The Living Murray story

One of Australia's largest river restoration projects





Australian Government

Published by the Murray–Darling Basin Authority

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Cover image: The Murray Mouth (photo by Michael Bell © MDBA)

Timeline images (from left to right) Construction of Lock 1 on the Murray River; barrage near Goolwa SA by John Kruger; great egret at Barmah Lake by David Kleinert; stressed river red gums at Chowilla Floodplain by Arthur Mostead; participants in the River, Country, Spirit ceremony by Ali Sanderson; canoeing in Gunbower Forest by Sandra Volk; Murray Mouth by Michael Bell; Lock 15 on the Murray River by Michael Bell.



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Acknowledgments

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The Authority understands that Traditional Owners have a deep cultural, social and spiritual connection to lands and waters and The Living Murray icon sites. It recognises that it is because of this connection that Aboriginal people have provided valuable contributions to The Living Murray program and wish to play an ongoing meaningful role in environmental watering and other icon site management.

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Ruth Wade, Executive Director, Ricegrowers' Association of Australia

Keith Ward, wetland ecologist, Goulburn Broken Catchment Management Authority

Foreword

The Living Murray program has been operating as a large-scale river restoration program since 2002 and, as a successful pioneer in the field, provides a valuable source of information and example about the challenges of returning environmental water to a river.

The story of The Living Murray is about finding ways to work within a federal system to resolve cross-jurisdictional issues and pursue a common purpose. The fact that this has been possible reflects the strength of community-wide determination to reverse the evident deterioration in the Murray River environment.

This publication

The Living Murray story is intended for anyone who is interested in the work of the program or river restoration. It outlines the history of The Living Murray program to date and describes its progress in recovering water for environmental use, building water management structures, and delivering environmental water.

Audited implementation reports on the program are published annually and are available on the Murray–Darling Basin Authority website.

The program

The Living Murray is a joint initiative of the Australian Government and the governments of New South Wales, Victoria, South Australia and the Australian Capital Territory. It was initiated in response to compelling evidence of a long-term serious decline in the health of the Murray River system. Its primary goal is to achieve a healthy, working river for the benefit of all Australians. To this end, it focuses on improving the health of six important 'icon sites' along the river by increasing the flow of environmental water to benefit the plants, animals and communities that the river supports.

Climate context

A variable climate is an intrinsic part of The Living Murray story. For most of the life of the program so far, these conditions have been particularly challenging.

From 1996 to 2010 the Murray–Darling Basin was in drought, characterised by below-average rainfall in autumn and winter and few wet periods. This drought was significantly drier than the Federation Drought (mid-1890s to early 1900s) and the droughts of the World War II era (c. 1937–45).

In spring 2010 and summer 2010–11 there was widespread above-average rainfall across the Murray–Darling Basin.

Timeline







1850

First pumping schemes for Murray River

1863

Intercolonial conference on navigation and management of the River Murray agrees to make major rivers navigable

1887

Irrigation settlements established at Renmark (SA) and Mildura $\left(\text{Vic} \right)$

1901

Federation places constitutional powers relating to water resources in the hands of the states

1902

Interstate Royal Commission examines conservation and distribution of waters of the Murray River

1915

New South Wales, Victoria and South Australia sign the River Murray Waters Agreement, dividing water resources between them and establishing the River Murray Commission

1922

Lock 1 completed on the Murray River (10 more built by 1937)

1936

Hum Dam completed after 17 years of construction

1939

Barrages completed in South Australia to prevent seawater from entering the Lower Lakes

1981

Murray Mouth closes for the first time in recorded history

1987

Murray–Darling Basin Agreement is signed, expanding the resource-sharing arrangements between the states to cover the whole Basin area, establishing the Murray–Darling Basin Ministerial Council and increasing focus on water quality

1993

Murray–Darling Basin Ministerial Council approves an annual Environmental Water Allocation of 100 GL to the Barmah–Millewa forest

1995

Murray–Darling Basin Ministerial Council introduces 'the Cap': a permanent limit on the amount of water that can be extracted each year from Murray–Darling Basin water resources for consumptive uses

1996

Queensland joins Murray–Darling Basin Agreement and Australian Capital Territory agrees to participate

1998

Snowy Water Inquiry recommends environmental water release options, which includes the Murray River $% \left({{{\rm{A}}_{{\rm{A}}}} \right)$

2002

Murray–Darling Basin Ministerial Council proposes The Living Murray river restoration program, releases The Living Murray discussion paper and initiates Basin-wide discussion about restoring the health of the Murray River system

2003

After considering the outcomes of the community discussion process, the Murray–Darling Basin Ministerial Council announces The Living Murray First Step Decision to begin returning the Murray River to the status of a healthy, working river

Fishway at Lock 7 completed

2004

Intergovernmental Agreement on Addressing Over-allocation and Achieving Environmental Objectives in the Murray–Darling Basin formalises the agreement between partner governments to implement the First Step Decision — notably the commitment of \$500 million to recover 500 GL of water for six icon sites, and \$150 million for water management structures to facilitate delivery of this water

Fishway at Lock 9 completed



2005

The Living Murray Business Plan is released, describing the implementation of the actions and milestones in the Intergovernmental Agreement

The Living Murray Community Reference Group is established

2006

Funding commitment for The Living Murray water recovery increased to \$700 million, and Works and Measures Program to \$270 million

The Living Murray Indigenous Partnerships Program is established after the signing of a memorandum of understanding with the Murray Lower Darling Rivers Indigenous Nations

Murray River inflows the lowest on record

Fishway at Lock 10 completed

2007

Murray–Darling Basin Commission enters the water market for the first time to purchase irrigation entitlements

Only 22 GL of water is delivered to the icon sites because of the severe drought. While very good localised environmental benefits are observed, the health of the vast majority of the icon sites continues to decline

Water Act 2007 (Cwlth) is passed, establishing the Murray–Darling Basin Authority, requiring the Authority to develop a strategic plan for integrated management of water resources across the Basin, and establishing the Commonwealth Environmental Water Holder

2008

Water Act amended, giving effect to the Intergovernmental Agreement on Murray–Darling Basin reform

Commonwealth Government purchases water for the first time

First recovered water, 133 GL (LTCE), is listed on The Living Murray's Environmental Water Register

16.522 GL of The Living Murray environmental water is delivered to icon sites (by June 2008)

Pumping begins from Lake Alexandrina to Lake Albert to maintain water levels in Lake Albert and avoid the risk of acidification

Most icon sites with floodplains or shallow waters are dry or almost dry and support few waterbirds

Fishway at Lock 1 is completed

2009

342.5 GL (LTCE) of water is recovered for The Living Murray (by 30 June 2009)

6.45 GL of The Living Murray environmental water is delivered to the icon sites to protect threatened species and maintain important refuges during the continuing drought

Annual aerial survey of waterbird populations finds a 44% increase from the 2008 survey

Record low water levels in the Lower Lakes have resulted in high levels of salinity and increased risk of acidification

16-member Basin Community Committee is established

2010

472.099 GL (LTCE) of water is recovered for The Living Murray (by June 2010)

65.729 GL of The Living Murray environmental water is delivered to the icon sites (to 30 June 2010)

Environmental monitoring indicates that 79% of river red gum and black box communities at the icon sites are in a stressed condition

Environmental works start at Gunbower Forest, Chowilla Floodplain and Mulcra Island

Fishways at locks 3, 5 and 6 are completed

Guide to the proposed Basin Plan for integrated management of Basin water resources is released

2011

486 GL (LTCE) of water is recovered for The Living Murray (by 30 June 2011)

271.176 GL of The Living Murray water is delivered to the icon sites (by 30 June 2011) — the largest volume of water since the program began

Environmental works start at Koondrook–Perricoota Forest

Murray River summer inflows the highest on record

Flooding results in major waterbird breeding events at Barmah–Millewa Forest and other sites along the Murray

Proposed Murray-Darling Basin Plan released



Brief history of The Living Murray

Lock 15 on the Murray River (photo by Michael Bell © MDBA) The Living Murray is a recent, pivotal chapter in a story of river management that stretches back over a hundred years.

Since the 19th century the towns and industries that rely on the Murray River have manipulated it by means of storages (lakes and dams), weirs and barrages to produce a more reliable water supply. These methods successfully regulated the uneven natural flow to deliver steady supplies of water for consumptive purposes — for towns, irrigation and industry. However, they reduced the amount of water in the system and disrupted natural flooding patterns. As became apparent by the late 20th century, this compromised the health of the river and its surrounding environment.

The Living Murray is an attempt to restore the balance by returning water to the environment and building water management structures which will help deliver the water to over 37,000 hectares of significant forests, wetlands and lakes along the Murray River.

About the river

The Murray is the 16th largest river in the world and the major river in the Murray–Darling Basin. It starts in the Snowy Mountains and runs for over 2,500 km through New South Wales, Victoria and South Australia before reaching the sea at the Coorong. The Murray–Darling Basin covers over 1 million sq km - 14% of the total area of Australia. It produces over 70% of Australia's irrigated agriculture and has a population of over two million people.

Natural patterns

For its length and catchment area, the Murray has always contained a relatively small volume of water. River flows were highly variable from season to season and year to year, as conditions naturally range from deep drought to heavy flooding, and the ecosystems of the Murray evolved in tune with these natural patterns of variability.

Values

The Murray River with its floodplains, wetlands, forests and estuarine systems forms a rich, complex, fragile and unique environment that has incalculable ecological value. The Murray is the backbone of Australia's largest river red gum forests and a number of internationally significant wetlands. It supports a diverse range of plant and animal species, many of them rare and endangered.

The Murray also has enormous economic and social value to the Basin area and to Australia as a whole. As well as being the lifeblood of irrigated agriculture it supports a range of other industries (including tourism, mining and commercial fishing) and many large and small towns. The river's cultural value is equally important: it is a fundamental part of the identity of the Aboriginal and other people who live in the Basin area.



The Murray supports a diverse range of plant and animal species. Royal spoonbill and chick in Barmah–Millewa Forest icon site (photo by Keith Ward)

Brief history of river use

Long before European settlement, the Murray River¹ was centrally important to Aboriginal communities and shaped their lifestyles, folklore, history and identity in ways that continue to this day. The relationship of Aboriginal people with the river stretches back tens of thousands of years. The language groups and nations associated with the Murray River include the Wiradjuri, Yorta Yorta, Wamba Wamba, Wadi Wadi, Barapa Barapa, Muthi Muthi, Latji Latji, Barkindji, Wergaia and Ngarrindjeri. Aboriginal people still live on traditional lands around the river and maintain traditional knowledge and values about its resources and management. There are numerous sacred and significant places all along the river.

OTHER NAMES FOR THE MURRAY

Aboriginal names for the Murray River include Millewa, Milloo and Murrundi.

The Murray River has also played a key part in Australia's history since Europeans arrived. Since the 19th century it has helped shape the identity and build the prosperity not just of Basin communities but also of modern Australia as a whole. It was the focus of many early European settlements and quickly became a major transport network, underpinning the development and increasing prosperity of towns and agriculture.

River management

River regulation began around the mid-19th century with the building of the first dams and weirs to improve the reliability of water supply. Large-scale agricultural irrigation made the Basin a major food source for the whole country, bringing wealth and opportunity to the area.

WHAT IS RIVER REGULATION?

River regulation refers to storage of water and manipulation of flow levels and rates through the use of structures such as dams and weirs.

¹ Unless otherwise specified, all references to the river include its surrounding environment of wetlands, floodplains, estuarine systems and forests.

The question of how the states should share the waters of the Murray was a contentious one in the lead-up to Federation. Although South Australia argued that the Commonwealth should be given the constitutional power to manage these resources, the 1901 Constitution gave this power to the states. Since then, the states have jointly managed the river based on two key agreements: the River Murray Waters Agreement of 1915 and then the Murray–Darling Basin Agreement of 1987 and 1992. Both agreements were concerned with the fair distribution of water between states for consumptive purposes.



Figure 1.1 Increase in government storage and diversion in the Murray–Darling Basin²

Over-extraction and the Cap

The amount of water extracted from the Murray for irrigation and other consumptive uses continued to increase from the 1870s to the 1990s. After World War II the level of diversions increased rapidly, tripling in the 50 years to 1994. Essentially, towns, agriculture and industry extracted larger volumes than the river could afford.

In the mid 1980s to early 1990s it was becoming apparent that over-extraction had contributed to significant environmental problems such as salinity and decline of wetland health, and that there needed to be a more sustainable balance between meeting consumptive water needs and looking after the health of the river itself.

² Water diverted for interception activities such as farm dams and forestry plantations are not included in the diversion graph.

The long-term average annual flow of water from the mouth of the Murray into the Southern Ocean had fallen to an estimated quarter of what it would be under natural conditions. River regulation and overallocation were found to have severely affected the ecology of the river and its wetlands. Declining habitats threatened the survival of a number of native species, while certain pest plants and animals thrived in the changed conditions.

In 1995 the Murray–Darling Basin Ministerial Council responded to growing evidence that extraction levels had become unsustainable by agreeing to cap water extractions from Murray–Darling Basin rivers. This agreement is known as the Cap. Since then, extraction levels for each Basin state and territory have been audited against the Cap annually. The Cap was the first significant step towards balancing the economic and social benefits of water extraction against the environmental benefits of leaving water in the rivers. The introduction of the Cap was followed by the establishment of a national water trading market within which participants could buy, sell and transfer tradeable water rights.

The health of the river continued to cause concern and by 2002 there was compelling evidence that the ecological decline caused by river regulation and diversion needed to be actively reversed by some means. Drought was obviously creating immediate environmental stress, but the river's ability to withstand and recover from harsh conditions had clearly been compromised by river regulation and overallocation of water. The possibility that climate change would reduce the amount of water going into the system was a further cause for concern about the river's long-term future. There was widespread agreement about the urgent need for intervention; the challenge was working out what form that intervention should take.

If you've got a healthy, sustainable river then it's great to be able to irrigate and grow stuff. But if the river's not sustainable it starts to die. That's what's happening down here. Year after year we're seeing species being lost from the area. There's no leeches here anymore, there's no shrimps here anymore, there's no little snails in the water that the swans and the musk ducks and the diving birds used to feed on — they're not here anymore. Without that water to be able to flush salt out of the system, things are just dying slowly before our eyes.

Henry Jones



A jetty on the shoreline of Lake Alexandrina (near the Murray Mouth) in 2008, showing the impacts of the prolonged drought (photo by Arthur Mostead © MDBA)

The concept of environmental water

The concept of 'environmental water' became a key part of water policy considerations in the early 2000s. The term refers broadly to water used to improve or maintain the health of a river system — including the plants and animals that live in and around it. 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).

Water-dependent ecosystems such as those in the Murray River system have critical volume and other water flow requirements such as timing and duration of flows. If these requirements are not met over time, the resulting environmental losses can be extremely difficult, sometimes impossible, to reverse.

WHAT IS ENVIRONMENTAL WATER?

Environmental water refers broadly to water used to improve or maintain the health of a river system.

Hence the emergence of the concept of environmental water — allocating water for environmental objectives such as improvements to ecosystem function, biodiversity, water quality and water resource health.

The Living Murray

The Living Murray initiative arose from a major shift in thinking about river management: recognition that to achieve a healthy, functioning river system would require going beyond the Cap and starting to return to the environment water that was previously taken out for consumptive purposes. The practice of trying to prevent or reverse ecological damage by allocating and directing water flows for environmental purposes was not entirely new, but The Living Murray has taken environmental water management to a new level.

Vision, consultation and consideration

In 2001 the Murray–Darling Basin Ministerial Council adopted a vision for the Murray – 'a healthy River Murray system, sustaining communities and preserving unique values' — supported by a set of high-level objectives relating to river health, environmental flow, water quality and the human dimension.

Through the Ministerial Council, the Australian and Basin state governments set up The Living Murray in April 2002 as a long-term river restoration program with the stated aim of restoring a healthy, working river system. The partner governments agreed that in order to achieve this they would need to invest in increasing the volume of environmental water available.

The Ministerial Council initiated a range of scientific and community consultations between 2001 and 2003, including:

- scientific assessments by an expert reference panel to determine how much water was needed to meet environmental requirements
- a number of socioeconomic impact assessments
- an 18-month community consultation process to determine the relative costs and benefits of returning 350 GL, 750 GL or 1,500 GL of water to the Murray
- consideration of a package of works and measures to complement the delivery of environmental water.

REFLECTION: THE SCIENCE

The development of the Murray Flow Assessment Tool, otherwise known as MFAT, was basically the start of The Living Murray program, whereby we needed to identify what types of volumes of water we are likely to require for flora and fauna on the floodplain.

The expert panels basically got a range of researchers or other people with experience to put on paper what they believed are the water requirements of a range of key flora and fauna species, just a ballpark. When do these things need water? What time of year? How deep? For how long? Is there a temperature requirement? Day length? Et cetera, et cetera. Very little of that information actually existed in texts at the time and it was really trying to pull it together.

The science is very much driving it. It's been encouraged right from the start of the whole program.



Keith Ward

Ecologist Keith Ward surveying moira grass in Barmah Forest (photo by Keith Ward)

In July 2002 the Ministerial Council released a discussion paper on improving the health of the Murray River system and finding a fair and practicable balance between social, cultural and environmental needs. Stakeholders — including irrigators, residents, governments, scientists and Traditional Owners — had opportunities to participate in the discussion process.

The discussion paper emphasised the need for increasing environmental flows, which it defined as 'any river flow pattern provided with the intention of maintaining or improving river health'. It talked about making the best use of water currently available to the environment, saving water lost during the distribution process and returning it to the environment, and reducing the amount of water removed from the river for consumptive purposes.

In October 2003 the Murray–Darling Basin Ministerial Council considered the outcomes of the community engagement process, the advice of the Murray–Darling Basin Community Advisory Committee and the recommendations of the Murray–Darling Basin Commission to decide which direction the program would take.

'First Step' Decision

Based on this work, in November 2003 the Ministerial Council announced what is referred to as the 'First Step' Decision: to invest \$500 million over five years to recover 500 GL for six 'icon sites' along the Murray. This was in addition to \$150 million already committed to works and measures for river restoration. Part of the First Step Decision was the announcement of a set of specific ecological objectives for each of the six icon sites. The decision was formalised in an Intergovernmental Agreement between the Commonwealth, New South Wales, Victorian, South Australian and Australian Capital Territory governments in 2004. This included commitments to specified water recovery volumes and funding targets for each jurisdiction.

In summary, the First Step objectives were:

- to recover an average of 500 GL per year of water for the environment
- to deliver a package of infrastructure works to increase the environmental benefits gained from using this water
- to deliver environmental water to improve the health of the six icon sites
- to involve Aboriginal people in planning and management of the icon sites.

The First Step Decision established The Living Murray as the largest river restoration initiative in the country.

WHY 500 GL?

To help understand the economic, social and ecological outcomes of returning varying amounts of water to the Murray River the Ministerial Council gave three reference points — 350 GL, 750 GL and 1,500 GL. These were assessed by an independent scientific reference panel, which concluded that:

- 350 GL would provide little whole-of-river ecological benefit but might provide local benefits to targeted parts of the river
- 750 GL could provide some whole-of-river benefits
- 1,500 GL combined with improved, structural, operational and water quality management, could deliver a 'healthy, working river'.

Based on these assumptions the Ministerial Council considered that 500 GL would be a beneficial first step, particularly when combined with proposed water management structures at icon sites.

The icon sites

The icon sites are six important locations along the Murray River selected for their high ecological value and cultural significance. The focus of The Living Murray is on improving the environmental health of these sites.

They are:

- Barmah–Millewa Forest (just downstream of Tocumwal, near Deniliquin)
- Gunbower-Koondrook-Perricoota Forest (just downstream of Echuca)
- Hattah Lakes (between Robinvale and Mildura)
- Chowilla Floodplain and Lindsay–Wallpolla Islands (spanning the border between South Australia, New South Wales and Victoria)
- the Lower Lakes, Coorong and Murray Mouth (near Goolwa in South Australia)
- the River Murray Channel (running from near Albury to the sea).

All the icon sites are regionally, nationally and internationally significant and are recognised under international agreements such as the Ramsar Convention on Wetlands.



2. The Living Murray icon sites

Dying river red gums at Chowilla Floodplain and Lindsay–Wallpolla Islands (photo by Arthur Mostead © MDBA)

The six icon sites that are the focus of The Living Murray were chosen by the Murray–Darling Basin Ministerial Council and announced as part of its First Step Decision in November 2003. These sites stood out because of their high ecological and economic value and their cultural and heritage significance to Aboriginal people and the whole community. The sites encompass areas of high conservation value — the floodplains, wetlands and forests along the Murray, the Murray's estuary and the river itself.

The icon sites are compelling examples of how river regulation, despite its many social and economic benefits, has negatively affected the ecological health of the river. The problems faced by these sites starkly illustrate the need for an initiative like The Living Murray to return water to the environment.

The six icon sites are all very different from each other. Each has different needs and will receive different types and amounts of watering in order to meet those needs.



Figure 2.1 Location of The Living Murray icon sites

Ecological objectives

The Living Murray is working towards specific ecological objectives to improve the health of each icon site. Overall, the objectives seek to maintain healthy aspects of the sites and to start reversing the decline observed at all sites.

Improving the health of the icon sites will also improve the health of the river system as a whole. It is increasingly clear from scientific research that maintaining the health of floodplain wetlands and forests is vital for the health of the whole river system because these areas play an important role in processes such as filtering sediments, improving water quality by recycling nutrients, mitigating floodwaters, providing breeding and other lifecycle habitat, and replenishing nutrients and microfauna for birds, fish and other animals to feed on.

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 — something that will become increasingly important as the scale of the program's watering activities increases.

Because of the extreme drought experienced by all sites throughout most of the life of the program so far, and because most of the dedicated environmental water was secured in the last few years, the sites are in poorer health than might reasonably have been expected when the objectives were announced in 2004. This is starting to change as a result of the 2010–11 floods and environmental watering in the last two years.

We know that if we get floods on the floodplain most of the water in Barmah actually returns to the Murray River. If you flush the floodplain frequently you're feeding the river through carbon and an inoculum of bugs and fish and all sorts of things, and it's a very healthy river because of the floodplain connection. If you divorce the floodplain from rivers, as they've done overseas, you can starve the river system of energy. Keith Ward

Barmah-Millewa Forest

The Barmah–Millewa Forest icon site covers about 66,600 ha and is just downstream from Tocumwal, near Deniliquin. It straddles the Murray River, with Millewa Forest on the northern side in New South Wales, and Barmah Forest on the southern side in Victoria. It is a continuous forest and wetland system reserved as the Barmah National Park and Murray River Park in Victoria, and as part of the Murray Valley National Park in New South Wales.



Figure 2.2 Barmah–Millewa Forest icon site

The Yorta Yorta people are the Traditional Owners, and have occupied and used the country around the Barmah–Millewa Forest for over 60,000 years. It was one of the more densely populated areas of Australia before European settlement. In 2004, the Yorta Yorta Nation and the state of Victoria entered into a cooperative management agreement over designated areas that included Barmah State Park and Forest (now Barmah National Park). The Yorta Yorta Nation is now formally recognised as a joint land manager of Barmah National Park.



A flooded Barmah Forest (photo by David Kleinert © MDBA)

As a cross-border site, Barmah–Millewa is jointly managed by Parks Victoria and the NSW National Parks and Wildlife Service in accordance with its environmental water management plan. The two states alternate the role of lead icon site manager from year to year. The Living Murray program for this icon site is managed by the Goulburn Broken Catchment Management Authority in partnership with the Victorian Department of Sustainability and Environment and in New South Wales by the National Parks and Wildlife Service.

Ecological significance

The Barmah–Millewa Forest supports the largest river red gum forest in Australia, and is the largest and most intact freshwater floodplain system along the Murray River. It is listed under the Ramsar Convention on Wetlands.

When flooded, Barmah–Millewa Forest provides important feeding and breeding habitat for thousands of waterbirds. About 54 species have been recorded breeding in the forest, including 25 colonial nesting species.

The Living Murray icon site objectives

The vision for the icon site is to maintain and, where practicable, enhance the ecological character of the Barmah–Millewa floodplain. Ecological objectives for the icon site are to:

- restore the extent and distribution of healthy wetland and floodplain vegetation communities
- provide suitable feeding and breeding habitat for a range of waterbirds, including colonial nesting species
- support successful breeding and recruitment of native fish species
- provide high quality feeding, breeding and nursery habitat for native frogs, turtles and crayfish.

Barmah–Millewa Forest already had numerous small to medium regulators to control unseasonal flooding of the forest. No major infrastructure works were proposed for this site because it already has a natural feature called the Barmah Choke, a point in the forest at which the river capacity reduces from 25,000 ML/day to 8,500 ML/day. This acts as a partial dam that naturally helps floodwater to back up onto the floodplain and thereby inundate the forest.

Barmah–Millewa Forest is the only icon site that has a dedicated environmental water allocation apart from The Living Murray: the Barmah–Millewa Environmental Water Allocation. This allocation, established before The Living Murray, is for 100 GL per year (with an additional 50 GL 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. The use of this allocation — most notably the release of over 500 GL in 2005 and 410 GL in 2010–11 — has demonstrated the types of positive outcomes that can be achieved with environmental water.

Challenges³

The ecological health of the forest is under threat from several factors. The main one is river regulation, which has contributed to a decrease in the number of mediumsized spring floods and an increase in the number of small floods in summer, which are undesirable. The reduction in spring flooding is particularly important because the river red gums need frequent flooding in spring to regenerate and grow. It has been calculated that because of river regulation:

³ In this chapter, information about statistics and trends is largely drawn from the detailed accounts provided in Murray–Darling Basin Commission, The Living Murray Foundation Report on the significant ecological assets targeted in the First Step Decision, 2005, available at www2.mdbc.gov.au/subs/dynamic_reports/foundation_report/.

- the frequency of medium-sized spring floods has more than halved
- the duration of inundation of river red gum forest has reduced from an average of five months to two months per year
- the maximum length of dry periods has increased six-fold
- the variability of river flows has reduced: under natural conditions, average monthly flows vary between 100 GL and 980 GL; under current regulated conditions they vary between 110 GL and 400 GL
- the volume of river flows has reduced: downstream of Yarrawonga, diversions reduce annual flow by 25% compared to natural conditions.





The change in flooding regimes through river regulation has compromised the health of river red gums and other vegetation and degraded other aspects of the river environment. For example, there has been a dramatic reduction in the frequency of successful waterbird breeding events.

Barmah–Millewa Forest experienced drought conditions from 2000 to 2010. During that decade, one medium-size flood occurred in 2005, when about 57% of the floodplain was inundated. Otherwise most of the forest's wetlands and waterways completely dried up — many for the first time in decades and some possibly for the first time in recorded history.

Gunbower-Koondrook-Perricoota Forest

The Gunbower–Koondrook–Perricoota Forest icon site is just downstream of Echuca. It straddles the Murray River, with Koondrook–Perricoota Forest on the northern side in New South Wales, and Gunbower Forest on the southern side in Victoria. Koondrook–Perricoota Forest covers 31,150 ha, and Gunbower Forest 19,931 ha.



Figure 2.4 Gunbower-Koondrook-Perricoota Forest

Aboriginal people occupied and managed this resource-rich area for many thousands of years. The forests contain middens, burial sites and canoe trees and are a rich source of information about traditional land use. The Barapa Barapa and Yorta Yorta nations are the traditional owners of Gunbower–Koondrook–Perricoota Forest. A number of other groups may also have connections and interests in the site, including native title claimants, knowledge-holders such as elders' groups, and Aboriginal corporations. They continue to be actively involved in the management of this site.



A stressed environment, Gunbower–Koondrook–Perricoota Forest icon site (photo by David Kleinert © MDBA)

The site is jointly managed by Forests New South Wales, the Victorian Department of Sustainability and Environment and Parks Victoria in accordance with the environmental water management plan. The two states alternate the role of lead icon site manager from year to year. The Living Murray program is managed in Victoria by the North Central Catchment Management Authority and in New South Wales by the Murray Catchment Management Authority in partnership with the state agencies.

Ecological significance

Gunbower–Koondrook–Perricoota Forest is a highly significant conservation area, and is listed under the Ramsar Convention on Wetlands. The site has a diverse range of habitats, including permanent and semi-permanent wetlands, creeks and open woodlands. It has internationally significant biodiversity values, particularly with regard to waterbirds and floodplain and wetland vegetation. Gunbower Forest provides breeding habitat for colonial waterbirds and several rare or threatened species such as the carpet python and white-bellied sea eagle. Koondrook– Perricoota Forest represents a substantial proportion of the total river red gum forest in New South Wales and, when flooded, supports large numbers of waterbirds. Together they form the second largest river red gum forest in Australia (after Barmah–Millewa Forest).

The Gunbower, Koondrook and Perricoota forests depend on flooding from the Murray and its tributaries for their existence, as rainfall is not sufficient to sustain them. Unlike Barmah–Millewa, they have no natural features that assist with flooding. Instead they rely on large natural floods, when the flow volumes in the river are sufficiently high to push water over its banks and onto the floodplain. This is why The Living Murray is funding major works projects at this site.

The Living Murray icon site objectives

Ecological objectives have been set for Koondrook–Perricoota Forest to maintain and restore a mosaic of healthy floodplain communities, as indicated by:

- 80% of permanent and semi-permanent wetlands in a healthy condition
- 30% of river red gum forest in a healthy condition
- successful breeding of thousands of colonial waterbirds in at least three years out of ten years
- healthy populations of resident native fish in wetlands.

The vision for Gunbower Forest is to maintain and improve Gunbower Island by enabling native plants and animals to flourish, restoring the floodplain's health for future generations. Ecological objectives for this component of the icon site include:

- increase area of healthy permanent and semi-permanent wetlands
- ensure maintenance of healthy river red gum communities
- maintain black box and grey box communities
- provide suitable feeding, breeding and refuge habitat for waterbirds, including colonial nesting species
- maintain healthy populations of native fish in wetlands and increase opportunities for riverine fish to access floodplain resources
- increase the diversity and abundance of native frog species within the forest.

Challenges

Under natural conditions the river flow at Gunbower–Koondrook–Perricoota varied throughout the year and from year to year. River regulation has altered the hydrology of the forests, most notably in reducing the frequency of medium-sized spring floods. Flow regulation has been identified as a major threat to the health of this site.

The reduction in frequency of small, regular flow peaks in late winter and spring has created a water deficit which has caused some permanent wetlands to become semipermanent. This has had serious ecological consequences, because permanent water is an important requirement for fauna such as small fish and colonial nesting waterbirds.

It has been calculated that because of river regulation:

- the average volume of monthly flows has greatly reduced
- the duration of inundation of river red gum forests has reduced from an average of five months to two months per year



• the frequency of medium-sized spring flooding has more than halved.

Figure 2.5 Median monthly flows downstream of Torrumbarry Weir under natural and current conditions

Hattah Lakes

The Hattah Lakes icon site is located between Robinvale and Mildura. It is a large floodplain wetland system consisting of more than 20 shallow lakes, streams and temporary swamps and bordered by riverine forest. It is approximately 15 km from the Murray River and is mostly fed by Chalka Creek, which is connected to the Murray at times of medium to high flow. Flood flows from the Murray are therefore vital to the condition of the lakes. The total area of this system is at least 1,120 ha.



Figure 2.6 Hattah Lakes

The site has been a focus for traditional Aboriginal society for thousands of years and has high cultural heritage values and archaeological significance. It provided a rich supply of food and other resources, and was densely populated. There are two groups of traditional owners, the Latji Latji and the Tati Tati, who continue to be involved in the management of the site today.



Birdwatching in Hattah Lakes icon site (photo by Corey Brown © MDBA)

As a national park, Hattah Lakes is managed by Parks Victoria in accordance with the site environmental water management plan. The Living Murray program at this site is managed by the Mallee Catchment Management Authority in partnership with the Victorian Department of Sustainability and Environment.

A feature of the site is the large variation in permanency of aquatic habitats, ranging from episodically flooded lakes to almost permanent lakes. Rainfall can briefly fill the lakes and plays an important part in maintaining vegetation between flood events, but the overall wetting and drying cycle is largely dependent on inflows from Murray River flooding. There have been substantial changes to these inflows as a result of regulation of the river flows. Historically, internal structural alterations and earthworks in Chalka Creek have been carried out to increase inflows from the Murray and partially offset the reduction in flooding from the river.

Ecological significance

Hattah Lakes is a highly significant conservation area and 12 of its 20 or so lakes are listed under the Ramsar Convention on Wetlands. The size of its system of permanent and semi-permanent wetlands is significant, as is the highly diverse range of vegetation species it supports. It plays an important role in the lifecycles of waterbirds, including providing breeding and feeding habitat. Historically the site supported large numbers of waterbirds, and it provides an important refuge for waterbirds in times of drought.

The Living Murray icon site objectives

The vision for Hattah Lakes is to preserve and where possible enhance the biodiversity values of Hattah Lakes and to restore healthy examples of all original wetland and floodplain communities. Ecological objectives for the icon site include:

- restore a mosaic of healthy wetland and floodplain communities to maintain the ecological character of the Ramsar site
- maintain high quality habitat for native fish in wetlands and support successful breeding events
- provide feeding and breeding habitat for a range of waterbird species, including threatened and migratory species
- provide conditions for successful breeding of colonial nesters at least twice every ten years.

Challenges

Flood flows from the Murray River are fundamentally important to the environmental condition of the Hattah Lakes. Under natural conditions some of the lakes were permanent. As a result of river regulation, the lakes now receive reduced inflows and are wet for shorter periods than under natural conditions. This affects vegetation communities and waterbird breeding.

Flows in spring are considerably lower than under natural conditions. In addition, a reduced 'commence-to-flow' threshold (the volume of water at which an area begins to flood) allows water to drain faster from the lakes than under natural conditions. The reduced 'commence-to-flow' threshold in principle allows for more frequent flooding of the lakes. However, the frequency of flood events has been reduced by flow regulation, and most flows still fail to reach the inflow threshold. The floods that do occur do not last as long, and there is more time between them.


Figure 2.7 Comparison of the natural and current median monthly flows passing downstream of Euston Weir



Environmental watering helped to create drought refuges and prevent loss of species such as the endangered Murray hardyhead (photo by Gunther Schmida @ MDBA)

Chowilla Floodplain and Lindsay-Wallpolla Islands

The Chowilla Floodplain and Lindsay–Wallpolla Islands icon site is near the border between South Australia, New South Wales and Victoria. It comprises four separate locations: Lindsay, Mulcra and Wallpolla islands in Victoria, and Chowilla Floodplain spanning South Australia and New South Wales.



Figure 2.8 Chowilla Floodplain and Lindsay–Wallpolla Islands

The Maraura, Ngintait and Erawirung people occupied the Chowilla area for many thousands of years before European settlement. The area is rich in Aboriginal cultural heritage sites, including burial grounds and middens. Lindsay, Wallpolla and Mulcra islands are highly significant for Aboriginal people and there is an extremely long history of occupation by the traditional owners, the Wergaia and Latji Latji people. The islands have a number of culturally important places, including burial grounds and middens.



Chowilla Floodplain and Lindsay–Wallpolla Islands icon site (photo by Corey Brown © MDBA)

Chowilla Floodplain and Lindsay–Wallpolla Islands are separately managed by the South Australian Department for Water, the New South Wales Office of Water, and Parks Victoria in accordance with the environmental water management plan. Implementation of The Living Murray program is managed by the Mallee Catchment Management Authority, the South Australian Department for Water and the New South Wales Office of Water.

Ecological significance

The Chowilla Floodplain and Lindsay–Wallpolla Islands icon site is a highly significant conservation area. It has a diverse range of both terrestrial and aquatic habitats and supports populations of rare, endangered and nationally threatened species. Chowilla Floodplain is the largest floodplain complex (17,700 ha) in the lower Murray River and forms part of the Riverland Ramsar wetland of international importance.

The Chowilla floodplain is one of the last remaining parts of the lower Murray floodplain that retains much of the area's natural character and attributes. Significantly, 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 with diverse landforms and a range of native fish and bird species. They are important fish breeding habitats, supporting Murray cod and other native fish nurseries. The permanent wetlands are important drought refuges for waterbirds and are used for breeding by some species. The ephemeral wetlands are important for waterbird breeding.

The Living Murray icon site objectives

Ecological objectives have been set for Chowilla Floodplain and Lindsay–Wallpolla Islands. The objectives for the Chowilla Floodplain are to maintain high biodiversity values, as indicated by maintenance of:

- high value wetlands
- the current area of river red gum forest
- at least 20% of the original area of black box vegetation.

The vision for Lindsay–Wallpolla Islands is to maintain and restore a mosaic of healthy floodplain communities which will ensure that native species survive and flourish throughout the site. Ecological objectives for this component of the icon site are to:

- increase the diversity, extent and abundance of wetland vegetation
- increase abundance, diversity and extent of distribution of native fish
- provide habitat for a range of waterbirds, including migratory species and colonial nesters.

Challenges

Flow regulation and changes to salinity and groundwater are major challenges at this icon site. Drought has been a serious problem. While droughts are a natural phenomenon, their effects are more serious if the drought is intensified by flow regulation or if flow regulation and salinity have placed the vegetation in a more stressed condition than it would otherwise be in. This is a problem at all sites but intensifies towards the end of the system, as has happened at Chowilla, Lindsay–Wallpolla Islands and Mulcra Island.

Historically this site has depended on flooding from the Murray River and a system of more than 100 km of anabranch creeks. Various factors — primarily river regulation limiting flooding — have reduced the area's ability to sustain plant and animal communities. As a consequence of river regulation, including large diversions of the river:

- typical flows each month are considerably less than they would be under natural conditions: it has been calculated that the median flow in the Murray River at the South Australian border has been reduced to 39% of its natural volume
- the frequency and duration of all but the largest floods (which are rare) has been reduced, with the biggest impact on medium-sized floods. For example, under natural conditions a flood of 80,000 ML/day (covering about 50% of the Chowilla Floodplain) occurred almost every two years. Such flows now occur only once in approximately eight years
- temporary wetlands flood less frequently
- anabranch creeks that were dry for the greater part of the year are now permanently flowing. It is worth noting, however, that while the anabranches are now permanent rather than temporary they are now ecologically important given that they represent some of the only diverse flowing habitats in the Murray.

Regular flooding is 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.

The poor condition of an increasing proportion of the vegetation across Chowilla and Lindsay–Wallpolla (including Mulcra Island) has been linked to flow regulation and groundwater level and salinity. Sustained periods of low flows and lower frequency, shorter duration and lower magnitude flooding has affected plant and animal communities and caused considerable deterioration in ecosystem health throughout this site.



Figure 2.9 Median monthly flows to South Australia under natural and current conditions

Lower Lakes, Coorong and Murray Mouth

The Lower Lakes, Coorong and Murray Mouth icon site is near Goolwa in South Australia, at the downstream end of the Murray River system. The Coorong is a long, shallow lagoon, 140 km long, separated from the Southern Ocean by a narrow sand dune peninsula. A system of barrages separates the estuarine area, including the Coorong, from the Lower Lakes (Lake Alexandrina and Lake Albert). Water in the Coorong, Lower Lakes and Murray Mouth varies from fresh to hyper-saline depending on flows over the barrages and how open the Murray Mouth is.

The traditional owners are the Ngarrindjeri people. They are strong advocates for the return of flows to ensure that the health of the area is maintained and improved. They believe that the land and waters must be healthy if Ngarrindjeri people are to be healthy.



Figure 2.10 Lower Lakes, Coorong and Murray Mouth icon site



Dredging the Murray Mouth to keep it open. The Murray Mouth closed in 2001 and required continual dredging to keep it open until 2010, when it opened again due to high rainfall throughout the Basin (photo by Michael Bell © MDBA)

The site is managed by the South Australian Department for Water in accordance with the icon site environmental water management plan.

Being at the end of the system, the Lower Lakes, Coorong and Murray Mouth icon site is unique. Its condition reflects not just local factors but things going on in the entire system, and its ecological challenges highlight more than those of any other site the seriousness of the problems to which overallocation has contributed.

The recent sustained drought in the Murray–Darling Basin was the worst since records began and caused problems of unprecedented intensity and scale for the Lower Lakes, Coorong and Murray Mouth, particularly acidification and salinisation. More than 12 years of below-average rainfall and increased evaporation resulting from record high temperatures produced the longest period of low flows since river regulation began. During the drought, vast areas of lakebed in Lake Alexandrina and Lake Albert were exposed to air and acidified — that is, they reacted with oxygen to form acid sulfate soils containing sulfuric acid. Acidification can also cause toxic metals to be mobilised in solution. When the soil is wet again, from rainfall or river flow, the acid and metals can spread and affect large areas. Acid sulfate soils can also cause rapid deoxygenation of the water. With an ongoing lack of flows, by 2010 localised acidification at the Lower Lakes was seriously affecting water quality and the health of plants and animals. Management agencies managed the situation to reduce the impact in areas that had been exposed so that the entire lake system did not acidify.

Low flows caused many wetland areas of the Lower Lakes, Coorong and Murray Mouth to reach salinity levels well above their historical ranges. In Lake Alexandrina and Lake Albert, salinity levels rapidly increased as water levels dropped. Salinity levels also escalated in the waters of the Coorong, where summer levels in the South Lagoon reached about five times the salinity of seawater, beyond the thresholds for key plant and animal species. These levels severely affect the entire landscape and biodiversity.

One of the biggest threats to fringing wetlands of the Lower Lakes was their complete disconnection from the lake edge (often several hundred metres away) and consequent long-term dryness. There was an almost complete lack of aquatic habitat — that is, inundated vegetation — within the lakes, leading to a loss of endemic species.

Ecological significance

The Lower Lakes, Coorong and Murray Mouth icon site is a highly significant conservation area, and Lake Alexandrina, Lake Albert and the Coorong are listed under the Ramsar Convention on Wetlands. The icon site includes a diverse range of ecosystems covering the full spectrum between saline and freshwater environments as well as ephemeral to permanently watered systems. This area, where the Murray River meets the sea, is one of the most important havens for large concentrations of wading birds in Australia, and is recognised internationally as a breeding ground for many species of waterbirds and native fish.

The Living Murray icon site objectives

The objectives for the Lower Lakes, Coorong and Murray Mouth are to achieve a healthier Lower Lakes and Coorong estuarine environment, as indicated by:

- open Murray Mouth
- more frequent estuarine fish spawning and recruitment
- enhanced migratory waterbird habitat in the Lower Lakes and Coorong.

Challenges

This site is acutely sensitive to water management in the whole Murray–Darling Basin. Being at the end of the Murray River, flows here are affected by regulation and diversions along the length of the whole river, and the condition of this site represents the culmination of all upstream local impacts.

The ecological health of the Lower Lakes, Coorong and Murray Mouth has been in decline for some time. A major cause is the considerable change to the natural flow regime caused by regulation in the catchment, which has dramatically reduced flows past the barrages.

Regulation of the river by headwater storages and diversion structures and increasing levels of diversions have dramatically reduced the volume of flow to the estuary. It has been calculated that:

- there has been a threefold reduction in the frequency of medium-sized flooding, and the duration of these events has decreased
- low flows, which occurred 7% of the time under natural conditions, now occur 66% of the time
- flow to the Murray Mouth now stops on average once every two years (compared to once every 20 years naturally)
- the median annual outflow from the Murray system to the sea is only 27% of the natural outflow.



Figure 2.11 Median monthly flows over the barrages under natural and current conditions

During the prolonged drought the lower flows from the Murray River led to the water levels in Lake Alexandrina and Lake Albert falling below sea level. The wetlands fringing the lakes dried and became disconnected from the main water bodies. Vast areas of the lakebed became exposed to air and acidified. Inflows were so low that salt was not flushed through the barrages to the sea for some years. The resulting increasing salinity damaged the ecology of the Lower Lakes as well as the Coorong, which was affected by a constricted Murray Mouth and an absence of freshwater inputs because there were no flows over the barrages.

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 so closure of the mouth has serious ecological consequences. The Murray Mouth closed, for the first time in recorded history, in 1981 and was opened artificially. In 2001 it closed again and required continuous dredging to maintain an open channel until December 2010. Dredging was suspended in late 2010 with the return of flows through the system because of heavy rain throughout the Basin.

We never get the little floods that we used to get — the in-between years. You get one 50-year flood like now, but previously there used to be lots of smaller flows come September/October and now we never see them, they never get here — they're used by mainly irrigators before they get here. We hear about rain events in the eastern states but they just never get down here. And that's really important: we need those smaller ones to get down here. You've got to have these little floods that used to come and kept the water fresh.

The Murray Mouth is the most difficult part but also the most important part, because this is where we get rid of all the salt. This is the only place that can exclude salt from the Murray–Darling Basin. It's really important for water to flush the salt. There's 2 million tonnes of salt that comes down the river each year, and it's really important for it to be flushed out to sea like it's been doing for many thousands of years.

Henry Jones

River Murray Channel

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 riverbed and banks, the water within the river and the surrounding dependent riverine ecosystem. The River Murray Channel is the link that connects the other five icon sites.



Figure 2.12 River Murray Channel icon site

Aboriginal communities have lived along the river for many thousands of years. These language groups and nations include the Wiradjuri, Wergie, Yorta Yorta, Wamba Wamba, Wadi Wadi, Barapa Barapa, Muthi Muthi, Latji Latji, Barkindji, Wergaia and Ngarrindjeri. The groups are culturally diverse but share a sense of custodianship and similar spiritual, cultural, economic and social values in relation to the river environment. The river and floodplain are central to the beliefs and lives of Aboriginal people and contain many sacred and significant places.



River Murray Channel icon site (photo IOJ © MDBA)

The Living Murray Environmental Watering Group oversees the management of the river as an icon site in accordance with the site environmental management plan. The Murray–Darling Basin Authority coordinates The Living Murray activities for the site.

Ecological significance

The River Murray Channel connects the river's headwaters, lowlands, floodplains and wetlands (including the other icon sites), estuary and ocean. The integrity of these systems depends on water, sediment and nutrients delivered from the river channel.

The River Murray Channel was chosen as an icon site because, for effective management of natural resources, it is important that the other five sites be treated not as discrete, isolated locations but as part of a bigger system connected by the Murray River. The River Murray Channel is the backbone of a unique landscape. Its flooding and drought patterns and seasonal flow variations have produced habitats that have resulted in the evolution of unique plants and animals. Many of these species depend on natural Murray River characteristics such as patterns of drying and wetting. This means that if wetlands that naturally dried up for part of the year are permanently inundated through river regulation, or if flood flows are restricted by water storages, the plants and animals that have evolved to thrive in natural conditions specific to the Murray River struggle to survive. Most native fish, for example, have breeding cycles that are directly linked to natural flood patterns.

The Living Murray icon site objectives

The objectives for the River Murray Channel are to:

- increase the frequency of higher-volume flows in spring, that are ecologically significant
- overcome barriers to migration of native fish species between the sea and Hume Dam
- maintain current levels of channel stability.

Challenges

The River Murray Channel is the main 'highway' for delivery of water to irrigators and towns along the system. It is highly regulated by dams, weirs and other means and historically has been managed to serve consumptive priorities (such as irrigation) rather than environmental priorities. This site highlights the tension between the consumptive and environmental uses of water and the fact that The Living Murray is largely operating within a broader river system that has evolved over the past century around consumptive priorities. The challenge of modifying management of the system to include environmental concerns is substantial and will take a long time to resolve.

One of our greatest challenges is to take the next step so that we go from just delivering environmental water within a regulation system that's designed for consumptive use to actually redesigning the river regulation system so that river regulation is all about river system management with all of its many users, including the environment, instead of just jamming the environment into a system that's designed for consumptive use.

Linda Broekman

Extensive river management has greatly altered flows in the River Murray Channel. Significant changes include:

- increase in flow at Albury by approximately 12% because of the extra water diverted into the basin from the Snowy Mountains Hydroelectric Scheme
- greatly reduced flows downstream, below major diversions like Yarrawonga Weir
- reduction in median annual flow to the sea to only about 27% of what it would be under natural conditions
- diversions of water from the River Murray Channel, largely for irrigation, accounting for about half of the Murray–Darling Basin's annual runoff
- reduced natural seasonal and day-to-day variations in flow
- reduction in spring flows because much of the water from naturally high spring flows is captured in storages instead
- a greater proportion of flow now being contained within the river channel, reducing the connection between the river and the floodplain
- reduced flows from the river to nearby billabongs and anabranches
- a change in the season of peak flow in the upper parts of the river.

Overall environmental conditions are degraded all along the river, most of all in the lower floodplains and near the Murray Mouth. A number of the species and ecological communities the River Murray Channel supports are under threat, including fish populations, wetlands and riverine habitat. Water quality is threatened by acidification, salinity, blue-green algae and turbidity (a high load of suspended sediment).

Community consultation

The Living Murray consults directly with communities at each icon site in a number of ways to give everyone the opportunity to be fully informed and able to comment on and contribute to the program's activities.

Icon site consultation reference groups have been formed to advise on local development and implementation issues relating to the icon site management plan, and to consult with other local and regional groups that have an interest in the site. Community forums have been held throughout the implementation of the First Step to discuss how the river's various needs and functions should be prioritised and combined, and how the desired balance can be achieved.⁴

⁴ For community consultation on the works and measures program, see Chapter 4.

Indigenous partnerships

The Living Murray respects the knowledge and values of Traditional Owners, and consults them on all major program activities.

Consultation with Aboriginal stakeholders is chiefly through The Living Murray's Indigenous Partnerships Project. The project was formally established through a memorandum of understanding between the Murray–Darling Basin Commission and the Murray Lower Darling Rivers Indigenous Nations in 2006. This project employs Indigenous facilitators or contracts Indigenous organisations, which engage with Aboriginal people on The Living Murray program.

A major part of my role is problem solver. If there's a problem I've got to come up with a way to fix it and get proper engagement to keep the thing rolling. I try to step back, take a look at the bigger picture — you've got to take it from the Indigenous side, the government agency side, their point of view, what they've got to achieve, then come out and work out a solution from there. Ken Stewart

The Indigenous Partnerships Project has been valuable to Aboriginal communities in enabling them to reconnect with their Country and identify and protect areas of cultural significance during the Living Murray works and measures phase.⁵ This phase has also resulted in the employment and training of Aboriginal people, who act as cultural heritage monitors.

The Indigenous Partnerships Program has also tested new and participative methodologies to develop cultural maps that provide a graphical reference of Aboriginal social, spiritual, cultural, and environmental interests in the icon sites. These cultural maps remain the property of the Traditional Owners who produce them.

It is hoped that, as the Living Murray program progresses, it will continue to engage with Aboriginal communities so that Indigenous values and objectives can inform and enhance the environmental water management plans at the icon sites.

⁵ For Aboriginal consultation on the works and measures program, see Chapter 4.



3. Recovering water

Rice crop in southern New South Wales (photo by Arthur Mostead © MDBA) Essentially, water recovery is about transferring water from consumptive uses to environmental uses. The Living Murray has successfully undertaken a number of large-scale water recovery measures to secure a portfolio of environmental water entitlements. The water recovery effort can be seen as one of two pillars of The Living Murray initiative — the other being the building works and measures discussed in the next chapter — that will enable it to deliver water to icon sites on an ongoing basis to improve their health.

The First Step targets for water recovery were:

- recover a permanent annual average supply of 500 GL of water to be used to achieve environmental objectives at the icon sites
- invest up to \$700 million to achieve the water recovery objective.

The Living Murray has had outstanding achievements in this area:

- it has reached 95% of the 500 GL target originally set
- a number of its water recovery projects have been innovations that have paved the way for current water recovery efforts beyond The Living Murray.

A unique commitment

The commitment to invest \$700 million to recover 500 GL (LTCE⁶) for The Living Murray was unique in terms of its:

- size and scale: at the time it represented, in volume terms, the biggest effort in Australia to recover water for the environment
- joint nature: it was the largest multijurisdictional water recovery effort in Australia, with the overall \$700 million and 500 GL targets apportioned across six jurisdictions — New South Wales, the Australian Capital Territory, Victoria, South Australia, the Commonwealth and the Murray–Darling Basin Commission (now the Murray–Darling Basin Authority).

⁶ Long-term cap equivalent — see explanation on page 49.

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KEY CONCEPTS

Water recovery: Seeking to redress overallocation by permanently returning water from the consumptive 'bucket', or from water efficiencies, to the environmental 'bucket'.

Environmental water: Water used to achieve environmental outcomes, including benefits to ecosystem functions, biodiversity, water quality and water resource health.

There are two types of environmental water: 'planned water' and 'held water'. Planned environmental water is established through the provisions or rules of a water sharing plan. Held environmental water consists of water entitlements held (owned) by someone. All the water recovered by The Living Murray is held environmental water.

Managing water recovery

A necessarily complex management framework was established to coordinate the joint water recovery effort between the states and the Commonwealth.

The Living Murray Business Plan established a clear framework for managing the water recovery process. Briefly, any of the partner governments could propose a specific water recovery project. The project is then assessed by all the partners and, if approved, is developed and implemented.⁷

Projects are all recorded on a register, and a comprehensive set of rules — including checks and balances — ensures that funds are invested wisely. Once projects are completed the jurisdictions receive due credit against their targets for investment and water recovery. For each project, all governments were given the option to cross-invest in each other's projects.

⁷ The water recovery management framework is described in detail in Murray–Darling Basin Commission, *The Living Murray Business Plan*, 2007, available at http://thelivingmurray2.mdbc.gov.au/__data/ page/1327/TLM_Business_Plan_2007_Revision.pdf.

Projects

A total of 18 water recovery projects were approved for implementation.⁸ These are listed in table 3.2.

Water has been recovered in a few different ways across these projects. The recovery methods fall into three main categories:⁹

- infrastructure improvements to increase water-use efficiency (including on-farm efficiency improvements)
- market-based recovery (that is, buying water entitlements)
- regulatory changes (changes to the way water is shared and allocated to users under a state's water sharing plan).

Of the total volume of water recovered for the Living Murray, 30% has been through infrastructure improvements, 45% through market-based recovery and 25% through regulatory changes.

Water entitlements

The water recovered under these projects is secured for The Living Murray in the form of a variety of types of water entitlements.¹⁰ These include:

- standard irrigation water entitlements, which can usually be traded and carried over to subsequent years as per rules applying to other water holders
- specific environmental entitlements, including those created for water that has been recovered by reducing the losses from the river system in some way
- other water entitlements, including those that are accessible only when flows are high or for certain specified periods or purposes.

Different types of water entitlements have different reliabilities of access. Highreliability entitlements are expected to provide the full allocation of water more often than low-reliability entitlements. A range of low, medium and high reliability offers the

⁸ The full list is available on the Murray–Darling Basin Authority website at www.mdba.gov.au/programs/ tlm/water-recovery-measures. It is still possible that a further project will be proposed and implemented by the ACT.

⁹ For more information about these methods, see www.mdba.gov.au/programs/tlm/faqs#How_is_water____ recovered___.

¹⁰ The current make-up of the entitlement portfolio held by The Living Murray is available at www.mdba.gov. au/programs/tlm/programs_to_deliver/environmental_delivery/water-holdings.

best balance between providing guaranteed water in low-rainfall years and providing the largest volume of water possible in high-rainfall years. Because of this, The Living Murray water portfolio includes a broad range of entitlements in terms of reliability.

LONG-TERM CAP EQUIVALENT

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 long-term cap equivalent, or LTCE.

LTCE 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 Murray River, you could purchase either a 1,053 ML High Security Water Access Licence or a 1,237 ML General Security Water Access Licence.

LTCE equates approximately to the theoretical long-term average (using a hydrological model based on climate data from 1891 to 2003) increase in flows into the Murray River resulting from implementation of a water recovery measure.

The 500 GL target is in this LTCE metric. Over the long term, the average volume available to The Living Murray is estimated to be around 500 GL, but the actual volume available in a given year will vary significantly depending on annual rainfall and allocation announcements.¹¹

Achievements

The Living Murray is close to achieving its First Step water recovery targets. The program also broke new ground in working out the best ways to recover water for the environment — especially through its pioneering decision to 'buy back' water from the market.

¹¹ To see what individual entitlement volumes equate to in GL LTCE, see the entitlement portfolio table at www.mdba.gov.au/programs/tlm/programs_to_deliver/environmental_delivery/water-holdings.

By the end of 2010 The Living Murray had virtually met its volume and investment targets for water recovery. Out of a total of 18 water recovery measures, 14 were finished and the rest were near completion.

The Living Murray is expected to recover 486 GL of its 500 GL target (more than 97%), and to expend over \$690 million of its \$700 million target (more than 98%).

Jurisdiction	Indicative investment target (\$ million)	Actual investment at 30 June 2010 (\$ million)	Indicative water recovery target (GL LTCE)	Water recovered at 17 December 2010 (GL LTCE)
New South Wales	115	113.1	249	217.498
Victoria	115	114.8	214	218.812
South Australia	65	65.2	35	41.528
ACT	5	0	2	0
Australian Government (DEWHA) ¹²	200	199.6	-	-
Australian Government (MDBA)	200	197.6	-	_
Total*	\$700	\$690.4	500	477.838

Table 3.1 Progress towards TLM investment and water recovery targets at 17 December 2010

*ACT was yet to bring forward its water recovery project for approval at the time of writing

In the early years of The Living Murray the projects put forward were mostly infrastructure based and took some time to develop and implement. A significant step forward was working out the concept and technicalities of recovering water from the market by buying it from water entitlement owners. These market-based measures and a number of on-farm efficiency projects helped accelerate the pace of water recovery.

¹² Water recovered by the Australian Government (Department of the Environment, Water, Heritage and the Arts and MDBA) is apportioned across state targets according to the source of water recovery on completion of the measure.

Measure title	Proponent	Measure type	Volume recovered (GL LTCE)	Type of entitlements recovered
Murray Irrigation Ltd supplementary water access licence	NSW	Market based	17.8	NSW Supplementary
NSW package B	NSW	Infrastructure	56.0	NSW General Security
NSW market purchase measure	NSW	Market based	115.27	NSW High Security NSW General Security NSW Supplementary
Tandou Limited supplementary water access licence	NSW	Market based	9.3	NSW Supplementary
RGA on-farm water efficiency A1	MDBA	Infrastructure	1.19	NSW General Security
NSW wetlands water recovery — stage 1	NSW	Infrastructure	0.55	NSW High Security VIC High Reliability
Pipe it	NSW	Infrastructure	0.16	NSW General Security
RGA on-farm water efficiency round 2	MDBA	Infrastructure	5.84	NSW General Security
Goulburn–Murray Water recovery package	VIC	Regulatory and infrastructure	144.9	VIC Low Reliability VIC High Reliability
Shepparton Irrigation Area modernisation	VIC	Infrastructure	29.3	VIC Low Reliability VIC High Reliability
Lake Mokoan water recovery package	VIC	Infrastructure	28.1	VIC Unregulated
Securing government held water for environmental use	SA	Other	13.0	SA Water Entitlement
Purchase from willing sellers — stage 1 (5 GL)	SA	Market based	5.0	SA Water Entitlement
Securing government held water and purchases from willing sellers	SA	Market based	17.0	SA Water Entitlement

Table 3.2 The Living Murray Environmental Water Register at 17 December 2010

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Measure title	Proponent	Measure type	Volume recovered (GL LTCE)	Type of entitlements recovered
Water through efficiency tender	Aust Govt	Infrastructure	0.18	NSW General Security
Pilot market purchase measure	MDBA	Market Based	13.29	NSW General Security VIC High Reliability
The Living Murray water purchase project	MDBA	Market based	18.65	VIC High Reliability SA Water Entitlement
Sustainable soils and farms on-farm reconfiguration demonstration	MDBA	Market based	2.33	VIC High Reliability
Total			477.86	

HOW MUCH WATER WILL BE AVAILABLE EACH YEAR?

The water recovered for The Living Murray use is subject to annual allocations in the same way that water for irrigation is. This means that the amount of water actually available to the program in any given year will vary depending on climate conditions and state allocations — the same factors that affect all owners of water entitlements.

In dry years there may be significantly less than 500 GL available for use, and in wet years there may be significantly more, particularly when the unregulated flow licenses are available. The Living Murray is expected to end up with a total (not LTCE) of around 1,000 GL worth of water entitlements, all of which could be available in very wet years.

Innovative solutions

The achievements of The Living Murray's water recovery effort go well beyond meeting a target.

To begin with, even the concept of recovering water for the environment required a major shift in the way people — particularly those involved in river operations — thought about water use. From a complete focus on efficiently delivering water to purchasers for consumptive uses, river operators and managers had to adapt to the idea of environmental water as a defined use.

Buying water from the market was a bold and creative solution and a huge step forward not just for The Living Murray but also for environmental water recovery efforts more broadly.

It took a while to recover the water getting hold of entitlements. That was difficult, complicated and the first time it had been done. There were lots of policy problems that had to be worked through, and the tension between old and new had to be overcome.

Because every decision you make with water can have third-party impact. Every time you change the way you do something, it may change the probability of someone's entitlement or allocation being higher or lower both in a particular year and as an average over the long term. So it's very complicated; it took a lot of consultation to develop the rules and the sharing arrangements between the states.



Linda Broekman (photo by Irene Dowdy © MDBA)

Linda Broekman

Many aspects of the water recovery effort have been pioneering in nature, overcoming challenges that had not previously been tackled. Two examples are the Pilot Environmental Water Purchase and the Ricegrowers' Association of Australia On-farm Efficiency Project.

The lessons and experience gained from such innovative projects have provided models and knowledge that now underpin other water recovery efforts under way across parts of Australia, including the Commonwealth's Restoring the Balance in the Murray– Darling Basin Water Buy-back Program¹³ and On-farm Irrigation Efficiency Program.¹⁴

Pilot Environmental Water Purchase

The Pilot Environmental Water Purchase in 2007 was a test project to recover water from the market. It used a public expression of interest tender to buy 13 GL (LTCE) of water entitlements in the southern Murray–Darling Basin at market prices.

The Pilot Environmental Water Purchase tender generated a highly enthusiastic response from the market — in fact the call for expressions of interest closed only four weeks into the expected 11-week tender process because the response from irrigators, water brokers and others wanting to sell water entitlements was so great.

Before starting the pilot project the Murray–Darling Basin Commission had resolved complex equity and probity issues relating to the ownership of entitlements. Essentially, the solution was that entitlements purchased would retain their previous characteristics and The Living Murray would be treated the same as irrigator holders of the same entitlements. It had also resolved process issues to ensure a rigorous, fair and transparent system for purchasing and conveyancing.

Ricegrowers' Association project

The Ricegrowers' Association of Australia On-farm Water Efficiency Project was one of the early on-farm efficiency projects under The Living Murray. It demonstrated the enormous potential for industry to drive water use improvements in partnership with government and directly contribute to environmental water recovery. This project was extremely popular with farmers and has paved the way for a number of similar initiatives.

¹³ See www.environment.gov.au/water/policy-programs/entitlement-purchasing/index.html.

¹⁴ See www.environment.gov.au/water/policy-programs/srwui/irrigation-efficiency/index.html.

CASE STUDY: RICEGROWERS' ASSOCIATION PROJECT

The Living Murray project gave individual irrigators an opportunity to improve their efficiency and therefore their productive capacity while still returning water to the environment.

The Ricegrowers' Association of Australia approached the Murray– Darling Basin Ministerial Council in 2006 and proposed that farm-level improvements in water-use efficiency to generate water savings were best delivered by industry.

There's a distance between government and people out on the ground that makes it difficult for government to implement a number of small projects. And a lot of



Ruth Wade, Executive Director, Ricegrowers' Association of Australia (photo courtesy of the Ricegrowers' Association)

these people would be very sceptical about government telling them how to improve their efficiency on farm. It really needs to be someone that's in touch with people on a fairly regular basis on the ground. So, because many of our members had indicated they'd be interested in participating in some sort of program, we instituted discussions and got a project going.

We did a feasibility study, then we did a pilot program, and in the pilot program we had 20 projects. We delivered back 1,747 ML of water.

We then had a call for expressions of interest in what we called Round 2, which was the second phase, and it was way oversubscribed. People were really excited about it. We ended up doing 45 separate farm contracts. We delivered back 9,278 ML of water across the New South Wales Murray and the New South Wales Murrumbidgee valleys. This project has since become the model for the current On-farm Irrigation Efficiency programs. We think it was tremendously successful, and that's been evidenced over and over again by the willingness of people to jump in to calls for expressions of interest in new similar projects. Every time we've done it it's been way oversubscribed.

So clearly there's a need, clearly we're delivering water back for the environment and clearly, from an industry perspective, we're maintaining the productive capacity of our industry. We're not just taking water away; we're actually taking water away but giving people the ability to maintain their production system.

The power of it is that nobody stands there and says: 'This is what you've got to do to increase your efficiency.' They voluntarily look and say: 'If I do this, I can save that much water and I can therefore share the water savings with the environment.' And that's a very powerful motivator to get people to look at how they could do things better.

It all came out of The Living Murray project and out of the opportunity that it gave industries and groups to interface with government in a different way. We've been delighted with the success of it. We've been delighted that government has picked up the concept. It's no longer under The Living Murray — it's now under Water for the Future¹⁵ — but it definitely came out of the pioneering work that was done under The Living Murray project.

Ruth Wade

¹⁵ See www.environment.gov.au/water/australia/index.html.

4. Environmental work and measures

A regulator in the Barmah– Millewa Forest icon site (photo by Arthur Mostead © MDBA) Under The Living Murray, around \$280 million has been committed to a highly innovative construction program of environmental works and measures at icon sites. The two fundamental pillars of The Living Murray are the water recovery effort and these works and measures. It is the 'works + water' combination that will enable the delivery of water to icon sites in a way that maximises the environmental benefits.

The program's major floodplain water management structures are under construction at the icon sites of Gunbower–Koondrook–Perricoota Forest, Hattah Lakes, and 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 'ladders' along the Murray River restoring migratory passage for native fish along the length of the Murray instead of having their passage blocked by weirs and dam walls.



Construction site at Mulcra Island, Chowilla Floodplain and Lindsay–Wallpolla Islands icon site (image courtesy of Mallee CMA).

The need for works and measures

The Living Murray works and measures are an inventive response to compelling evidence that under current regulated conditions the river would not flood for long enough, often enough, or with big enough floods at the right times to maintain important floodplain habitats. The health of the forests, lakes and wetlands of the Murray River system would continue to decline as a result.¹⁶

Essentially, the objective of the works and measures is to multiply the environmental benefits achievable from the water available to The Living Murray. Just 'water' and no 'works' would not enable benefits on the same scale as 'works + water' — a combination that is probably unprecedented at this scale anywhere in the world. Certainly no other program to date has taken on the challenge of engineering the landscape-scale flooding of multiple Ramsar-listed sites.

The water management structures being built at the floodplain sites are intended to enable controlled landscape-scale flooding using environmental water — often in much smaller volumes than would be required without these works. For example, the Koondrook–Perricoota Forest requires flows of over 30,000 ML/day in the Murray River to get water up over the banks of the river and into the forest naturally. However, when The Living Murray structures are in place it will be possible to water up to half of the forest with flows of only 3,500–6,000 ML/day.

The key element of such works and measures is, in effect, reducing the water level at which the floodplain starts flooding or enabling floodplain inundation to occur at flows that would normally not cause this to occur. What the works projects are often trying to do is to either build a channel that will enable water to be taken from the river at lower flow levels or back up the water to produce overbank flooding.

Works and measures can also provide a level of control that enables:

- replication of the extent, frequency and duration of natural flooding but at regulated flow conditions and heights
- adjustments to provide the most suitable patterns of watering for animal breeding cycles and plant growth.

¹⁶ This is detailed in Murray–Darling Basin Commission, *The Living Murray Foundation Report on the significant ecological assets targeted in the First Step Decision*, 2005, available at www2.mdbc.gov.au/ subs/dynamic_reports/foundation_report/.

Flooding with works may not always deliver the full range of environmental outcomes provided by a natural flood. There are also increased risks which will need to be managed by a committed adaptive management program. However, works already completed have shown they can deliver significant environmental outcomes.



Figure 4.1 Works planned for Koondrook-Perricoota Forest

TYPES OF WATER MANAGEMENT STRUCTURES

Regulators: water-controlling structures that can be opened or closed to produce controlled flooding and drying of wetlands to reinstate more natural flood cycles.

Channels: excavated creeks or waterways, sometimes with containment banks, used to direct water in or out of an area.

Levee banks: earthen embankments that keep water inside a site that is being watered and enable placement of regulators for improved management. Levees protect neighbouring properties from flooding and enable control of the water depth, inundation period and rate of draw-down of a flooding event.

Fishways: site-specific structures that allow fish to pass through or around physical barriers such as dams, weirs and road crossings. Four types are being used in the Murray:

- vertical-slot fishways, which consist of a series of interconnected pools bypassing an obstruction such as a weir
- lock fishways, which attract fish to a holding area at the base of the lock which is then sealed and filled with water to reach the height of the water upstream of the barrier so that fish can swim out of the lock
- rock-ramp fishways, artificial rapids made from rocks which provide a diverse flow path and allow fish to pass over low weirs
- Denil fishways, which use a series of baffles to reduce the flow of water, allowing fish to swim around the barrier.

Progress so far

The initial focus of the program was mainly on identifying and testing feasible options for works and measures projects that would meet or make a big contribution to the environmental water requirements of the sites. This was a significant exercise, which took three to four years.

The significance of The Living Murray has been identifying and having the chance to complete a range of water management works for improving the efficiency of water management. The budgets just weren't around to even dare to design or think big. The Living Murray has enabled resource managers at all the icon sites to have a clean slate — 'What do we actually require?' — rather than being constrained by minuscule budgets. Keith Ward

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A review of all the options for the works, in 2008–09, found that it would not be feasible to fund all of them. The options were then assessed and prioritised to get the best value from the available funding, and the priority projects were put into development. These projects have now progressed to the stage of detailed design and/or construction.

Given the substantial investment required for these projects, the investigations and planning that underpin them have been complex and challenging, requiring extensive hydraulic modelling, on-ground studies and consultation. Collection of digital elevation data and building the hydraulic models took many years but became the best way to develop and test the works options. They also helped to ensure that the best works projects were funded.

Operating plans for the works are being developed in parallel with the detailed design process and the review of icon site environmental management plans. The operating plans are intended to:

- minimise any environmental risks, such as those associated with salinity, blackwater and unseasonal waterings
- enable effective adaptive management of sites in response to a range of events and scenarios, including long-term climate change
- allow for watering at a range of extents and durations to replicate the natural variability that the sites experience
- achieve multiple environmental objectives at each site.

The Living Murray will conduct controlled test runs of the new works when they are finished, and will continue to carefully monitor and assess their operation and impact when they are in use, and use this to inform future management of the sites.

Major projects

The centrepieces of The Living Murray Works and Measures Program are summarised in the following table.

Table 4.1 Major projects under The Living Murray Works and Measures Program

Koondrook–Perricoota Forest Flood Enhancement Proje 16,000 ha	ect — to enable flooding of up to				
3.6 km of new channels	To divert water from the Murray River above Torrumbarry Weir to the forest				
Regulators and levees	To control flooding within the forests and return flows to Wakool River via Barbers Creek				
Gunbower Forest — to enable flooding of up to 7,250 ha					
Widening and deepening of an existing irrigation channel from Gunbower Creek, and construction of associated regulators	To enable environmental water to be supplied to the forest				
Hattah Lakes — to enable flooding of up to 6,000 ha					
Pumping station	To supplement natural flows from the Murray River into Hattah Lakes				
Three regulators and three levees	To allow water to be retained within the lakes				
Excavation of small sections of natural creek beds	To increase the frequency of natural inflows				
Chowilla Floodplain and Lindsay–Wallpolla Islands (including Mulcra Island) — to enable flooding of up to 7,500 ha					
Large regulator on Chowilla Creek	To raise water levels in the Chowilla anabranch system, allowing wetlands and the floodplain to be inundated (an anabranch is an offshoot of the river that rejoins it further down the channel)				
Smaller secondary regulators	To control flows in and out of the anabranch system				
Fishways	To provide passage in and out of the anabranch system				

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Table 4.1 (continued)

Regulator on Potterwalkagee Creek	To inundate Mulcra Island floodplain	
Two small regulators on the upper Lindsay River anabranches	To allow greater variability of flows through the system	
Replacement of an existing weir on Mullaroo Creek with a gated structure and fishway	To allow greater control of flows and fish passage	
River Murray Channel		
Fishways on locks and weirs along the Murray River	To restore passage for native fish along 2,225 km of river	

Nearly all of the works designed to assist in flooding the floodplain can be fully operated at regulated flow levels.



Protecting cultural heritage sites at the Koondrook–Perricoota Forest construction site (photo by Irene Dowdy @ MDBA)

CASE STUDY: WORKS AND MEASURES AT KOONDROOK-PERRICOOTA

The major water delivery structures being built at Koondrook–Perricoota mean that for us it's the first time ever that serious water management will be possible in that forest. In the past we've tweaked things in a natural flood, but essentially water management just couldn't be done in there. We've got very high river banks and essentially unless the river's flooding we can't get water into the forest. The construction of the structures means not only can we water it but we can actually manage the whole forest better.

For example, in the past we knew there were bird breeding sites in the forest but we never bothered to map them or research them or find out what bred in there, or when or how often, because it didn't matter; we couldn't do anything about it anyway. But the construction of the structures means now we can. Now we can deliver water to them and so now we're starting to document what we know and find out more information about those breeding sites, fish movements in the forest and the responses of vegetation, because we can now play a role in actively improving the health of the forest, whereas previously it couldn't be done.

All our water management plans said 'One day in the future, if someone comes along with a pot of gold, we could build this scheme' — and then skipped on to the next chapter. So it's made a real change for us — not just improving our water management but going from not being able to manage at all to being able to essentially manage more than half the forest. It makes a huge difference for us as land managers. Water management is receiving the status that it should receive in land management on a floodplain but previously wasn't possible.

Linda Broekman

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The floodplain inundation projects

As noted in Chapter 2, the health of the three floodplain-based icon sites has historically relied on large natural flows getting water onto the floodplains. Increased regulation of the river and over allocation of water over the past century have reduced the frequency and duration of natural floods at these sites. This has contributed to their declining health and biodiversity.

The Living Murray floodplain inundation works and measures projects seek to tackle this decline by enabling large-scale inundation of the floodplains at these icon sites:

- at frequencies and durations closer to what used to happen naturally (before extensive river regulation)
- using significantly smaller volumes of water than would be required for a natural flood
- at lower rates of flow in the rivers (lower 'commence-to-flow' point) than would be required for a natural flood.

At Barmah–Millewa the Barmah Choke naturally helps ensure large-scale inundation of the site from time to time and there are already regulators in the forest, which is why there are no works planned for this site.

The works at Gunbower–Koondrook–Perricoota Forest, Hattah Lakes and Chowilla Floodplain and Lindsay–Wallpolla Islands will end the dependence on natural floods to get water over the banks and onto the floodplains. However, they will also boost the effects of natural floods when these do occur.

Table 4.2 Frequency of overbank floods at sites with floodplain inundation works projects

lcon site	Natural conditions	Without works	With works
Koondrook- Perricoota	25 in 100 years	<10 in 100 years	Once every 3 to 4 years
Hattah Lakes	20 in 100 years	<10 in 100 years	Once every 8 years
Chowilla Floodplain	45 in 100 years	12 times in 100 years	One year in 3

These works are the largest of their type in Australia. From an engineering perspective, their design and construction has required significant innovation to overcome considerable challenges.

CASE STUDY: OVERCOMING THE CHALLENGES AT HATTAH LAKES



Hattah Lakes (photo by Richard Kingsford, University of NSW)

The Hattah Lakes icon site is located within a semi-arid mallee landscape consisting of more than 20 shallow lakes that receive and hold water at different levels. It is located within the Hattah–Kulkyne National Park and is a highly significant conservation area, with 12 of its lakes listed under the Ramsar Convention on Wetlands.

The Hattah Lakes system is important to Aboriginal people because it is a unique water system that was a traditional meeting place. This means that Aboriginal people have a strong cultural connection to Hattah Lakes through spiritual, ceremonial, cultural and social activities, including song lines and dance stories.

Flood flows from the Murray River are vital to the condition of the lakes, which are connected to the Murray via Chalka Creek. As a result of river regulation the lakes now receive reduced inflows from the river and are wet for shorter periods of time than under natural conditions. Under the current water regime the lakes, floodplain vegetation communities and cultural heritage (such as canoe trees) would continue to decline. 4

The Hattah Lakes project has faced two major challenges: how to inundate the Hattah Lakes system so that it mimics the natural flow regime; and how to construct the works in a way that will cause minimal disturbance to cultural heritage places and objects.

To overcome the first challenge the Victorian Government, the MDBA, the Mallee Catchment Management Authority and the land manager, Parks Victoria, worked together to discuss the best options within the available budget. The package of works that was agreed upon enabled natural inflows into the Hattah Lakes system — watering all 12 Ramsar-listed wetlands — without obstruction and allowed water to be diverted into Hattah Lakes using controlled pumping.

Increasing the frequency of natural flows into Hattah Lakes involves lowering high sections of the Chalka Creek bed. The commence-to-flow threshold — the rate of flow of the Murray River that is needed to flood the lakes — would then be reduced from 37,600 ML/day to 20,000 ML/day, meaning flooding could occur more frequently.

To retain the water within the lakes and surrounding floodplain, three new regulators and three blocking banks will also be constructed. A pumping station will be constructed near the mouth of Chalka Creek to top up natural floods and fill the lakes during long dry periods.

The second challenge was to make sure that minimal harm was caused to cultural places and objects during construction. This involved building a stronger partnership with Aboriginal stakeholders over a number of years and complying with Victorian legislation. A cultural heritage management plan was developed which set out ways to minimise any disturbance to cultural heritage, while also making it possible to build the works to protect and enhance the environmental values of Hattah Lakes.

The works proposed for Hattah Lakes are significant and will reinstate the natural regime using natural and controlled watering events. The works will help to restore the role of the lakes as a drought refuge for waterbirds and other species, as well as providing an important breeding habitat for waterbirds, frogs and fish. Returning water to Hattah Lakes will also help to stop erosion of cultural sites and encourage the growth of native plants used by Aboriginal people for cultural practices, helping to maintain their connection to country.

The design of the works is based on analysing the most effective methods of moving water through the icon sites. High-resolution computer models (hydraulic models) of the landscape were used to simulate how water currently moves through the sites and model how it will move when the water management structures are in place. Using more than a century of data on river flows and climate, various strategies for operating the structures have been tested to determine the range of potential environmental outcomes under different climate scenarios. The results suggest that when these works are operating, even the small amounts of environmental water available in very dry conditions will produce significant environmental benefits.



Figure 4.2 Works planned for Hattah Lakes

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Sea to Hume Fishway Program

Regulation of the Murray River by means of barrages and weirs has been a major factor in the serious decline in both distribution and numbers of native fish since European settlement. Around a third of the Basin's native fish are listed as threatened.

The Sea to Hume Fishway Program aims to help restore native fish populations to 60% of pre-European settlement levels by 2050. It is funding the design and construction of 14 new fishways to restore migratory passage for native fish along 2,225 km of the Murray River, from the mouth to Hume Dam.

Results show that large numbers of fish of diverse species and sizes are passing through the fishways, with resulting improvements starting to be seen in monitored fish communities along the river.

This program is the largest fish passage restoration initiative ever undertaken in Australia. It represents over 10 years of cooperative effort from a diverse range of individuals and organisations. In 2009 it was recognised as one of the top 25 ecological restoration projects in Australia by the journal *Ecological Management & Restoration*.



Vertical slot fishway at Lock 6 (© MDBA)

CASE STUDY: SEA TO HUME FISHWAYS

One of the major challenges and achievements was delivering on a major capital works program within a given budget and over a very short period of time — if it weren't for the floods this year it would have been successfully achieved. In addition, it's been a case of managing the needs of separate jurisdictions and trying to coordinate a works program that keeps people from a range of different disciplines all happy — and satisfying both engineering and ecological needs. That's been a massive undertaking but it's gone really well.

It's been very much an adaptive process. As we've learned things, the design criteria for fishways have changed. We've learned things through research that have been directly translated into management. It's great for the program to do it that way. But what it's also done is make sure that work we started 10 years ago hasn't stayed 10 years old; it's actually improved. That's been a major outcome: we've learned things and they've been directly applied. We've had an opportunity to do this under The Living Murray.

The most significant change has been the transformation of the Murray River from a series of isolated weir pools into a fully connected river where fish can migrate. That is a huge change and that's something that's been affecting fish for longer than 80 years. If it wasn't for these floods, which have restored fish passage, this would have been the first time when fish would theoretically have been able to swim from the Murray Mouth up to Hume Dam since the river was developed. That in itself is an amazing achievement. Not just one or two species — it's been designed for all native fish species between 20 mm and 1 m. Making these dams and weirs totally transparent for all species that's where we're setting a worldwide standard, because no-one's doing that anywhere else in the world.

Over the last 10 years the Murray fishways program has been independently reviewed both domestically and internationally and it has held up in light of some pretty tough reviews from people who know about the area really well.

Lee Baumgartner

4

Community consultation

There has been extensive consultation and liaison with local communities affected by the construction of the program's major structural works at Gunbower–Koondrook– Perricoota Forest, Hattah Lakes and Chowilla Floodplain and Lindsay–Wallpolla Islands.

Community advice arising from the consultation process has directly influenced the planning and construction of The Living Murray works and measures. Examples are:

- the relocation of a portion of a planned levee in Koondrook–Perricoota to form part of an existing Barham township flood mitigation plan (this also meant that the area of Ramsar wetland was increased)
- negotiation with community members to receive spoil which would otherwise have been stored in the forest, requiring further clearing
- consultation with the local rural fire service resulting in the design of suitable access points across levees
- staggered closures of public access along the Chowilla Creek, rather than total closure for the whole construction period.



Jamie Hearn, the Living Murray communications coordinator for NSW, and Barham community members (photo by Irene Dowdy © MDBA)

CASE STUDY: COMMUNITY INVOLVEMENT IN KOONDROOK-PERRICOOTA WORKS

We've had some really good social outcomes from The Living Murray. We've been able to do some really good work, particularly with Indigenous engagement that has made a big difference to the local Indigenous community. We've found that the construction project in the forest has provided a catalyst for the local communities to get together and to start working with us on land management issues rather than just agreeing to disagree.

People had motivation for turning up and for working together and for learning about land management from our perspective and the constraints we were under, and working out what they really wanted and what was possible. The construction project has generated a lot of job opportunities, which has had follow-on benefits with training and work experience.

And there are also opportunities for Indigenous people to be working in the forest. I think most Indigenous people knew they had access to the forest — it's a public forest and they can go in there whenever they want — but I think there was a sense that they weren't really allowed in. But now that they're working in there, and particularly working in the area of cultural heritage, they've gone in there and found all these sites that they knew were there. And now they've been able to document them and work through the stories attached to them. So there's been a big boost in the dissemination of cultural knowledge amongst the groups and a real increase in their sense of connection with the forest.

We've also had some really good outcomes with the non-Indigenous community. We've done a lot of consultation with neighbours and with downstream landholders particularly. At first that was very 'us and them'. But the more we've worked with them the more they've got on board with the idea. They all wanted to see the forest healthy, so we've been able to unite on that now that they better understand the constraints we're working under. They've been really constructive in terms of identifying problems that we hadn't been able to identify and to bring those to our attention and help us work through solutions to those things. And also just to contribute local knowledge to the project. We didn't know where the water went when it went out a certain flood runner. People who lived there were able to say: 'Well, in 1996 it flowed this way and in 1993 it flowed that way.'

Linda Broekman

4

The Living Murray recognises the importance of involving Aboriginal people and local communities directly in decision making about the works and measures, and has worked closely with a number of groups — such as the Joint Indigenous Group at Koondrook–Perricoota and icon site community reference groups — to ensure that this happens.

CASE STUDY: INDIGENOUS CONSULTATION ON MULCRA ISLAND WORKS

With Mulcra Island it's worked really well — the role that Indigenous people played in getting that infrastructure built and the partnerships they built with government agencies and contractors. That's the key thing: it's building relationships and partnerships.

I found that with the Indigenous people being engaged fairly regularly they were more positive about getting the infrastructure built. Where you'd think they'd make you jump through big hoops, they really went along with the idea that if we build this infrastructure and minimise these problems we can achieve these results — and that's what it's all about.

The good project managers did a lot of good work and got the trust of the Indigenous people and showed them that there's no nonsense. I always believe that if you tell people what's going on and put it on the table for them they're more sympathetic. If you keep them in the dark and don't give the information out it's like anything — you're scared of the unknown. You need to put it on the table.

The best thing is cross-cultural — getting the feedback from contractors who do a bit of work with Indigenous people coming back and saying: 'We're starting to understand why this land's important to people the history.'

Ken Stewart, Indigenous facilitator, Mallee CMA

5. Delivering water

Pumping water from Lake Alexandrina into Narrung Wetland and Lake Albert (photo by John Kruger) Water recovered by The Living Murray is used to meet agreed ecological objectives at the six icon sites. The delivery of this water is prioritised according to where the water is most needed and where it is most likely to be effective.

The Living Murray's water recovery and works and measures projects provide the tools needed to start improving the ecological health of key floodplain sites. As the tools become available, the challenge becomes how to manage the delivery of water to those sites as effectively and responsibly as possible.

Between 2003 and 2010 only small volumes of water were available to the program, so very little water could be delivered — and only to the most critical places. By 2010 the completion of water recovery measures, along with higher allocations made possible by better inflows to the river, presented for the first time the prospect of considerable volumes being available for environmental watering.

The wide range of watering options now becoming possible — including large single watering events and watering of multiple sites — can be expected to accelerate progress towards achieving the icon site ecological objectives, particularly when the works and measures projects are completed.

How much water will there be?

As a long-term average, The Living Murray will have approximately 500 GL available to it each year. However, The Living Murray water entitlements are subject to seasonal allocations (the amount of water actually made available for use) in the same way that irrigation water is. The amount of water allocated depends on annual rainfall and inflow levels, meaning that there will be less water allocated in dry years and more in wet years.

How will it be divided between the icon sites?

To achieve the best environmental benefits, The Living Murray water will generally not be distributed evenly across sites each year; instead it will be delivered in a 'rostered' way that mimics the natural flooding cycles of sites. This will typically involve alternating large-scale waterings of different sites every three to five years, with smaller waterings in between.

Potential watering opportunities are prioritised based on where the water will achieve the biggest environmental outcomes, the availability of water in the river and to the Living Murray, seasonal outlook and icon site condition. These factors help to make the best decisions about when, where and how to use environmental water at the icon sites.

What I find exciting is having the ability to interpret the scientific papers and new understandings and incorporate that into environmental watering management plans so that we can achieve our expectations.

We're really trying to fill in parts of the natural hydrograph that we know are very important that are now missing and are missing because of river regulation. It's not like we're trying to reinstate everything back to completely natural, because we simply can't do that. But we are identifying some very critical components of the hydrograph that we can't afford to mess up, and they don't always require a great deal of water.

Keith Ward

THE LIVING MURRAY ENVIRONMENTAL WATERING PLAN

Decisions on the use of The Living Murray water are made collectively by The Living Murray Environmental Working Group, which includes representatives from each partner government. This group develops The Living Murray Environmental Watering Plan¹⁷ at the start of each financial year to guide and inform decision-making for the year ahead. The plan takes into account a number of factors, including:

- the ecological condition and watering needs of each site
- rainfall and water allocation forecasts
- the costs, benefits, risks and trade-offs of various watering options.

Different watering objectives are set based on the climatic outlook for the year ahead. For example, in extremely dry scenarios the objective of The Living Murray waterings would generally be to avoid catastrophic loss, whereas in very wet years the focus would be on improving river and floodplain health. This can be done by increasing the extent and duration of flows at key sites, as well as contributing to the full range of possible flows, including over-bank flows, to improve the connection between the river and its floodplains.

The Environmental Watering Group meets regularly during the year to review circumstances and make watering decisions.

How much water was delivered?

Until 2010 The Living Murray was only able to deliver relatively small volumes of water to icon sites each year and was not yet in a position to implement the 'rostering' approach to waterings described above. This was due to:

- the time required to recover water entitlements for The Living Murray
- the most severe and prolonged drought on record (and therefore very low water allocations).

Because of these factors The Living Murray's access to water for delivery to sites was restricted, even once water recovery was well under way. The situation is summarised by the table below.

¹⁷ See, for example, the 2010–11 Environmental Water Plan at www.mdba.gov.au/files/publications/ TLM-Watering-Plan-2010-11.pdf.

	2005–06	2006-07	2007–08	2008–09	2009–10
Annual inflows into Murray system (GL) (excl. Snowy releases) (long-term average = approx. 10,900 GL)	6,200	1,040 (lowest on record)	2,930	2,075	5,600
TLM entitlements recovered (GL LTCE)	0	0	133	342.5	472
Volume allocated to TLM entitlements (GL)	0	0	16.96	13.05	155.67
Volume delivered from allocations to TLM entitlements (GL)	0	0	16.52	6.45	65.73

Table 5.1 Inflows, entitlements and allocations, 2005–06 to 2009–10

How was it divided between the icon sites?

In the prevailing extremely dry conditions, the objectives of The Living Murray waterings in most years was to:

- avoid critical loss of threatened species
- avoid irretrievable damage or catastrophic events
- provide refuges to enable species to recolonise following the drought.

At sites where works and measures were completed and small amounts of The Living Murray water was available, it was possible to see the 'works + water' combination making an important contribution in practice, if on a limited scale at this stage.

There have been numerous challenges. Some of them have been due to the fact that we've had very small volumes of water during a particularly difficult period. While on the one hand it's been fantastic that we've been able to achieve such terrific local results from an ecological perspective, it's also been extremely frustrating that it's been on such a small scale.

Judy Goode

The on-ground works at Wallpolla Island were a key success for me — the Horseshoe Lagoon regulator. While the rest of the landscape was basically dying through the longest, biggest drought on record, the little refuges of Horseshoe Lagoon on Wallpolla Island were flourishing with the combination of The Living Murray structures and the local environmental watering program. Peter Kelly

The year-by-year waterings and interim outcomes observed at each icon site are detailed in various reports on the Murray–Darling Basin Authority website.¹⁸

ACIDIFICATION AT THE LOWER LAKES

Between 2008 and 2010 extremely low water levels in the Lower Lakes required urgent measures to avoid widespread acidification of the area. The Living Murray environmental water was allocated along with water from South Australia and the Commonwealth to ensure that water levels in the lakes were prevented from falling to critical acidification levels.

The strategy was to prevent acidification by maintaining an agreed depth of water and saturating soils that could potentially acidify when exposed to oxygen.

In late 2009 record low water levels in the Lower Lakes were forecast, and high salinity levels were recorded. The risk was alleviated in early 2010 when higher flows reached the lakes.

¹⁸ See www.mdba.gov.au/programs/tlm/programs_to_deliver/environmental_delivery.

Results of watering

Overall, the story told by the monitoring data from the icon sites is that while all the sites declined in health as a result of prolonged drought, the areas that did receive some Living Murray water showed clear positive responses (see the table below). In some cases this watering played a crucial role in helping to avoid critical ecological losses or damage and providing refuges to support recovery post-drought.



Reedy Lagoon (Gunbower–Koondrook–Perricoota Forest icon site) before and after environmental watering to create a drought refuge (photos by David Kleinert © MDBA)



Chowilla floodplain — the trees here would have died if they had not been watered through The Living Murray program (photo by Judy Goode)

REFLECTION: YOU CAN'T RECOVER FROM DEAD

Last week I went onto the Chowilla floodplain in a little tinny and spent six hours floating around flood runners that I'd never seen water in before. We went to a site called Lake Limbra up in the north-western end of Chowilla. It's a site that takes quite a lot of water and it hasn't been watered for probably 10 years. That site would have had literally thousands of dead trees ringing it, including tens if not 100-plus trees that were clearly well in excess of 100 years old.

Contrast that with a site that we also motored into that we secured water for through The Living Murray over the last four to five years, and basically that site would have been dead too if The Living Murray had not existed. That's probably the most stark example that I can give you of the success of the program through what has been an incredibly difficult period of prolonged drought.

We don't have to wait for any monitoring advice: sites like that would be dead now. You can't recover from dead.

Judy Goode

Table 5.2 Trends in icon site health associated with environmental watering 2004–10¹⁹

Site	Observations
Barmah-Millewa Forest	 greater numbers of colonial waterbirds at watered sites some breeding of royal spoonbills suspected breeding of white-bellied sea eagles brolga observed in Barmah Forest (absent for about 60 years until 2007) watered areas of vegetation markedly healthier than non-watered areas growth of giant rush evident at watered sites
Gunbower- Koondrook- Perricoota Forest	 resilience of Gunbower Forest wetlands following dry conditions in 2008 highlights the benefits of environmental watering (which this site received) during dry periods watering in spring 2009 triggered a small breeding event of little pied cormorants and a few egrets
Hattah Lakes	 diverse and abundant aquatic vegetation communities in flooded wetlands, suggesting that the site objective for wetland vegetation can be met by environmental watering
Chowilla Floodplain and Lindsay– Wallpolla Islands	 species diversity increased over time at sites that experienced wetting and drying cycles, providing confidence that objectives for wetland vegetation can be met by environmental watering condition of understorey vegetation improved at watered sites. Many unwatered sites have become dominated by salt-tolerant or terrestrial understorey vegetation, while watered sites are dominated by flood-dependent vegetation. increasing numbers of southern bell frogs and breeding events in response to environmental waterings condition of river red gum and black box at watered sites continued to improve. This is particularly apparent at sites which have been watered multiple times
Lower Lakes, Coorong and Murray Mouth	 preventing the level of Lake Albert dropping to acidification thresholds by maintaining water levels protecting and enhancing Murray hardyhead and southern pygmy perch populations by delivering environmental water to key refuge sites protecting the submerged aquatic seedbank of a key Lower Lakes wetland and providing refuge habitat for waterbirds, frogs, invertebrates and fish

Initial successes such as these affirm the potential of The Living Murray to realise its original vision of improving the health of the icon sites over the longer term.

¹⁹ The River Murray Channel is not included because The Living Murray has had limited capacity to date to influence outcomes at this site, where environmental outcomes are largely the result of river operations.

CASE STUDY: ANNUAL WATERBIRD SURVEYS



Waterbird survey of the Murray River (photo by Richard Kingsford, University of NSW)

Since 2007, researchers from the University of New South Wales have conducted aerial monitoring of waterbird populations at all six The Living Murray icon sites each year. The results are already starting to tell an interesting story.²⁰

The surveys track changes in waterbird numbers, species diversity and breeding at wetland sites, and provide a useful measure of wetland health. Three sets of findings have been published to date: those from 2007, 2008 and 2009.

In each year, waterbird numbers, species diversity and breeding were overwhelmingly concentrated at the Lower Lakes, Coorong and Murray Mouth — 92% in 2007, 96% in 2008 and 95% in 2009 — which is one of Australia's most important waterbird habitats. Few active breeding sites were recorded at any other icon site.

In 2009 the total number of waterbirds across all sites was significantly (44%) higher than in 2008 but slightly (4%) lower than in 2007.

²⁰ For details see RT Kingsford and JL Porter (Australian Wetlands and Rivers Centre, University of New South Wales), Survey of waterbird communities of the Living Murray icon sites — November 2009, 2010.

Individual icon sites have their own stories separate from overall trends.

- Results for the Lower Lakes, Coorong and Murray Mouth are essentially the same as results overall, as in each year over 90% of the waterbirds counted were at this site.
- Chowilla Floodplain and Lindsay Wallpolla Islands showed little change over the three years.
- At Hattah Lakes numbers decreased dramatically in 2008 and again in 2009.
- At Barmah–Millewa numbers decreased sharply in 2008 but bounced back in 2009 to higher than 2007 levels.
- At Gunbower–Koondrook–Perricoota Forest numbers increased in 2008 but decreased significantly in 2009.
- In the River Murray Channel numbers decreased in 2008 and again in 2009.

The survey results to date clearly show a combination of severe drought and long-term cumulative effects of river regulation limiting the availability of wetland habitats and, in turn, waterbird numbers and breeding. As it continues, this monitoring will become an increasingly valuable resource and will help track the effects of The Living Murray environmental watering.



Counting birds at the Coorong (photo by Richard Kingsford, University of NSW)

Thanks to wetter conditions in late 2010 and 2011, the completion of the water recovery phase and the scheduled completion of the program's works and measures, the prospect of The Living Murray being able to make significant progress over the next few years looks encouraging. The Living Murray's monitoring at icon sites has made possible a more comprehensive perspective on environmental health that brings together information from a whole range of specialised monitoring activities in a way that highlights the interconnections between different elements of the ecology in a particular area over time.

The layered information base coming from monitoring is beginning to produce a much more accurate and nuanced understanding of the real environmental water requirements of a site under various conditions.

REFLECTION: RETURN ON INVESTMENT

We're starting to see the first applications of the environmental water allocations, which have already resulted in significant environmental outcomes. At Barmah– Millewa there's an egret breeding event at the moment that's basically been unrivalled for most memories. We've got great egret, little egret, intermediate egret all breeding in very large numbers — I think for all three species it's the largest breeding event in Victoria at the moment. And that's largely due to environmental water allocations augmenting the natural flood events that have occurred to keep them on site and having feeding areas.

The Living Murray program — yes, it's been a big injection of funding and in the initial stages people were saying: 'We don't see a lot of return for that investment' — but, like anything, there's a lot of time and energy and effort involved in planning. And now we're going to see this domino effect where we've set it up now let's play.

Keith Ward

REFLECTION: MONITORING OUTCOMES

The Living Murray has encouraged us to say we want to look after fish but at the same time we want to look after vegetation, and in particular the river red gum communities along the river, and we also want to look after birds as well. So trying to deliver an environmental program which provides benefits for all three of those categories of life is very difficult and has been challenging but for me very interesting,

While I haven't been directly involved in the [non-fish] research I've been able to understand the results of the research and turn that back on to fish and say, wow, these birds are reliant on fish and these red gums are reliant on water which helps fish and also helps birds, so it sort of ties the ecology together really well.

Lee Baumgartner

I think one of the most interesting aspects of The Living Murray has been enabling the long-term monitoring and the research. Very few places have long-term datasets. At places like Barmah, because of the history prior to The Living Murray and now because of The Living Murray, we've got datasets that are now 20 years or more long, and that's providing some really firm information and understanding of environmental water requirements. That's been a fantastic outcome.

Keith Ward

Postscript — after the floods

Extensive flooding in the Murray–Darling Basin in late 2010 and early 2011 brought dramatic changes to The Living Murray icon sites and the Basin as a whole. Landscapes that had been struggling were transformed.

High environmental flows had immediate positive effects on plants and animals after years of drought. For example, river red gums showed vigorous growth and endangered waterbirds such as great and intermediate egrets began breeding.

For The Living Murray, the prospect of receiving substantial water allocations for the first time since the program began opens up a whole new range of possibilities for environmental water delivery. Water was used for the first time down the length of the river.



6. Conclusion

Azure kingfisher in Barmah Forest (photo by David Kleinert © MDBA)

How far The Living Murray has come

The Living Murray is one of the biggest landscape-scale restoration projects undertaken in a river system anywhere in the world. It is also an extraordinary model of a cooperative inter-jurisdictional effort for river restoration. Since the program started in 2002 it has recorded substantial achievements and helped change the whole approach to river management in the Murray–Darling Basin.

Achievements

The first major achievement was the level of funding committed for the program. Together, the Commonwealth and the states have invested close to \$1 billion in total. This comprises \$700 million for water recovery (\$400 million from the Commonwealth and \$115 million each from the states) and \$280 million to \$300 million for works and measures, as well as to support the program's operations and monitoring each year. It is very rare for such a program to get this level of funding, and the fact that it has attests to the sustained commitment of each jurisdiction involved to restoring the Murray. It has been very much an investment by the partner governments in innovation to try to achieve lasting environmental outcomes over the long term.

Recovering nearly 500 GL (LTCE) of water was another major achievement, particularly as developing ways to recover environmental water in a way that was affordable and practicable in an inter-jurisdictional context was complicated and took time to work out and gather momentum. The Living Murray pilot project to buy water from the market proved for the first time that environmental water could be directly purchased from the consumptive market, that this process could be managed effectively and that owners of water entitlements were willing and in many cases keen to sell water to the environment. This was a paradigm-changing experiment and became the precursor for the current Australian Government policy of buying water entitlements for the Commonwealth Environmental Water Holder to manage.²¹

Changes

While such things are difficult to measure, there is a strong sense among those involved with the program on the ground that The Living Murray has contributed to important changes in community thinking about the issue of water for the environment.

²¹ See www.environment.gov.au/water/policy-programs/cewh/index.html.

REFLECTION: PUSHING CONCEPTUAL BOUNDARIES

It's really pushed the boundaries of community thinking and values. I think that the whole concept of water for the environment has become much more mainstream and much more acceptable as a concept. The Living Murray has paved the way for, in many ways, a mindset or values in the community that may not have been there otherwise. Particularly because of many of the localised successes of The Living Murray through watering projects et cetera, in the River Murray community in South Australia there is a general acceptance that water for the environment is good and that there may have to be some compromises in order to maintain a healthy river.

Judy Goode

Perhaps the most significant change that has occurred through The Living Murray is the successful cooperation between the states to manage the river for environmental outcomes. Previously the river was operated collectively to meet irrigation and other consumptive requirements but not to address the needs of riverine and floodplain ecosystems. The Living Murray has moved the focus to actively managing the river for environmental outcomes rather than just leaving the environment with whatever is left over from consumptive uses. There are two important elements to this change: one is recognition of the need for active management of environmental water; the other is the sustained commitment of the governments involved to work together on this in a genuinely cooperative manner.

REFLECTIONS: WORKING ACROSS STATE BOUNDARIES

The issues of on-ground construction — we're working with another state and there's a lot of issues where they operate in a whole different range of approvals and things like that. So you need to work with not only the management arrangements in one state. At one stage we were working with SA Water and getting approvals from New South Wales to do works on the Victoria/New South Wales border. There has to be a lot of goodwill to make things work. In short, most of the challenge is really the paperwork. Once you get to the on-ground work it's quite easy.

Peter Kelly

A significant achievement of The Living Murray has been the ability to link sites to achieve multiple benefits between the icon sites, which include return flow re-use. It seems easy to think: 'Oh we'll just release water from Hume Dam, pass it through Barmah Forest, reuse it a little bit in Gunbower and whatever returns back into the Murray we'll use at Hattah, et cetera.' But that's involved significant political decisions — sometimes changes to Acts and regulations. It's just been a huge change.

Keith Ward

The Living Murray is in some ways unique in the degree of collaboration and respect that the individuals involved in the program have shown each other. Negotiations around where water should go and what watering priorities should be have been extremely collaborative and respectful. It's just been a program that's been a delight to work in.

Judy Goode

Where The Living Murray will go next

Essentially the First Step water recovery and works and measures are about providing the tools needed to really proceed with addressing the problems of the icon sites and the river as a whole. The Living Murray is now in the excellent position of having substantial resources — the result of huge investments in works and water recovery — and highly effective cooperative management between the different states to do this.

Watering

As the recovery of water ends and structural works are completed The Living Murray will focus on water management and delivery. The scale of watering activities will increase substantially. Priorities include:

- developing a range of watering scenarios and operating strategies using the new water management structures
- managing risks associated with delivery of environmental water over the long term, such as effects of climate change, acid sulfate soils and salinity
- developing environmental water accounting protocols and measurement policies and tools at icon sites
- coordinating watering activities with other environmental water holders such as the Commonwealth Environmental Water Holder
- developing agreed approaches to monitoring, evaluating and reporting on the delivery of environmental water, and linking these to longer term condition monitoring of icon sites
- aligning with the forthcoming Basin Environmental Watering Plan.

The transition to alignment with the Basin Plan is expected to be accomplished without disrupting the activities or compromising the practical benefits of The Living Murray. It is to be hoped that the level of inter-jurisdictional cooperation that characterises The Living Murray not only continues but also translates across to Basin management as a whole.

REFLECTIONS: FROM THE LIVING MURRAY TO THE BASIN PLAN

I think the new Basin Plan is a once in a lifetime opportunity of doing some good. The Living Murray was the start and hopefully we'll be able to carry on from there.

Henry Jones

It's such a fantastic program and the rationale behind it is great; why limit it to the Murray? The Basin Plan provides a good opportunity to apply this approach to other catchments in the Basin — to use The Living Murray as a showcase for something that can be adapted in other areas to deliver outcomes.

Lee Baumgartner

I think this whole thing's really basically a springboard, perhaps, for the new Basin Plan in showing what can be done.

Keith Ward

Drought, flood and the future of climate

Much wetter conditions in 2010 and early 2011 brought extensive flooding and immediate improvements to the condition of the icon sites, which have come back to life after years of devastating drought. While the full effects of such a drought cannot be erased overnight, many species have shown an amazing ability to recover. Others that are less resilient may take several years, and for some it may be too late.

What the extent and impact of climate change will be is, of course, not known. However, there is wide agreement that climate change will continue to exacerbate the problems facing the Murray–Darling Basin as a result of natural climate variability, frequent drought, typically low water levels and the effects of past water allocation decisions.

The ability to use the Living Murray works to connect the floodplain to the river at regulated (non-flood) flows will assist in managing these high-value environmental sites in the face of a changing climate.



Wetter conditions in 2010 and 2011 have benefitted many species including rare and endangered fish such as this purple spotted gudgeon. Some species may take longer to recover and others may have disappeared (photo by Gunther Schmida © MDBA).

We're going through this wonderful flood now and it's going to recuperate, but there are many things that just aren't there to be able to be resurrected. You can't just have one flood in 50 years — you've got to have these little floods that used to come and kept the water fresh. Without them, as soon as this water goes we'll be back to where we were in the drought. Henry Jones

What next?

The completion of the First Step represents the beginning of an exciting phase in which the 'works + water' combination will be put into full effect and The Living Murray partner governments should begin to see substantial environmental returns on their investment. The Living Murray is also expected to continue as an important model for other restoration programs and river management in general.

6

REFLECTIONS: THE BEGINNING

We as ecologists don't see the construction program as the end of the program; it's really the beginning. Once the works are in place, that's when the really exciting ecological responses will start. The long-term benefits for waterbirds and fish that are very long lived may not appear within the next five years — it took generations to decline and it may take generations to recover. So making sure there's a commitment maintained to monitoring the success of the program beyond the construction is really important.

Delivering the ecological outcomes, improving red gum stands and providing opportunities for fish and birds — that won't start till the last bit of concrete's poured. It's really exciting stuff. And that's when, I guess, they'll learn about the return on their investment.

Lee Baumgartner

We've currently got a momentum that's now just starting to pay the dividends. This is just so important we can't afford to stop it in its tracks. We've achieved the additional water allocations and the funding for works, we've got the monitoring and the research. Because we've dammed the whole system, we're committed; we have to keep tweaking it. It's just part of the cost of doing business, and if that business is irrigation benefits, then part of that cost is we've got to ensure that we maintain an aspect of the environment along with it.

Keith Ward

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The Living Murray story is a recent chapter in the history of managing the Murray River. A story which stretches back for more than a hundred years for Europeans, and tens of thousands of years for Aboriginal people.

The Living Murray program is an attempt to restore the health of the Murray River by returning water to the environment and building water management structures to deliver water to the Murray's wetlands, floodplains and forests.

It is also a people story, about the many who have worked to make the vision of the program a reality. This book will be of interest to those who continue to use, visit, or be inspired by this great river.







