



Australian Government
Commonwealth Environmental Water Holder



Monitoring
Evaluation
Research

Celebrating 10 years of the Commonwealth
Environmental Water Holder's science program:

Flow-MER





Acknowledgement of Country

The Flow-MER Program team acknowledges the First Nations communities of the Murray–Darling Basin and pays respect to Elders past and present. We acknowledge First Nations people as the Traditional Owners of the land, water and sky Country across the Basin and value the expertise, wisdom and enduring connections that have informed their care for Country over millennia. We recognise the intrinsic connection of First Nations people to Country, and we value the enduring cultural, social, environmental, spiritual, and economic connection to the rivers, wetlands, and floodplains of the Basin. We are committed to working with First Nations people across the Murray–Darling Basin to build relationships in a meaningful and genuine way to support and empower them in reaching their aspirations.

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COVER PHOTO:
Narran Lakes during an Australian Pelican breeding event, March 2023.
Photo credit: Shot by Harro, University of New South Wales.

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Foreword

Looking back on a decade of environmental water management in the Murray–Darling Basin, I’m struck by both the scale of what we’ve achieved and the strength of the science that has guided us every step of the way.

This booklet captures that journey. It reflects the progress, partnerships, and knowledge built through Flow-MER – the Basin’s largest and longest-running environmental water science program. But to truly understand how far we’ve come, you have to go back further.

Fifteen years ago, Flow-MER began as a bold vision—an ambitious idea to pair water delivery with rigorous science so that every drop of environmental water could do the most good. In those early days, it wasn’t just about launching a program—it was about laying a foundation. One built by pioneers: scientists, river managers, and community leaders who recognised the urgent need to act and who helped shape how we manage water for the environment today.

Their legacy endures in how we adapt and make decisions. It’s visible in the way we target flows, measure outcomes, and stay accountable to the ecosystems and communities that depend on us. Thanks to them, Flow-MER is more than a research initiative—it’s the backbone of how we manage Commonwealth water for the environment. It helps us decide when, where and how to act to support the health of rivers, wetlands, floodplains, and the species that live there.

During the past 10 years alone, we’ve delivered more than 18,000 gigalitres of Commonwealth environmental water to 56 different ecosystem types.

Those numbers speak to real impact: some native fish returning to breed and thrive, waterbirds nesting in greater numbers, and species like the southern bell frog reoccupying parts of their former range.

These outcomes aren’t accidental—they are the result of science-informed decision-making, careful monitoring,



Dr Simon Banks
Commonwealth Environmental Water Holder

and enduring partnerships. We’ve seen more than 28,000 kilometres of waterways restored and more than 470,000 hectares of vital habitats (lakes, wetlands, floodplains and estuarine ecosystems) revived. We’ve helped keep 11 Ramsar-listed wetlands resilient and supported threatened species like silver perch, Murray cod, and Murray hardyhead through critical life stages.

Every success is built on evidence. Every action we take is grounded in a clear vision: Healthy rivers for healthy communities—valuing every drop. It’s this vision that continues to drive us as we face the challenges of a changing climate and work toward long-term resilience.

We operate with integrity, transparency, and a focus on results. Flow-MER’s collaborative approach—especially with First Nations peoples—remains central to building a better, more sustainable future.

This book marks an important milestone, but it’s not the end of the story. With continued investment and a clear strategy for the years ahead, we’re better positioned than ever to adapt, lead, and deliver. The Basin is alive, complex, and deeply valued—and thanks to the passionate people behind Flow-MER, it’s in capable hands.

I’m proud to lead this work and proud of the foundations laid 15 years ago. We honour those early visionaries by carrying their legacy forward—ensuring that the rivers, wetlands, wildlife, and communities of the Murray–Darling Basin continue to thrive for generations to come.



About the Program

The Flow-Monitoring, Evaluation and Research (Flow-MER) Program has **enabled greater understanding of how environmental water supports the Basin's water-dependent ecosystems** and has led to more effective delivery of environmental water.

Flow-MER is the Commonwealth Environmental Water Holder's (CEWH's) Science Program to inform adaptive management of Commonwealth environmental water in the Murray–Darling Basin (the Basin). The Flow-MER Program supports the CEWH's work to protect and restore the Basin's water-dependent ecosystems.

The CEWH has invested in science since 2009, working in partnership with scientists, water managers, First Nations peoples and communities across the Basin. It is the largest environmental watering monitoring program across the Basin. Flow-MER's objective is to monitor and evaluate environmental outcomes from the delivery of Commonwealth environmental water in the Basin.

This booklet provides some case studies from the Flow-MER Program that show the importance of Flow-MER information for effective environmental water delivery.

LEFT:

Platypus are regularly spotted along the mid Goulburn River. Photo credit: Ken Mival.

Flow-MER facilitates monitoring, evaluation, research, knowledge exchange and reporting in 10 Areas in the Basin, across 5 Themes:



River Flows & Connectivity



Native Vegetation



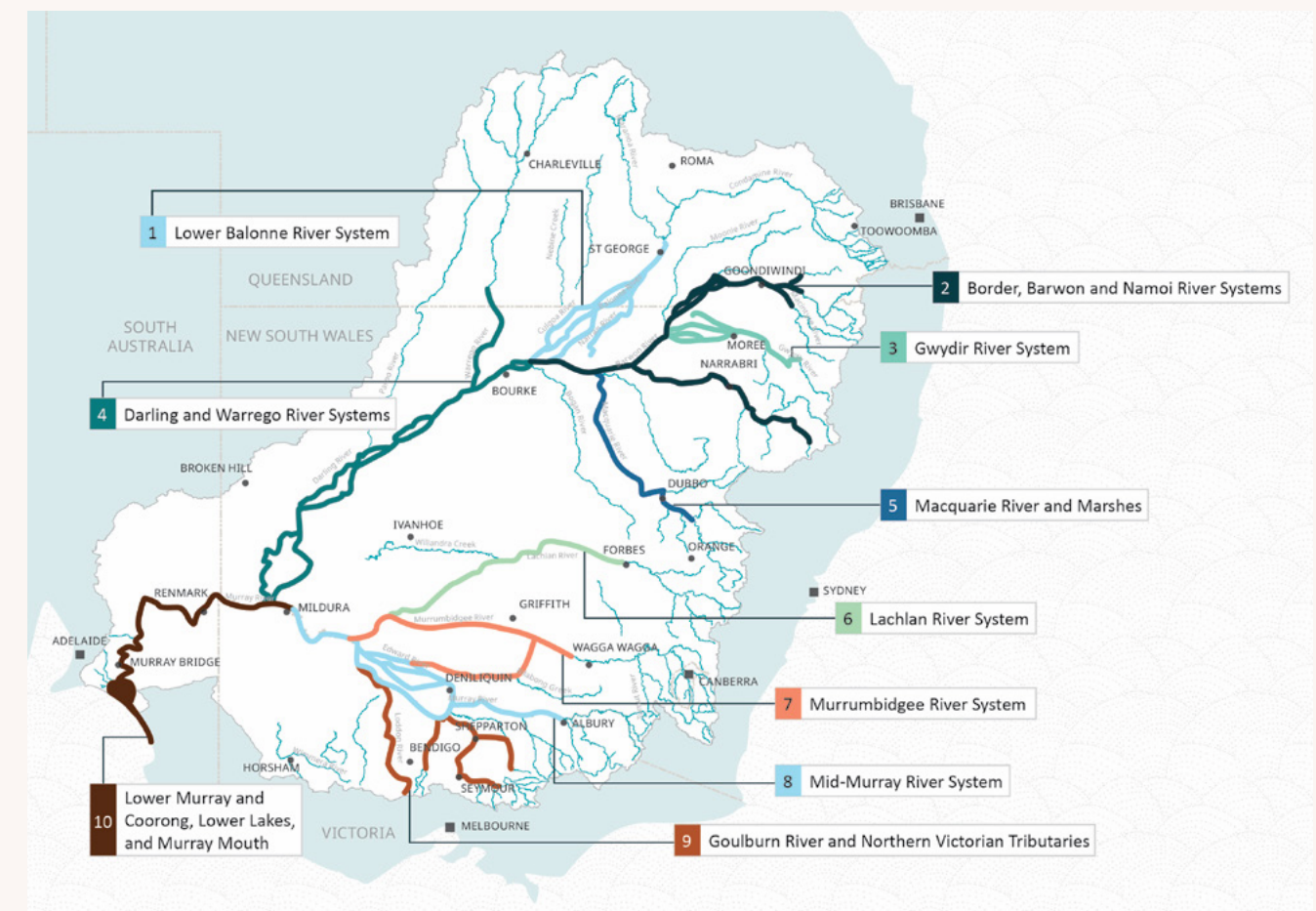
Waterbirds



Native Fish



Cultural Outcomes



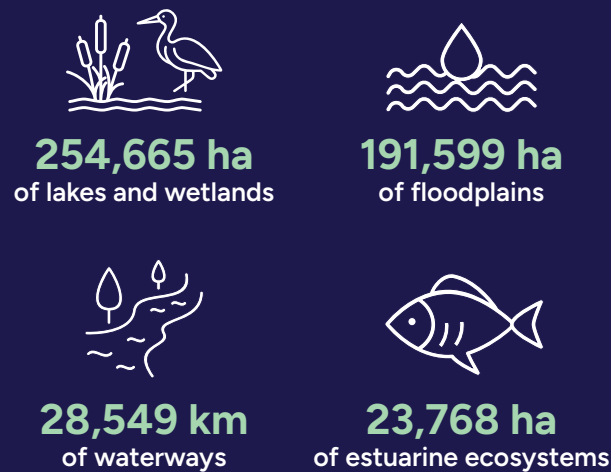
Environmental water in the Basin

Environmental water is water used to keep our rivers, wetlands and floodplains healthy. Water for the environment is not only about the amount of water flowing through a river. It's about the timing of that water flow.

Water for the environment is provided to:

- Change the flow in rivers to signal to native fish that it's a good time to breed or move
- Connect rivers to their floodplains to keep native plants healthy
- Help waterbirds, native fish, frogs and other animals to feed and breed
- Support river connectivity in dry times

Since Commonwealth environmental watering began in 2009, more than 18,000 GL of water for the environment has supported:



Representing 88% of the diversity of aquatic ecosystems types found in the Basin, **56 ecosystem types have been supported.**

Environmental watering has:

- Boosted vegetation diversity and resilience of over 804 taxa** (including 77 culturally significant species and 101 rare or threatened species).
- Helped some native fish populations recover and strengthen.**
Over 15 native fish species have been detected through Flow-MER monitoring, including our iconic species such as Murray cod, golden and silver perch.
- Contributed to the presence of southern bell frogs** (Vulnerable, EPBC Act) and supported habitats for Macquarie turtles and other significant fauna.
- Supported the breeding of 97 waterbird species** (59 of conservation significance).
- Enabled export of an additional 4.4 million tonnes of salt since 2014.**
- Maintained salt export from the Basin and reduced salt import to the Coorong in low flow years**, including providing 80–100% of flows over the barrages.
- Supported 11 of the 16 wetlands of international importance** (Ramsar sites) in the Basin.
- Improved water quality and decreased the likelihood of, and supported recovery from widespread hypoxic** (low oxygen) events across the Basin.

Getting the best possible results out of each drop of water we deliver for the environment is key to our work. This means we must have a philosophy of continually learning and improving our approaches. These learnings, delivered by our science program, are built year-on-year and inform how we manage water for the environment into the future.

CEWH has been investing in science since 2009, including a focus on both local-scale and Basin-wide monitoring, evaluation and research activities.

- Long-Term Intervention Monitoring Project
- Environmental Watering Knowledge and Research Project
- Short-Term Intervention Monitoring Projects
- Flow-MER Program

As a world-leading science-to-policy program, Flow-MER is unique in both its spatial scale and longevity.

In addition, we are increasingly working with First Nations partners to achieve better environmental outcomes together. We have dedicated funding to support research and monitoring activities important to First Nations people.

Flow-MER information plays a key role in informing adaptive management, both in real-time delivery and forward planning. The CEWH uses this knowledge to measure the success of environmental watering. It helps to demonstrate outcomes, tells us what we've achieved and what we could do next time to get the best results for the rivers, wetlands, plants and animals of the Basin.

Flow-MER plays a vital role in meeting reporting obligations under the *Murray–Darling Basin Plan 2012*, ensuring that environmental water outcomes are transparently tracked and evaluated.

Monitoring, evaluation, and research guide environmental water management in multiple ways:

- 1**
Informing annual water delivery
- 2**
Shaping multi-year planning
- 3**
Supporting reporting to assess long-term objectives





Waterbird monitoring guides when and how much water is needed

For almost half a century, waterbird populations across the Basin have been experiencing significant decline.

Environmental water can play a key role in supporting breeding sites with additional flows to extend the availability of habitat for breeding and foraging.

Management of water levels is important for waterbirds. If water levels rise too quickly, nests become flooded. As water levels fall chicks can become vulnerable to predators, food sources start to disappear, and parents may abandon nests.

Scientists worked directly with water managers to ensure that suitable levels of water were maintained during the extensive breeding events in 2022 and 2023 to support species such as Australian ibis, pelicans, spoonbills, cormorants, herons, egrets, and the endangered Australasian bittern at 110 sites across the Basin, including at Gwydir Wetlands, Narran Lakes and Macquarie Marshes (internationally significant Ramsar sites).

The largest number of nests were recorded since monitoring began in 2008 with an estimated 183,000 nests active in the Murrumbidgee Selected Area in the 2022–23 water year. The 2022–23 surveys coincided with the largest flood event recorded.

More than 30,000 pelicans bred at Lake Brewster in NSW in 2022–23, the species' largest breeding event in the Basin in three decades. Pelicans also bred for the first time in more than 20 years at Dharriwaa (Narran Lakes), an internationally significant Ramsar site near Brewarrina in NSW.

Monitoring involved aerial surveys in fixed-wing aircraft, on ground surveys on foot or kayak, intensive on ground monitoring of ibis breeding, and with the use of drone surveys by Flow-MER teams and partner organisations.

Ongoing monitoring allowed real-time information to be provided to water managers to guide water management decisions. This combination of science and water management ensured the chicks had every chance of survival.

FULL PAGE PHOTO:

Commonwealth water for the environment was used in 2023 at Lake Brewster to support the large pelican colonies to finish their breeding cycle which started in 2022.

Photo credit: Mal Carnegie, Lake Cowal Foundation and Environment and Heritage/ NSW Department of Climate Change, Energy, the Environment and Water.

INSET:

An Australian pelican breeding rookery at Narran Lakes in March 2023.

Photo credit: Shot by Harro, University of New South Wales.



View some of the waterbird breeding events between 2021 and 2023.

Threatened species recovery evident for the southern bell frog

Flow-MER has been pivotal in the recovery of the nationally threatened southern bell frogs (*Litoria raniformis*) across the Murrumbidgee, by providing critical science about their environmental water needs, and the effects of environmental watering over the past 10 years.



Since 2014, and with support from environmental water, southern bell frogs have expanded their range across the Lowbidgee Floodplain. Populations are now re-established at key sites in the Western Lakes, Redbank, and Gayini.

Environmental water has been used to maintain refuge habitats during dry periods and promote breeding during wetter years, and the subsequent expansion demonstrates the species' capacity for dispersal and recovery if environmental water is used in the right spots at the right times.

In 2023–24, detections of calling adults, foraging individuals, and tadpoles following environmental water delivery at Bala Swamp marked the strongest population response since monitoring began.

Adult southern bell frogs were detected at seven wetlands in the Lowbidgee Floodplain. Amongst those sites, tadpoles were detected at Bala Swamp, providing strong evidence for the link between the environmental water delivery and successful breeding for southern bell frogs.

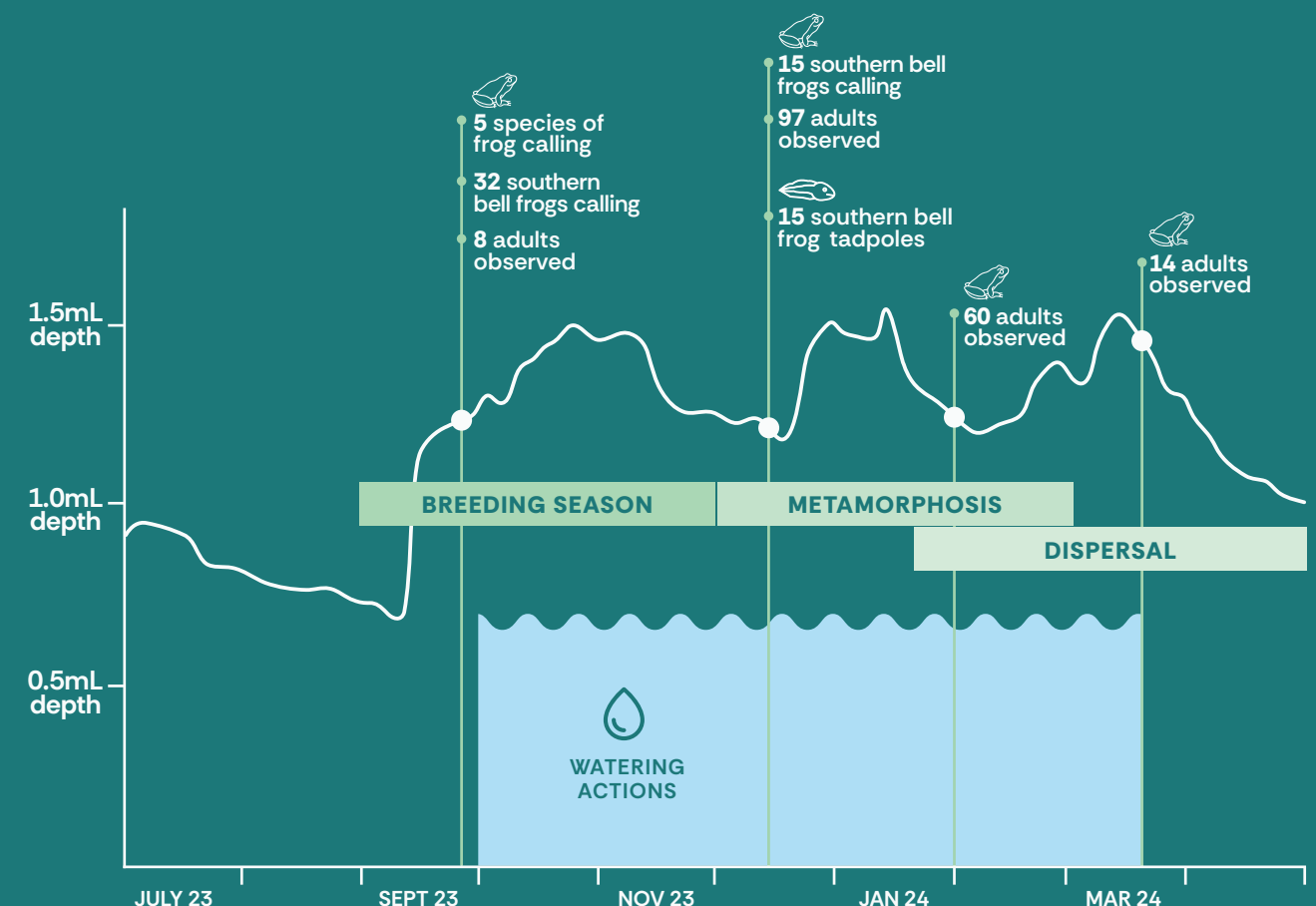
Monitoring demonstrates that sustained environmental watering has contributed to population recovery of the southern bell frog, supported breeding of multiple frog species, and created important refuge habitats that also benefit other fauna such as nationally endangered Australasian bitterns.

ABOVE LEFT:
Southern bell frog (*Litoria raniformis*).
Photo credit: Emmalie Sanders.

ABOVE RIGHT:
Monitoring tadpoles and wetland fish in the Murrumbidgee.
Photo credit: Emmalie Sanders.



Watering actions were delivered to Bala Swamp over the 2023–24 water year and created a breeding opportunity for southern bell frogs. This regime supported the tadpoles' metamorphosis and dispersal.





Environmental water in action: salt, science and system health

Salt is a natural part of the Murray–Darling Basin, but without regular flows through the end of the system, it accumulates and poses serious risk to ecosystems, industries and communities. Environmental watering guided by Flow-MER science has helped reduce the impacts of increased salinity and helped safeguard the Basin’s vital end-of-system ecosystems.

Since 2014, Commonwealth environmental water has enabled the export of 4.4 million tonnes of salt through the Murray Mouth and helped prevent the import of 28 million tonnes of salt into the Coorong by pushing back encroaching seawater. **In the Coorong, between 2014 and 2021, Commonwealth water for the environment accounted for 100 per cent of flows through the barrages in 3 out of 7 years, and ensured that 2-year minimum flows did not fall below 600 GL.**

Monitoring has shown that these flows are critical for maintaining healthy salinity levels, especially in the Coorong’s North Lagoon. **Between 2017 and 2021, environmental water slowed salinity increases during dry periods, avoiding an estimated spike to 180 g/L – nearly five times saltier than seawater – which would have occurred without these managed flows. Instead, salinity peaked at 120 g/L, already a challenge for wildlife but significantly less extreme due to environmental watering.**

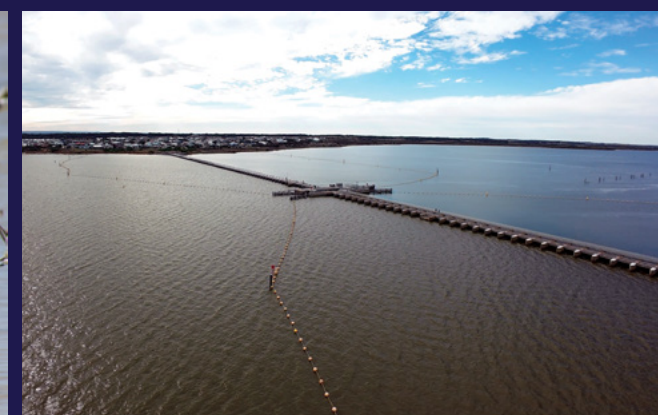
By reducing salinity and supporting more stable conditions, Commonwealth environmental water has helped maintain critical habitat for a range of species in the Coorong. For example, between 2017–18 and 2022–23, modelling shows that without

environmental water, the system would have lost 34% of suitable habitat for mullet, 16% for smallmouth hardyhead, and 53% for black bream – three key estuarine fish species. The benefits extend to plant life too. Without environmental flows, suitable habitat for the reproduction of *Ruppia tuberosa*, an important aquatic plant, would have declined by 48% between 2018 and 2022. These figures highlight the vital role of environmental water in sustaining the Coorong’s ecological resilience during dry periods.

Long-term monitoring and modelling through Flow-MER have provided clear evidence that environmental water is safeguarding the ecological integrity of the Coorong. By preventing extreme salinity and supporting habitat for fish and aquatic plants, Commonwealth environmental water is helping to keep one of Australia’s most iconic and vulnerable wetland systems alive. As the climate becomes drier, this work is not just important – it is essential.

OPPOSITE PAGE:

Connections between natural and human made landscapes in the Coorong, Lower Lakes and Murray Mouth region. Photo credits: Goyder Institute for Water Research.



Growth of bank vegetation following the delivery of environmental water.
Photo credit: Dan Lovell, Goulburn Broken Catchment Management Authority.



Improving operating rules for water management in the Basin

Flow-MER monitoring and research has been used to inform policy and has played a critical role in the review and amendment of operating rules for the lower Goulburn River.

The environment of the Lower Goulburn River has been adversely impacted by inter-valley transfer (IVT) operating rules. IVTs in the Goulburn River can significantly exceed the environmental flow recommendations for summer and early autumn, damaging bank vegetation and eroding riverbanks.

Informed by expertise and evidence from Flow-MER and complementary monitoring programs, the Victorian government developed new operating rules that limit the daily and total volumes of IVTs that can be released.

The rules minimise environmental damage by setting limits on the maximum volume of regulated water that can be delivered through the lower Goulburn River to the Murray River during summer and autumn.

Flow-MER science has been instrumental to informing this policy change. As the new rules are applied in coming years, monitoring will be crucial to evaluating the effectiveness of these changes, to maximise the vegetation, habitat and bank stability outcomes being achieved by environmental water.

Delivering variable flows of environmental water in the lower Goulburn River supports outcomes such as vegetation growth and recovery, fish movement and platypus nesting.



Juvenile Golden perch.
Photo credit: Greg Ringwood.



Using science to increase fish spawning

Improving native fish populations is crucial in restoring the overall health of the Murray–Darling Basin.

Many of the critical life-history processes for fish (pre-spawning condition and maturation, spawning cues and movements, larval and juvenile dispersal, growth and survival) are linked either directly or indirectly to the flow regime.

Environmental water provided at the right time, in the right amount, and for the appropriate duration has supported the resilience of native fish populations.

Long-term monitoring through Flow-MER shows that environmental water has contributed to increased fish spawning, recruitment, population growth, frequency of occurrence, body condition, and improved community composition for several native species over the past decade including the Murray cod, golden perch and the nationally vulnerable Murray hardyhead.

This knowledge has enabled water managers to plan and coordinate environmental flows more effectively, delivering high flows during spawning (spring) and restoring hydrological connectivity.

Coordinating delivery to coincide with golden perch spawning

Coordinated, evidence-based watering has led to multiple successful golden perch recruitment events across the southern Murray–Darling Basin in recent years.

Golden perch can use hundreds of kilometres of connected flowing river for their spawning migrations and spawning often coincides with increased flow during spring and summer. Environmental water helped maintain their habitat by providing connected flow events across multiple rivers (Goulburn, Murrumbidgee, Murray) at critical times.

Monitoring supported real-time decision making to extend the duration of these events and maximise the chance of recruitment success. Water managers, scientists and river operators worked together to identify and respond to this demand in an extremely short timeframe.

Flow-MER research demonstrated that environmental water supported critical life-history processes of golden perch, including spawning, body condition and population growth. Between 2014 and 2024, spawning of golden perch increased with delivery of Commonwealth environmental water.



Using drones to monitor vegetation across the Basin

The Flow-MER Program uses the latest science and is an active contributor to developing effective monitoring and evaluation tools and techniques, for the benefit of the broader scientific community.

Activities funded under the Flow-MER Program have directly led to the development of a new method to monitor the response of aquatic plants to environmental water.

The Flow-MER team working in the Lachlan developed a drone-based approach to monitor the reedbed of the Great Cumbung Swamp from 2019–2022. Previous monitoring of reedbeds was undertaken using traditional field-based methods and remote sensing.

Drones were used to efficiently collect imagery and a deep-machine learning method was used to process, recognise and estimate the cover. Using cutting-edge technology has improved

the ability to access sites and collect high-quality data. It provides a highly accurate and standardised method for evaluating the response of key vegetation communities to the provision of environmental water.

The drone-based approach developed in the Lachlan is now being used widely within the Flow-MER Program and has been adopted by other Commonwealth and State monitoring and evaluation programs, including The Living Murray.

Nine years of reedbed monitoring in the Lachlan valley previous to drone monitoring showed that wetlands (such as the Great Cumbung Swamp) that have regularly received Commonwealth environmental water are the most species rich for native vegetation. These sites are also in a more resilient condition.

Inundation of the reedbed of the Great Cumbung Swamp with environmental water in March 2021 (Lachlan River in the background).
Photo credit: Alica Tschierschke, University of Canberra.



First Nations knowledges and science in environmental water management

Diverse knowledges are critical for improving environmental water management.

Flow-MER is building long-term partnerships, recognising, valuing and protecting First Nations people’s knowledges across the Basin and working together on environmental water monitoring, evaluation and research.

In 2021, Cultural Advisors were engaged to provide Indigenous leadership in monitoring, evaluation and research in some Areas of the Flow-MER Program, and now every project area has Cultural Advisors to build connections between the Program and First Nations people.

Cultural Advisors provide Indigenous leadership and support Area-scale Projects’ engagement to understand how First Nations people would like to be involved in the Program and if they would like to share their knowledges and science as part of the Program.

To further strengthen First Nations knowledge and science in the Program a Cultural Outcomes Theme

was introduced in 2024. For the Flow-MER Program, a cultural outcome from environmental watering is a specific cultural value that First Nations people have identified as being influenced through the delivery of environmental water. Cultural outcomes can be living things, special places or important activities.

Cultural Advisors come together to connect, share knowledge, and influence the Program through the Cultural Network. The Cultural Network is part of the Program governance along with other working groups.

In 2025, On-Country Cultural Network meetings were held in Armidale and Mildura to reflect on the positive collaborations formed, and the importance of bringing everyone together to consider continuous improvements for the Program and to get the best environmental outcomes for Country.

ABOVE: Flow-MER’s in-person Cultural Network meeting in Mildura, connecting Area-scale project teams in the Southern Basin. Photo credit: Amanda Shipp, Alluvium.

OPPOSITE PAGE: Flow-MER’s in-person Cultural Network meeting in Armidale, connecting Area-scale project teams in the Northern Basin. Photo credit: Amanda Shipp, Alluvium.



Reflections from Uncle Kevin Knight
Cultural Advisor, Darling–Warrego team

**“Without the Baaka,
there is no Barkindji.”**

To be a part of the Flow-MER Program is more than an opportunity, it is a privilege. It means that people are there for the right reasons: to listen, to learn, and to walk alongside community with respect. Too often, people seek knowledge, especially cultural knowledge, without building the trust needed to truly walk together. Culture comes from the Elders, and should be respected.

Out on Country, we’re seeing heartbreaking changes. Totem species like the brolga and eagle hawk are struggling without the environments they need to thrive. Bush foods, once abundant across the landscape (pigweed, bush tomato, quandong, bush banana, wild orange and Gruie) are becoming harder to find.

The big catfish that once filled the waters are now small and scarce. But through trapping, monitoring and research, combining both western and First Nations sciences and knowledge, there’s hope.

With the use of cameras and environmental monitoring, possible solutions are emerging. The return of the big catfish would mean more than just food; it would mean cultural healing and a great Cultural outcome.

“Getting back on Country is more than a return, it’s an obligation. Caring for scar trees, protecting cultural artefacts, and reviving traditional practices is vital. Because for the Barkindji people, Baaka isn’t just a river. It’s identity. It’s Lore. It’s life.”

Baaka (Darling River) near the confluence with the Warriku (Warrego River) in January 2025.
Photo credit: University of New England

The investment in Flow-MER has been essential to demonstrating outcomes from environmental water use, informing ongoing adaptive management of water for the environment, and helping meet legislative reporting requirements.



The largest environmental water monitoring program across the Basin.



150 partners, including 9 principal partners (7 universities, CSIRO and One Basin Cooperative Research Centre).



Supports employment of more than 200 scientists across the Basin.



Outcomes have been presented at 27+ international scientific symposia, showcasing Flow-MER as a world leading science to policy program.



Outcomes have been **presented at 80+ science webinars and forum presentations**.



Flow-MER outcomes have been **published in 100+ leading peer reviewed journals**.



Flow-MER has trained some of the next generation of Basin scientists, **supporting > 80 early-career researchers** over the past 10 years.



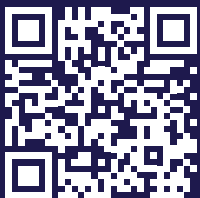
A strong community of practice, underpinned by collaboration and trust.



Thanks to all our
Program partners,
listed on the website:
flow-mer.org.au

Flow-MER continues to build on the legacy it has created.

Monitoring, evaluation and research activities have been expanded to new areas and there is an increased focus on First Nations knowledges and science, along with knowledge exchange, communication and engagement.



See more information
and updates on the
Flow-MER website:
flow-mer.org.au