victorian Environmental Water Holder on (03) 9637 8951 or email general.enquiries@vewh.vic.gov.au.

This document is also available at www.vewh.vic.gov.au



The Victorian Environmental Water Holder acknowledges the significant contribution of its program partners, particularly the Commonwealth Environmental Water Holder and Commonwealth Environmental Water Office, the Murray–Darling Basin Authority and Victoria's waterway, storage and land managers, all of which work tirelessly to improve the health of the state's rivers, wetlands and floodplains.

Acknowledgement of Country

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

Warning to Aboriginal and Torres Strait Islander people: this publication may contain images or names of deceased persons.

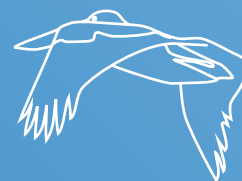


Front cover: Lake Carpul, by Mallee CMA

This page: Kids swimming in the Glenelg River at Harrow, by Glenelg Hopkins CMA

vewh.vic.gov.au

environmental health



VICTORIAN ENVIRONMENTAL WATER HOLDER

T: (03) 9637 8951
E: general.enquiries@vewh.vic.gov.au
PO Box 500, East Melbourne VIC 3002
8 Nicholson Street, East Melbourne