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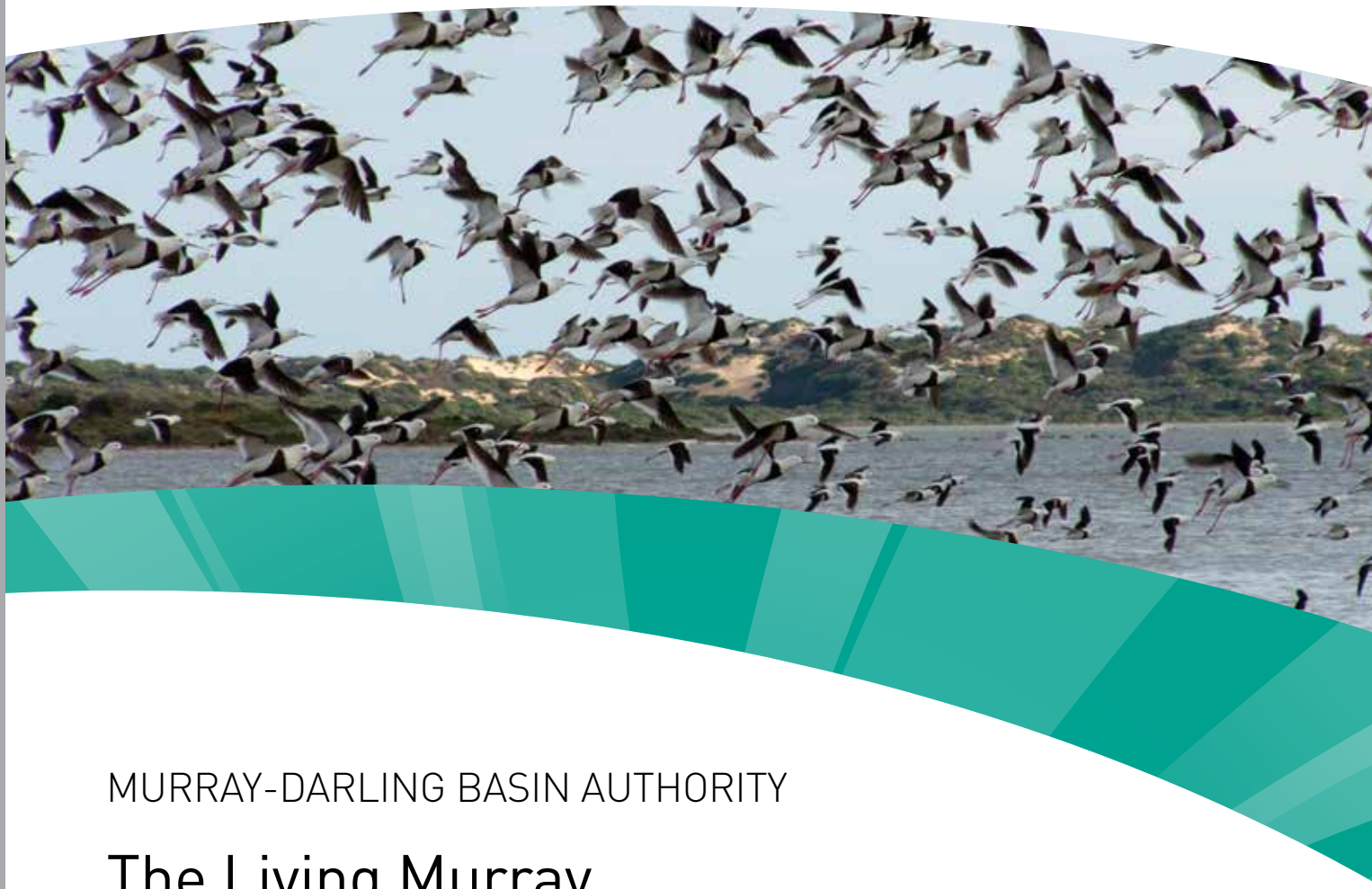
MURRAY–DARLING BASIN AUTHORITY



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The Living Murray

Watering the icon sites—a snapshot (2011-2012)

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Cover image: Banded stilts at the Coorong (photo by Pamela Gillen)

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Contents

Watering the environment

The ways Australians live and think have been shaped by water — or the lack of it.
Michael Cathcart *The water dreamers*

The importance of environmental watering, setting water aside for the environment, is becoming increasingly recognised as the impacts of regulating the river on the health of river and floodplain systems have become better understood.

The long-term average annual flow of water from the mouth of the Murray into the Southern Ocean has fallen to an estimated quarter of what it would be under natural conditions. There is also the possibility that climate change will further reduce the amount of water going into the system.

The concept of environmental water encompasses quantity (enough water flowing into and staying in the system), timing (flows at the right times of year or critical points in the ecological cycle) and location (water reaching the parts of the river system that most need it). If the water requirements of particular plant and animal communities are not met over time the resulting environmental losses can be extremely difficult, sometimes impossible, to reverse.

Along the River Murray environmental watering has faced considerable challenges due to an extended drought, from 1997 to 2010, as well as the complexity of delivering and accounting for water across different river systems and states. Results have, however, been very positive. The timely delivery of small amounts of water through the longest drought since records began, provided refuges for stressed plants and animals, and prevented local extinctions. More recently, after record rain in the southern Murray–Darling Basin in 2011, environmental water was used between flood peaks to ensure that water did not recede too quickly and cause waterbirds to abandon their nests.

Given that there is now more environmental water available than ever before, coordination between environmental water holders is very important.

The Living Murray program also works closely with river operators and water delivery partners, such as the catchment management authorities, to maximise the outcomes achieved by environmental watering, without impacting on other users.

Royal spoonbill eggs in Barmah Forest, December 2011 (photo by Keith Ward, Goulburn Broken CMA)

The Living Murray and environmental watering

The Living Murray is one of Australia's largest river restoration programs, established in 2002 in response to evidence that the health of the River Murray system was declining.

The success of this program is underpinned by the strong collaborative approach that has developed between the Murray–Darling Basin Authority and the partner governments who deliver the program on-ground.

The Living Murray delivers environmental water to improve the health of six icon sites:

- Barmah–Millewa Forest
- Gunbower–Koondrook–Perricoota Forest
- Hattah Lakes
- Chowilla Floodplain and Lindsay–Wallpolla Islands
- Lower Lakes, Coorong and Murray Mouth
- River Murray Channel.

The Living Murray icon sites are part of the highly-regulated, southern Murray–Darling Basin. Water can be delivered from a number of sources including the upper Murray (Hume Reservoir), Goulburn (Lake Eildon and Goulburn Weir), Campaspe (Lake Eppalock), Murrumbidgee (Burrinjuck Dam) and Darling (Menindee Lakes) systems. Environmental water releases can be combined with unregulated flows and the delivery of consumptive water en route to maximise environmental outcomes.

The Living Murray water portfolio provides a long term average of 479,973 megalitres. The actual volume available in a given year will vary significantly depending on annual rainfall and allocation announcements. The program has also initiated an environmental works program to build water management structures, at three icon sites, which will improve delivery of environmental water.

Environmental water available for use along the River Murray and surrounding icon sites comes from a range of sources, see page 27.

Water and works

The two fundamental pillars of the The Living Murray program are the water recovery effort and the works and measures program. It is the 'works' + 'water' combination that will enable the delivery of water to icon sites in a way that maximises the environmental benefits.

Major floodplain water management structures are under construction at Gunbower—Koondrook—Perricoota Forrest; Hattah Lakes; Chowilla Floodplain and Lindsay—Wallpolla Islands (including Mulcra Island). These projects are the largest of their kind in Australia.

The Living Murray is also funding the Sea to Hume Fishway Program, an innovative series of fish 'ladders' along the River Murray restoring migratory passage for native fish along the length of the Murray.

High flows over the past two years have delayed construction with the completion of the most structures scheduled for 2013.

To achieve the best environmental benefits The Living Murray water will generally not be distributed evenly across the icon sites each year. Once all the water management structures are completed water will be delivered in a 'rostered' way that mimics the natural flooding cycles of sites. This will also depend on the availability of water, and the particular environmental requirements of each icon site.

The icon sites are monitored to assess their ecological health over time, measure progress towards the ecological objectives and ensure that environmental water is used in the best possible manner.

Watering in drought years (2007 to 2010)

The drought, from 1997 to 2010, was the longest drought since records began in 1892. With a changing climate there are forecasts that droughts of this duration could become more frequent.

The Living Murray program had not recovered any water until 2007, part way through the drought. By then there were clear signs that the icon sites were suffering and facing the loss of species, and irreversible changes to wetlands and floodplains.

Environmental monitoring was beginning to tell a disturbing story. Vegetation surveys showed that the number of stressed and dying river red gums had risen from 52%, in 2002, to 78% in 2004. Waterbird surveys in 2007 showed that the severe drought conditions continued to impact on waterbird communities with most floodplain or shallow icon sites dry or almost dry and supporting few waterbirds. The main river channel held water but relatively few birds and with low species richness (see environmental monitoring references on page 25). By 2007 key wetlands were dry and many species were relying on drought refuges to survive.

In very dry times environmental watering focuses on survival. By providing enough water for species and communities to survive the drought, plants and animals can recolonise and recover when conditions improve.

Environmental watering in 2008 and 2009 helped to maintain drought refuges and prevented the loss of river red gums. Watering at the Lower Lakes was aimed at maintaining water levels in Lake Albert to prevent acidification and to prevent the loss of species such as the endangered Murray hardyhead.

Punkah River, Chowilla Floodplain, in July 2008 when high salinity had killed river red gums and black box trees (photo by Arthur Mostead © MDBA)

The key reasons for watering during extreme dry periods are to:

- avoid the critical loss of threatened species and communities
- protect drought refuges to allow recolonisation following drought
- avoid irreversible damage or catastrophic events.

Prioritising watering

Potential watering actions are prioritised based on where the water will achieve the best environmental benefits, the water available and constraints such as whether watering will impact on private land. This year the watering program aimed to maximise opportunities to deliver environmental water to multiple sites.

In order to prioritise between individual watering actions, ranking criteria have been developed, these include: significance of the ecological outcome; amount of benefit for the volume of water used (including the opportunity to take advantage of other events); the risk of not watering and the certainty or likelihood of benefits.

Watering in wet years (2010 to present)

After years of drought, high inflows and environmental watering since 2010 have significantly benefited the icon sites. Some sites, however, such as the Lower Lakes, Coorong and Murray Mouth are taking longer to recover.

In wet years the focus of environmental watering is to improve the health of the icon sites, and to build resilience. Environmental watering aims to increase the extent and duration of inundation at key sites. It can also be used between flood peaks to ensure that water does not recede too quickly. This is particularly important for waterbirds who may abandon their nests if water levels drop.

At Hattah Lakes most of the lakes were filled naturally. Lake Kramen, however, required water to be pumped because natural flows were not high enough. This was the first time the lake had received water since natural flooding in 1993.

Water levels in the Lower Lakes rose well above the critical acidification levels and large volumes of water have been released through the barrages since September 2010, exporting salt to the Southern Ocean and improving fish passage. The system is beginning to slowly recover from years of low flow in the river.

The key reasons for watering during wet periods are to:

- improve the health and resilience of aquatic ecosystems
- enable growth, reproduction and large-scale recruitment for a diverse range of plants and animals
- contribute to overbank flows to connect the river to the floodplain, to ensure that floodplain processes, such as carbon cycling, continue. Carbon is an important food source in river systems.

In 2010–11 The Living Murray water was used for the first time down the length of the river as part of a multi-site watering trial, which meant using The Living Murray environmental water allocation at more than one icon site. Flows returning to the river after being used at Barmah–Millewa were used again downstream at the Lower Lakes, Coorong and Murray Mouth icon site.

For a summary of environmental watering at the icon sites since 2007 see page 7.

Case study: Watering river red gums — a time to water and a time to dry

Environmental monitoring of the river red gum forests in Barmah–Millewa forest showed that large areas of floodplain forest had declined from 'in good health' in 2003 to 'stressed' in 2009. The trees that remained in good condition were restricted to areas surrounding the river, creeklines and wetlands. Environmental watering during this period was important in helping to avoid the wide-scale loss of river red gums.

River red gums are influenced by the frequency, depth and duration of floods. At Barmah Forest the ideal time between floods appears to be about five to fifteen months. In woodland communities river red gums seem to be able to tolerate longer dry-periods, about three to four years, but start to decline in health after two years, and die after about five years without flooding, or access to groundwater.

In extreme drought years avoiding the loss of significant species is achieved by understanding and managing to critical ecological thresholds. River red gums, for example, need watering at least once in fifteen years to maintain recruitment.

It is also important to allow the forest to dry out so that forests and grasslands are not over-watered. River red gums can drown if inundated for more than three years. Water management structures, such as regulators, enable forest managers to direct unseasonal flooding to different parts of the icon site to ensure that no part of the forest is inundated for too long.

The ideal flooding regime for river red gum forest appears to be a flood frequency not exceeding one in three years, for two to six months, from late winter to early summer (see *Floodplain wetland biota in the Murray–Darling Basin*).

River red gums in Barmah Forest thrive where shallow frequent seasonal flooding occurs (photo by David Kleinert © MDBA)

Environmental watering by icon site 2011-12

The Living Murray is working towards specific ecological objectives to improve the health of each icon site. Improving the health of the icon sites will also improve the health of the river system as a whole.

The Living Murray story

Heavy rainfall in 2011–12 again caused significant flooding in parts of the Murray–Darling Basin. This provided an opportunity for The Living Murray program to add to the environmental outcomes already being achieved by natural flooding. This was carefully achieved without risk to property or infrastructure.

A total of 274,065 megalitres of The Living Murray water was delivered to the icon sites in combination with other water holders. This was used to supplement natural flows and provided significant environmental benefits at five icon sites: Barmah–Millewa; Gunbower Forest; Chowilla Floodplain; the Lower Lakes, Coorong and Murray Mouth; and the River Murray Channel. Environmental water was not used at Hattah Lakes and Koondrook–Perricoota Forests as sites were watered naturally and because major water management structures were being constructed at these sites.

Watering, along with the second year of high flows, built on the environmental benefits of the previous year. Water levels at the Lower Lakes continued to improve, and salinity decreased due to continuous flow through the Murray Mouth. The health of many of the plant and animal communities in the icon sites continued to improve, building further resilience.

Researcher holding a golden perch captured during the annual TLM fish survey in Gunbower Creek (photo by Clayton Sharpe)

The Living Murray water delivered to the icon sites 2011–12

1

Barmah–Millewa Forest
TLM 120,000 ML
Total 424,600 ML
No construction

2

Gunbower–Koondrook–Prricoota Forest
TLM 6,701 ML
Total 11,636 ML
Construction due for completion in 2013

3

Hatah Lakes
TLM 0 ML
Construction due for completion in 2013

4

Chowilla Floodplain Lindsay–Wallpolla Islands
TLM 5,000 ML
Total 8,877 ML
Construction due for completion in 2014

5

Lower Lakes, Coorong and Murray Mouth
TLM 142,364 ML
Total 399,832 ML
No construction

6

River Murray Channel
TLM 0 ML*
Final 4 fishways due for completion in 2013.

* no specific environmental water allocation was made to the River Murray Channel but environmental benefits were gained from the delivery of water on-route to other sites

Barmah–Millewa Forest icon site

Flood marks on giant rush at Barmah Lake (photo by Keith Ward, Goulburn Broken CMA)

The Barmah–Milewa Forest icon site covers about 66,600 hectares, and straddles the River Murray. Barmah Forest is on the southern side, in Victoria, and Millewa Forest is on the northern side, in New South Wales. The icon site contains the largest river red gum forest in Australia, and the largest freshwater floodplain system along the River Murray. The Barmah Forest also forms part of the Barmah Forest and Central Murray State Forests Ramsar site, which makes it internationally significant. The Barmah–Millewa Forest is the only icon site to have its own environmental water allocation, known as the Barmah–Millewa Environmental Water Allocation.

A natural feature on the River Murray called the Barmah Choke acts as a funnel causing river flows of more than 10,500 megalitres a day to overtop the river banks and flow into the Barmah–Millewa forest.

If you flush the floodplain frequently you're feeding the river and it's a very healthy river because of the floodplain connection. If you divorce the floodplain from rivers you can starve the river of energy.

Keith Ward, Goulburn Broken CMA

Barmah–Millewa Forest relies on natural wet and dry periods, with periodic large floods giving it the resilience to cope with prolonged dry periods. Prior to the high inflows over the last two years more than half the forest, which has historically received annual flooding, had not been inundated for four years. Most of the forest's wetlands and waterways dried up, many for the first time in decades and some possibly for the first time in recorded history.

During the drought small volumes of environmental water were delivered to the icon sites to maintain critical drought refuges. While this improved the health of reed and rush beds and fringing river red gums, some of the higher regions of the floodplain had not been inundated since natural flooding occurred in 1996.

After a decade of drought, the Barmah–Millewa Forest experienced prolonged flooding from July 2010 to March 2012. About 90% of Barmah–Millewa Forest was flooded, around 60,000 hectares. This flooding, along with environmental watering, revitalised many parts of the forest ecosystem and helped consolidate the benefits from the initial drought-breaking rains during the previous season.

Environmental watering in 2010–11 was timed to maintain key bird-breeding areas during periods of lower flows. This resulted in one of the best colonial bird breeding events in Barmah Forest for over 60 years.

The Barmah Choke (photo by Denise Fowler MDBA)

Colonial nesting waterbirds

Colonial nesting waterbirds such as egrets, spoonbills and ibis gather together to breed and nest. They source some or all their food from aquatic environments and are vulnerable to sudden drops in water levels beneath nesting sites. Egrets and particularly ibis, only breed successfully when their nest sites are surrounded by water. If the level of water surrounding the nests drops before the young birds fledge the adult birds often abandon their nests, even if eggs have hatched. This is probably because falling water levels indicate to the birds that food resources will decline and so there will not be enough to feed the young birds. There is also an increase in the risk of predation from animals such as quolls and foxes.

Waterbirds are more sensitive to water level drops during the early stages of breeding and some species are more sensitive than others. Slow breeders such as eastern great egrets require a minimum inundation period of 10 months.

White ibis chick, Barmah Forest, December 2011 (photo by Keith Ward Goulburn Broken CMA)

Environmental water delivered to Barmah–Millewa Forest in 2011–12

A total of 424,600 megalitres of environmental water was delivered in 2011–12, including water from Victoria, New South Wales and the Barmah–Millewa Environmental Water Allocation. The environmental water flowed through the forest and then re-entered the Murray, also providing flows and benefits to the Lower Lakes, Coorong and Murray Mouth.

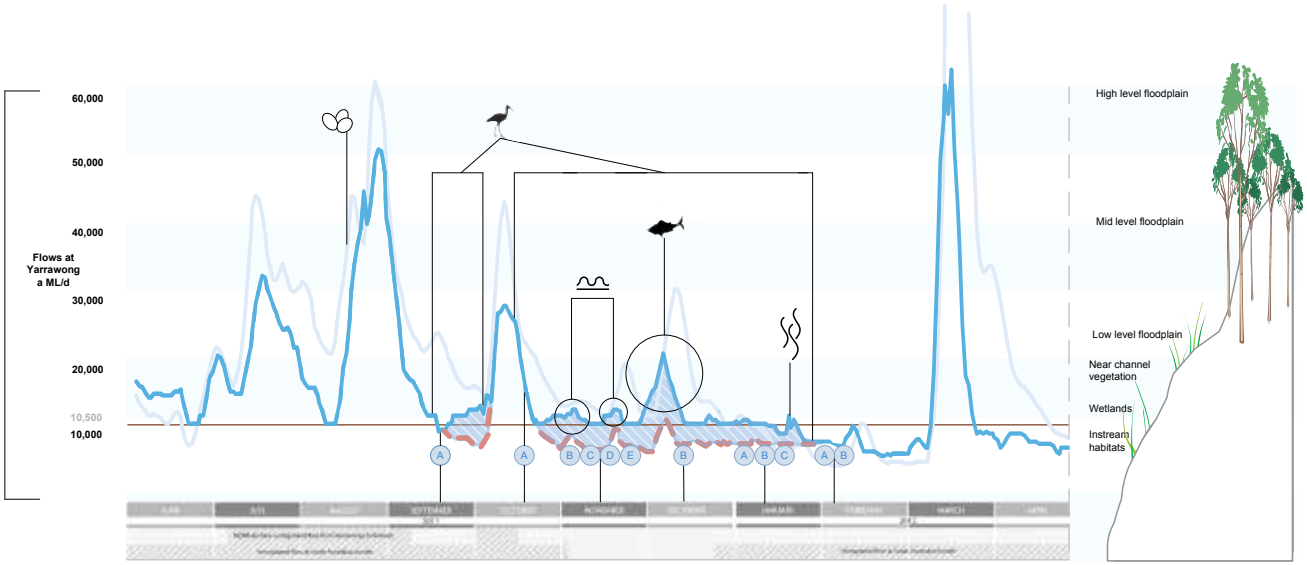
Water source	Location	Timing	Volume (ML)
The Living Murray	Barmah–Millewa Forest	Sep–Feb	120,000
Barmah–Millewa Environmental Water Allocation	Barmah–Millewa Forest	Sep–Feb	279,600
NSW environmental water	Barmah–Millewa Forest	Sep–Feb	15,000
Victorian environmental water	Barmah–Millewa Forest	Sep–Feb	10,000
TOTAL			**424,600 ML**

The environmental water, including The Living Murray water, was used to improve the health of river red gums and other floodplain vegetation. A pulse of water was also delivered in late November to early December to encourage native fish to spawn.

Environmental water was also used to maintain water levels for nesting waterbirds. In August–September 2011 a colonial bird breeding event commenced during a period of higher inflows. By mid-October levels in the River Murray were falling below the top of the riverbanks and there was a risk that the forest would drain before breeding was completed causing birds to abandon their nests. Environmental watering maintained low flood levels for nearly five months so that breeding could be completed.

The watering resulted in significant breeding for ibis, spoonbills, darters and cormorants. It also built on the watering provided in 2010–11. The consecutive years of successful breeding is critical for colonial waterbird populations which had declined after years of drought.

Barmah–Millewa Forest environmental watering timeline 2011–12



LEGEND

- Actual flow at Yarrawonga Weir
- Assumed flow at Yarrawonga Weir without Environmental Water Releases
- Approximate (estimated) flow at Yarrawonga Weir under natural conditions*
- River channel capacity
- environmental watering releases from Hume (424.6 GL)
- A NSW Barmah-Millewa EWA (139.8 GL)
- B Vic. Barmah-Millewa EWA (139.8 GL)
- C The Living Murray (120 GL)
- D NSW Adaptive Env. Water (15 GL)
- E Vic. Env. Water Holder (10 GL)

KEY

- Start of bird breeding event
- Variation in water release to maintain bank stability
- Water released in support of bird breeding
- Water released in support of fish spawning
- Drying phase required

* Natural conditions defined as the estimated flow of the river without regulation or extraction

Gunbower–Koondrook–Perricoota Forest icon site

Waterbird monitoring in Gunbower Forest in January 2012 (photo by Anna Chatfield North Central CMA)

The Gunbower–Koondrook–Perricoota Forest straddles the River Murray and covers about 51,081 hectares. Gunbower Forest is on the southern side in Victoria and the Koondrook–Perricoota Forest is on the northern side in New South Wales. The icon site is a highly significant conservation area and is listed under the Ramsar Convention on Wetlands (Gunbower Forest and Central Murray State Forests). It has a diverse range of habitats, including permanent and semi-permanent wetlands, creeks and open woodlands and is the second largest river red gum forest in Australia.

Providing environmental water this year will build on recent environmental and unregulated (natural) flows to provide native fish with the opportunity to access different habitats and food resources within Gunbower Creek.

Seasonal watering proposal for the Gunbower Forest, Gunbower Creek and Pyramid Creek 2012–13, North Central CMA

The Gunbower–Koondrook–Perricoota icon site depends on floods to sustain the forest, as rainfall alone is not sufficient. Under natural conditions, medium to high flows in the River Murray enter Gunbower Forest through channels distributing water into the wetlands of the forest. Under flood conditions, when volumes of water in the River Murray flow over the banks, large scale flooding occurs across the forest floodplain. River regulation has reduced the frequency of medium-sized spring floods by more than half.

Prior to the high inflows and floods of 2010–11 only small areas of Gunbower Forest had been inundated since 2001, and Koondrook–Perricoota forests had not been flooded since 1993. Relatively small volumes of environmental water had been delivered via regulators on Gunbower Creek to create critical drought refuge areas and maintain wetland vegetation communities in Gunbower Forest. However, the condition of eucalypts had steadily deteriorated since 2005.

The icon site received its first extensive natural flooding in over ten years during 2010–11. Overbank flooding of the River Murray occurred as three major flooding 'peaks' of above 45,000 megalitres a day inundated about 9,000 hectares of Gunbower Forest, and 27,000 hectares of Koondrook–Perricoota Forest, between September 2010 and January 2011. River Murray Unregulated Flows were diverted through the Gunbower Creek system to facilitate the recovery of native fish populations.

Natural flooding occurred again during winter to early spring 2011 and March 2012 refilling permanent and semi-permanent wetlands. The March 2012 floods resulted in overbank flows into the forest, watering about 14,700 hectares of Gunbower–Koondrook–Perricoota Forest and benefitting the creeks, forests and wetlands which were still recovering from the drought.

Progress of the works

New environmental regulators have been built, and older ones upgraded, in the Gunbower Forest (Victoria) to enable water to be delivered more efficiently to the lower forest. They will allow about 2,500 hectares of the forest to be watered.

Further construction, which will allow wide-scale watering of up to 4,800 hectares of the forest, will soon commence. This will involve constructing a one kilometre channel by widening and depending and existing irrigation channel. A large off-take regulator will also be constructed to divert the flow of water from Gunbower Creek into Gunbower Forest. These water management structures will be used to shorten the gaps between natural floods and to ensure that environmental water is used more efficiently. Construction is due for completion in spring 2013.

In the Koondrook–Perricoota Forest (New South Wales) the Torrumbarry Weir provides an opportunity for water to be diverted into the upstream end of the Koondrook–Perricoota Forest. Construction of a channel, levees and regulators has commenced and is expected to be completed in mid 2013. The structures will enable up to 16,000 hectares of the forest to be watered, as well as allow water to be returned directly to the River Murray.

Environmental water delivered to Gunbower–Koondrook–Perricoota Forest in 2011–12

During the 2011–12 year, water was provided to both Gunbower Creek and Gunbower Forest. Gunbower Creek provides an important route for environmental water to enter the Gunbower Forest and allows native fish to move into and out of the forest. Environmental watering included a spring flush, to stimulate fish spawning and migration, as well as summer watering to increase the area available for juvenile fish to access food and habitat.

Water source	Location	Timing	Volume (ML)
The Living Murray	Gunbower Creek	Nov–Mar	6,056
The Living Murray	Gunbower Forest	Dec–Feb	645
Victoria's unregulated entitlement[1]	Gunbower Creek	Mar–May	4,935
TOTAL			**11,636 ML**

1 This water was not from The Living Murray portfolio, but from Victoria's environmental water unregulated entitlement and contributes to environmental outcomes at Gunbower Forest

While environmental monitoring had shown that there was a good diversity of fish species in Gunbower Creek the abundance was low, indicating the potential for flows to improve the overall number of fish in the creek (Victorian Environmental Water Holder 2012–13). Further monitoring in early summer 2011 indicated that the environmental watering was successful in stimulating the movement of a range of native fish species, in particular golden perch.

The Living Murray environmental water was also delivered to Gunbower Forest to top up wetlands. This was to sustain bird breeding which had been triggered by natural high flows in early spring.

Koondrook–Perricoota Forest received natural flows but was not targeted for environmental watering due to the construction of water management structures.

The Thule Creek regulator (Koondrook–Perricoota Forest) under construction in March 2012 (photo by Jamie Hearn, Murray CMA)

Hattah Lakes icon site

Hattah Lakes was not targeted for watering in 2011–12 due to the construction of water management structures which will enhance the ability to provide environmental water to the site in future years (photo by Heather Peachey MDBA)

Hattah Lakes icon site is a large floodplain wetlands system consisting of more than 20 shallow lakes, connected by a network of streams and surrounded by river red gums. Large areas of black box woodland occur higher up on the floodplain. Twelve of the wetlands are listed under the Ramsar Convention as the Hattah–Kulkyne Lakes Ramsar Site.

The Lakes need a more frequent flooding regime, for longer and at the right time of year. Before the recent floods the last good natural flood was in 1993, and the park was suffering.

Brendan Rodgers, The Living Murray Project Manager, Parks Victoria

The wetting and drying cycle for the lakes is largely dependent on inflows from the River Murray during flooding. However, the number and length of floods has been significantly altered by river regulation.

Prior to the last two years the last major flood at the Hattah Lakes was in 1993 and there have been no natural flows into the lakes since 2000. Many of the outlying lakes had not received water since 1996 and floodplain vegetation was in poor health. Emergency environmental water was pumped into the lakes on six occasions since 2005 to maintain existing river red gum communities and to provide drought refuges.

In late 2010 Hattah Lakes received natural inflows for the first time since 2001. This connected the wetlands and creeks and the River Murray for the first time since 2000, allowing fish to move freely into and out of the lakes. Natural flooding again in spring and summer 2010–11 resulted in overbank flows and provided a connection between the River Murray and Hattah Lakes, and the surrounding floodplain, with the majority of lakes still holding water. Not all lakes were inundated so water was pumped into Lake Kramen, filling the lake for the first time since 1993. This watered river red gums which were in a highly stressed condition.

High river flows during spring 2011 resulted in flows to Chalka Creek which helped reconnect the system of creeks and wetlands and filled the lakes before construction commenced in early 2012.

Progress of the works

Three large regulators have recently been constructed and a major pump station (which will enable 1,000 megalitres a day to be pumped) is almost complete. These engineering works will enable nearly 6,000 hectares of wetland and floodplain communities to be watered, including all 12 Ramsar-listed wetlands at the site. This will be achieved by using the regulators to hold the water in the lakes, to reflect more natural durations, and using the pumps to help increase the frequency of River Murray water entering the lakes.

It is expected that the structures will be ready to use for environmental watering in spring 2013.

Environmental water delivered to Hattah Lakes in 2011–12

Hattah Lakes were not targeted for any environmental watering during this year due to the construction of water management structures, which have been underway during 2012 to enhance the ability to provide environmental water to the site in future years.

Watering of the site, in particular Lake Bitterang which has not received flows since 1993, is scheduled for 2012–13. In future water will be delivered to the lakes by a combination of overbank flows, when the Murray is high enough, and pumps when the river is lower.

Chowilla Floodplain and Lindsay–Wallpolla Islands icon site

The completiton of the Chowilla Creek environmental regulator in 2014 will allow water to be used more efficiently and enable up to 50% of the floodplain to be inundated (photo by SA Water Corporation in July 2012)

Chowilla Floodplain and Lindsay–Wallpolla Islands icon site is a highly significant conservation area. Chowilla Floodplain, in South Australia, is the largest floodplain complex (17,700 hectares) in the lower River Murray and forms part of the Riverland Ramsar wetland of international importance. It contains the largest remaining area of natural river red gum forest in the lower Murray and has a highly diverse assemblage of floodplain vegetation. Lindsay, Mulcra and Wallpolla islands are nationally significant wetlands and important fish breeding habitats, supporting Murray cod and other native species. The permanent wetlands are important drought refuges for waterbirds.

Regular watering of selected Chowilla wetlands vastly improved their ecology, particularly back-to-back watering in consecutive years.

South Australian 2012–13 environmental watering plan

Changes to river flow, caused by river regulation, and an increase in salinity are major challenges at this icon site. Most ecological communities on the floodplain cannot be sustained by rainfall alone and are dependent on overbank flows. A flow of 65,000 megalitres a day is required to provide sustained overbank flows. During the drought, flows to South Australia were reduced and there was a complete absence of overbank flows between 2000 and 2010.

Regular flooding is also important for controlling salinity because it recharges the soil and groundwater and flushes away accumulated salt. As a result of less frequent flooding, saline water at shallow depths is affecting the vegetation, lake beds and stream beds.

While droughts are a natural phenomenon, their effects are more serious if the drought is intensified by river regulation or if river regulation and salinity have placed the vegetation in a more stressed condition. This is a problem at all sites but intensifies towards the end of the system.

From 2007 environmental watering sustained river red gum, black box and lignum communities; maintained the flood dependent nature of the understorey; and provided refuge, feeding and breeding opportunities for fish, birds and frogs. To hold this water in the wetlands for extended periods of time, temporary earthern banks were built. Lindsay–Wallpolla Islands also received environmental water, providing drought refuge for waterbirds and frogs.

Prior to environmental watering in 2009–10, Lake Limbra and Coombool Swamp had not received water for more than 10 years, and Lake Wallawalla had not been filled since 1993.

By early September 2010, South Australia experienced unregulated flow events, and flows continued to rise into 2011, peaking at about 93,000 megalitres a day in February 2011. All major wetlands in Chowilla and about 60% of the floodplain were inundated.

Monitoring Chowilla

Environmental monitoring, since 2010, has shown an improvement in the condition of black box. Sites watered several times during the drought years responded more positively to the natural high flows than those that remained dry during the drought.

Large scale movements of Murray cod were observed, highlighting the importance of maintaining a connection between habitats. Freshwater catfish were recorded for the first time, and the spangled perch was recorded for only the third time in South Australia.

Since environmental watering *Cyperus difformus* (dirty dora), a flood-dependent native plant, was recorded for the first time since 1989. Many of the vegetation communities at Chowilla, however, are still recovering and follow-up watering will be essential to continue to build the system's resilience.

The completion of the Chowilla Creek environmental regulator in 2014 will help reduce the severe ecological decline that has resulted from the reduction of overbank flows. It will allow water to be used more efficiently and enable up to 50% of the floodplain to be inundated under a range of conditions.

Progress of the works

A large regulator on Chowilla Creek is under construction. It will raise water levels in the Chowilla anabranch system, allowing up to 9,000 hectares of wetlands and floodplain to be watered. Secondary regulators will control flows into and out of the anabranch system. This work is expected to be completed in autumn 2014.

The construction of two small regulators on the upper Lindsay River anabranches (Victoria) will reinstate about 20 kilometres of flowing habitat for native fish as well as help to protect river vegetation. It is expected that these will be completed in the first half of 2013.

An existing rock weir on Mullaroo Creek (Victoria) will be replaced with a gated structure and fishway to allow for greater control of flows and fish passage. This work is expected to commence in late 2013 and to be completed in mid 2014.

On Mulcra Island (Victoria) the completion of a regulator on Potterwalkagee Creek, in early 2013, will allow for the managed watering of up to 1,000 hectares of the Mulcra Island floodplain as well as opening up the creek for fish passage. The creek is expected to provide important habitat for small fish.

Environmental water delivered to Chowilla Floodplain and Lindsay–Wallpolla Islands in 2011–12

Environmental water delivery to Chowilla wetlands was initially planned as a pumping program to supply The Living Murray water to high value wetlands. However, high flows naturally inundated many sites, reducing the amount of environmental water needed.

The Living Murray provided 3,000 megalitres of water to Coombool Swamp, which had been highly stressed, prior to being watered in 2009. This top up was required to build on the benefits provided by the natural flooding and to improve the health of river red gums, lignum and black box. After watering, over 1,200 waterbirds were recorded included freckled duck, which are listed as vulnerable in South Australia.

The Living Murray water was also delivered to Lake Wallawalla as an important follow-up to the environmental watering the previous year. Black box seedlings on the edge of the lake, which had germinated during previous flood events, were watered again to increase their chance of survival. Aquatic vegetation within the lake was also targeted.

Water source	Location	Timing	Volume (ML)
The Living Murray	Lake Coombool	Dec–Mar	3,000
The Living Murray Unregulated Entitlement (Victoria)	Lake Wallawalla	Feb–Mar	2,000
River Murray Unregulated Flow (RMUF)	Lake Wallawalla		3,877
TOTAL			**8,877 ML**

The Lower Lakes, Coorong and Murray Mouth icon site

Salinity levels in the South Lagoon of the Coorong improved, allowing small-bodied fish and chironomid larvae (a key food source for waterbirds) to become widespread and abundant. Fairy terns (an endangered species) nested at the Coorong in 2012 for the first time since 2006 (photo by Pamela Gillen)

The Lower Lakes, Coorong and Murray Mouth icon site (South Australia) extends over 140,000 hectares, covering 23 different wetland types, from freshwater to hypermarine. This area, where the River Murray meets the sea, is one of the 10 major havens for large concentrations of wading birds in Australia, and is recognised internationally as a breeding and feeding ground for many species of waterbirds and native fish.

A system of barrages isolates the estuarine area, including the Coorong, from the Lower Lakes (lakes Alexandrina and Albert).

> ***We never get the little floods that we used to get — the in-between years. You get the one in 50-year flood like now, but previously there used to be lots of smaller flows that come in September–October and now we never see them.***
>
> Henry Jones, fisherman Goolwa and Basin Community Committee member

Being at the end of the river the condition of this icon site reflects not just local factors but changes across the entire system. The recent drought caused significant problems for the Lower Lakes, Coorong and Murray Mouth. Due to falling water levels, large areas of Lake Alexandrina and Lake Albert were exposed to air and acidified. Fringing wetlands along the river were completely disconnected from the lake edge leading to a loss of species.

The Murray Mouth is the only place where contaminants such as silt, salt and nutrients can be discharged from the Murray–Darling Basin into the ocean. The Murray Mouth closed for the first time in recorded history in 1981 and was opened artificially by dredging. In 2001 it closed again and required continuous dredging to maintain an open channel. Dredging was suspended in December 2010 with the return of flows through the system because of heavy rain throughout the Basin.

During the drought salinity levels escalated in the Coorong. Summer levels in the South Lagoon reached about five times the salinity of seawater, well beyond the thresholds for key plant and animal species.

Regular fish monitoring since 2005 showed a gradual decline in the three threatened small-bodied species that inhabit lakes Alexandrina and Albert — Yarra pygmy perch, Murray hardyhead and southern pygmy perch. Their preferred habitat was isolated and dried out as the drought progressed.

With high inflows over the past two years, as well as environmental watering, water levels in the lakes rose well above the critical acidification threshold levels and Lake Albert was reconnected to Lake Alexandrina. Since September 2010 there has been continuous flow through the barrages, for the first time since March 2007, which has exported salt and improved fish passage.

Juvenile congolli were recorded in the lakes for the first time in over five years (in summer 2010–11) and as the previously isolated fringing wetlands became reconnected to the lakes, populations of threatened fish — Murray hardyhead and southern pygmy perch — entered Lake Alexandrina to take advantage of the new wetland habitat. Salinity levels in the South Lagoon of the Coorong improved, allowing small-bodied fish and chironomid larvae (a key food source for waterbirds) to become widespread and abundant.

Positive responses from diadromous fish species (fish that move between fresh and saltwater environments to complete their life cycles) were also recorded. Lampreys, congolli and common galaxias were recorded using the fishways. These included many juveniles indicating successful breeding.

Pouched (pictured) and short-headed lampreys were captured moving upstream at the barrage fishways, in July 2011, for the first time since 2006 (photo by Qifeng Ye, SARDI Aquatic Sciences)

Case study: Watering fish

Native fish have specific water requirements that determine where they live and when they breed. Some fish, such as golden perch, need a peak in river flow, or a 'pulse', before they start breeding. Flows are also needed for the eggs and larvae to disperse. For other fish such as the purple-spotted gudgeon it may be water temperature that triggers breeding but flows are still important for maintaining their spawning habitat. For diadromous fish, those that move between freshwater and saltwater to breed, flows of water through the barrages at the Murray Mouth at the right time are critical.

Lampreys spend most of their adult life at sea or in estuaries. They are parasitic on other fish. Young adults migrate upstream in spring and summer to breed in rivers. This spawning run can last for a year or more and the adults die afterwards. The young (ammocetes) then migrate down to the sea, usually in spring.

About 250,000 waterbirds were recorded in the icon site in January 2012, with the majority found at the Coorong. Fairy terns returned to their traditional breeding islands and bred successfully in the Coorong for the first time in six years.

Populations of small-bodied threatened fish in lakes Alexandrina and Albert, such as the Murray hardyhead, southern pygmy perch and Yarra pygmy perch, are yet to show signs of recovery indicating that the drought has had long-lasting impacts on threatened fish species.

Several bivalve species which had been rarely encountered in previous monitoring, during the drought, were recorded in the Murray estuary and Coorong during 2011–12. However the smaller bivalve species *(Arthritica helmsi*), which was once abundant in the region, was not recorded.

While aquatic plant communities have continued to improve in Lake Alexandrina there are still several species which have not been recorded since before the drought. The key aquatic Coorong plant, *Ruppia tuberosa*, continues to struggle, probably due to the loss of an effective seed bank over the last decade.

Overall, despite the positive response from the fish and waterbird communities, the ecological recovery of the site is still tenuous.

Environmental water delivered to Lower Lakes, Coorong and Murray Mouth in 2011–12

To complement the natural high flows, 110,064 megalitres of The Living Murray water was released in the Goulburn and Campaspe systems to provide benefits to these river systems, the River Murray Channel, as well as across the South Australian border. The Commonwealth Environmental Water Office also contributed water.

Barrage releases were the highest priority for environmental water to provide fish passage, to reduce salinity levels and to improve connectivity between the river and the ocean.

Timing of water delivery (and quantity) is critical to achieving ecological outcomes. For the Coorong, if too much water is delivered in mid-summer, mudflats will be inundated and waders will be without feeding habitat; if too little water is delivered in midsummer, water levels will drop and *Ruppia tuberosa* recruitment will fail.

Water source	Location	Timing	Volume (ML)
The Living Murray (released from Goulburn River and Campaspe River)	Lower Lakes, Coorong and Murray Mouth	Spring 2011	110,064
The Living Murray Unregulated Entitlement (Victoria)		Spring 2011	32,300
Commonwealth Environmental Water Office[1]	Various, including Lower Lakes, Coorong and Murray Mouth	Throughout year	195,868
Victorian Environmental Water Holder			61,600
TOTAL			**399,832 ML**

[1] This volume does not include return flows from the Goulburn and Broken Creek in Victoria, totalling 130,000 ML. Further information about the use of Commonwealth environmental water is on the Commonwealth Environmental Water Office website www.environment.gov.au/ewater.

River Murray Channel icon site

The River Murray Channel at Chowilla Floodplain (photo by Callie Nickolai SA Department of Environment, Water and Natural Resources)

The River Murray Channel icon site comprises the whole of the river channel from near Albury to the sea — more than 2,000 km. It includes the river bed and banks, the water within the river, and the fringing wetlands and riparian zone that can be watered under regulated flows. The River Murray Channel is the link that connects the other five icon sites.

The recent drought took parts of the River Murray in South Australia to the brink of collapse. Legacies of the drought still remain.

2012–13 Annual Environmental Watering Plan for the South Australian River Murray

The River Murray Channel connects the river's headwaters and floodplains with the Lower Lakes, estuary and ocean. Flows in the river stimulate fish movement and breeding and also help to reduce salinity as well as recharge groundwater. The River Murray also plays a vital role in cycling carbon and other nutrients throughout the river system and onto the floodplains during periods of high flow.

River regulation has greatly altered flows in the River Murray Channel. This includes reducing spring flows because much of the water is now captured in storages. A greater proportion of flow is now contained within the river channel reducing the connection between the river and the floodplain.

Conditions have been degraded all along the river, most of all in the lower floodplains and near the Murray Mouth. The drought had a further impact on the channel and in 2007–08 a number of wetlands were disconnected from the river to achieve evaporative savings for critical human water needs in South Australia.

The high flows, and environmental watering, in the last two years have provided significant ecological benefits along the river channel, reconnecting many anabranches and billabongs, watering river red gums, providing habitat for a range of species, and enhancing the dispersal of native fish. Water delivered to other icon sites also provides environmental benefits to the River Murray Channel on-route.

Progress of the works

River regulation in the form of dams, weirs and barrages have provided barriers to migrating fish. The Sea to Hume Fishway Program is a major construction project, funded by the Living Murray, which will restore migratory passage for native fish along the Murray Mouth, a distance of 2,225 kilometres. The remaining four of the 14 fishways to be constructed along the River Murray will be completed in 2013.

When combined with the fishways built by partner governments, the Sea to Hume program will allow passage for fish through a significant area of the southern Murray–Darling Basin.

Towards the Basin Plan

The Living Murray program has now delivered environmental water through the longest drought in recorded history and during two years of close to record rainfall across the Murray–Darling Basin. Monitoring has shown that the icon sites have continued to improve in the last two years with areas that had been watered during the drought showing faster improvement.

The prospect of The Living Murray being able to make significant progress over the next few years looks encouraging thanks to wetter conditions from late 2010, and the scheduled completion of the water management structures over the next few years.

The focus of The Living Murray is now shifting to how it will be integrated with the new Basin Plan to ensure the most effective use of environmental water within the six icon sites. Greater attention will be given to optimising the use of environmental water with operational trials an important component.

In 2012–13 a third multi-site environmental watering will be trialled using environmental water from a number of water holders, including The Living Murray. Up to 1,000,000 megalitres will be released from Hume Reservoir and 500,000 megalitres from tributaries, subject to water availability. This will be the largest coordinated watering in the Murray–Darling Basin and will require the coordination of multiple water holders.

References and further information

Bureau of Meteorology annual climate summary reports
www.bom.gov.au/climate/annual_sum/annsum.shtml

Commonwealth Environmental Water Office annual water use options 2012–13 reports
www.environment.gov.au/ewater/publications

Environmental water use in New South Wales, Annual Report 2011–12 (in prep)

Floodplain wetland biota in the Murray–Darling Basin 2011 by Kerrylee Rogers and Timothy J Ralph, New South Wales Department of Environment, Climate Change and Water

Murray–Darling Basin environmental water holders report June 2012
www.environment.gov.au/ewater/publications/mdb-environmental-water-holders-report-2012.html

Seasonal watering proposal for the Gunbower Forest, Gunbower Creek and Pyramid Creek 2012–13, North Central CMA

South Australian 2012–13 environmental watering plan
www.waterforgood.sa.gov.au/rivers-reservoirs-aquifers/river-murray/environmental.water.management

The Living Murray annual environmental watering plan 2012–13
www.mdba.gov.au/services/publication/more-information?publicationsid=137

The Living Murray story
www.mdba.gov.au/services/publication/more-information?publicationsid=108

Victorian Environmental Water Holder seasonal watering plan 2012–13
www.vewh.vic.gov.au/news-and-resources/resource-library/seasonal-watering-plan

Environmental monitoring references

Mapping the condition of river red gum and black box stands in The Living Murray icon site (2009)

Annual survey of waterbird communities of The Living Murray icon sites (2008)

For all The Living Murray environmental monitoring reports see www.mdba.gov.au

Environmental water available for use at the icon sites

The Living Murray Initiative

The Living Murray was established in 2002, and is a joint initiative funded by the New South Wales, Victorian, South Australian, Australian Capital Territory and Commonwealth governments coordinated by the Murray–Darling Basin Authority. The Living Murray water portfolio provides a long term average of 479,973 megalitres for use at six icon sites along the River Murray.

Commonwealth environmental water

The Commonwealth Environmental Water Office manages the Commonwealth's portfolio of environmental water entitlements, supporting the Commonwealth Environmental Water Holder established under the *Water Act 2007*. Water entitlements were purchased through the water market or acquired through water savings due to infrastructure improvements. Commonwealth environmental water is managed to protect and restore rivers, wetlands and other environmental assets in the Murray–Darling Basin. In the southern connected Basin around 840,000 megalitres long-term average of Commonwealth environmental water is currently available.

Barmah–Millewa Environmental Water Allocation

Barmah–Millewa Forest is the only icon site that has a dedicated environmental water allocation, apart from The Living Murray water. This allocation is for 100,000 megalitres a year (with an additional 50,000 megalitres per year under certain conditions), provided equally by New South Wales and Victoria. The provision of the allocation is triggered based on a series of rules (rather than by a discrete decision to allocate water, as is the case under The Living Murray) designed to extend the duration of medium-sized floods and break long dry periods. It was first used in 1998 when 98,000 megalitres were released.

The Office of Environment and Heritage (NSW)

As the environmental water holder in New South Wales the Office of Environment and Heritage manages environmental water (established through the provisions of a water sharing plan) and adaptive environmental water (held as water access licences by the Minister for the Environment and others). The Office may also deliver environmental water owned or acquired by other parties, including non-government organisations.

Victorian Environmental Water Holder

The Victorian Environmental Water Holder was established in July 2011 and is the independent statutory body responsible for holding and managing Victoria's environmental entitlements (the Water Holdings). In doing so, the Victorian Environmental Holder helps to protect the environmental values of Victoria's rivers, wetlands and floodplains.

The Victorian Environamental Water Holder works with Victorian waterway managers (catchment management authorities and Melbourne Water), other water holders and delivery partners to ensure environmental water entitlements are used to achieve the best environmental outcomes with the water that is available.

Environmental Water Reserve (Victoria)

This is the legally recognised amount of water set aside to meet environmental needs. The reserve includes minimum river flows, unregulated flows and specific environmental entitlements.

South Australian Environmental Water Reserve

In recognition of the Commonwealth Government's financial contribution to the expansion of the Adelaide Desalination Plant to 100,000 megalitres capacity per annum, the state government

will secure a high reliability entitlement for environmental purposes (6,000 megalitres), and establish an environmental provision per annum (to a maximum of 24,000 megalitres) if South Australia annually receives 1,850,000 megalitres of entitlement flow, which it is entitled to under the River Murray Agreement. Under these arrangements, these volumes of water are to be earmarked for environmental purposes in South Australia's part of the Murray–Darling Basin.

South Australian River Murray Class 9 Water Access Entitlements

The Water Allocation Plan for the River Murray Prescribed Watercourse establishes Class 9 water access entitlements of 200,000 megalitres or 200,000,000 unit shares, with the use of this water limited to wetlands connected at pool level. This volume is the estimated annual evaporative loss from all wetlands that are connected to the South Australian River Murray at normal operating pool level.

A portion of the Class 9 shares has been added to a water licence held by the Minister for the River Murray to manage 31 wetlands.

River Murray Increased Flows (RMIF)

Is water recovered under the Snowy Water Inquiry Outcomes Implementation Deed that is returned to the River Murray as an environmental flow.

River Murray Unregulated Flows (RMUF)

Unregulated flows in the River Murray system are defined as water that cannot be captured in Lake Victoria and is, or will be, in excess of the required minimum flow to South Australia (under the River Murray Agreement South Australia is entitled to receive a minimum of 1,850,000 megalitres a year).

New South Wales and Victoria have existing rights to unregulated flows. If there is a volume of unregulated flow that remains after New South Wales and Victoria have exercised their existing rights it is deemed River Murray Unregulated Flows and is available to prioritise for environmental benefit.

Donated water

People who hold water entitlements sometimes donate water to their local catchment management authority for environmental use.

Other water sources

In addition to environmental entitlements there are other ways that the environment receives water, for example water intended for consumption can refresh river reaches en route to its consumptive purpose.

Commonly used terms

Allocations	This is the amount of entitlement that is available each year, based on the volume of water available. Allocations may increase during the year. It is an asset that can be sold or transferred.
Blackwater	When organic matter, such as eucalypt leaves and twigs, decays it turns water black. It also reduces the amount of oxygen available in the water. Blackwater events are a natural part of the ecology of lowland river systems and although they can cause stress to fish, crayfish and other animals that breathe underwater, they also contribute to the long-term health of the system by allowing carbon to enter the food web.
Carryover	Allows entitlement holders to retain access to unused water into the following season (according to specified rules).
Commence to flow	The flow at which a river starts to run, for example flows into Gunbower Forest start when the flow in the River Murray at Torrumbarry Weir is 13,700 megalitres a day.
Entitlements	The ongoing right to a specified share of the water resource. It is an asset that can be sold or transferred. Different types of water entitlements have different reliabilities of access. High reliability entitlements are expected to provide the full allocation of water more often than low reliability entitlements.
Environmental water	Refers broadly to water used to improve or maintain the health of a river system. The concept encompasses quantity (enough water flowing into and staying in the system), timing (flows at the right times of year or critical points in the ecological cycle) and location (water reaching the parts of the river system that most need it).
Freshes	small or short duration peak flow events. They help to maintain or improve water quality.
Gigalitre	one billion litres.
Megalitres	one million litres.

Long-term cap equivalent (LTCE)	To provide a common unit to equitably measure and compare the amounts of water recovered across a range of projects, entitlement volumes are converted into a common metric known as the long-term Cap equivalent or LTCE. Long-term Cap equivalent volume is a type of average. It takes into account the different characteristics of water entitlements in New South Wales, Victoria and South Australia, and their reliability. For example, to recover an LTCE of 1,000 megalitres (ML) in New South Wales on the River Murray, you could purchase either a 1,053 ML high security water access licence or a 1,237 ML general security water access licence.
Overbank flows	flows that go over the river's banks resulting in the inundation of the adjacent floodplain. Overbank flows are critical for the health of the surrounding floodplain communities, and stimulate fish and bird breeding.
Return flows	in many cases when an amount of environmental water has been delivered to meet its objective, some of the water is returned to the bulk supply system. This amount may be recorded by the storage operator and made available for reuse for environmental benefits downstream (Victorian Environmental Water Holder seasonal water plan).
River regulation	refers to storage of water and manipulation of flow levels and rates through the use of structures such as dams and weirs. Regulated rivers can have flow patterns opposite to those which would naturally occur. This is because water is stored in winter (when river flows would naturally be high) and then released to irrigators in summer (when rivers would naturally be drier).
Unregulated flows	in the River Murray is water that cannot be captured in Lake Victoria and is, or will be, in excess of the required minimum flow to South Australia (under the River Murray Agreement, South Australia is entitled to receive a minimum of 1,850,000 ML a year).
Water year	from July to June each year.

The Living Murray is a joint initiative funded by
the New South Wales, Victorian, South Australian,
Australian Capital Territory and Commonwealth governments,
coordinated by the Murray–Darling Basin Authority.

Australian Government

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