



Reflections

**Water for the Environment
in Victoria 2022-23**

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Water for the Environment in Victoria 2022-23

Reflections highlights actions in 2022-23 by the Victorian Environmental Water Holder (VEWH) and our partners to support the health of waterways, landscapes and communities through the Victorian environmental watering program.

Partners who work with us to put the program into action include waterway managers in nine catchment management authorities (CMA) and Melbourne Water, other environmental water holders, storage managers, land managers, Traditional Owners, and scientists. Our stakeholders are those organisations and people with an interest in the environmental watering program.

Water held for the environment in storages helps to support our rivers and wetlands since natural flows were changed through the introduction of dams, weirs, channels and other infrastructure in many river systems to support important human needs.

Water for the environment looks to provide outcomes such as:

- cueing fish migration and breeding
- improving water quality
- improving the condition of floodplain trees
- triggering the growth of wetland plants, and
- providing feeding and nesting habitats for waterbirds.

Management of water for the environment aims to build resilience and halt declines in species as the climate changes. Each year watering actions are managed in response to

seasonal conditions, including responding to natural events, such as the 2022 floods.

Waterway managers plan with Traditional Owners, stakeholders and communities to enhance shared benefits when environmental flows are delivered, including for Traditional Owner cultural values, recreation and social values and community wellbeing.

Photo: Glenelg River at Harrow, supplied by Glenelg Hopkins CMA



Our reflections on 2022-23

The flooding events that spanned almost the entire state of Victoria in late 2022 were felt well into 2023 and still leave people impacted today in some parts of the state. But even when it's wet, water for the environment can be used to meet environmental objectives.

Across much of 2022-23 program managers moved to adapt to unexpected effects of large scale flooding across Victoria. The culmination of three back-to-back La Niña events and several years of wetter-than-average conditions peaked with record-breaking floods in some regions later in 2022.

The record-breaking rainfall during spring 2022 caused the biggest flood in recent history in the northern region of Victoria, with all major water storages filling and spilling. In large parts of the Gippsland region, wet conditions continued for the third consecutive year, even though floods there were not as big as two years ago.

In central Victoria many areas of greater Melbourne experienced their highest October rainfall, either on record or in the last 20 years, although summer and autumn were drier than the long-term average. For the western region, there were exceptionally wet months between September and December, followed by drier than average conditions in autumn.

Environmental water managers stood back through spring, stopping watering actions that had started, while prevailing wet conditions replaced planned watering and produced results the program continues to assess.

Emergency efforts

Small volumes of water were delivered to parts of rivers in northern Victoria experiencing hypoxic blackwater, in the hope that fish could find refuge in distinct areas of better-quality water while the blackwater event passed through.

Waterway managers' actions like emergency efforts to salvage native fish, pre-emptive deliveries of environmental water from irrigation outfalls to create fish refuges, and close monitoring of dissolved oxygen levels may have helped prevent more fish deaths.

After the floods water managers were assessing the outcomes, learning from what was happening on the ground, and focusing on the best combination of environmental watering actions to be delivered for changed conditions.

Blackwater had a major impact on current fish populations and there was a proliferation of carp following the floods. Waterway managers and environmental water holders had to determine where environmental flows were needed to support waterbird breeding and fish spawning and migration, and where to hold off flows to minimise the risk of further increasing carp populations.

Helping waterbirds breed and feed

Normal summer and autumn environmental flows were delivered in many rivers after the floods had peaked. Fairly dry conditions had returned, dams had stopped spilling and harvesting from major rivers was back to normal. Most wetlands were still holding water so there was generally no planned floodplain watering through autumn.

When waterbirds breed after natural floods it's vital to give them every chance of success for their hatchlings to reach maturity. Extra water was delivered in February and March to some wetlands where floods had triggered breeding later than usual, so that birds had water for food, nesting sites, and protection from predators for their chicks to fledge and become independent.

Waterbird breeding responds well to large natural floods, but there must also be enough food in subsequent years to enable them to survive to breeding age. Maintaining adequate foraging habitat near key waterbird nesting areas will be a priority for environmental water managers in 2023-24.

The next important stage after flooding is deliberately letting wetlands dry out for the next year. Shallow margins of drying wetlands provide abundant foraging habitat for wading waterbirds and the muddy bases of drying wetlands are rapidly colonised by lakebed herbland plant communities. A range of broad-leaved herbs, grasses, sedges, rushes and shrubs have adapted to survive under both wet and dry conditions and flourish as wetlands draw down.

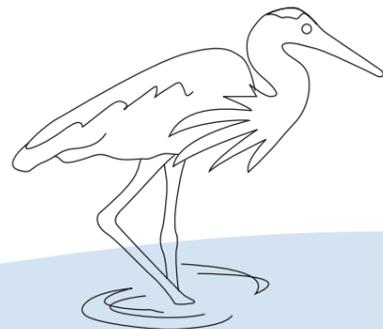


Photo: Barapa Barapa Traditional Owners returning fish to Country after the floods, by North Central CMA



Achievements and outcomes 2022-23

These snapshots highlight the program achievements and outcomes of water deliveries for 2022-23.

They resulted from planning and active coordination between partners, deep engagement with Traditional Owners and communities, and the combined efforts of waterway and land managers to take care of water, land and biodiversity from the top to the bottom of Victoria's catchments.

620,593 megalitres (ML) of water for the environment was delivered by partners in the environmental watering program across Victoria, in line with priorities published in the Seasonal Watering Plan 2022-23.

This includes water managed by these water holders and programs:

- Victorian Environmental Water Holder – 147,971 megalitres
- Commonwealth Environmental Water Holder (CEWH) – 334,941 megalitres
- The Living Murray (TLM) program – 137,681 megalitres

These deliveries and the associated volumes for each waterway system are reported in our Summary of Water for the Environment Delivery.

The VEWH oversaw **delivery of 620,593 ML of environmental water**. The total includes 147,971 ML of water made available by the VEWH, 334,941 ML of water made available by the CEWH and 137,681 ML made available by the Living Murray program.

88% of environmental flows delivered in northern Victoria were re-used to meet downstream environmental water needs. To further increase efficiency, environmental flows are also 'piggybacked' on water delivered for towns and farms.

99% of required potential watering actions were fully or partially achieved. These actions were achieved through environmental flow deliveries, natural river flows or delivery of consumptive water en-route to customers.

All six Ramsar sites that can receive water for the environment were watered.

93% of Victoria's top recreational fishing river reaches that can receive environmental flows (28) were watered this year.

The VEWH coordinated delivery of water for the environment to **154 river reaches and wetlands in Victoria.**

At least **281 stakeholders and program partners** contributed to planning for environmental flows.

Traditional Owners partnered in planning and/or delivered **26 watering activities in 12 river systems**, of which **23 were fully or partially achieved.**



Photo: North Central CMA Project Officer Will Honybun translocating cod after a blackwater event, by North Central CMA

Lake Boort - a case study by Djarra

Yung Balug Clan have cared for the Boort Wetlands as part of a holistic cultural landscape for thousands of years, and it holds ancient lore and presence that is a vital legacy for Yung Balug people living on and managing the Boort landscape today.

The wetlands and surrounding land in the Boort region are rich in cultural heritage, with sites and artefacts of cultural practices present throughout the landscape. The rivers and floodplains are valued as food and fibre sources and contain many sites of significance (such as camp sites and meeting places).

Yung Balug and Djaara have been advocating for cultural flows, water rights (water governance) and returning water to the rivers and wetlands. Djaara and Yung Balug have been promoters for environmental watering at Lake Boort for a number of years, with conversations leading to input into

the 2021-22 Seasonal Watering Proposal (SWP) for Lake Boort, developed by the North Central Catchment Management Authority. Djaara guided the development of a target water level for Lake Boort by ensuring alignment with the watering requirements (depth and season) for culturally significant species, such as spiny flat-sedge.

In 2022, Djaara and North Central CMA co-delivered the first delivery of water for the environment to Lake Boort. One low level partial fill was delivered in autumn/winter to 'prime' the wetland after a long dry period, and one larger top up followed in winter/spring to reach culturally significant vegetation.

Following the second watering, Yung Balug conducted a Traditional Welcome Water to Country Ceremony and Smoking Ceremony which provided an opportunity for Yung Balug to directly connect with their

culture and highlight the importance of their involvement in caring for the waterway.

During the fill and draw down Yung Balug through DJANDAK have conducted a range of monitoring across the Lake Boort complex, including fire and vegetation species mapping and the return of Djandak Wi burning to the landscape. Culturally important species, such as weaving grasses, were also monitored to understand how they change and respond to the watering throughout the year. Combined with Djandak Wi monitoring, this insight enables examination of indicators of climate change and aids in informing plant selection for future reveg, watering and fire events.

Other monitoring conducted by Djandak included general observations of condition, i.e. water quality, photo points, effects of floods and watering on Cultural sites,

general tree and vegetation health and ecological vegetation class (EVC) studies, and drone and aerial mapping. The monitoring of Lake Boort with water in the landscape helps to give an idea of condition benchmark to be better able to understand future changes in the condition of the wetland, whilst also building capacity within Yung Balug to be able to take over water management roles and undertake Djaara designed monitoring in the future.

Cultural Heritage monitoring and mapping has also been completed by the Cultural Heritage team at DJAARA with development of a Cultural Heritage Management Plan (CHMP) for the wetland underway. Through this process, Yung Balug are gathering pieces of a greater story to explore and potentially secure a World Heritage listing for the site into the future.

- Caitlin Dunolly-Lee, Dhelkunya Dja Gatjin Policy Manager, Dja Dja Wurrung Enterprises trading as DJANDAK, 2023.

Water on Country

The VEWH is committed to increasing the self-determination and agency of Traditional Owners in the environmental watering program.

The Victorian Government policy document *Water is Life: Traditional Owner Access to Water Roadmap* was released in 2022, providing a framework for Traditional Owner water access and management, including for environmental water.

In 2022-23 the VEWH continued to work with Traditional Owners, both directly and through waterway managers, to strengthen the Traditional Owner self-determination and agency in water delivered for environmental outcomes.

The case study on Lake Boort outlines in DJAARA's (Dja Dja Wurrung Aboriginal Clans Corporation) words how environmental flows can heal Country and the benefits that can be gained when Traditional Owners are empowered to fulfil their custodial obligations.

Photo: Lake Boort, by Djaara



Gippsland region

Gippsland

Our reflections for 2022-23

West Gippsland had its third very wet year in a row in 2022, testing communities again after major flooding across the region in 2021.

Natural flows from spilling reservoirs and local catchment run-off met most planned watering actions during the year.

Rain and storage releases and spills flushed the Latrobe, Macalister and Thomson rivers across winter and spring. Water for the environment was not needed in the Macalister or Latrobe rivers at all because the natural flow met or exceeded flow recommendations.

Upper sections of the Latrobe River catchment received their highest total June rainfall in 24 years. Thomson Dam spilled in October for the first time since 1996.

Sustained high river flows and low salinity have produced signs of better ecological condition in West Gippsland rivers and wetlands, including:

- breeding in the Latrobe estuary of estuary perch and Australian bass at a scale not seen in recent decades
- freshwater plants like ribbon weed growing in large areas across the Heart Morass wetland at levels not seen for many years
- the vulnerable green and golden bell frog successfully reproducing in Heart Morass
- large-scale breeding of royal spoonbills, little black cormorants pied cormorants and Australasian darter in Dowd Morass, the biggest breeding event seen since the floods of 2010-11
- continued high numbers of tupong and river blackfish in the Thomson River, including in the reaches upstream of Horseshoe Bend where river restoration works completed in 2019 enabled permanent fish passage to 80 kilometres of the Thomson and Aberfeldy rivers.

A second consecutive year of high allocations of water for the environment in the Snowy River was able to be delivered to mimic seasonal snow melt patterns to boost the river's ecological and physical conditions.

Thomson, Macalister & Latrobe systems

Snowy system

Photo: Thomson Dam spilling, by West Gippsland CMA

Boom in waterbird and fish breeding

For three years, West Gippsland has had consecutive wet seasonal conditions, including record breaking rainfall in high altitudes around Mount Baw Baw – the catchment which feeds into Melbourne’s biggest urban water storage, the Thomson Dam.

The cumulative years of high rainfall saw the Thomson Dam spill on 28 October 2022 for the first time since 1996, and for only the second time in the water storage’s 40-year history.

Water volumes between 2000 to 3000 megalitres (ML) flowed over the spillway and into the Thomson River in November. The size of these flows is much greater than can be achieved with the annual environmental water 18 gegalitre (GL) entitlement and caused bankfull and overbank flows in some downstream sections of the river.

Consecutive years of above average river flows have provided great breeding conditions for native fish such as tupong and river blackfish, and coupled with the Cowwarr fishway, allowed fish to move freely through the Thomson River downstream of Thomson Dam, the Latrobe River downstream of Blue Rock Dam and the Macalister River downstream of Lake Glenmaggie.

Waterbird and fish boom in response to high rainfall

In December 2022, Dowd Morass recorded a significant waterbird breeding event with more than 100 little black cormorant, black cormorant, little pied cormorant, pied cormorant and Australasian darter nests. Fish populations also increased due to the high flows. Preliminary results from the Thomson River annual survey results in February 2023 showed high numbers of tupong, higher than catch rates in 2021, and catch rates of river blackfish were the highest since survey results started in 2005.

High flows from all three rivers have also improved the health of the lower Latrobe wetlands over the last three years. Notable responses in the wetlands include significantly reduced salinity, increased growth of freshwater plants, such as ribbon weed, and increased waterbird breeding.

Water for the environment in 2022-23

Most of the time, the Thomson River (Carran Carran) and the plants and animals that depend on it, are heavily reliant on water held for the environment. Winter is one example, with passing flows in winter typically around 125 ML a day. When available, water for the environment is used to boost these winter flows to 350 ML per day to increase the quality and quantity of habitat available for fish, platypus and waterbugs and to help control salinity levels in the Latrobe River estuary.

Water for the environment was used in July 2022 to boost winter low flows in the Thomson River, but ceased after 23 days when local inflows exceeded the environmental flow target.

Planned spring freshes described in the Seasonal Watering Plan 2022-23 were also exceeded by natural river flows, and a combination of storage spills and natural flows achieved summer low flow and fresh targets. Water for the environment was used from mid-April to deliver autumn freshes which aim to trigger the migration of native fish, followed by low flows in June to maintain a minimum level of habitat for fish and waterbugs.

Environmental flows supporting fish breeding cycles

“The Thomson River has been highly modified because of the Thomson Dam,” West Gippsland CMA Environmental Water Officer Stephanie Suter said.

“Approximately 70 per cent of the native fish population in the Thomson River are migratory, travelling either upstream or downstream from fresh to marine environments for critical parts of their breeding cycles.

“These fish have evolved to migrate based on seasonal temperature and flow cues, particularly in the higher rainfall seasons of autumn and spring. As a regulated system, the natural flow triggers in the Thomson do not occur as often as they would have before the dam.”

Each year, the full 18 GL environmental water entitlement is generally used – even in wet years.

“To give the native fish population more opportunities to successfully migrate, breed and grow, water for the environment is delivered in autumn and spring to mimic the natural flow pattern, with an increase in flow timed to coincide with the peak migration window for most species,” Dr Suter said.

The Thomson Dam is the largest urban water storage in Victoria and was hydrologically designed to build up water reserves over wetter years to use during drier conditions to secure Greater Melbourne’s urban water supplies. Water that would have flowed into the river is captured and held in storage – and diverted west away from the river.

Water held for the environment gives environmental water managers the resource to respond to what the fish and other animals and plants need to survive.

Photo: Cormorant rookery at Dowd Morass, by West Gippsland CMA



Central region

Central

Our reflections for 2022-23

Wet conditions generated by a La Niña weather pattern continued in central Victoria for the third year in a row.

Intense rainfall in spring generated high river flows, flooding, and spills from some storages in the Tarago, Yarra, Werribee, Moorabool and Barwon systems.

The high rainfall and subsequent flooding across greater Melbourne during October 2022 was unprecedented, with many areas experiencing their highest total October rainfall on record, and others the highest total October rainfall for at least 20 years.

Spills and high natural river flows took care of and exceeded many watering actions that had been planned for the year to allow fish movement and breeding, waterbird and frog breeding, boost growth in plants and food for native fish and other animals, flush waterways and improve water quality.

Large natural floods achieve this to a much greater extent than environmental flows, but they can also harm some species and the landscape. For example, the floods may have drowned young platypus in low level burrows, caused bank erosion and boosted growth in pest plants on floodplains.

All the lower Yarra (Birraring) River billabongs were inundated, some for the first time in 10 years. Flood levels in the Barwon River rose over the banks to fill the wetlands Reedy Lake and Hospital Swamps, which form part of the internationally recognised Port Phillip Bay (Western Shoreline) and Bellarine Peninsula Ramsar site used by thousands of migratory birds from around the world.

As flooding and storage spills subsided, water for the environment was delivered in the Yarra, Tarago and Werribee systems under the seasonal watering plan's wet scenario.



Photo: The Moorabool River, by Jake van Dam, Corangamite CMA

High flows improve life for plants, animals and waterbugs

Native fish, plants, animals like platypus and rakali (water rats) and waterbugs in the flow-stressed Moorabool River (Moorabool Yulluk) rely on water for the environment to survive, breed and grow in the highly regulated system.

The Moorabool flows south from Victoria's Central Highlands near Ballarat and joins the Barwon River north of Geelong, connecting it to the internationally recognised Port Phillip Bay (Western Shoreline) and Bellarine Peninsula Ramsar site used by thousands of migratory birds from around the world.

The Moorabool system is in a heavily farmed water supply catchment for Barwon Water and Central Highlands Water, and water available for the environment is limited. The river system is disconnected by intense regulation and its lower section alone has nine private diversion weirs that form barriers to fish.

The Moorabool, Bostock and Lal Lal Reservoirs are the major storages, with water allocated to the Moorabool River Environmental Entitlement 2010 stored in Lal Lal Reservoir. The Moorabool River relies greatly on winter and spring rainfall and environmental water to maintain flows over dry periods.

Use of the water entitlement is limited by inflows to Lal Lal Reservoir and specified conditions that cap deliveries to a maximum of 7,500 megalitres (ML) over three years, or an effective average of 2,500 ML each year for the environment.

Water for the environment is released from Lal Lal Reservoir as a base flow to maintain connectivity immediately downstream of the reservoir and provide fresh water for native plants and animals. It is also released as a fresh event (i.e. a high pulse of water), timed to trigger fish migration and spawning.

The river needs a continuous low flow through the year and periodic freshes to achieve the intended environmental outcomes in the seasonal watering plan. In average and wet years, most of the recommended flow is expected to be provided through a combination of natural flow, passing flow and operational releases. This allows the delivery of additional freshes to improve environmental conditions.

Environmental values

The river sustains life for animals and plant communities like streambank shrubland, grassy woodland, escarpment shrubland, plains grassy woodland, riparian woodland and floodplain riparian woodland. It is a vital corridor for birds, fish and platypus, and one aim of planned environmental watering is to maintain a self-sustaining breeding population of platypus and support dispersal of juveniles and movement of adults.

Native fish that are known to live in the Moorabool catchment include the Australian grayling, river blackfish, Australian smelt, flat-headed gudgeon, southern pygmy perch, short-finned eel, short-headed lamprey, spotted galaxias and tupong.

Moorabool Yulluk has great cultural significance for Wadawurrung Traditional Owners and their Country. Traditional sources of food, materials and medicines include short-finned eel (bunyia), tupong, river blackfish (ware-rap), platypus (wad-dirring/perridak), common reed (tark) and bull rush, and river confluences and deep pools are places for meeting, ceremonies, trade and marking clan boundaries.

Wet conditions boost effects of watering

The Moorabool enjoyed very wet conditions in 2022-23, following two wetter than average years. Lal Lal Reservoir spilled and high natural flows meant no environmental releases were needed in the Moorabool from September to December 2022. There were no major floods, but in one day the fourth highest flow over the past 50 years was recorded in the river.

The high river flows allowed native fish to move past the Moorabool's many low flow fish barriers and recent monitoring conducted as part of the Victorian Environmental Flows Monitoring Assessment Program (VEFMAP) detected increased abundance and distribution of native fish throughout the river.

- the total number of river blackfish caught was more than double the number caught in 2022 (i.e. 121 vs 55)
- fish ecologists from the Arthur Rylah Institute (ARI) who conducted the VEFMAP surveys caught 1,771 fish from 15 sites in the Moorabool system and noted these improvements to native fish numbers
- river blackfish were caught in a section of the east branch of the Moorabool River for the first time since regular monitoring began three years ago
- nearly twice as many tupong were caught in the lower Moorabool compared to 2022.

The high natural river flows also increased the amount of inundated habitat and improved the quality and quantity of food within the river channel, which would have likely improved the health and condition of native fish.

In most years, the environmental watering program's first priority is to maintain low flows in certain river reaches and to deliver freshes when possible to help native fish, platypus and other animals and plants persist within the Moorabool River.

Because natural flows met many of the minimum environmental flow requirements during 2022, water for the environment was used to increase the magnitude of low flows and freshes during summer and autumn to improve, rather than just maintain, conditions for native fish and platypus.

Delivering low flows closer to the upper end of their recommended range increases opportunities for native fish movement, improves water quality, inundates more woody habitat and fringing riparian vegetation that waterbugs can use, and increases habitat and food for platypus.

All of these outcomes will help to consolidate the environmental benefits of recent wet conditions and increase the resilience of the Moorabool's distinctive plants and animals to help them cope with the next dry period.

Photo: Releasing fish and one eel in the Moorabool, by Rhiannon Glover, Corangamite CMA



Western region

Western

Our reflections for 2022-23

High rainfall in 2022 ended five consecutive dry years in western Victoria.

The Wimmera River and all tributaries had high flows that continued naturally through to late December. The catchment had its highest unregulated flows since 2011, with some areas being the wettest in 160 years.

Flooding started gradually in August, then spring rain quickly increased storage levels and boosted flows in the Wimmera River's arterial system, with water pushing through the heart of the region and filling the previously dry Lake Hindmarsh to 65 per cent capacity. Many landholders were affected and broadacre crops were lost.

Wimmera CMA worked with Grampians Wimmera Mallee Water to direct excess flows into areas that do not regularly receive water, with Dock Lake near Horsham reaching an estimated capacity of 95 per cent.

Conditions began to dry out in December and water for the environment was used to deliver base flows and freshes in Burnt Creek, MacKenzie River and the Wimmera River from January.

These watering actions were in line with the Seasonal Watering Plan 2022-23 and aimed to ease water quality issues, including low dissolved oxygen levels caused by the floods.

High flows in the Glenelg River peaked at nearly 16,000 ML per day through November and early December. Floods, natural high flows and passing flows met or exceeded the planned priority watering actions through spring and summer, which meant that water for the environment was only needed from March onwards.

The low use of water for the environment early in the year allowed a larger proportion of desired watering actions to be delivered through autumn 2023 without compromising potential watering actions in 2023-24 or beyond.

Surveys during March and April by VEFMAP reported large numbers of tupong moving upstream, indicating successful spawning and migration on the back of the floods and subsequent environmental flows.

The floods resulted in 100 per cent allocations for all entitlements in the Wimmera- Glenelg headworks system for the first time in many years. The boost in supplies of water available for the environment means a greater proportion of recommended flows can be delivered to the Wimmera and Glenelg systems in 2023-24.



Photo: The Glenelg River near Harrow, supplied by Glenelg Hopkins CMA

Helping tupong swim between ocean and rivers

Tupong (*Pseudaphritis urvillii*) belong to an unusual group of fish, called diadromous fish, that spend part of their lives in freshwater, and part in saltwater.

Although common to coastal Victoria, for many years tupong were not found in the mid and upper reaches of the Glenelg River (Bochara-Bogara-Pawur). Fortunately, waterway restoration efforts focusing on improving connectivity, including deliveries of water for the environment and the removal of barriers to fish movement, has seen them return in increasing numbers.

In autumn 2023, significant numbers of young-of-year tupong were recorded during monitoring by the ARI. The monitoring supports our understanding of how water for the environment works alongside habitat restoration to help improve fish populations in the Glenelg River.

The results followed wet conditions in 2022 which contributed to the creation of excellent conditions for these native fish to migrate and breed.

Not just adding water

River flows are important to the life cycles of diadromous fish, with increases in river flow triggering migration from the ocean, upstream to freshwater, and then back to the ocean.

Young tupong migrate into freshwater from the ocean in response to spring and summer high flows, while adult tupong head back downstream to the sea in autumn and winter to breed.

The return of tupong in the Glenelg River started in 2013, when environmental flows were first released in an attempt to trigger fish breeding. This resulted in many tupong heading upstream from the sea – where unfortunately they were stopped by the Sandford Weir.

In response the Glenelg Hopkins CMA built a fishway later that year allowing the tupong to take full advantage of the chance to migrate further. Since then, the fish have been found some 330km upstream of the estuary.

“Working at a landscape-scale informs how we can remove barriers to fish movement, restore habitat and introduce environmental flows to support migration and provide connectivity in the river – and for the tupong, to the ocean,” Glenelg Hopkins CMA Water Resources Coordinator, Alex Lewis said.

Responding to seasonal conditions

Between July and December 2022, natural flows provided by wet conditions meant that supplementary water for the environment was not needed to trigger migration and spawning of tupong. Overbank flows during this time also connected the Glenelg River to its floodplain in places. This natural event brought a pulse of carbon into the river.

While large, sudden, influxes of carbon into rivers can cause ‘hypoxic blackwater’ events where dissolved oxygen levels become too low for fish and crayfish, the majority do not. These pulses of carbon are a vital ecosystem process which provide food for the invertebrates that many fish rely on, including tupong.

Water for the environment was delivered from December 2022 to mid-April 2023 to support low flows and a fresh was delivered in late February. These deliveries of water for the environment were aimed to support native fish, including providing a cue for the upstream migration of tupong to complete their lifecycles.

Average and wet conditions are most likely to see water for the environment used to for fresh events (i.e. a high pulse of water), boosting natural flows and in turn helping re-establish small-bodied native fish populations, such as tupong, through providing migration and breeding triggers.

The use of held environmental water in autumn and winter 2023 demonstrates how water for the environment can be used even after wet conditions, to achieve environmental outcomes – in this instance helping the tupong migrate from and to the ocean.

Managing to changing conditions

Management of water for the environment in the Glenelg River has adapted over the years as we learn more about how to best use the water we have available in a changed system.

There are stories that refer to the Glenelg as a ‘chain of ponds’ and of the river retreating to pools in the height of summer. However, due to both river regulation and land-use change, many pools are now filled up with sand. Now if the river stopped flowing, there is not the same number of refuge pools available, increasing the risk of large fish death events.

Also, if the Glenelg stops flowing completely it can take a large volume of water to get it moving again. As these events typically only occur when there isn’t much water to work with, waterway managers try hard to avoid letting that happen.

Glenelg Hopkins CMA’s Alex Lewis explains: “Even though we can and sometimes do trigger the migration of tupong, we don’t always. Over the last few years, we’ve shifted our thinking more towards maintaining connectivity to support migration when it happens naturally.

“In 2022-23 we adapted our management of water held for the environment to consolidate the gains from the 2022 natural flood event.

“That’s led to a great outcome for tupong in 2022-23. They’re a really interesting fish, and it’s great to hear stories of tupong coming back to sections of the river they had been lost from.

“We hear stories from community members of fish showing up that they hadn’t seen since they were kids.”

Alex said the tupong were also a great indicator species. Where they are present upstream, it demonstrates that the river is connected.

“They will instinctively move as far upstream as they can in pursuit of food and habitat. If tupong can move freely through the river then other species can too. This benefits all species in the river, including key recreational fishing species such as estuary perch.”

Photo: Tupong in Glenelg River, by Arthur Rylah Institute



Northern region

Northern

Our reflections for 2022-23

Flood levels in the Goulburn Broken catchment in October 2022 included the highest-recorded levels at Shepparton and Seymour and a one in 50-year major flood level at Caseys Weir and Orvale.

A peak flow of around 172,000 ML per day in the Murray River downstream of Yarrowonga inundated 100 per cent of the Barmah Forest floodplain.

Water quality deteriorated after the big floods and there were hypoxic conditions throughout the Murray system, including Gunbower Creek from late October to December 2022.

North Central CMA carried out emergency fish salvage to remove stressed fish from Gunbower Creek, moving more than 700 large-bodied native fish to parts of the upper Loddon River, Campaspe River and Kow Swamp that had higher dissolved oxygen, and to Victorian Fisheries Authority's breeding sites at Arcadia and Snobs Creek.

In early February, some of the fish stored at Arcadia were returned to Gunbower Creek with Barapa Barapa Traditional Custodians. The rest were kept as brood stock to support future stocking programs.

The floods caused an increase in European carp across many systems that challenged water deliveries. Waterway and water storage managers and environmental water holders worked closely together to support native fish populations, support waterbirds and floodplain plant growth, and prevent further boosting carp populations.

Some watering actions were stopped to avoid redistributing carp. For example, fishways were closed in protected areas such as Gunbower Creek to prevent more carp moving up from the Murray. The autumn high flow planned in the Lower Goulburn River to help migration of juvenile native fish was cancelled after fish ecologists advised there were fewer than expected juvenile native fish in the Murray River and the flow would likely favour carp more than native species. Other environmental objectives from the Goulburn autumn flow were also not needed, including supporting native bank vegetation which was in great condition following the flood.

While environmental flows aren't able to provide the volumes needed to mitigate really low oxygen levels in places like the Murray River, small releases can make a difference at a local scale. An example is the Lower Broken Creek where environmental flows were used to oxygenate the water to help minimise fish deaths from blackwater.

Adaptive management will continue in 2023-24 in response to the previous season and the carp proliferation, with plans to draw down some wetland sites such as Reedy Swamp in the Goulburn system and Hird Swamp

in Central Murray to reduce carp numbers.

Following the 2022 flood, Gunbower Forest had its largest waterbird breeding event for some years with more than 1,000 juvenile waterbirds recorded, while 835 young birds from threatened species like blue-billed ducks, musk ducks and magpie geese were recorded at the Central Murray and Boort wetlands. Environmental watering started again in June 2023 to support bird breeding and juveniles at this site with habitat and food sources, and continue the restoration of the river red gums.

Early monitoring has shown a halt in the decline of river red gums across Gunbower Forest and Guttrum and Benwell Forests, and positive understorey plant growth.

The floods elevated the priority of the combined autumn high flow in the Loddon River and Pyramid Creek to promote fish movement and help native fish recover.

Natural flooding at Wirra-Lo near the Loddon River created favourable conditions for the vulnerable growling grass frogs, and large numbers were recorded across the 11 wetlands within the Wirra-Lo complex that also support breeding of the endangered Australasian bittern.

Natural inflows from floods replaced planned water deliveries to most Central Murray and Boort wetlands. A notable exception was Kunat Kunat (Round Lake) where water for the environment was delivered in spring and autumn to maintain water and salinity levels within target ranges to support breeding and development of endangered Murray hardyhead fish.



Photo: Gunbower Creek and Forest, by North Central CMA

Forest watering and waterbird breeding

Water for the environment played an important supporting role in northern Victoria last year, even after one of the biggest floods on record.

One example is Gunbower Forest, an internationally significant site under the Ramsar Convention that also forms part of the Living Murray Gunbower-Koondrook-Perricoota Forests' icon site.

Bounded by the Murray River to the north and Gunbower Creek to the south, Gunbower Forest contains diverse and rare wetland habitats, including a large area of flood-dependent forest and species-rich floodplain wetlands. These habitats support internationally recognised migratory waterbirds, along with vulnerable and endangered plants and animals including river swamp wallaby-grass, wavy marshwort, winged peppergrass, great egrets, white bellied sea eagles and musk ducks.

Environmental flows before the 2022 flood

Before the floods, water managers were completing their scheduled environmental watering actions for the latter half of 2022. An environmental flow was delivered to Gunbower Forest in winter through to early spring 2022, mimicking pre-regulation winter flows and helping prime the forest, start the breakdown of carbon on the floodplain while conditions were cool, and start to flush carbon off the floodplain in cooler weather when the risk of low dissolved oxygen is low.

Once natural events were pushing river levels higher in spring, deliveries of water for the environment were stopped and natural flooding took over.

Floodplain inundation triggers bird breeding events at Gunbower

The combination of water held for the environment and large unregulated inflows in spring provided the largest amount of wetland and fringing floodplain habitat for waterbird breeding and feeding since 1993-94. An estimated 70-80 per cent of the Gunbower Forest floodplain was inundated, significantly more than the 23 per cent that can be inundated

with deliveries of water for the environment alone.

The flood triggered significant waterbird breeding and gave the Gunbower Forest floodplain vegetation a much-needed drink. Waterbird numbers are in serious decline across the Murray-Darling Basin, and although waterbird abundance in 2022 increased compared with 2021, it is still below the long-term average¹.

During the floods, more than 1000 juvenile waterbirds were recorded in Gunbower Forest. A number of large breeding events were seen across the Murray-Darling Basin on the back of the floods and supporting a diversity of breeding locations across the Basin helps spread the risk of breeding failure – not putting all our eggs in one basket!

Environmental flows after the floods

But these youngsters need habitat and food to survive to breeding age. CSIRO research² in the Murray-Darling Basin has shown just how vulnerable young birds are to starvation, predation, and habitat loss, with low juvenile survival rates meaning that waterbird numbers haven't improved long term, despite previous large breeding events. To survive to adulthood, they need healthy wetland and floodplain vegetation, and for the vegetation of Gunbower Forest to stay healthy it needs regular flooding. Maintaining the health of floodplain forests beyond one seasonal event is vital to support chicks to survive to breeding age themselves, with wetland areas providing foraging grounds and habitat.

The forest within the flood footprint where water for the environment deliveries can occur has experienced seven flood years over the past 20 years - this is only slightly more than half of the flooding frequency required to support the river red gum floodplain³. We know from monitoring after the 2010-11 floods how quickly the condition of trees, wetland and understorey vegetation deteriorated as the forest dried out. This is not surprising given the forest communities evolved with a very different pre-regulation regime of flooding.

The Gunbower Forest river red gums are still recovering from the effects of the Millennium Drought, and while the flooding in 2022 led to increased canopy health, it was preceded by three dry years in a row where annual monitoring showed a decline in tree condition.

A high wetting frequency is required to maximise the river red gums' chance of recovery. Environmental flows started in June 2023 to support Gunbower Forest vegetation in between natural flow events, in turn providing appropriate habitat variation and food resources for young waterbirds and their parents.

Flexible, responsive environmental water management is an important tool the VEWH uses to maximise environmental outcomes in varying seasonal conditions. Here, we can see how water for the environment can be used to support outcomes in a wet seasonal scenario and the importance of deliveries over multiple years to achieve long-term outcomes after natural floods, such as improved vegetation condition and increased waterbird populations. Plants and animals have evolved to respond to Australia's notoriously variable river systems, but river regulation has reduced the resilience of floodplain ecosystems like Gunbower Forest. With dry conditions forecast for the coming year, we will continue to work with our partners to support this very special place.

1. Porter, J. L., Kingsford, R. T., Francis, R., Brandis, K., & Ahern, A. (2022) *Eastern Australian Waterbird Aerial Survey-October 2022 Annual Summary Report*.
2. O'Brien, L., McGinness, H.M. Ibis and spoonbill chick growth and energy requirements: implications for wetland and water management. *Wetlands Ecol Manage* 27, 725-742 (2019).
3. MDBA (2012) *Gunbower Forest Environmental Water Management Plan*.

Photo: Australasian darter with chicks at Little Gunbower Complex, by Damien Cook



A final reflection

The VEWH's annual seasonal watering plan communicates where water held for the environment can be used across Victoria, based on emerging seasonal conditions and listening and adapting to what's happening on the ground.

The 2022-23 year was an excellent example of how being prepared for almost every eventuality helps to plan and deliver water for the environment for maximum benefit - before, during and after extreme conditions.

It's not every year we get a big flood. In much of northern Victoria a flood of this size hasn't been recorded since 1956, half a century before the VEWH was created over 10 years ago to manage environmental water. And it is certainly not every year that storages such as the Thomson Dam spill.

It's vital that we plan for different climate scenarios and have strong working relationships with program partners to collectively consider and make decisions as events unfold.

Our environmental watering program adjusts to current conditions and seasonal variability, including our lived experience under accelerating climate change.

Watering actions in some systems aim to build on positive ecological outcomes achieved in recent years. In other systems environmental water will be used to support recovery from flood impacts like loss of native fish from hypoxic blackwater and loss of plants on the water's edge of rivers, creeks and wetlands from bank erosion.

Supporting native fish will be a priority in coming years to help populations recover from the significant impacts of the extended hypoxic conditions in parts of some rivers.

"Thanks to our program partners, including Traditional Owners, and stakeholders for all for all their hard work, efforts and support," said VEWH CEO, Dr Sarina Loo.

"Our program continues to work closely with people on the ground to learn how systems operate differently in the cycle of 'boom and bust' between record floods and drought, and everything else in between.

"The aim is to understand where in that cycle we can influence results in rivers and wetlands at a landscape-scale, and how can we track the influence of watering in dry years that translates to environmental benefits in wet years," she said.

Photo: Gunbower Creek, by North Central CMA

Summary of water for the environment delivery 2022-23

System	Site	Total (ML)	VEWH (ML)	TLM (ML)	CEWH (ML)
GIPPSLAND REGION					
Latrobe system	Latrobe River	-	-	-	-
	Lower Latrobe wetlands	Water may be diverted into Heart Morass, Dowd Morass and Sale Common from the Latrobe River ⁱ			
Thomson system	Thomson River	18,160.0	18,160.0	-	-
Macalister system	Macalister River	13,121.0	13,121.0	-	-
Snowy system	Snowy River	N/a ⁱⁱ			
GIPPSLAND REGION TOTAL		31,281.0	31,281.0		
CENTRAL REGION					
Yarra system	Yarra River	6,942.0	6,942.0	-	-
	Annulus Billabong	23.0	23.0	-	-
	Yering Backswamp	43.0	43.0	-	-
Tarago system	Tarago River	151.0	151.0	-	-
Werribee system	Werribee River	1,024.0	1,024.0	-	-
	Pyrites Creek	940.0	940.0	-	-
Maribyrnong system	Jacksons Creek	321.9	321.9	-	-
Moorabool system	Moorabool River	2,500.0	2,500.0	-	-
	Upper Barwon River	535.8	535.8	-	-
Barwon system	Lower Barwon wetlands	Water may be diverted into Reedy Lake and Hospital Swamps from the Barwon River ⁱ			
CENTRAL REGION TOTAL		12,480.7	12,480.7	-	-
WESTERN REGION					
Glenelg system	Glenelg River	11,470.7	11,470.7	-	-
	Wimmera River	3,682.9	1,241.7	-	2,441.1
Wimmera system	MacKenzie River	3,840.2	3,840.2	-	-
	Burnt Creek	21.3	21.3	-	-
	Lower Mount William Creek	1,292.5	1,292.5	-	-
	Upper Mount William Creek	68.0	68.0	-	-
	Bull Swamp (Bulls Swamp)	2.9	2.9	-	-
	Carapugna	5.4	5.4	-	-
	Challambra Swamp	1.9	1.9	-	-
	Chiprick (both)	5.1	5.1	-	-
	Chirrup Swamp	0.9	0.9	-	-
	Clinton Shire Dam	1.7	1.7	-	-
	Cokum Bushland Reserve	5.1	5.1	-	-
	Considines	6.9	6.9	-	-
	Corack Lake	4.1	4.1	-	-
	Coundons Wetland	1.1	1.1	-	-
Wimmera-Mallee wetlands system	Creswick Swamp	1.0	1.0	-	-
	Cronomby Tanks	5.9	5.9	-	-
	Crow Swamp	4.1	4.1	-	-
	D Smith Wetland	0.7	0.7	-	-
	Davis Dam	0.8	0.8	-	-
	Falla Dam	3.3	3.3	-	-
	Fieldings Dam	1.0	1.0	-	-
	Goulds Reserve	3.5	3.5	-	-
	Greens Wetland (2)	0.7	0.7	-	-
	Homelea	1.1	1.1	-	-
	J Ferrier Wetland	3.5	3.5	-	-
	Jeffcott Wildlife Reserve	1.0	1.0	-	-
	Jesse Swamp	1.2	1.2	-	-
	John Ampt	2.8	2.8	-	-
Lake Danaher Bushland Reserve	6.0	6.0	-	-	
Mahoods Corner	0.8	0.8	-	-	
Morton Plains Reserve	1.5	1.5	-	-	

System	Site	Total (ML)	VEWH (ML)	TLM (ML)	CEWH (ML)
WESTERN REGION (CONT.)					
Wimmera-Mallee wetlands system	Mutton Swamp	2.0	2.0	-	-
	Newer Swamp (Round Swamp)	2.3	2.3	-	-
	Opies Dam	0.7	0.7	-	-
	Pam Juergens Dam	0.9	0.9	-	-
	Part of Gap Reserve (Stephen Smith Dam)	1.4	1.4	-	-
	Paul Barclay	3.3	3.3	-	-
	Pinedale	0.9	0.9	-	-
	Poyner	2.2	2.2	-	-
	Roselyn Wetland/ Reids Dam	4.8	4.8	-	-
	Schultz/Koschitzke	1.3	1.3	-	-
	Shannons Wayside	1.5	1.5	-	-
	Tarkedia Dam	2.3	2.3	-	-
	Tchum Lakes Swimming Pool (North Lake - dam)	10.0	10.0	-	-
	Towma (Lake Maribed)	1.2	1.2	-	-
Uttwilllock Wetland	3.7	3.7	-	-	
Wal Wal Swamp	3.0	3.0	-	-	
WESTERN REGION TOTAL		20,491.1	18,050.0	-	2,441.1
NORTHERN REGION					
Victorian Murray system	Barmah Forest	102,250.8	7,000.0	30,073.9	65,176.9
	Boals Deadwood	723.1	723.1	-	-
	Gunbower Forest	45,036.6	9,190.6	35,846.0	-
	Gunbower Creek	9,868.5	8,745.5	-	1,123.0
	Johnsons Swamp	1,148.0	1,148.0	-	-
	Kunat Kunat (Round Lake)	250.1	250.1	-	-
	Lake Cullen	5,000.0	5,000.0	-	-
	Lake Elizabeth	645.5	645.5	-	-
	McDonalds Swamp	401.7	401.7	-	-
	Muringa wetlands	3.3	3.3	-	-
	Wirra-Lo wetlands (Bunyip Swamp East)	12.6	12.6	-	-
	Wirra-Lo wetlands (Bunyip Swamp West)	7.0	7.0	-	-
	Wirra-Lo wetlands (Cattleyard Creek)	8.9	8.9	-	-
	Hattah Lakes	29,311.8	10,059.9	19,251.9	-
Catfish Billabong	877.4	877.4	-	-	
Murray River via lower Darling ⁱⁱⁱ	60,000.0	-	15,000.0	45,000.0	
Ovens system	Ovens River	73.0	-	-	73.0
	King River	142.0	92.0	-	50.0
Goulburn system	Goulburn River	220,945.5	15,554.2	37,509.5	167,881.8
	Horseshoe Lagoon	70.3	70.3	-	-
Broken system	Broken River	2,501.9	1,735.9	-	766.0
	Upper Broken Creek	1,146.0	573.0	-	573.0
Campaspe system	Lower Broken Creek	47,427.9	-	-	47,427.9
	Campaspe River	13,856.3	12,784.2	-	1,072.1
Loddon system	Coliban River	215.9	215.9	-	-
	Loddon River	10,837.7	7,481.7	-	3,356.0
	Pyramid Creek	64.9	64.9	-	-
	Serpentine Creek	716.9	716.9	-	-
	Lake Boort	1,912.9	1,912.9	-	-
	Little Lake Meran	883.5	883.5	-	-
NORTHERN REGION TOTAL		556,340.0	86,159.0	137,681.3	332,499.7
Total water use		620,592.8	147,970.7	137,681.3	334,940.8

i The VEWH's environmental entitlements in the lower Latrobe and lower Barwon wetlands allow diversion of water from the Latrobe and Barwon rivers into the wetlands at any time when specific river height triggers are met. The entitlements do not consist of a set volume and the volume of water diverted into the wetlands is not measured.

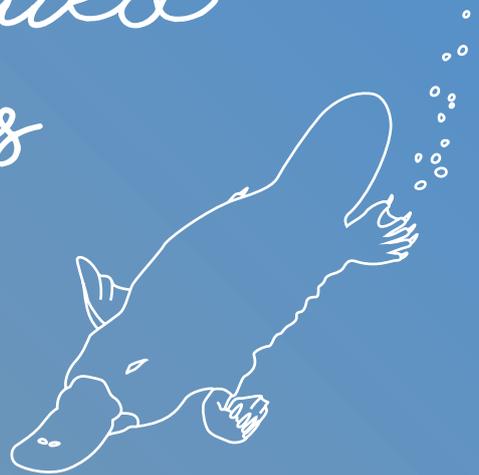
ii 200,509 ML of water for the environment delivered to the Snowy River by the New South Wales Department of Industry between 1 May 2022 and 30 April 2023. This water is authorised and delivered by NSW and therefore is not included in the regional or statewide totals presented in this table.

iii Water available in the Victorian Murray system was delivered to achieve non-Victorian environmental objectives for the lower Darling River and Murray River in partnership with New South Wales, South Australia and other delivery agencies.



Photo: Cormorant rookery at Dowd Morass,
by West Gippsland CMA

water for healthy
waterways, valued
by communities



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