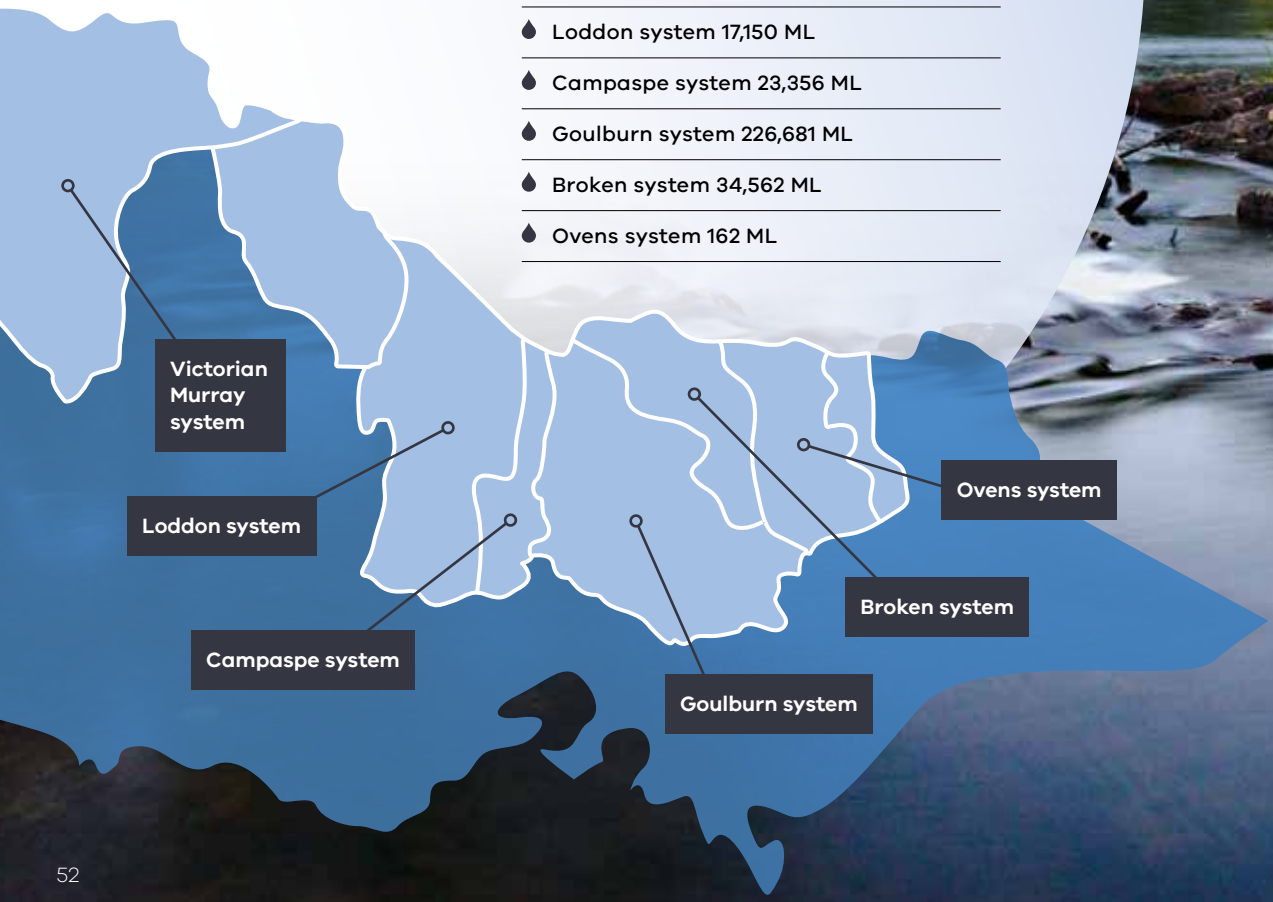
Northern region

It has been a great year for waterbirds in the north! Around 30,000 birds have been recorded at Lake Cullen since water for the environment deliveries began in 2018 with benefits flowing on to tourism and recreation in the area. And, more than 20 brolgas - currently listed as vulnerable in Australia - have been sighted at Gaynor Swamp!

Water for the environment delivered to the Northern region in 2018-19 (megalitres)

- Victorian Murray system 155,672 ML
- Loddon system 17,150 ML
- Campaspe system 23,356 ML
- Goulburn system 226,681 ML
- Broken system 34,562 ML
- Ovens system 162 ML



Barmah Forest
Moira grass makes a massive comeback

In a stunning lime green display, Moira grass in Barmah Forest is flourishing due to a combination of water for the environment and fenced areas which exclude grazing from feral horses and other pest animals.

Under the right conditions, Moira grass grows in large floating mats, with roots and stems hanging down in a tangle beneath the surface. The outstanding results of careful management of some Barmah Forest floodplain areas can be seen from the air!

After observing great results with Moira grass growth in 2017, following environmental flows and fencing, water for the environment was delivered to Barmah Forest in November and December 2018, which provided ideal conditions for wetland plants to thrive and set seed.

The floodplain includes Moira grass and the threatened river swamp wallaby grass, among other low-lying vegetation. They add to the mosaic of plant communities in the internationally significant, Ramsar-listed wetland complex of the Barmah Forest. Environmental flows support the growth, flowering and seed set of Moira grass, which has specific water needs to complete its lifecycle. Moira grass is a critical wetland species providing unique environmental values within the forest.

"Over the last two years, watching the rehabilitation of the Moira grass plains inside the enclosure clearly indicates the damaging effect of feral animals," said Goulburn Broken CMA Environmental Water Reserve Manager Keith Ward.

"Growth rates inside the enclosures have been exceptionally good with excellent flowering and stem length recorded. Moira grass has even been recorded in areas where it had previously disappeared, proving the effectiveness of long-term management in the forest."

"Significant improvements in Moira grass communities in the Barmah Forest is an exciting achievement. With continued support from the VEWH and land managers in coordinating water for the environment deliveries and reducing the impact of feral animals, we can continue to protect and enhance ecological values in the forest," Keith said.

Left: King River, by Natalie Ord

Waterway manager:
Goulburn Broken CMA

Storage manager:
Goulburn-Murray Water, Murray-Darling Basin Authority (River Murray Operations)

Site	Volume delivered 2018-19 (megalitres)			
	VEWH	MDBA	CEWH	Total
Barmah Forest	12,476	16,128	46,032	74,636

Above: Effects of grazing upon Moira grass already evident at Little Rushy Swamp despite remaining shallowly flooded, by Keith Ward, Goulburn Broken CMA

Gunbower Forest and Creek

"A healthy environment underpins healthy communities"

A healthy Gunbower Forest has big benefits for the local community and economy. For the forest to be healthy, it requires water for the environment.

Before regulation of the River Murray, Gunbower Forest would have flooded roughly seven out of every 10 years, with large widespread flooding lasting for up to six months in four of those seven years.

In the past 22 years, between natural floods and allocated water for the environment, key sections of the forest floodplain have been inundated only eight times – stretching the tolerances of wetland and floodplain plants to breaking point. While environmental flows in recent years have helped bring back some of these areas from the brink, there is still a long way to go.

In 2018, critical watering was required to ensure resilience of this internationally recognised site. Gunbower Forest had been in a drying phase for two very hot and dry summers and a very dry winter in 2017, and the floodplain was beginning to show signs of stress. The sedges, reeds and rushes that flourished after the 2016 flood had died back and river red gum trees were beginning to struggle.

"Water for the environment is the life support of Gunbower Forest. It provides Mother Nature with a much-needed helping hand and helps build resilience if dry conditions continue," said North Central CMA's Program Delivery Executive Manager Rachel Murphy.

"It can be hard to imagine given how heavily our river systems are managed today, but even in a dry year such as 2018, the forest would still have received water in spring if Murray River flows weren't regulated by dams and weirs." (Figure 1)

"The watering this year was critical to ensure we would not go backwards after the gains we've made through the watering program in recent years." Rachel said.

"Thanks to the watering, understorey vegetation in the red gum forests and box woodlands is in the healthiest condition it has been since we began monitoring it in 2005, though it still has some way to go towards making a full recovery."

"The Forest is also an incredibly important refuge site for waterbirds, particularly when such large areas of New South Wales and Queensland are so dry."

The flows ensured many species of waterbirds were able to breed and successfully fledge their young, including ducks, Australasian grebes and black swans. Monitoring surveys in December 2018 at Long Lagoon found over 50 nests (about 150 juveniles present) including Australasian darter, Australian ibis, little pied cormorants, little black cormorants and great cormorant species. Most chicks fledged successfully by January 2019.

The watering at Gunbower Forest was carefully planned to occur outside major irrigation demand periods, ensuring there would be no impacts on farm water delivery. It was also undertaken as efficiently as possible, with the same water being used as many times as possible at multiple sites upstream and downstream.

"A lot of people don't realise that the water that went into Gunbower was actually water that was used for healthy river flows down the Campaspe and Goulburn Rivers." Rachel explained.

"Over 70 percent of the water delivered to the forest in 2018-19 came from environmental flows in the rivers upstream. The water then passes through Gunbower Forest filling up its wetlands, and just under half of it flows out of the forest and ends up back in the Murray River. The water was used again multiple times by the environment as it travelled downstream, in the river channel itself and at other floodplain sites.

"That is an amazingly efficient use of water in anyone's language. And it is also great for our native fish, who thrive on the food that comes off the floodplain and back into the creeks and river."

Rachel said Gunbower Forest is a tourist hotspot, providing economic benefits for the region's towns and businesses.

"A healthy environment underpins healthy communities," she said.

"More than 95 percent of locals recently surveyed told us they value Gunbower Forest for its recreation and as an attractive place to visit.

"We are working hard to keep it that way and preserve it for the future economic benefit of our children and grandchildren.

"Tourism in the region is worth $503 million, up $100 million since the drought, and Gunbower Forest is a key part of that."

The Gunbower Forest Flooding for Life project is delivered by the North Central CMA in partnership with Goulburn–Murray Water, Murray-Darling Basin Authority, the Commonwealth Environmental Water Office, the Victorian Environmental Water Holder, DELWP and Parks Victoria.

It is part of The Living Murray program, a joint initiative of the New South Wales, Victorian, South Australian, Australian Capital Territory and the Commonwealth governments, coordinated by the MDBA.

The graph below shows that Gunbower Forest would have received two periods of natural inflows in April and September 2018 via the natural creek systems feeding the Forest floodplain.

Natural vs. Actual Flows over Torrumbarry Weir
April to mid-September

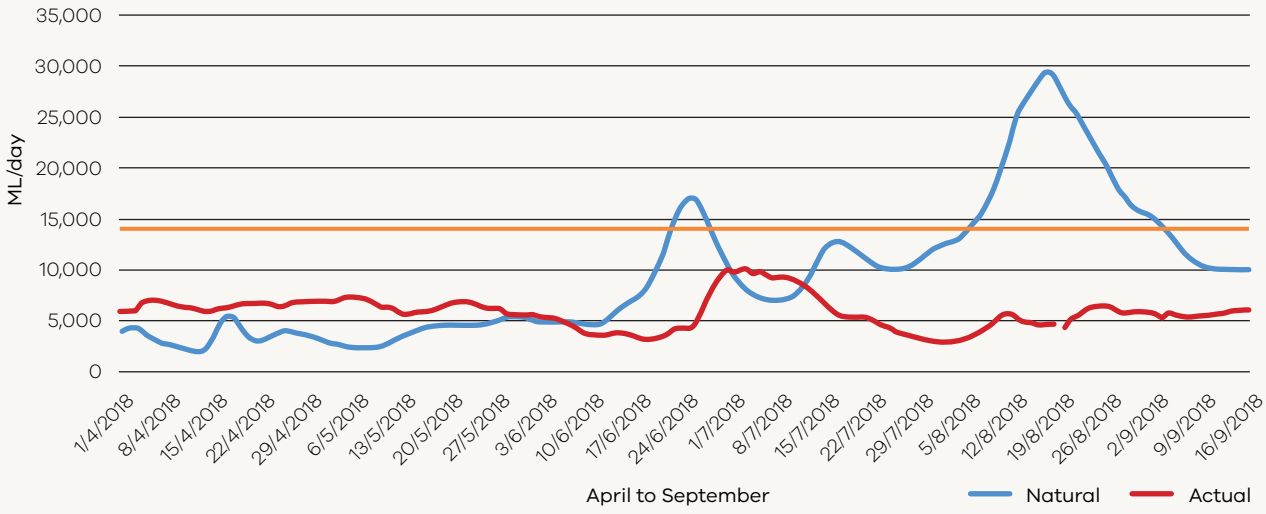


Figure 1 Actual flow vs modelled 'natural' flow into Gunbower Island Forest from April to September 2018. The flat orange line demonstrates when flows in the River Murray are high enough to flow into Gunbower Forest (i.e. when flows in the river reach 15,000 ML/day). This indicates that under natural conditions (blue line), there would have been two periods of inflows for Gunbower Forest in 2018. The red line shows the actual regulated flows delivered at Torrumbarry Weir on the Murray. (Source: MDBA river data, 2018)

Highlights of environmental watering across the Central Murray and Boort wetlands

Lake Cullen

Community knowledge helped deliver 7,790 megalitres of water for the environment to Lake Cullen making it become an efficient drought refuge for waterbirds over summer 2018-19! About 30,000 waterbirds were recorded across 60 different species! Birdlife Australia, supported by the VEWH, has been monitoring waterbirds at the lake.

Round Lake and Lake Elizabeth

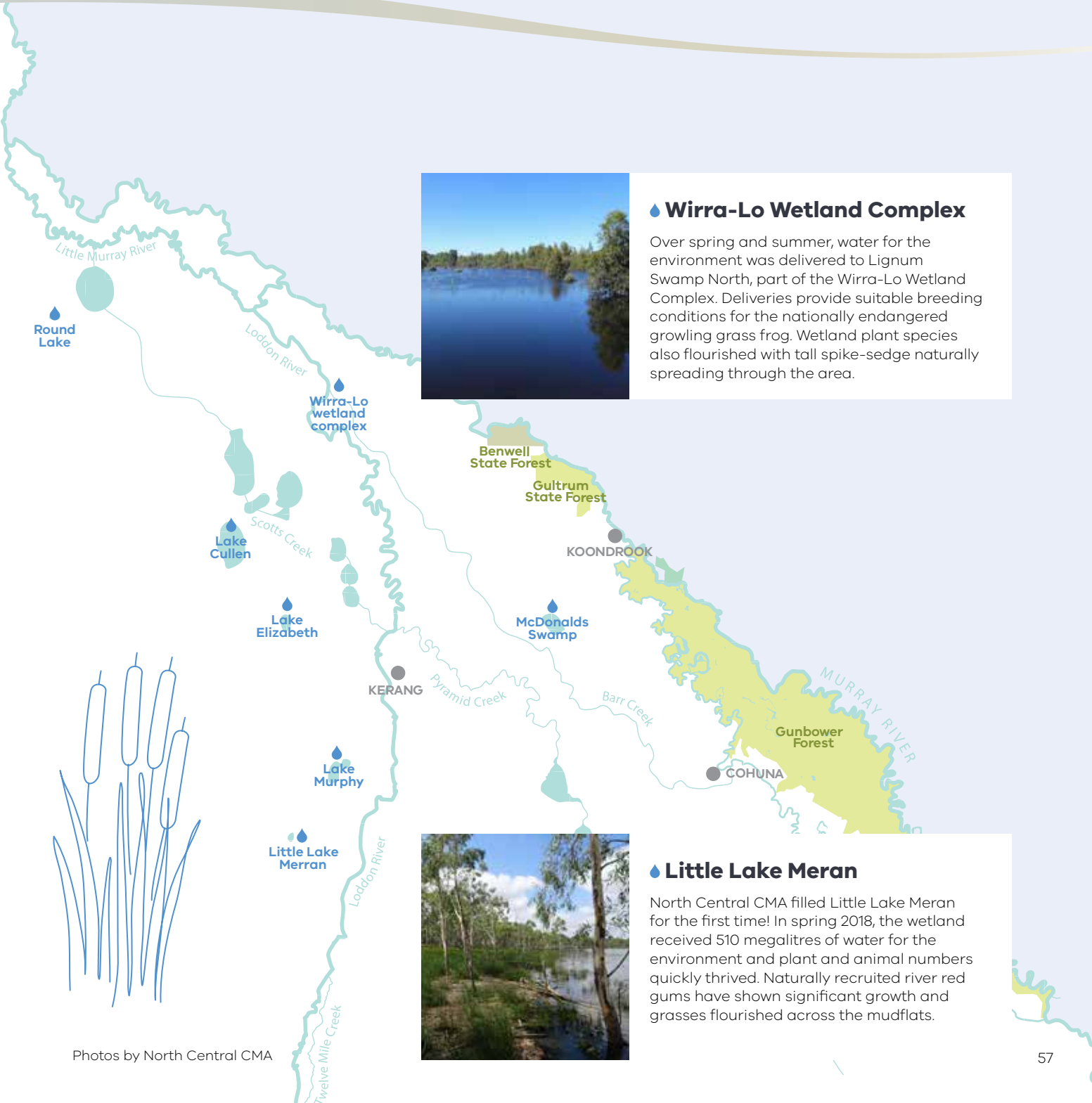
Water for the environment was delivered to Round Lake and Lake Elizabeth to maintain conditions for the critically endangered Murray hardyhead. Both lakes received two instalments of environmental flows, ensuring that they remain permanently inundated. Round Lake and Lake Elizabeth are both part of a program to re-establish Murray hardyhead populations.

Lake Murphy

North Central CMA's annual 'Breakfast with the Birds' event, funded by the National Landcare Program, was held at Lake Murphy this year. In February 2019, over 70 people met at the lake to see some of the bird species that have been flocking to the site after water for the environment deliveries.

McDonalds Swamp

North Central CMA is continuing to work with Barapa Barapa Traditional Owners at McDonalds Swamp through the Testing Wetland Decision Support Tool (DST) project. The project aims to revegetate aquatic species at the swamp. In spring 2018, the area was inundated with water for the environment and the revegetation sites showed significant improvement in aquatic plant species.



Wirra-Lo Wetland Complex

Over spring and summer, water for the environment was delivered to Lignum Swamp North, part of the Wirra-Lo Wetland Complex. Deliveries provide suitable breeding conditions for the nationally endangered growling grass frog. Wetland plant species also flourished with tall spike-sedge naturally spreading through the area.

Little Lake Meran

North Central CMA filled Little Lake Meran for the first time! In spring 2018, the wetland received 510 megalitres of water for the environment and plant and animal numbers quickly thrived. Naturally recruited river red gums have shown significant growth and grasses flourished across the mudflats.

Photos by North Central CMA

Community Highlights

Central Murray wetlands

We want to know what you know! How the Lake Cullen community helped inform water management decisions.

Community members are a wealth of local knowledge. Sharing this knowledge can be instrumental in adapting water management decisions. North Central CMA and the VEWH have listened to feedback from community members in the Kerang Wetlands region, resulting in excellent outcomes for Lake Cullen.

Forming part of the central Murray wetlands, Lake Cullen is an important part of the internationally recognised and protected Kerang Wetlands, supporting thousands of waterbirds of many different species. The lake is a popular spot for birdwatching and hosts some of Australia's endangered species including the Australasian bittern and freckled duck.

In planning for and delivering water for the environment, North Central CMA has been guided by the Lake Cullen Environmental Water Management Plan (EWMP). The watering regime developed in the EWMP in part relied on a technical groundwater report prepared during the Millennium Drought. The report suggested that when Lake Cullen fills, saline groundwater could be pushed into the neighbouring Avoca Marshes, with potentially negative consequences for the marshes and surrounding environment.

Above: Cormorants at Lake Cullen, by North Central CMA

"The Loddon Murray Wetlands are important for the region's economy, especially for tourism. The wetlands are key attractions for recreation, education, cultural connections and social wellbeing."

Based on this hypothesis, the watering regime for Lake Cullen recommended that the marshes need to be full when filling Lake Cullen to reduce the risk of saline groundwater intrusion.

North Central CMA Water for the Environment Program Manager Louissa Rogers said that local community members and landholders shared a different theory based on their knowledge and observation of the landscape over time. This led North Central CMA to undertake further scientific investigation, which confirmed the local knowledge.

"What we found was very little interaction at all between the two water bodies, which was great news. It presented the local community with a rare opportunity - locals wanted to see the benefits of the bird breeding, including the tourism benefits, flow on for another year, and asked if water for the environment could be added again," Louissa said.

"We all understand the current dry conditions are tough, and the local community is working side by side with the CMA and the VEWH to deliver water for the environment to make the region a better place to live and visit."

North Central CMA worked with the Loddon Murray Wetlands Environmental Water Advisory Group and the wider community to deliver water for the environment to wetlands in the region this year.

"The Loddon Murray Wetlands are important for the region's economy, especially for tourism. The wetlands are key attractions for recreation, education, cultural connections and social wellbeing," Louissa said.

"About 30,000 birds across 60 different species were recorded on Lake Cullen in 2018, and the community advisory group was keen to give them a chance to survive the very dry conditions this year by providing high quality refuge habitat. With most of the nearby wetlands drying up, Lake Cullen is now taking on extra importance. It is better for all these birds to stay there and breed than to have to find another home."

Waterway manager:
North Central CMA

Storage manager:
Goulburn-Murray Water

Site	Volume delivered 2018-19 (megalitres)
Johnson Swamp	1,500
Lake Elizabeth	1,080
Lake Murphy	2,550
McDonalds Swamp	230
Round Lake	461
Lake Cullen	7,790
Wirra-Lo wetland complex	92

Hattah Lakes

How drying at Hattah Lakes helps keep the habitat healthy

Home to many threatened species and highly valued by the local community, the Hattah Lakes system contains more than 20 semi-permanent freshwater lakes.

Both wet and dry periods are vitally important for these wetlands as these phases help improve the ecological health of the site.

To consolidate the outcomes of five years of watering, no water for the environment was delivered to the lakes in 2018-19. The planned dry year was important for enhancing the diversity in plant and animal communities and helping ensure that the lakes remain a local hot spot!

Five years of watering has helped restore declining black box trees and support over 140 native plants, on the Hattah floodplain, as well as an abundance of wildlife. Since the installation of pumping infrastructure at Hattah Lakes, environmental flow deliveries have been able to efficiently target the most elevated parts of the floodplain. This has provided much-needed relief to stressed black box trees and other vegetation, some of which, before the pump installation in 2014-15, had not received a drink since the 1990s.

The lakes underwent a planned drying phase 2018-19 to enable understorey plants to germinate, grow and set seed.

The ecological benefits of the wetting and drying phases are revealing themselves, with monitoring indicating floodplain vegetation has responded well.

Andrew Greenfield, senior ecologist with the Mallee CMA explains, "We've seen a vast improvement in the blackbox trees over the past decade, with monitoring following the recent watering events showing that over 60 percent of blackbox trees are healthy, compared to just 19 percent in 2009."

"In 2018-19 we implemented widespread drying to enable seeds to germinate and plants to grow and become established. As the lakes slowly dry, the exposed mudflats and shallow-water habitats continue to provide amazing feeding habitat for waterbirds," said Andrew.

Drying the lakes also increases the environmental benefits that can be achieved from future environmental watering.

"By June 2019, 15 of the lakes were dry," Andrew said. "When the next flood occurs, or when we next pump water for the environment to Hattah Lakes, we should see a boom in productivity because all the nutrients and carbon that have accumulated on the dry lake bed will be released rapidly, building the food chain from the bottom up."

Above: Regent parrot at Hattah Lakes, by Mallee CMA

Waterway manager:
Mallee CMA

Storage manager:
Goulburn-Murray Water, Murray Darling Basin Authority (River Murray Operations)

Site	Volume delivered 2018-19 (megalitres)
	MDBA
Hattah Lakes	281[1]

[1] A small volume of water for the environment was used at Hattah Lakes for maintenance and testing of the Hattah pump station

Lower Murray wetlands

Microbats, frogs, sugar gliders – helping out the little guys

At the eastern edge of the Lower Murray wetlands lies Vinifera floodplain, located between Nyah and Swan Hill.

Originally slated for watering during spring 2018, the watering was delayed until autumn 2019 to allow for complete drying of the wetland over summer.

"The drying phase is really important," explains Andrew Greenfield, senior ecologist with Mallee CMA.

"Allowing time for the floodplain to completely dry kills any carp that have populated the wetland when water was pumped in from the River Murray. Drying also allows clays in the bed of the wetland to crack, which provides habitat for insects and reptiles and allows carbon and other soil nutrients to accumulate. This input of carbon and nutrients during a dry phase leads to increased productivity when a wetland is next watered."

Vinifera Floodplain is known as a breeding area for colonial nesting waterbirds (cormorants and Australasian darters) and may also support breeding by royal spoonbill and Nankeen night heron. Providing environmental water to Vinifera floodplain when it needs it (and when water is available) is one method of creating ideal habitat for these waterbirds. Microbats, frogs, sugar gliders and wallabies are also known to live on or visit Vinifera.

Vinifera Floodplain is one of the wetlands in the Lower Murray section of Victoria, which includes wetlands across the floodplain of the River Murray between Swan Hill and the South Australian border. The system includes a myriad of interconnected creeks, wetlands and floodplains. Over the last fifteen years, 54 waterbodies in this area have received water for the environment resulting in increased biodiversity and health, providing important places for the local community to relax and enjoy.

Waterway manager:
Mallee CMA

Storage manager:
Goulburn-Murray Water

Site	Volume delivered 2018-19 (megalitres)
Brickworks Billabong	251
Burra Creek North	250
Burra Creek South	747
Lake Hawthorn	1,498
Lake Koorlong	57
Nyah Floodplain	1,000
Vinifera Floodplain	665
Yungera Wetland	184

Left: Microbat found at the Lower Murray wetlands, by Mallee CMA

Lindsay, Mulcra and Wallpolla islands

Horseshoe Lagoon - a perfect nursery habitat for native fish

Near the border between Victoria and South Australia lies the Lindsay, Mulcra and Wallpolla islands – a remote but significant part of the Victorian River Murray floodplain in the Murray-Sunset National Park which is traversed by a network of permanent waterways, small creeks and wetlands.

The islands and their waterways are special places and, in 2018-19, Horseshoe Lagoon on Wallpolla Island, became home to more than 120,000 golden and silver perch that were released into the wetland, just days after hatching.

The lagoon was dried in 2016-17 which eliminated carp. Water for the environment, delivered to Horseshoe Lagoon in 2017-18 and 2018-19, improved the productivity of the wetland making it an ideal nursery habitat for stocked native fish to grow and develop.

The fish release was an initiative of the Mallee CMA along with Victorian Fisheries, Traditional Owners and other partners.

"Off-stream habitats like this provide the perfect recipe for heightened survival rates for native fish," explains Mallee CMA senior ecologist Andrew Greenfield.

"A small top-up of environmental water in spring 2019 will help ensure Horseshoe Lagoon continues to be a perfect nursery for native fish."

With fish populations in the Murray-Darling Basin at an estimated 10 per cent of their pre-European occupation levels, environmental flows and stocking of hatchery-bred native fish are both important management tools that can help ensure recovery of our native species. Ensuring the survival of stocked fish, and ultimately their establishment in self-sustaining populations is critical.

"The stocked fish face the same threats as our natural populations – predation by carp and other large fish, habitat loss, barriers to migration, water quality and many others. Opportunities like this, where we've been able manage our environmental flows to enable removal of carp, support the growth and development of the stocked fish, and plan for their dispersal into the population show how these two tools can work together," Andrew said.

Waterway manager:
Mallee CMA

Storage manager:
Goulburn-Murray Water, Murray-Darling Basin Authority (River Murray Operations)

Site	Volume delivered 2018-19 (megalitres)
Wallpolla Island - Horseshoe Lagoon	737

Above: Undertaking fish surveys at Wallpolla, by Mallee CMA

Community Highlights

Ovens system

"The rivers are the veins of the Country"

Taungurung Traditional Owners and the North East CMA have worked with the VEWH and Goulburn Murray Water to release water for the environment. In June 2019, 39 megalitres of water owned by Taungurung Land and Waters Council was delivered as an environmental flow to the King River.

This water release contributed to healing Country by providing a boost to the health and productivity of the waterway. This flow provided a small variation in the water level of the King River downstream of Lake William Hovell, which inundated new habitat for waterbugs and fish, allowing them to move more freely and find new sources of food.

The release coincided with the Taungurung Water Group visiting the King Valley to scope out sites for a future Aboriginal Waterway Assessment of the King River.

Shane Monk, Taungurung man, said "The rivers are the veins of the Country, if you take too much water from them Country would get sick. Taungurung has a responsibility and we are only doing the right thing for Country by bringing water back to the river. We are working with the North East CMA, VEWH and GMW to achieve this. We feel confident we can do more if we continue working together."

Catherine McInerney, Environmental Water Officer at the North East CMA, explains "The King River catchment has recently been incorporated into the Taungurung Clans Aboriginal Party area. It has been great to start our working relationship with them by providing some positive environmental and cultural outcomes on the ground, or waterway as the case may be!"

"This project shows a great collaboration between Traditional Owners and water agencies, with a positive impact on the environment," said Catherine.

Waterway manager:
North East CMA

Storage manager:
Goulburn-Murray Water

Site	Volume delivered 2018-19 (megalitres)		
	Taungurung	CEWH	Total
Ovens River	-	73	73
King River	39	50	89

Above: Taungurung and North East CMA at King River, by North East CMA

Goulburn system

Bigger is not always better: the story of Goulburn system inter-valley transfers and the environment

A winter fresh and spring fresh were delivered in spring 2018 to try to stabilise the lower banks of the lower Goulburn River by helping to deposit sediment and seed and improve bank and in-stream vegetation. Bank stability is of major concern to the Goulburn Broken CMA and the wider community as a result of high unseasonal summer and autumn flows. More water is not necessarily good for the environment - the timing of high and low flows during the year is important to environmental outcomes. The Goulburn River's environment is healthiest if it is low-flowing in summer and autumn, as naturally occurs in these low-rainfall seasons.

In recent years, however, the lower Goulburn River is increasingly relied on as a passage to supply inter-valley transfers (IVTs) from the Goulburn system to the Murray system. The amount of water delivered as IVTs has substantially increased, causing significant damage to lower Goulburn River banks and native vegetation.

Goulburn Broken CMA and the VEWH are using drone technology and on-ground field visits to investigate the environmental impacts of the high IVTs in summer and autumn.

Early data shows the IVTs delivered last summer-autumn resulted in:

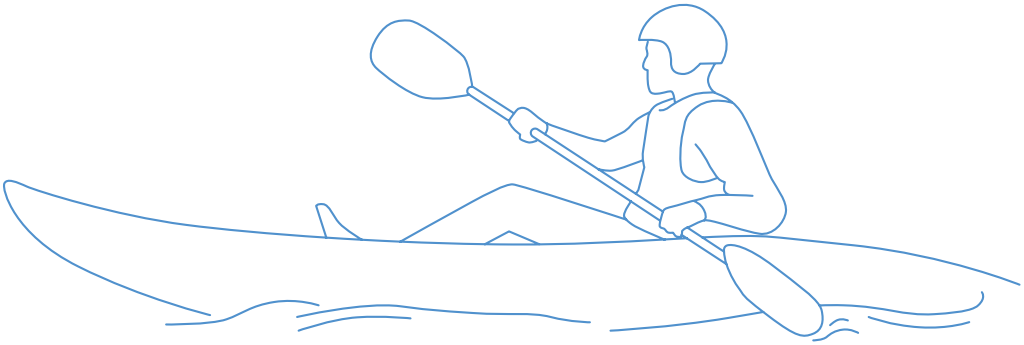
- increased bank erosion, with some lower banks receding by up to 20 cm and others affected by mass failure (slumping)
- loss of lower bank vegetation and reduced survival.

This reduces the habitat available for native plants and animals supported by the Goulburn River including several threatened fish species such as Murray cod.

"We know that the Goulburn River is the lifeblood of this region, providing numerous economic, recreational and environmental benefits and we are continuing to meet with key agencies to look at ways we can minimise the environmental effects of high unseasonal flows due to IVTs," said Goulburn Broken CMA CEO Chris Norman.

It is a continuing balancing act to manage the rivers in a way that supports the environment, farmers and communities the whole way along.

"We know that the Goulburn River is the lifeblood of this region, providing numerous economic, recreational and environmental benefits and we are continuing to meet with key agencies to look at ways we can minimise the environmental effects of high unseasonal flows due to IVTs."



What are inter-valley transfers?
In the big river systems that connect to the River Murray, part of the water stored in systems like the Goulburn and Campaspe contributes to supplying water users downstream in the Murray. Storage managers account for how much water is available to support the Murray, balanced with the water needed to supply water entitlements in the Goulburn and Campaspe.

Water allocation trade affects the balance of these accounts. For example, when water is traded from the Goulburn to a water user in the Murray, the account increases to record the change in location of the demand.

When water from these upstream systems is delivered to meet the needs of the downstream system, this is known as an 'inter-valley transfer'. When the demand for water is high, like it is during irrigation season, large volumes can be released over a short period of time.

Waterway manager:
Goulburn Broken CMA

Storage manager:
Goulburn-Murray Water

Site	Volume delivered 2018-19 (megalitres)			
	VEWH	MDBA	CEWH	Total
Goulburn River – Reach 1	9,665	-	-	9,665
Goulburn River – Reach 4 & 5	15,000	26,468	174,447	215,915

Above: Drone technology monitoring high IVT on the lower Goulburn River, by Goulburn Broken CMA

Goulburn Weir spider web,
by Emma Coats, VEWH

Broken system
Just enough to keep things flowing

In the Broken River, platypus and native fish populations would struggle to survive without water for the environment. When demand for irrigation water ceases, water levels in the system can became dangerously low.

"Environmental flows help keep the Broken system healthy," said Goulburn Broken CMA Environmental Water Manager Simon Casanelia.

"A continuous low flow using water for the environment provides connectivity for fish between deeper pools, which could disconnect into isolated pools after the irrigation season."

"Ideally, to maintain water quality and bank vegetation, provide shelter and food for fish and wildlife such as platypus and support water bugs, we need at least 15 megalitres per day to flow along the Broken River."

The Lake Nillahcootie dam on the Broken River captures water mainly to supply irrigation demands along the river and the upper Broken Creek. During the winter months, demand for this water downstream ceases and flow in the river drops, especially during dry winters like in 2018 and 2019.

Goulburn Broken CMA works closely with Goulburn-Murray Water, the VEWH and the Commonwealth Environmental Water Holder to ensure the river continues to run in winter with water for the environment.

"Due to limited tributary inflows and low operational releases from Lake Nillahcootie this autumn and winter, this minimum flow target would not be met in the section of the river between Nillahcootie and Hollands Creek. Fortunately, in winter 2018 we were able to use 250 megalitres of water for the environment to maintain a low flow," said Simon.

Goulburn Broken CMA CEO Chris Norman said water for the environment would become even more critical to the Broken River if dry times continue.

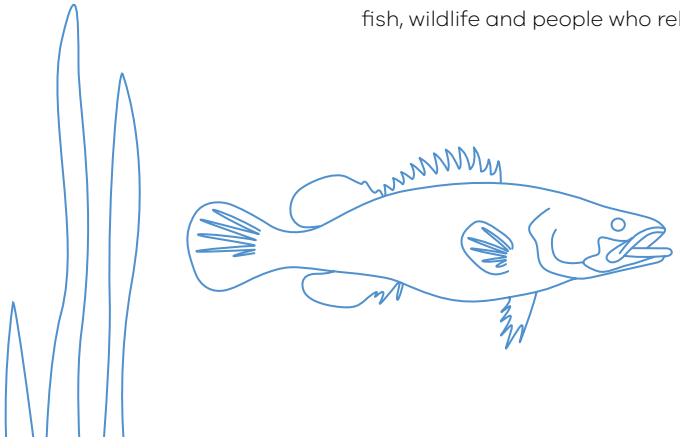
"Anyone living by the Broken River knows how low the river level can be. Delivering this small amount of water over winter is critical for maintaining the health of the entire river and the fish, wildlife and people who rely on it."

Waterway manager:
Goulburn Broken CMA

Storage manager:
Goulburn- Murray Water

Site	Volume delivered 2018-19 (megalitres)		
	VEWH	CEWH	Total
Broken River	250	-	250
Lower Broken Creek	-	33,847	33,847

Above: Graeme Hackett, with a tagged Murray cod in the Broken River, by ARI



Goulburn Broken wetlands

Oh My Brolga! Bird numbers soar at Gaynor Swamp

Brolga numbers continue to rise at Gaynor Swamp! More than 20 brolgas - currently listed as vulnerable in Australia - have been sighted since water for environment deliveries began in 2018.

The brolgas were seen displaying breeding behaviour at the wetland. Courtship and breeding between brolga pairs is quite a scene – they toss grass in the air and catch it, dance, leap, flap their wings and trumpet!

Colbinabbin local John Avard said the environmental flows support ecological and community values.

"This will be great for the waterbirds, particularly the brolga, and those of us who live in the area and value the wetland and the wildlife it attracts, are pleased that water for the environment is being used to improve and protect this special spot," John said.

Maximising on this positive ecological response Goulburn Broken CMA made additional water deliveries in spring and summer 2018.

"The community has been calling for environmental flows to be delivered to Gaynor Swamp for some time now and were very supportive when, back in autumn, water for the environment was delivered to the wetland for the very first time," said Goulburn Broken CMA CEO Chris Norman.

"Given the terrific response from wildlife and to maintain the water level for a few more months, another 101 megalitres of water for the environment was delivered to the site."

Providing feeding and breeding habitat for a range of waterbirds including brolgas is a key environmental objective when delivering water for the environment to Goulburn Broken wetlands.

"We've seen freckled ducks, which is very, very exciting as they are endangered in Victoria, and black-tailed native hens, brolga and massive numbers of yellow spoonbills, which is unusual as they tend to gather in small groups," said Chris.

Below: Brolgas at Gaynor Swamp, by Pat Feehan

"We've seen freckled ducks, which is very, very exciting as they are endangered in Victoria, and black-tailed native hens, brolga and massive numbers of yellow spoonbills, which is unusual as they tend to gather in small groups."

Goulburn Broken wetlands
A speedy response at Reedy Swamp

Water for the environment provides relief for plants and animals at Reedy Swamp as it quickly becomes an aquatic refuge during dry times. The swamp, located just off the Goulburn River north of Shepparton, is listed under the Directory of Important Wetlands in Australia.

Goulburn Broken CMA has undertaken extensive wetland monitoring at Reedy Swamp. Since monitoring began in 2008, 104 water-dependent animal species have been recorded and 85 plant species.

When delivering environmental flows to wetlands, the VEWH and waterway managers try to manage and time deliveries to reflect natural watering regimes. This is often tricky because changes have been made to the waterways and the land, compromising natural inflows.

Ensuring wetlands undergo drying is an important part of their management. It provides time for plants to germinate and soils to settle. When it comes time to add water for the environment, it can have a much greater impact if deliveries are made after the swamp has been given time to dry.

Over the last three years, Reedy Swamp has undergone a drying period. Water was able to recede completely, and the wetland was dry for 12 months before being re-filled.

Goulburn Broken CMA CEO Chris Norman said that wetlands in the area such as Reedy Swamp and Gaynor Swamp provide a much-needed refuge during dry times.

"Reedy Swamp is classed as a drought refuge because it has so many types of natural features – mud flats, deeper open water and giant rushes – that provide valuable habitat for a huge range of waterbirds, as well as frogs, during dry times. During the hot dry spring and summer experienced in this region, these wetlands provided much-needed habitat for wildlife at a critical time in the breeding and migration cycle," said Chris.

Monitoring of environmental flows at Reedy Swamp and Gaynor Swamp will continue with acoustic recorders and time-lapse cameras.

Waterway manager:
Goulburn Broken CMA

Storage manager:
Goulburn-Murray Water

Site	Volume delivered 2018-19 (megalitres)
Reedy Swamp	500
Gaynor Swamp	601
Kinnairds Wetland	384
Black Swamp	80

Left: Reedy Swamp in the evening, by Goulburn Broken CMA

Community Highlights

Fishers and scientists working together to help native fish

Recreational fishers in northern Victoria joined forces with scientists to find out how water for the environment helps the migration, spawning and survival of native fish.

Every year thousands of Victorians head to local waterways to catch fish. For those who keep Murray cod and golden perch for the dinner table, they were asked to help the scientists at the Arthur Rylah Institute (ARI) discover how fish populations have benefitted from environmental flows. All they needed to do was hold on to a part of each fish that they would normally throw away – its 'ear bones'.

These ear bones, found at the back of the fish head, are actually calcium carbonate structures called 'otoliths', and play a role in balance and hearing. They are made up of layers like miniature tree rings, and when examined under the microscope, they can reveal an amazing amount about the origin, age, growth and movement history of a fish, and even whether it is a stocked fish or a natural recruit.

"We've been partnering with fishing clubs, North Central CMA and Goulburn Broken CMA since early 2018 to collect this useful data," ARI's Pam Clunie explained.

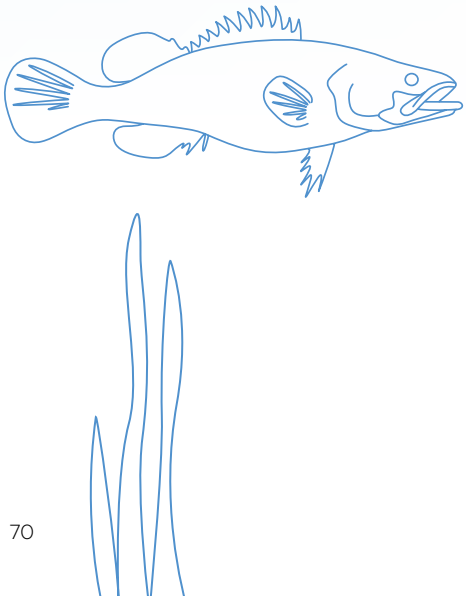
"The angler scientists are really interested in the work that's happening to support and monitor our native fish, and they understand the important contribution they're making to our scientific knowledge."

In November 2018, angler scientists and staff from the ARI, North Central CMA and the Victorian Fisheries Authority got together on the Campaspe River near Elmore to have a go at extracting fish otoliths (ear bones), hear about environmental flows and fish monitoring, and enjoy a barbeque.

Plenty of keen angler scientists came along - some with frozen fish heads and some with ear bones already extracted! Anglers practiced extracting the ear bones, under the guidance of ARI experts.

Fishing club members, along with individual recreational fishers from across northern Victoria, collected ear bones from fish caught in waterways including the mid-Murray, Goulburn, Broken, Loddon and Campaspe rivers, and Pyramid and Gunbower creeks.

Above: Pam Clunie, ARI, talking at Angler Scientist field day at Aysons Reserve, by ARI



"We've collected 84 golden perch ear bones and 25 Murray cod ear bones during the project, which is a great result. Once we've finished the analysis, every angler will receive a 'fish profile', telling them all about each of the fish they collected!" said Pam.

"There are so many benefits to citizen science projects such as this. Angler scientists help us gather a larger sample size to analyse, which will provide us with a better understanding of how fish respond to environmental flows. Scientists and anglers also build relationships and better understand each other's perspectives and interests," said Pam.

Above: An angler scientist extracting a fish earbone, by ARI

This work is part of the Victorian Environmental Flows Monitoring and Assessment Program (VEFMAP), which is monitoring how fish and vegetation along rivers respond to the delivery of water for the environment. This information in turn helps waterway managers to make informed decisions about where, when and how to deliver environmental flows.

To find out more, contact Pam.Clunie@delwp.vic.gov.au or go to https://www.ari.vic.gov.au/research/people-and-nature/fishers-fishing-for-fish-ear-bones.

"We've collected 84 golden perch ear bones and 25 Murray cod ear bones during the project, which is a great result. Once we've finished the analysis, every angler will receive a 'fish profile', telling them all about each of the fish they collected!"

Campaspe River

Snow falling along the Campaspe River in October...? Surely not!

When water for the environment was used to create a spring fresh in the Campaspe River, a site near Barnadown was briefly transformed to look like an alpine winter wonderland.

Already special due to the rocky riffle habitat which is unusual in lowland rivers, the site was quite a spectacle when covered in a crunchy white layer resembling fresh snow – on the Campaspe River floodplain – in October!

The actual explanation for this pretty scene is growth and bleaching of diatoms; diatoms are microscopic algal organisms with a 'boom and bust' lifecycle. They can proliferate in water and settle on rocks during higher flows and then, when water levels drop, exposure to air and sun dries and bleaches them.

Diatoms are an indicator of good water quality and a source of food in the freshwater food web. A diatom boom adds to the productivity of the whole system, providing food for bugs, yabbies, frogs, turtles and fish. As the bleached crust of diatoms breaks down it returns carbon to the system, fuelling growth and supporting a healthy ecosystem.

The Campaspe River downstream of Lake Eppalock provides habitat for several native fish species including Murray cod, silver perch, golden perch, Murray-Darling rainbowfish and flat-headed gudgeon. Platypus, rakali (water rats), turtles and frogs are also present along the length of the Campaspe River. All these animals need a productive food chain in the river.

Water for the environment is supporting a broad range of environmental objectives in the Campaspe River including river productivity, a robust food chain, water quality and healthy native plant and animal populations.

Waterway manager:
North Central CMA

Storage manager:
Goulburn-Murray Water

Site	Volume delivered 2018-19 (megalitres)			
	VEWH	MDBA	CEWH	Total
Campaspe River	16,522	3,104	3,730	23,356

Above top: Rocky riffle on the Campaspe River at Barnadown, by Darren White, North Central CMA

Above bottom: The same rocky riffle with bleached algae appearing as a dusting of snow, by Darren White, North Central CMA

Community Highlights

Coliban River

Dja Dja Wurrung and North Central CMA unite in helping the Coliban River

"Waterways are special places for Dja Dja Wurrung people. The rivers are the veins of Dja Dja Wurrung country which provide food and medicine, places to camp, hunt, fish, swim and hold ceremony. Our waterways are places that we connect with our ancestors and pass traditional knowledge on to our children and grandchildren." - Rivers and Waterways, in the Dja Dja Wurrung Country Plan.

Above: The Coliban River, by North Central CMA

The Coliban River is a highly-valued place within a wider catchment that is culturally significant to Dja Dja Wurrung people. Undertaking an Aboriginal Waterways Assessment, Dja Dja Wurrung representatives have recently measured the impact of environmental flows in the Coliban during very dry autumn conditions.

The Coliban River provides habitat for platypus, rakali (water rats) and small-bodied native fish (such as flat-headed gudgeon and mountain galaxias). The river also supports plenty of aquatic vegetation which is home to a diverse range of waterbugs. It is bordered by patches of shrubland vegetation and river red gum woodland with callistemon, woolly tea-tree and inland wirilda, which provide habitat for land animals.

The knowledge gained from the Aboriginal Waterways Assessment will help Dja Dja Wurrung Aboriginal Corporation and North Central CMA to plan and deliver environmental flows that maintain the environmental and cultural values of the Coliban River.

The Aboriginal Waterways Assessment on the Coliban River is also helping to deliver on the goals of the Dja Dja Wurrung Country Plan which describes Dja Dja Wurrung people's aspirations around the management of rivers and waterways and articulates Dja Dja Wurrung people's support for the reinstatement of environmental flows as an overall objective for the management of water on country.

Waterway manager:
North Central CMA

Storage manager:
Coliban Water

Site	Volume delivered 2018-19 (megalitres)
Coliban River	1,715

Loddon system

Continual learning along the Loddon system ensures maximum water use efficiency

Despite very dry conditions in the Loddon River catchment in 2018-19, a carefully planned and executed environmental watering and water trading strategy ensured there was adequate water available to deliver minimum required flows for the Loddon River in 2018-19 and the year ahead.

"We cannot make it rain but we can be efficient with the water that is available for the environment," North Central CMA Environmental Water Reserve Officer Phil Slessar said.

"We had to balance conserving water with providing enough flow throughout the year to manage the high risk of low dissolved oxygen and fish deaths over summer."

The CMA kept a close eye on conditions and regularly monitored flows and water quality throughout the summer.

"We cautiously adapted the rate of summer low flows and freshes in response to our monitoring, and as a result saved the water we needed for carryover into next year, which is critical given the very dry outlook for 2019-20," Phil said.

"Our tactics were to release a high flow in spring that flushed the whole system, reducing the risk of future blackwater events, and setting the river up to withstand harsh conditions in summer." Phil explains. "This meant that over summer, we were able to successfully provide the bare minimum low flows in the Loddon River downstream of Loddon Weir for summer and autumn to protect fish habitat."

Kathryn Walker, Environmental Water Coordinator at the VEWH, explains that the high flow that was released in spring was made possible by the VEWH's administrative water trading.

"In September 2018 we assessed that, between the VEWH and the Commonwealth Environmental Water Holder, we did not have enough water to deliver both the spring and summer flows we needed," Kathryn said.

"We had some water available in the Goulburn system, which we were able to transfer across to the VEWH's water accounts to the Loddon system to deliver the flow."

"We never know when the next wet period will be, so adaptive management through trade and carryover planning are critical tools we use to safeguard critical biological functions until the next wet period arrives."

Waterway manager:
North Central CMA

Storage manager:
Goulburn-Murray Water

Site	Volume delivered 2018-19 (megalitres)		
	VEWH	CEWH	Total
Loddon River and Tullaroop Creek	12,136	2,636	14,772
Serpentine Creek	826	-	826
Pyramid Creek	1,042	-	1,042
Little Lake Meran	510	-	510

Above: Loddon River at Bridgewater, by North Central CMA

Community Highlights

Lake Boort

To enhance ecological outcomes and cultural values we've 'Boort' together all the great minds!

Above: Dja Dja Wurrung mapping out quadrats for vegetation monitoring at Lake Boort, by Damian Cook

The Dja Dja Wurrung Clans Aboriginal Corporation (through Djandak) and North Central CMA are conducting vegetation monitoring and undertaking planting at the culturally significant Lake Boort site on the Loddon River floodplain.

A highly-significant area for Dja Dja Wurrung, this floodplain not only contains some of the highest densities of scarred trees in the world but numerous cooking mounds and other reminders of past productivity. This connection continues through to this day and is embedded in the plants, animals, Gatjin (water), Wi (fire) and Djandak (land). The vegetation monitoring program looks to inform the recovery of this landscape and its bountiful resources.

With funding from the VEWH to support the project, Dja Dja Wurrung and ecologists have collected plant surveys and recorded incidental animal observations such as frog, mammal, reptile and bird sightings. The project is a great example of Dja Dja Wurrung and western scientists continuing to share knowledge.

Nathan Wong, Natural Resource Program Manager at Djandak, says "Involving Dja Dja Wurrung in monitoring not only allows for people to share knowledge but also increases the understanding of the wetland system."

"It is amazing to see through the monitoring that healing of Lake Boort is occurring and that the greater involvement of Dja Dja Wurrung is delivering this change. By working together, we will succeed and create lasting change in the landscape," Nathan said.

While Gatjin can be distributed to the Boort wetlands using Loddon Valley Irrigation Infrastructure, the current environmental water management plan for Lake Boort involves long drying phases to mirror a more natural wetting and drying cycle and is consistent with the aspirations of Dja Dja Wurrung.

Kevin Mah, Environmental Water Reserve Officer at North Central CMA, said "We're really pleased to be working with Dja Dja Wurrung at Lake Boort. Working with the Traditional Owners has helped build our understanding of the site, and has allowed us to share knowledge about managing this important wetland into the future."

"Wetlands like Lake Boort need both wet and dry phases. As the wetland begins to dry vegetation species such as southern cane grass and common spike-sedge that grow and establish at wetland sites. The receding water levels also provide habitat and feeding opportunities for wading waterbird species including the little egret, which is critically endangered in Victoria."

It's not just about adding water

Progress on the Native Fish Recovery Plan – Gunbower and lower Loddon

The North Central CMA's vision is to restore native fish populations, improve waterway health, and create a world-class native fishery in the Gunbower and lower Loddon region.

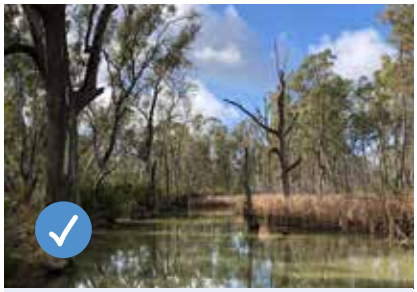
The *Native Fish Recovery Plan – Gunbower and lower Loddon,* involves the large-scale, long-term and holistic rehabilitation of the network of creeks, lagoons, wetlands and floodplains in northern central Victoria.

This integrated action plan was developed in collaboration with fish ecologists, and is being delivered in partnership with government agencies, Traditional Owners, and recreational fishing groups. 2018–19 saw significant progress in several of the key Recovery Plan initiatives. The following highlight boxes show some of the achievements of this plan.

Threatened species recovery

Southern pygmy perch (Murray-Darling lineage) numbers have severely declined since the 1970s, and only three wild populations remain in north central Victoria. In partnership with Native Fish Australia, City of Greater Bendigo Council and Australia and New Guinea Fish Association, brood stock has been collected from the remaining populations and a captive breeding program has commenced, with the aim returning the species to managed Gunbower Forest wetlands.

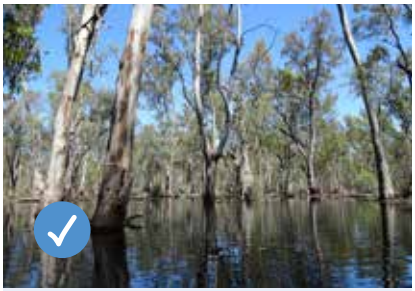
Above: Monitoring fish communities, by North Central CMA



Gunbower Creek flows

Flows targeting Murray cod spawning and recruitment were delivered for the fifth consecutive year. Flows include a steady spring flow to keep Murray cod on their nests, some areas of permanent fast flowing water, and higher winter flows to provide habitat for juvenile cod. Juvenile cod recruitment has occurred annually since the flows have been implemented.

Above: Gunbower Creek, by Erin Round, VEWH



Gunbower Forest floodplain watering

An efficient forest floodplain watering not only provided refuge for waterbirds and helped maintain the health of this iconic red gum forest in dry conditions, it also provided important native fish populations with a boost, as vital food and nutrients flowed off the floodplain and back into our creeks and rivers in spring when they needed it most.

Above: Gunbower Forest, by North Central CMA

Little Murray River fishways

Fishways were installed at Little Murray Weir and Fish Point Weir through the Swan Hill Modernisation Project. Migrating fish species can now move ~180km from the Murray River through Little Murray River, lower Loddon River and Pyramid Creek to high quality nursery habitat in Kow Swamp.

Above: Pyramid Creek, by North Central CMA

Cohuna fish screens installed

In an Australian first, Victorian-designed and made irrigation channel fish screens were installed on the Cohuna Irrigation Channel to prevent native fish from being lost to the irrigation channel system.

Above: Installation of the fish screens, by North Central CMA

Koondrook Weir fishway

Detailed design commenced on a vertical slot fishway for the Koondrook Weir, and funding from a recent sale of water for the environment was committed to its future construction.

Above: Physical modelling workshop of Koondrook fishway, by North Central CMA

Instream habitat

More than 50 instream woody habitat structures were installed in Little Murray River and the Lower Loddon River creating habitat, resting points and feeding areas for threatened freshwater catfish, silver perch, Murray cod and wild populations of golden perch.

Above: Installed instream habitat, by North Central CMA

Loddon River and Pyramid Creek flows

Coordination of Loddon River and Pyramid Creek flows provided a trigger for target native fish species such as golden perch and Murray cod to move from the Little Murray and Lower Loddon River. Large numbers of golden perch were observed moving through the recently installed Box Creek Fish Lock into Kow Swamp.

Above: Golden perch release Pyramid Creek, by ARI

Streambank habitat

15 km of riparian fencing was installed, protecting stream banks from stock access.

Above: Revegetation along Pyramid Creek, by North Central CMA

Cohuna fish screens a win-win for community and native fish

In an Australian first, countless numbers of native fish will be saved thanks to a Victorian-designed and made irrigation diversion channel fish screen. The screen, which is located between Gunbower Creek and the Cohuna Irrigation Channel, was funded by the Victorian Environmental Water Holder and is a key action in the North Central Catchment Management Authority's Native Fish Recovery Plan for the Gunbower and lower Loddon system.

Each year, up to hundreds of thousands of native fish and larvae are lost from the Gunbower Creek and the Murray River system as fish move into irrigation channels. Once in irrigation channels, the fish are lost to the natural system forever, having a negative impact on breeding and population numbers of native fish.

Since early European occupation, native fish populations have decreased by 90 percent across the Murray-Darling Basin. In the Gunbower and lower Loddon, only 13 of 22 native fish species are still present in the system today. And of these, six are listed as threatened.

Migratory Australian fish species, such as yellowbelly and silver perch, are particularly vulnerable to getting lost in irrigation channels. Whilst in the egg larvae stage, many species drift and are therefore just as vulnerable. Loss of native fish through irrigation infrastructure is one of the key factors behind the decline of native fish populations within the Gunbower Creek.

For example:

- During a tagging project in Gunbower Creek 20 percent of tagged young-of-year and adult golden perch were found to enter an irrigation channel but none were recorded returning to the creek.
- Surveys of the Cohuna Channel (before the construction of the fish screens) found that it traps up to 5,500 native fish larvae, including more than 160 Murray cod larvae, per day.

The screens act like a giant tea strainer – allowing water to pass into the channel so it can be used by irrigators but preventing fish larvae and eggs from passing through.

The Cohuna Irrigation Screen is a win-win-win project for native fish, irrigators, and the broader community. Native fish are kept in Gunbower Creek without compromising the delivery of water for irrigators. The screens are locally designed and made, supporting local jobs. Investments in fish habitat restoration, flows and fishways are enhanced, and more Murray cod and golden perch in the creek means better fishing opportunities for recreational fishers, supporting the local tourism and economy.

Left: Cohuna Irrigation Screen, by North Central CMA

Fish on the move at Koondrook Weir

Thousands of native fish will be able to freely move between the River Murray and the rich habitat of Gunbower Creek due to a funding boost from the VEWH's autumn sale of water for the environment.

The Koondrook fishway will provide passage to native fish, such as the iconic vulnerable Murray cod and threatened golden perch, from the river into the creek for the first time in more than a century.

Key partners including the VEWH, North Central CMA, DELWP and Goulburn Murray Water have agreed to take the proposed Koondrook fishway into a detailed design and costing phase, and then through to construction.

Fish studies have shown that large numbers of native fish accumulate at Koondrook Weir trying to access the creek, but they cannot get past the weir.

"A fishway will dramatically improve connectivity for fish movement and migration and help boost native fish numbers in the creek," North Central CMA CEO Brad Drust said.

"It will also add significant value to the fantastic wins we are already seeing with environmental flows and native fish recovery – such as Murray cod spawning in the Gunbower Creek and the critical fish food provided by flows through the Gunbower Forest."

The detailed design is currently underway with a focus on ensuring the fishway is able to pass a wide range of species, both large and small, under a range of flow conditions. The design aims to ensure the most ecological benefit to the native fish population, whilst not impacting on the delivery of water to irrigators.

"Through the detailed design process, we will ensure that the solution works for everyone, including Torrumbarry irrigators that rely on the irrigation delivery system for their livelihood," Brad said.

Victorian Fisheries Authority CEO Travis Dowling said the Koondrook fishway would provide a significant boost to native fish at Gunbower, and in turn, to tourism and recreation in the area.

"Enabling fish to move between Gunbower Creek and the Murray is a key to helping realise the vision of creating a world-class Murray cod fishery in north central Victoria, and in turn will lure recreational anglers from all over to try their luck hooking a big one and, in the process, the region will get a massive boost of tourist dollars."

Victorian fishing peak body chairman Rob Loats said VRFish had worked closely with North Central CMA on the Native Fish Recovery Plan for Gunbower and the Lower Loddon, which earmarked a fishway at Koondrook weir.

"The Koondrook fishway will be a magnificent project to restore native fish numbers at Gunbower," Mr Loats said.

"Recreational anglers see first-hand the benefits of sustainable fishing and improved fish habitats, and this fishway will open up Gunbower Creek to thousands of fish looking to move upstream there."

Above: Koondrook Murray cod - looking at fish accumulation below the weir at different flows, by North Central CMA