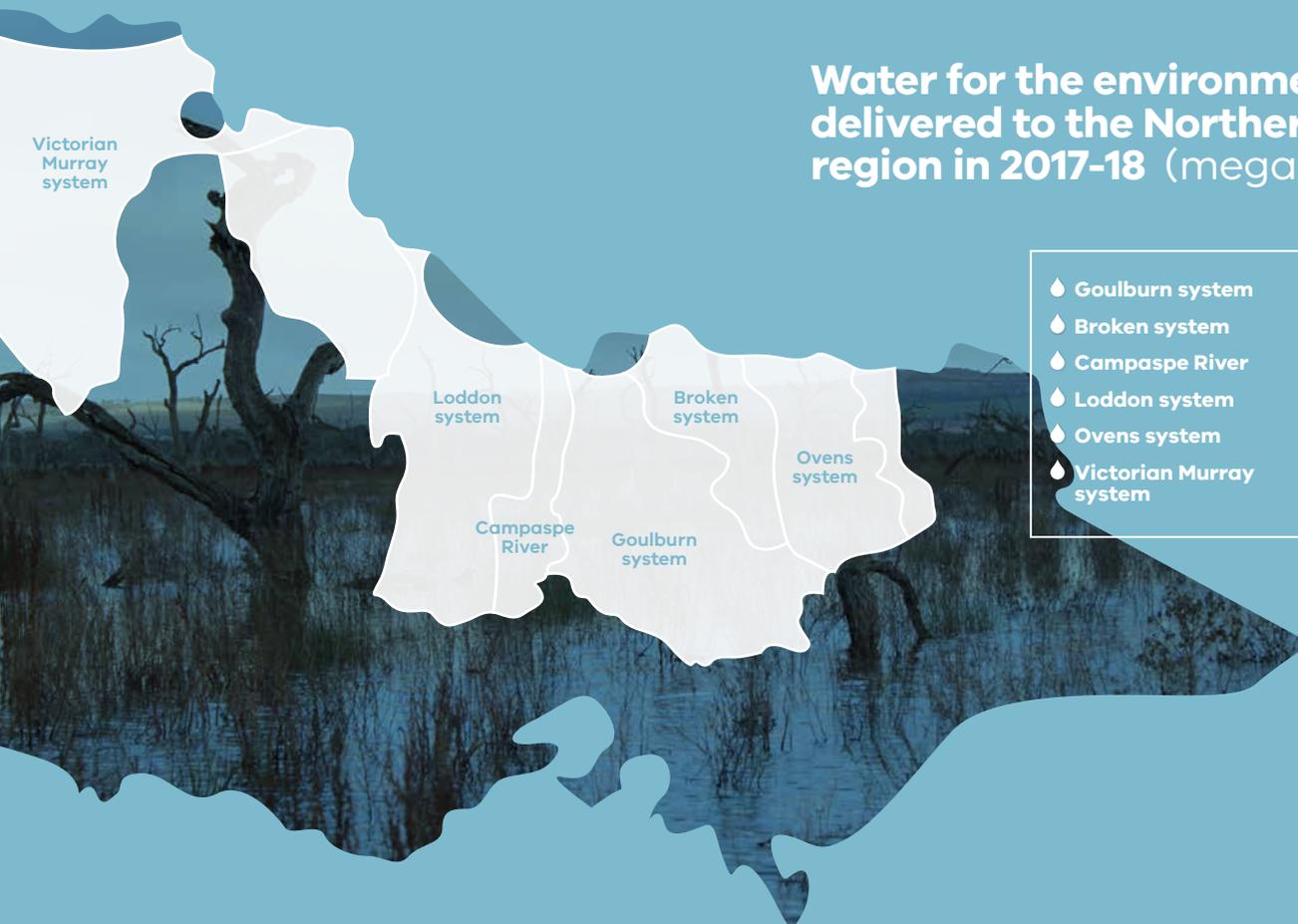


Northern region

Despite a dry year, 2017-18 provided an amazing opportunity to use water for the environment in the Northern Region to consolidate the environmental outcomes provided by wetter conditions in 2016. Water for the environment provided the iconic Murray cod a chance to spawn in the Campaspe River – the first time ever recorded. Gaynor Swamp saw a waterbird boom after environmental flows were delivered there for the first time.

Water for the environment delivered to the Northern region in 2017-18 (megalitres)



◆ Goulburn system	355,333 ML
◆ Broken system	42,908 ML
◆ Campaspe River	31,294 ML
◆ Loddon system	18,868 ML
◆ Ovens system	123 ML
◆ Victorian Murray system	605,185 ML

Goulburn system

Water quality and plants on the banks of the Goulburn River benefitted from an environmental flow along the lower Goulburn River in June 2018, with additional benefits extending all the way to South Australia's Coorong.



"Most of the rain and resulting run-off into the Goulburn River is now captured in dams and used to supply towns, industry and farms, so the amount of water flowing down the river in winter and spring has reduced," Goulburn Broken CMA's Simon Casanelia said.

"It also means the river flows higher and faster in the hotter months of the year when communities require more water, which is the opposite of what would happen if there were no dams and weirs. These changes have affected the health and survival of native plants and animals, so we're giving nature a helping hand and delivering environmental flows to provide what the Goulburn River needs to be a healthier waterway."

Simon said 2018 flows along the lower Goulburn River had been running higher than usual to meet increased downstream demand in the River Murray, so they designed the winter environmental flow to decrease at a slower rate than in the past to reduce the risk of riverbank slumping or erosion.

Once the environmental flow reached the Lower Lakes in South Australia, the water was used to deliver a large winter release from the lakes into the Coorong. This flow triggers upstream migration and spawning of pouched lamprey, a rare and primitive eel-like fish, that enters the Murray system through South Australia's Coorong estuary.

Pouched lamprey move between saltwater and freshwater to complete their lifecycle, migrating from the sea and travelling large distances upriver to spawn. After a similar environmental flow from the Goulburn River made its way down the Murray

in winter 2015, a pouched lamprey that was tagged with a microchip at the Coorong estuary was tracked all the way to Lock 11 (near Mildura) – a journey of almost 900 kilometres!

Victoria and South Australia have been working closely to coordinate winter environmental flows, achieving the best possible environmental outcomes all the way from the Goulburn River to the Coorong.

Waterway manager:
Goulburn Broken CMA

Storage manager:
Goulburn-Murray Water

Site	Volume delivered in 2017-18 (ML)			Total
	VEWH	MDBA	CEWH	
Goulburn River – Reach 1	4,015	-	-	4,015
Goulburn River – Reach 4 & 5	37,635	77,559	235,624	350,818

Left: Gaynor Swamp, by Goulburn Broken CMA
Above: Goulburn River at Eildon, by Goulburn Broken CMA

Northern

Broken system

The 2017-18 watering year was the first year a flow down the Broken River had been managed specifically for environmental purposes, with the aim of improving habitat for native fish, plants and waterbugs.



Goulburn Broken CMA's Simon Casanelia said, "Summer was hot and dry, and much of the rain and resulting flow into the Broken River was captured by dams and weirs. We gave nature a helping hand by delivering water at this time of year (autumn) to mimic more natural and variable conditions."

The environmental flow also aimed to support the establishment, survival and growth of bankside plants and to maintain water quality.

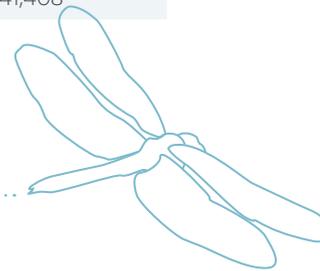
The water levels rose between 300 millimetres and 400 millimetres downstream of Lake Nillahcootie in response to the flow. There was 1,000 megalitres of environmental water traded into the Broken system from the Goulburn system to support this event, and this was delivered along with operational water transfers down the Broken River.

The trade in of environmental water enabled other Broken system water entitlement holders to trade their water out – a benefit to those often restricted by trade limits.

Waterway manager:
Goulburn Broken CMA

Storage manager:
Goulburn-Murray Water

Site	Volume delivered in 2017-18 (ML)		
	VEWH	CEWH	Total
Broken River	1,000	-	1,000
Lower Broken Creek	-	41,408	41,408



Above: Goulding Close looking upstream to Broken River, by Goulburn Broken CMA

Goulburn Broken wetlands

Waterbirds and plants were given a helping hand when Goulburn Broken CMA delivered water for the environment to Gaynor Swamp for the first time during autumn 2018.



“For a number of years, the local community has been asking for environmental flows to be delivered to the wetland and now, because we have suitable infrastructure in place, we were able to make the first significant delivery of water for the environment,” said Goulburn Broken CMA’s Simon Casanella.

Five hundred megalitres of water for the environment was provided to partially fill the wetland, which holds about 1,900 megalitres when full.

“The bird response to the watering was incredible! Gaynor Swamp is a known brolga breeding site, and within two days of the water going in our staff had spotted a pair,” Simon said.

Scientists from the Arthur Rylah Institute, visiting the site as part of Victoria’s Wetland Monitoring and Assessment Program (WetMAP), along with bird enthusiasts from The Melbourne Birder and Birdlife Australia, also reported a couple of brolga pairs, as well as a diversity of other birds.

“We saw over 300 whiskered terns feeding, along with sharp-tailed sandpipers, red-necked avocets, black winged stilts, yellow-billed spoonbills, white-faced and white-necked

herons picking through the mudflats and shallows,” said the Arthur Rylah Institute’s Danny Rogers.

Plenty of ducks also responded to the watering – grey teal, Pacific black ducks, chestnut teal, Australian shovelers, shelducks, pink-eared ducks and a freckled duck were all recorded. A black honeyeater – not often found in Victoria – was also heard.

The abundance of birds of prey indicated the wetland had boosted feeding and foraging opportunities for a range of birds and animals in the area.

“There were white-bellied sea eagles, swamp harriers, wedge-tailed eagles and whistling kites all circling the area while we were there – a sure sign that

there has been a productivity boom in response to the watering,” Danny said.

Researchers also discovered a vulnerable grassland community, known as Alluvial Plains semi-arid grassland, which is uncommon in this area and usually only found in the Mallee. Survival and growth of new plants in these grassland communities depends on shallow, intermittent flooding every five years, so environmental watering is giving these vulnerable plants a boost.

Waterway manager:
Goulburn Broken CMA

Storage manager:
Goulburn-Murray Water

Site	Volume delivered in 2017–18 (ML)			Total
	VEWH	MDBA	CEWH	
Moodie Swamp	-	-	500	500
Gaynor Swamp	500	-	-	500

| Above: Brolga seen during water delivery at Gaynor Swamp, by Goulburn Broken CMA

Northern

Campaspe system

Murray cod spawning was recorded for the first time in the Campaspe River in 2017, on the back of spring environmental flows.

The endangered fish has been a focus of North Central CMA's environmental watering program, as has the critically endangered silver perch, the vulnerable Murray-Darling rainbowfish, and golden perch (yellow belly).

North Central CMA's Darren White said, in more good news, summer environmental flows had triggered migration of silver and golden perch from the River Murray and into the Campaspe River.

"Water for the environment helps keep water levels relatively steady at key times of the year and prevents rapid increases or decreases that occur as a result of fluctuating demand during the irrigation season," Darren said.

Bendigo's Adrian Leo has been fishing in the Campaspe River between Eppalock Dam and Elmore for years.

"Over the past few years, everything is healthier," Adrian said.

"The water quality has improved, especially in the areas that have been fenced off, and the fishing has really improved. It's not just the amount and their size, but it is the health of the fish as well."



"My largest cod is 85 centimetres, but my mate caught a 104 centimetre one, which is almost unheard of in the Campaspe," Adrian said. "I've caught a couple of 70 centimetre cod, including a 75 centimetre with a surface lure, and a lot of 50s. I have also caught a heap of 30s, which shows there are different generations swimming around."

The river is starting to become healthier over time, as flows are delivered, with plants, animals and communities all reaping the benefits.

Waterway manager:
North Central CMA

Storage manager:
Goulburn-Murray Water

Site	Volume delivered in 2017-18 (ML)			
	VEWH	MDBA	CEWH	Total
Campaspe River	17,940	5,300	6,594	29,834
Coliban River	1,460	-	-	1,460

Above: Murray cod caught at the Campaspe River, by North Central CMA

Central Murray wetlands

Four Victorian agencies have been working together to relocate and help establish a healthy population of Murray hardyhead – one of Australia’s most endangered fish.



Since 2014, North Central CMA, the Department of Environment, Land, Water and Planning, Arthur Rylah Institute and the VEWB have been using water for the environment to create suitable habitat and conditions for the Murray hardyhead in Lake Elizabeth, near Kerang.

Murray hardyhead is a small native fish that was once widespread in rivers and wetlands of the lower Murray-Darling Basin.

“The species has suffered a severe decline, with less than 10 populations remaining in the Murray-Darling Basin, and the world,” said North Central CMA’s Amy Russell.

“Only two of these remnant populations exist in Victoria, one in the Swan Hill-Kerang region and the other near Mildura.

“We are trying our best to prevent further localised extinctions, and to increase their numbers by finding new wetland habitats for the species.”

Water for the environment was first delivered to Lake Elizabeth in 2014, and a small number of fish were placed in the lake a year later.

“Lake Elizabeth’s elevated salinity and abundant plant life provided us with an opportunity to create beneficial conditions for them,” said Amy.

“Through delivering water for the environment, we were able to bring the salinity level down considerably, but still keep it high enough to keep predators such as carp out.

“This has also promoted aquatic plant growth and increased the amount of zooplankton (microscopic animals) present, an important food source for Murray hardyhead.”

Surveys completed in April 2018 found 24 Murray hardyhead, proving the outstanding success of the relocation.

| Above: Murray hardyhead,
| by North Central CMA

Northern

Central Murray wetlands

Hird Swamp, part of the internationally recognised Kerang Wetlands, is an important wetland for waterbird resting, nesting and feeding. It is also valued by the community as a popular birdwatching and duck hunting spot.



North Central CMA has been managing a series of environmental flows and drawdowns at the swamp that will limit the growth of reeds, expand the amount of open water, support diversity of wetland plants, rehabilitate plants and provide habitat for waterbirds.

The results are in, and they are sensational! In February 2018, up to 8,000 birds from 47 different species were recorded. One of the highlights was 11 brolgas, including a breeding pair with their young.

Environmental flows are not intended to be delivered for at least another two years to further improve the swamp, as part of the natural wetting and drying cycles.

"Drying the wetland out will ensure the reeds don't creep back into the swamp and waders can come and make the most of the area," said Louissa Rogers from North Central CMA.

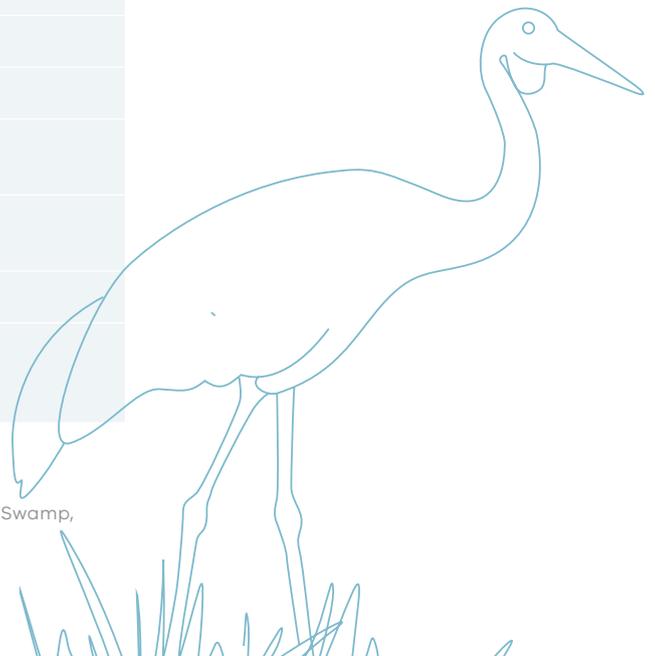
"Hird Swamp is a great example of environmental flow management being more than just about adding water. It's about the right amount of water at the right time, mixed in with complementary measures such as revegetation and fencing to protect the site."

Waterway manager:
North Central CMA

Storage manager:
Goulburn-Murray Water

Site	Volume delivered in 2017-18 (ML)
Hird Swamp	2,220
Lake Elizabeth	530
Lake Murphy	580
McDonalds Swamp	350
Richardsons Lagoon	458
Round Lake	422
Wirra-Lo wetland complex	80

Above: Brolga group at Hird Swamp, by North Central CMA



Highlights of environmental watering 2017-18



Maintained conditions for critically endangered Murray hardyhead

Nationally endangered growling grass frog was recorded at the rehabilitated wetland – the last record of growling grass frog in the area was in 2008

Supported establishment of new Murray hardyhead population. Threatened waterbirds were observed including royal spoonbill, blue billed duck, common greenshank, Australasian shoveler, hardhead and freckled duck

Revegetation (mainly for aquatic species) was successfully carried out at the wetland with Barapa Barapa Traditional Owners during the water delivery period

Promoted establishment of river red gum seedlings

Over 40 bird species recorded, including threatened Baillon's crake, whiskered tern, glossy ibis, royal spoonbill, eastern great egret, Australasian bittern, Australasian little bittern, magpie geese, white-bellied sea eagle, musk duck and nankeen night heron

Rehabilitated various habitat systems including various reedy environments, open water habitats, river red gum and black box floodplain communities

* Birdwatchers helping birds at Lake Cullen

Volunteer birdwatchers are giving waterway managers a vital insight into how water for the environment is helping to protect, restore or enhance wetlands and sustain waterbird populations.

Lake Cullen is one of 23 wetlands forming the internationally important Kerang Wetlands which occurs in the larger Central Murray wetlands system.

In 2016 and 2017, North Central CMA delivered environmental flows to Lake Cullen to provide a breeding ground for aquatic plants and waterbugs, which in turn would result in a food boom for birds. To find out if this was successful – and provide information that can guide future deliveries of water for the environment to Lake Cullen – Birdlife Australia teamed up with the VEWB and North Central CMA in February 2018 to hold a 'Waterbirds of Lake Cullen' training workshop and field trip for the local community.

Over 50 people from diverse backgrounds attended the workshop, where they gained knowledge from Birdlife Australia and the CMA about the importance of environmental watering to wetlands, how to identify birds, and how participants could contribute to monitoring and conservation. Since the workshop, information has been flowing into Birdlife Australia's national database from birdwatchers in the broader Kerang area. Five of these volunteers –

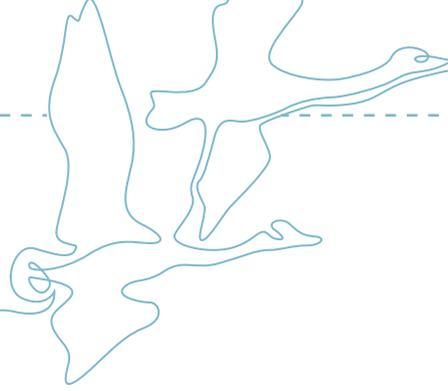


including four locals who had not previously been involved in the project – signed on as monthly waterbird monitors.

The records that the birdwatchers have collected are a resounding endorsement of both the success of the watering event and the invaluable contribution that citizen scientists can make to environmental management. Up to 18 threatened species were recorded during the monthly bird counts to June 2018, including freckled ducks, great egrets, little egrets, Australasian bitterns and a pair of brolga. Water for

the environment also assisted breeding in six species at Lake Cullen, including the threatened magpie goose. Furthermore, close to 27,000 waterbirds were recorded at Lake Cullen during January and March 2018.

Some of the most exciting observations were of international migratory species which visit Australia from their breeding grounds in the northern hemisphere. These included a black-tailed godwit, which is very rare in Victoria and is listed as a vulnerable species in Victoria.



The most exciting outcome is that citizen scientists have helped to not only record these species, but also identify important habitat needs. Their observations, along with scientific data collected by North Central CMA, gave the CMA and the VEWH the information they needed to deliver more water for the environment into Lake Cullen in the spring of 2018, giving the birds – and the volunteers observing them – a very welcome boost. Following

the top-up in October 2018, 29,600 waterbirds were recorded during the November 2018 count.

Far left: Waterbirds of Lake Cullen workshop at Kerang, by Zarleen Blakeley, VEWH Centre and right: Identifying birds at Lake Cullen, by Zarleen Blakeley, VEWH

Northern

Lower Murray wetlands

At Neds Corner station, Victoria's largest private nature reserve in the north-west corner of the State, environmental watering is being adapted to protect rare and threatened species.



"Based on the plants we've found, spacing of at least five years between environmental watering will be a good option to maximise biodiversity at the site."

Neds Corner, owned by Trust for Nature, has been managed for conservation since 2002. With 200 kilometres of River Murray frontage within the Murray Sunset National Park, the site is home to critically endangered reptiles, the De Vis's

banded snake and hooded scaly-foot legless lizard, as well as the nationally vulnerable regent parrot.

Water for the environment has been critical for keeping this valuable ecosystem healthy.

Waterway manager:
Mallee CMA

Storage manager:
Goulburn-Murray Water

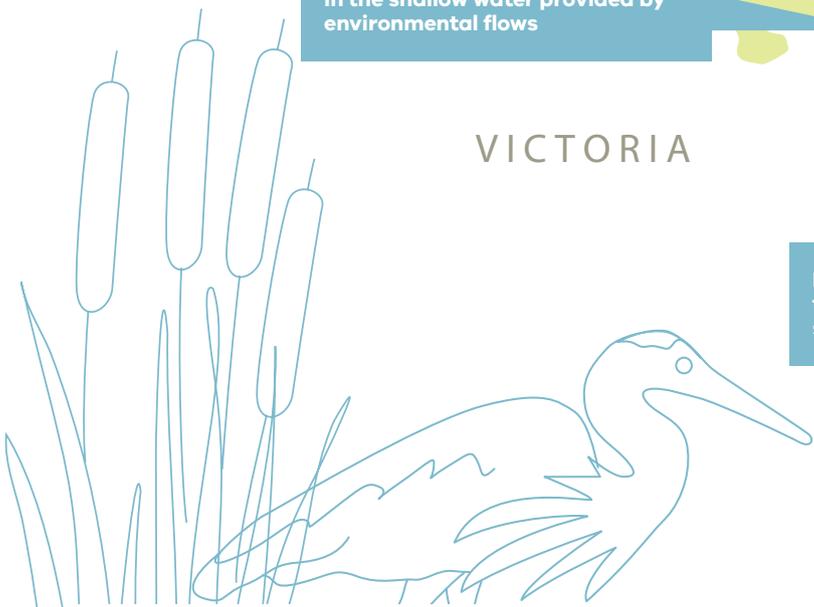
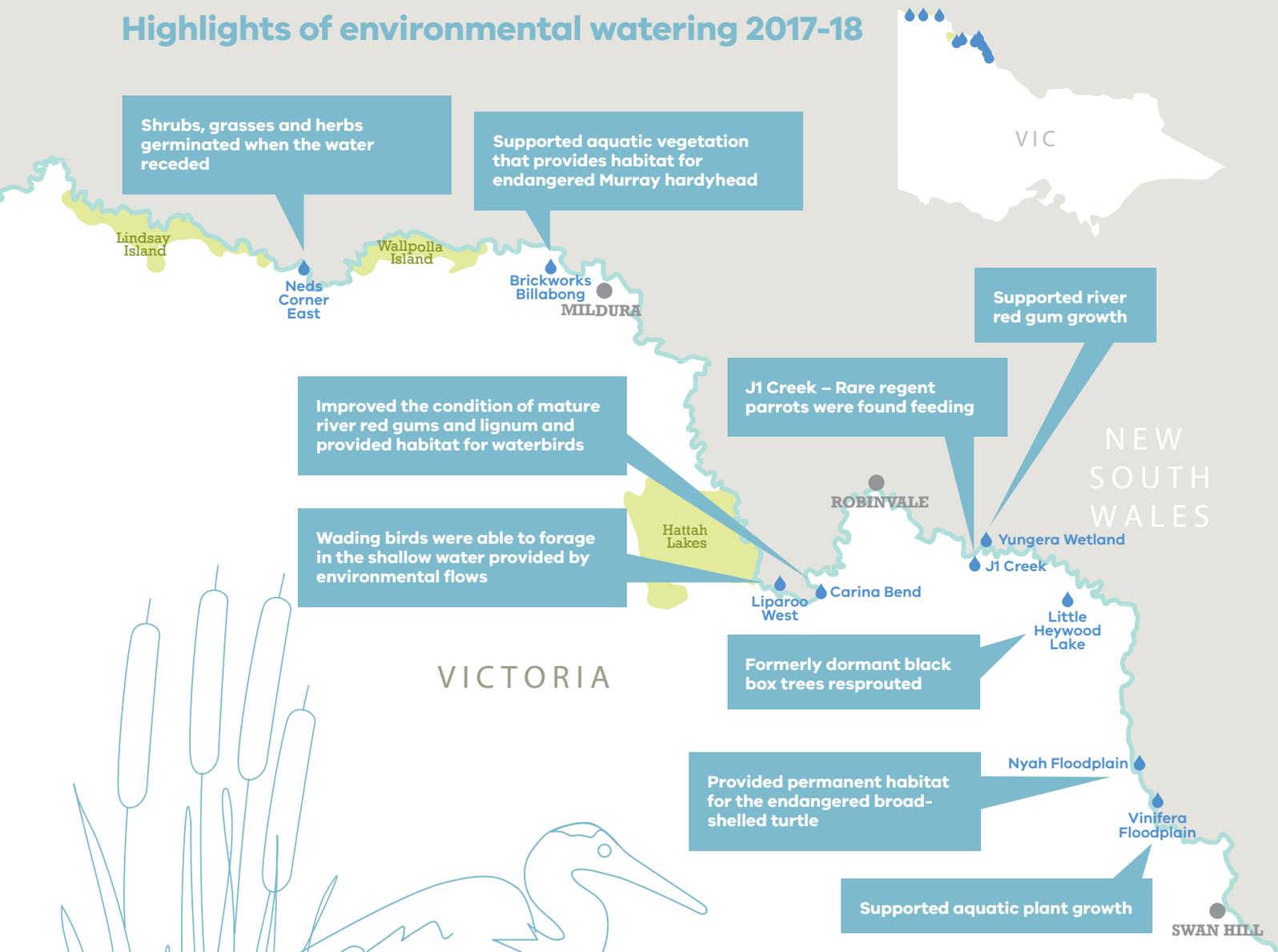
Each year, careful planning scopes out the likely deliveries of water for the environment at locations across Victoria. But the actual delivery can be influenced by a range of factors, including ecological or biological triggers; for example, the presence, absence or behaviour of key plants or animals. Monitoring and observation are critical to gather the information needed to adapt planning and delivery of environmental flows in the short and longer term.

In September 2017, before environmental flows were delivered, botanists from the Arthur Rylah Institute completed plant monitoring at two of the many wetlands on the property – Neds Corner Central and Neds Corner East. They found 15 threatened plants growing on the drying lake bed at Neds Corner Central, which had received environmental flows the year before.

Phil Papas from the Arthur Rylah Institute said, "Frequent inundation events would be likely to displace most of these rare plants from this wetland. As a comparison, more regularly flooded systems in this area are far more species-poor. While successive years of flooding could occur naturally, this is generally rare and not necessarily helpful to maintaining plant diversity."

Site	Volume delivered in 2017–18 (ML)	
	VEWH	Other
Brickworks Billabong	250	-
Cardross Lake	506	-
Carina Bend	800	-
J1 Creek	417	-
Lake Hawthorn	447	-
Liparoo West	240	-
Little Heywood Lake	512	-
Neds Corner East	104	-
Nyah Floodplain	1,877	-
Vinifera Floodplain	925	-
Yungera Wetland	111	-
Lock 15 wetlands	-	1,573

Highlights of environmental watering 2017-18



Left: Lagoon nightshade (*Solanum lacunarium*), by Nathan Johnson

Northern

Loddon system

Scientists from the Arthur Rylah Institute have been keeping their ears to the water listening for golden perch in the Loddon River and Pyramid Creek.

In October 2017, coordinated environmental flows were delivered to the Loddon River and Pyramid Creek to promote migration of Murray cod, silver perch and golden perch.

Before delivery of these flows, 69 golden perch were captured, implanted with acoustic tags and released back to the waterways to be tracked so that performance of the environmental flows could be assessed.

Arthur Rylah Institute scientist Matthew Jones said the fish are implanted with an acoustic tag that allows remote tracking of fish for research.

"The tag is a sound-emitting device that is harmless to fish.

"They are linked with acoustic receivers placed in the waterway, allowing us to track the position of fish and determine which way and how far fish are moving when environmental flows are delivered."

Many of the tagged golden perch responded by moving upstream in the Loddon River and Pyramid Creek when the environmental flow was delivered. One fish moved over 140 kilometres from the River Murray junction and into Kow Swamp. Nearly 40 percent of the fish moved at least 40 kilometres upstream, while about 60 percent remained close to the local area where they were tagged.



"It is an advantage that not all golden perch follow the same movement patterns," explained Matthew.

"It means they can avoid localised catastrophic events and have opportunities to exploit resources in new areas. All of these factors combined increase survival rates and the overall health of the population."

Waterway manager:
North Central CMA

Storage manager:
Goulburn-Murray Water

Site	Volume delivered in 2017-18 (ML)		
	VEWH	CEWH	Total
Loddon River and Tullaroop Creek	10,958	3,054	14,012
Serpentine Creek	3,497	-	3,497
Pyramid Creek	861	-	861
Little Lake Meran	499	-	499

Above: Justin O'Connor from the Arthur Rylah Institute releasing a golden perch into the Loddon River at Benjeroop, by Matthew Jones, Arthur Rylah Institute
Right: Loddon River, by Zarleen Blakeley, VEWH



Northern

Ovens system

The Ovens River system is home to several threatened and endangered native fish species, and environmental watering over 2017-18 provided a small amount of water that went a long way.



In autumn 2018, North East CMA worked with the Commonwealth Environmental Water Holder and Goulburn-Murray Water to deliver 73 megalitres of water for the environment from Lake Buffalo to the Buffalo River. Additionally, 50 megalitres of water for the environment was provided from Lake William Hovell to the King River. The environmental flows aimed to freshen water quality and provide variability in river height following a weekend rain event.

The Ovens system supports many native fish species including the Murray cod, trout cod, golden perch and fly-specked hardyhead. The Buffalo River is important for large fish species during part of their breeding cycle, while trout cod are found as far up the King River as Whitfield. The Ovens system has seen a successful recovery project for trout cod, and efforts to reintroduce Macquarie perch are underway.

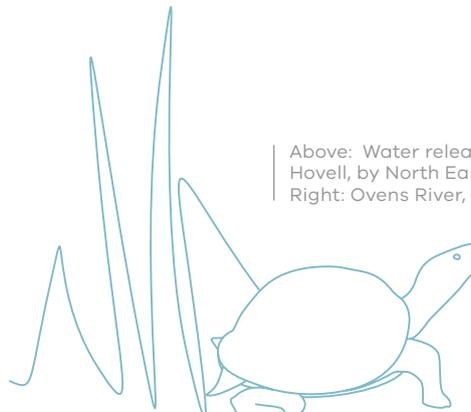
Even a small increase in river height can help fish and other aquatic animals find new food sources. Flows below Lake Buffalo and Lake William Hovell had been steady and low at the time, making this small release of environmental flows all the more important.

Waterway manager:
North East CMA

Storage manager:
Goulburn- Murray Water

Site	Volume delivered in 2017-18 (ML)
Ovens River	73 (CEWH)
King River	50 (CEWH)

Above: Water released from Lake William Hovell, by North East CMA
Right: Ovens River, by North East CMA





* Living Murray icon sites benefit from 10 years of water for the environment

Celebrating its 10th anniversary last year, the Living Murray program is one of Australia's most significant long-term river restoration projects.

The program uses water for the environment to improve the health of the River Murray Channel, significant floodplain sites along the river, and the wetland/estuary system near the Murray Mouth. Each targeted area is called an 'icon site' and four of these icon sites are in Victoria: Barmah Forest, Gunbower Forest, Hattah Lakes, and the Lindsay, Mulcra and Wallpolla islands.

The program started in the middle of the Millennium Drought, when all the sites were showing visible signs of stress or ill health. Trees such as river red gums and black box were in poor condition, and there were low numbers of native fish, waterbirds and other animals such as frogs and turtles using the sites.

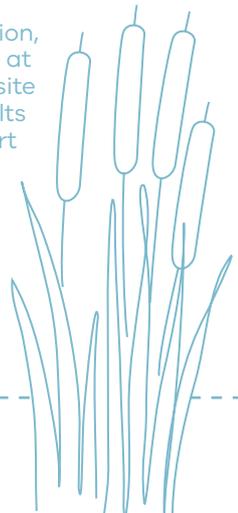
Management plans were developed for all icon sites at the start of the program. These plans described environmental objectives and the water regimes needed to achieve those objectives. The required water regimes have been met to varying degrees at each icon site over the last 10 years through a combination of natural floods and managed use of water for the environment.

New water delivery infrastructure built in 2013-14 and 2014-15 gave waterway managers more control over where and when water for the environment could be delivered. This infrastructure significantly improved the environmental outcomes that could be achieved at Gunbower Forest, Hattah Lakes, Lindsay and Mulcra Island and the Chowilla Floodplain. Barmah Forest and the Lower Lakes and Coorong already had good infrastructure. Koondrook-Perricoota Forest has new infrastructure, but it cannot be used to full effect yet.



Every year scientists monitor fish, vegetation, waterbirds and other biological indicators at the icon sites to determine how well each site is tracking against its objectives. The results for each indicator are presented in a report card format that would be familiar to any school student.

Top: Reedy Lagoon before watering, September 2017, by North Central CMA
Bottom: Swamp wallaby-grass in Reedy Lagoon after watering, December 2017, by North Central CMA



The table below shows a summary of the overall scores for each icon site over 10 years. Report cards are not currently produced for the River Murray Channel.

	Barmah-Millewa	Gunbower Forest	Koondrook-Perricoota Forest	Hattah Lakes	Lindsay, Mulcra and Wallpolla Islands	Chowilla Floodplain	Lower Lakes, Coorong and Murray Mouth
2016/17	A	B	C	A	B	B	B
2015/16	B	B	D	A	B	C	C
2014/15	B	B	D	A	-	C	B
2013/14	C	B	D	B	C	C	B
2012/13	C	B	D	C	D	C	B
2011/12	C	C	D	B	C	C	B
2010/11	B	B	D	C	C	C	D
2009/10	C	C	D	D	D	C	D
2008/09	D	C	D	D	D	C	D
2007/08	D	D	D	D	D	N/A	D
2006/07	D	-	N/A	-	-	N/A	C
Structures built and operational		Hipwell road 2014	2014/15 (but not able to be used)	2013	Mulcra 2013/14 Lindsay, Wallpolla and Wallawalla	2014/15	

The condition of icon sites that have largely received their recommended watering regime has improved since the Millennium Drought, with most of those sites recording overall scores of A or B over the last three or more years.

The recommended watering regime is yet to be implemented at Koondrook-Perricoota, and has only recently been implemented at Chowilla, and as a result these sites have improved little since the end of the Millennium Drought.

The contrasting results between icon sites demonstrates that the science behind the water for the environment program is sound. Where we can deliver the scientists' recommended water regime we see good outcomes, and where the recommended water regime cannot be delivered the environment suffers.

Northern

Key ecological outcome highlights at Victorian sites include:

Hattah Lakes

Understorey plants

Since condition monitoring started in 2007 and intervention monitoring projects started in 2011-12, 46 rare and threatened plants have been recorded on the Hattah Lakes floodplain. Some of these species (including *Pluchea rubelliflora*) are being recorded for the first time in Victoria, while others are being recorded after a prolonged absence, such as *Sauropus trachyspermus* (also called 'slender spurge') – not recorded in Victoria since 1982. The slender spurge is found in the River Murray floodplain in the Mildura and Hattah Lakes area, typically occurring following substantial floods.

Lindsay, Mulcra and Wallpolla islands

Fish

Twelve native fish have been recorded over the last 10 years, including high numbers of the iconic Murray cod. Although some species have fluctuated depending on water availability in wetlands, there has been a trend of increasing abundance over time for all native species. The last seven years have seen the return of the endangered freshwater catfish in the waterways of the icon site, while Mullaroo Creek is renowned as arguably the best Murray cod habitat in the Murray-Darling Basin.

Barmah Forest

Waterbirds

Water for the environment is used to provide ideal conditions in Barmah Forest for the successful breeding of waterbirds. In 2015-16, seven species of colonial nesting waterbirds raised chicks from 1,900 nests supported by environmental flows, including little pied cormorants, little black cormorants, Australasian darters, royal spoonbills, Australian white ibis, straw-necked ibis and eastern great egrets.

Gunbower Forest

Aquatic plants

In 2017, following a carp elimination trial, vast swards of river swamp wallaby-grass (listed in the *Environment Protection and Biodiversity Conservation Act*) have sprouted up in Reedy Lagoon. River swamp wallaby-grass had been observed in previous years that Reedy Lagoon was watered, but the coverage in 2017 was prolific. Another highlight has been the recovery of the aquatic and semi-aquatic understorey, found in areas where there was previously bare ground during the Millennium Drought.

The *Icon site condition: The Living Murray* report was released by the Murray-Darling Basin Authority in May 2018.

For more information:

Living Murray icon site condition report: www.mdba.gov.au/publications/mdba-reports/living-murray-icon-site-condition-report

Living Murray program: www.mdba.gov.au/managing-water/environmental-water/delivering-environmental-water/living-murray-program



Above: Royal spoonbill chicks at Boals, December 2016, by Keith Ward, Goulburn Broken CMA
Right: Blue pimperl (Anagallis arvensis caerulea), Hattah Lakes, by Mallee CMA



Northern

Hattah Lakes

More than 140 species of native plants and a declining black box tree population are getting a much needed drink thanks to the largest-ever delivery of water for the environment at Hattah Lakes.



Floods in 2016 provided a boost, however increased plant growth associated with floods can be short-lived without watering the next year. Over 110,000 megalitres of water for the environment was delivered between July and October 2017. This helped black box trees to germinate, grow and recover.

The method of watering was very efficient. Over 90 percent of the water was from return flows – that is, environmental flows first delivered to upstream sites like the Goulburn River, which continue flowing down the Murray and can be used again at Hattah Lakes. Additionally, nearly half of the flows delivered to the Hattah Lakes were returned to the River Murray and continued to provide environmental benefits in the lower Lakes of South Australia! A real win for all.

The Hattah Lakes and floodplains were inundated for four consecutive months, providing perfect conditions for the recovery of black box trees that had not been flooded since the 1990s. Flows were also timed to ensure the National Park was ready for visitors during the peak tourist period, ensuring access tracks were clear of water and that people could enjoy the benefits created by environmental watering.

Research into the health of the Hattah Lakes is already demonstrating that these environmental flows are achieving their intended outcomes. In 2009, only 19 percent of black box trees at Hattah Lakes were healthy, compared to 61 percent by 2017.

Prior to 2016, it was thought that as few as 500 threatened regent parrots were still living in the Hattah-Kulkyne region. In 2016 there were 1600 regent parrots sighted in just two hours. Regular environmental watering has helped the regent parrot find a new lease on life.

Meanwhile, monitoring has also shown that Hattah is supporting an increased number of native, rare and threatened plants. Environmental watering is delivering results in this place that is highly valued by visitors and locals alike.

Waterway manager:
Mallee CMA

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

Site	Volume delivered in 2017–18 (ML)			
	VEWH	MDBA	CEWH	Total
Hattah Lakes	6,958	72,830	32,145	111,933

Above: Regent parrot at Hattah Lakes, by Mallee CMA

Lindsay, Mulcra and Walpolla Islands

Environmental flows in the Murraro Creek and Lindsay River are helping Murray cod to recover after tragic events in 2016.



Before and during floods in 2016, Murray cod were recorded leaving the system and moving downstream towards South Australia. Sadly, many fish also died in a natural hypoxic blackwater event that followed the floods. Hypoxic blackwater can occur after floods when high loads of leaf litter and vegetation from the floodplain breaks down, depletes oxygen in the water, and suffocates fish.

Brad Hollis at the Mallee Catchment Management Authority explained that native fish are re-establishing following the floods.

"This year, a radio tracking study found that many tagged adult Murray cod have returned to the Lindsay-Mullaroo system. Juvenile Murray cod are also back in Mullaroo Creek, which means that they've been successfully breeding in recent years."

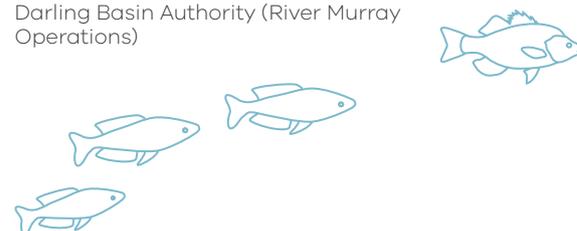
Environmental flows in Lindsay River also provided additional environmental watering opportunities at Lake Wallawalla, an important floodplain wetland adjacent to the river. The lake provides regionally important habitat for plants and animals and acts as a refuge in dry years.

"Depending on the height of the weir pool at Lock 7 in the River Murray, flows are delivered to Lindsay River at varying flow rates," Brad said.

"Weir pool raising in spring 2017, which was specifically for environmental objectives in the Lock 7 weir pool, increased flows in the upper Lindsay River, allowing us to deliver 8,000 megalitres of water for the environment to Lake Wallawalla. This provided habitat for threatened freckled ducks and other waterbirds."

Waterway manager:
Mallee CMA

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



Site		Volume delivered in 2017-18 (ML)			
		VEWH	CEWH	Other	Total
Lindsay Island	Lindsay River, Mullaroo Creek, Lock 7 weir pool	-	784	758	1,542
	Lake Wallawalla	8,001	-	-	8001
Mulcra Island	Potterwalkagee Creek and the Lock 8 weir pool			1,095	1,095
Wallpolla Island	Wallpolla East	1,000			1,000
	Horseshoe Lagoon	399			399
	Sandy Creek	232			232

| Above: Ngina it elder participating in a fishing event at Mullaroo Creek, by Mallee CMA

Northern

Gunbower Forest

Plants and animals in Black Swamp and Reedy Lagoon are thriving, due to a creative combination of management strategies adopted by Barapa Barapa Traditional Owners and North Central CMA.



Reedy Lagoon and Black Swamp are of particular cultural importance to Barapa people, who identified a need for an environmental flow in spring 2017 to support native vegetation and waterbirds – an assessment supported by the waterway managers at the CMA.

However, there was one big problem – water that had remained in the wetlands following the 2016 floods were full of carp. The carp were damaging wetland vegetation and stirring up sediment, causing high turbidity, and as most of them were mature adults ready to spawn, any new water would only boost their numbers.

To solve this challenge, the Barapa Barapa custodians and CMA staff hit on a novel solution. Firstly, they pumped the existing water out, and then Barapa Barapa and CMA staff manually removed the carp – all 600 kilograms of them – so that the water for the environment could be delivered once the carp were gone.

Additionally, Barapa Barapa monitored the pumping to ensure there were no impacts to cultural heritage.

The results of these complementary measures have been fantastic. According to North Central CMA's Sophia Piscitelli, "Water quality is

exceptionally clear in Reedy Lagoon and relatively good in Black Swamp too. This is most likely to be due to low numbers of carp, as larger carp can re-suspend sediment and pull out aquatic plants through their characteristic 'mumbling' feeding behaviour. The residual pools were extremely turbid before they were drawn down for the carp removal project, and now it is much clearer, especially in Reedy Lagoon. It's fantastic to see positive outcomes for the wetlands after all our work over the past few months."

"Wetland plants in Reedy Lagoon have been absolutely thriving since water for the environment was delivered in October 2017," Sophia said.

"Early results from our summer vegetation monitoring show a dense

cover of river swamp wallaby-grass (*Amphibromus fluitans*) in the shallower parts of Reedy Lagoon, which is listed as vulnerable under Federal environmental legislation."

The success of this program highlights how a successful partnership between Traditional Owners and catchment managers can result not just in benefits for communities, but also assist species and ecosystems in ways that far exceed what could be achieved by environmental flows alone.

Waterway manager:
North Central CMA

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

Site	Volume delivered in 2017–18 (ML)			
	VEWH	MDBA	CEWH	Total
Gunbower Forest	9,579	808	-	10,387
Gunbower Creek	-	-	20,656	20,656

Above: Sharnie Hamilton (Barapa Barapa) and CMA staff muddy from pumping Reedy Lagoon and Black Swamp, by North Central CMA

Barmah Forest

A trial exclusion of feral horses and pigs is having a great benefit for some of the vulnerable vegetation that makes Barmah Forest so special and internationally recognised as a highly significant environment.



In autumn 2017, a horse and pig-proof fence was erected in Little Rushy Swamp to protect 10 hectares of vegetation from over-grazing. The effects were remarkable. When environmental flows were delivered to Barmah Forest the following spring, Moira grass and river swamp wallaby-grass within the fenced-off area flourished.

Keith Ward at Goulburn-Broken CMA said that the pictures tell a thousand words. "From the photographs taken over 12 months, it is really clear that threatened Moira grass and river swamp wallaby-grass has flourished with less competition by introduced grazing animals. With the exclusion of the grazers, this trial helps us to better understand the optimal timing and duration of flows that we need to provide to benefit Moira grass across the whole forest".

While the fencing excluded grazing by introduced animals at Little Rushy Swamp, in another unfenced part of Barmah Forest the impact of feral pigs was severe. Over one hundred pairs of ibis had laid eggs and were busy fussing over their nests when feral pigs came through and destroyed the colony. Motion-activated cameras captured the moment the pigs



ate the eggs, resulting in the adult birds abandoning the colony and a generation of young birds lost.

The information captured from this event was used in real-time to end the delivery of environmental flows to the wetland early – no longer necessary after the birds abandoned their nests. It will also help managers adapt future delivery of water for the environment, for example by increasing the water height in future years to deter pigs and protect the birds.

These events highlight how other environmental management actions, such as fencing and pest animal control, can complement the delivery of water for the environment, resulting in greater benefits for native species and ecosystems.

Waterway manager:
Goulburn Broken CMA

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

Site	Volume delivered in 2017–18 (ML)				
	VEWH	MDBA	CEWH	Other	Total
Barmah Forest floodplain	17,720	27,834	140,547	247,457	433,558
Boals Deadwood	3,014	-	-	-	3,014
Top Island	967	-	-	-	967

Above left: Little Rushy Swamp, by Goulburn Broken CMA
Bottom sequence: Ibis nests attacked by feral pigs, captured on motion-activated cameras, by Goulburn Broken CMA

community highlights

* Aboriginal engagement at Hattah

The Mallee Aboriginal Reference Group (ARG) visited Hattah-Kulkyne National Park to see firsthand how water for the environment projects have improved the landscape – in particular, the health of the Hattah Lakes and floodplain.

Just over 100 years ago, the River Murray was changed forever. Instead of water flowing across the landscape naturally, it was captured in storages by dams and weirs, diverted by pipelines, levees and constructed channels, and used for towns, industry and farming. As a result, big floods became less frequent, and the health of the river and the wetlands, floodplains and lakes that relied on the river suffered. Environmental watering projects are helping mimic more traditional water flows, bringing new life and hope to unique sites in the Mallee, such as Hattah Lakes.

The focus of this on-Country day was to demonstrate the difference between areas receiving environmental water, compared to those which aren't. Thanks to a series of pumps and weirs installed in 2012 as part of the first stage of the Hattah project, large areas of the Hattah-Kulkyne National Park are receiving water, and the group

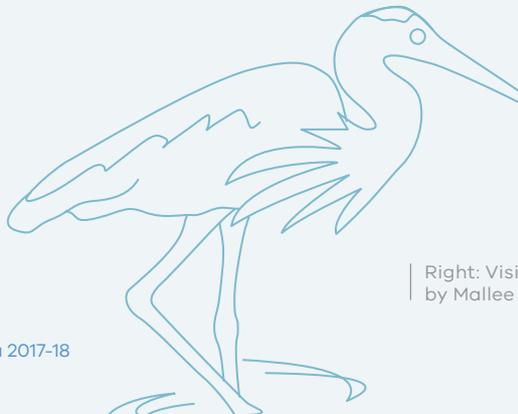
spent the day exploring these lakes, which are brimming with wildlife and fresh growth, before moving on to visit a dry area.

Everyone was stunned by the difference. The ARG members described the un-watered areas as being like a 'fire and brimstone landscape'.

"We ended up on the banks of a dry lake in the far north of the national park, and here we really saw what happens to our land when it's not cared for; all the water plants are gone, replaced with salt bush and other dryland plants. The banks are lined with trees only just clinging to life. There are no birds and a light salt crust has formed on the bottom of the lake."

The group participated in a plant survey and were delighted to see that native plants are returning to areas getting water, including 'old man weed' and 'broom brush'. ARG members were able to share the importance of these plants, once used for medicinal purposes and to keep their elders' camps clean.

The experience and knowledge-sharing between the ARG and Mallee CMA staff will be invaluable for future water for the environment projects, as the ARG provides guidance to the CMA on Aboriginal community engagement and input into Mallee CMA initiatives and regional plans.



Right: Visiting Hattah Lakes,
by Mallee CMA

