NSW environmental watering event sites 2010–11

Perry Lake, Paroo–Darling National Park in October 2010
In 2010–11, New South Wales experienced its wettest year in half a century with over 800 millimetres of rain falling across much of the state. As a result, the year also saw the largest ever delivery of environmental water with more than 1.1 million megalitres directed to wetlands and areas of high biodiversity value.

After a decade of managing small amounts of environmental water during drought to keep core wetland areas viable, the above-average rainfall across many catchments was a dramatic reminder of the boom and bust nature of the Australian environment. Scenes of townships and properties threatened by flooding and livelihoods placed under severe stress were viewed alongside images of nature regenerating. Dying river red gums rapidly sprouted new growth, large flocks of waterbirds congregated to breed once again in massive colonial nesting sites, and choruses of frogs filled the air as they emerged from their drought refuges, all testament to the restorative power of floods.

The NSW Government recognises the critical role wetlands play in supporting unique and diverse flora and fauna communities and the valuable services they provide to regional communities, including nurseries for recreational and commercial fisheries, opportunities for tourism, and support for sustainable timber production, grazing and apiculture. Rivers and swamps are also an important cultural focus for many regional communities, including Aboriginal communities.

Partnerships in the use and management of environmental water are critically important, particularly when identifying opportunities for more efficient and effective delivery. For example, water is delivered more effectively when high natural flows are used to reduce transmission losses and optimise the extent of inundation. The importance of these partnerships was reflected this year in over 260,000 megalitres of Commonwealth environmental water contributing to the environmental water releases managed by the NSW Office of Environment and Heritage (OEH), in collaboration with landholders, local advisory groups, catchment management authorities and other state agencies.

This annual report highlights the outstanding environmental outcomes achieved this watering year. It also provides an update on NSW Government investment in recovering water for the environment and the active management of environmental water by OEH. This water includes adaptive environmental water held on licences, allocations under water sharing plans, and water provided by the Commonwealth and through programs such as The Living Murray. It does not report in detail on the planned environmental water that is released in accordance with rules in water sharing plans.

NSW has been a leader in environmental water management since the early 1980s and understands that one wet year does not lessen the intensity of effort required to sustain a healthy environment. We will continue to build on our success in environmental water management in the coming year.

Lisa Corbyn
Chief Executive
Office of Environment and Heritage
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Floods are rarely predictable in size, timing and behaviour, hence the catchcry ‘no two floods are the same’. Similarly, the response of the environment may be dynamic and difficult to predict: water levels in wetlands can fluctuate markedly causing waterbirds to abandon their nests, while the passage of water across floodplains may lead to blackwater events with major consequences for aquatic ecosystems. By closely monitoring flood behaviour, managers constantly look for opportunities to enhance ecological outcomes through the judicious use of environmental water.

Waterbirds, along with many other animals and plants, responded dramatically to the floods across NSW in 2010–11. Colonies of straw-necked ibis, in particular, assembled to nest in the Macquarie Marshes, Narran Lakes, Wanganella Swamp, and the lower Murrumbidgee and lower Lachlan wetlands. This species is particularly susceptible to fluctuating water levels when nesting. Where water levels fall too rapidly, the adults desert the nests even when eggs have hatched; where levels rise too quickly, eggs and young chicks may drown.

Environmental water managers monitor water levels daily and supplement natural flows with managed flows to keep water levels stable. For example, the colonial waterbird breeding site in the Booligal Wetlands in the Lachlan Valley needed regular adjustments to flow rates and on-site infrastructure to maintain appropriate water levels for six weeks. While natural flows stimulated the breeding effort, managed flows allowed the resident ibis colony, with its 65,000 nests, to successfully fledge its young. Similar management activities took place at most waterbird breeding sites across NSW during the year.

Managed flows can also be added to natural flows to control the height of the inundation. As a result, a larger area of floodplain can be wet and the duration of a flood extended, allowing the completion of important ecological processes, such as the reseeding of aquatic plants and the development of tadpoles into frogs. Under very wet conditions like those of 2010–11, an environmental water manager looks for opportunities to complement the work largely being performed by nature.
Water is essential to the environment, the economy and the communities which rely on our rivers and wetland areas. In its role as the environmental water holder in NSW, the Office of Environment and Heritage (OEH) works collaboratively with many other partners to lead initiatives that secure water for the environment through planning mechanisms, the purchase of water from willing sellers, and investment in more efficient water delivery and management infrastructure.

Water sharing plans, developed by the NSW Office of Water for rivers and groundwater systems across the state, allocate a share of water to users for various purposes, including town water supply, irrigation, industry, native title rights and environmental needs. Environmental water is provided for in the plans as ‘planned’ environmental water and ‘adaptive’ environmental water.

‘Planned’ environmental water is allocated for fundamental ecosystem health via rules set out in water sharing plans. These rules typically:

- establish seasonal flow targets at specific points
- protect a proportion of specific flow events from being diverted
- provide for minimum flows below storages or at the end of systems
- protect the variability of instream flow.

In many regulated rivers, rules in the water sharing plan establish environmental water allocations to be released at the discretion of an environmental water manager.

‘Adaptive’ environmental water is committed for specified environmental purposes through a water access licence arising from either the purchase of entitlements from willing sellers or the recovery of water savings by infrastructure projects.

Planned environmental water is provided before water is allocated to other water users or town water supplies. Adaptive environmental water licences receive allocations on the same terms as other licences of the same category: for example, if a general security licence is purchased and committed as adaptive environmental water, the same allocations as any other general security licence in the same water source will apply.

In addition to the planned environmental water use described in this annual report, there are four regulated coastal water sharing plans in NSW that set aside planned environmental water in the form of Environmental Contingency Allowance (ECA). The largest of these provides for 20,000 megalitres (ML) per year in the Hunter Regulated River Water Sharing Plan. Due to favourable climatic conditions in these areas during 2010–11, no releases of ECA were required.

Other non-statutory environmental watering plans are ‘annual watering plans’ and ‘adaptive environmental management plans’. These plans are used to help define the water requirements of assets and prioritise the use of environmental water within an area on both an annual and strategic basis.

Environmental Water Advisory Groups (EWAGs) play an important role in providing advice to OEH on how to best manage environmental water. EWAGs provide a unique forum for drawing on expert knowledge, including local knowledge and experience. Local landholder, irrigator, environmental and indigenous community interests are represented on each of the EWAGs, which have been established in the Gwydir, Lachlan, Macquarie, Murrumbidgee and Murray/Lower Darling valleys.
Water recovery programs

Water recovery programs in NSW aim to improve environmental outcomes for rivers and wetlands without compromising regional, social and economic objectives. These programs operate through the purchase of water access licences and investment in efficient water delivery and management infrastructure.

Water recovered through these programs is managed by OEH for the benefit of NSW rivers and wetlands, with the exception of Water for Rivers and The Living Murray where recovered water entitlement is recognised as being jointly held by partner jurisdictions and inter-jurisdictional planning and management arrangements have been established.

Current programs

**NSW RiverBank** commenced in 2005–06 and was the first program in Australia dedicated to the purchase of water entitlements for the environment. The $105-million program, funded by the NSW Environmental Trust, had purchased 86,972 ML of water entitlement by 30 June 2011 and has funding to continue purchasing until June 2012.

The RiverBank Business Plan allows for the periodic trading of water allocations in the accounts of OEH water access licences to provide revenue to meet the statutory charges associated with holding and using the licences, and funding for infrastructure works and environmental water event monitoring and evaluation costs. In 2010–11, there was one trade only – in the Gwydir Valley. Increased levels of temporary trading are likely to occur in years to come as water entitlement purchase concludes and the focus moves to managing the portfolio of water products that have been acquired during the course of the RiverBank program.

**Pipeline NSW** is being implemented by the NSW Office of Water to improve the efficiency of delivering water for rural stock and domestic use by replacing open channels and dams with piped systems, tanks and troughs. The program will achieve water savings from reduced system and operational losses. Pipeline NSW is jointly funded with $3.5 million from RiverBank and $3.5 million from the Australian Government’s Water for the Future–Water Smart Australia Program and will conclude in 2012.

**Water for Rivers** was established by the NSW, Victorian and Australian governments in 2003 to recover 282,000 ML of water for the Snowy and Murray rivers by 2012. Water savings are being achieved through investment in more efficient water infrastructure, innovation and technology and the purchase of water access licences. As of January 2011, approximately 232,515 ML of water entitlement had been recovered under the program.
The Hawkesbury–Nepean River Recovery Program is a $77.4-million program funded by the Australian Government’s Water for the Future fund that aims to improve river health below that system’s major water supply dams. It is doing this by increasing the amount of water retained in the river for the environment and reducing nutrient loads. The project commenced in 2009 and includes $4.5 million for OEH to purchase water licences held within the Hawkesbury–Nepean, securing water for the environment into the future. The water licence purchase project is gauging the market value of water in a system with little history of water trading and will conclude in 2012.

Completed programs

The Rivers Environmental Restoration Program (RERP) was completed in June 2011. The $181-million program aimed to arrest the decline of some of the most important and threatened wetland habitats in NSW through water recovery and effective management of environmental water. RERP was funded by the NSW Government ($101.5 million from NSW RiverBank) and the Australian Government ($79.62 million from the Water for the Future initiative through the Water Smart Australia Program).

The primary focus of RERP was the purchase of water access licences from willing sellers. At 30 June 2011, RERP had recovered 33,905 ML of water entitlement (in addition to the 86,972 ML recovered by NSW RiverBank) through the purchase of water licences and water savings from infrastructure projects.

To maximise the benefits of the $147-million investment in water purchase, RERP spent approximately $34 million in water savings projects, including:

- completion of numerous infrastructure projects across targeted valleys, such as the installation of 10 regulating structures and 10 floodways, and the breaching of 40 pre-existing embankments in Yanga National Park alone
- completion of the Gingham stock and domestic pipeline, allowing for the decommissioning of the Gingham channel and the rehabilitation of wetlands covering over 3000 hectares
- negotiation of 15 agreements with landholders to improve their management of over 3200 hectares of high conservation value wetlands on private land
- engagement of Aboriginal communities throughout the Lowbidgee Floodplain and lower Lachlan to record their connection to wetlands, facilitate access to culturally significant wetlands, and improve capacity and understanding to allow for greater engagement in wetland and water management
- development of an innovative solution to cold water pollution at Burrendong Dam, which State Water will now construct and which can be applied to other large dams of a similar configuration
- strategic purchase of over 14,000 hectares of high conservation value wetland properties for inclusion in the national reserve system
- development of hydrologic and hydrodynamic models for the Gwydir Wetlands, Macquarie Marshes and Lowbidgee Floodplain, and decision support systems for these valleys and Narran Lakes – these models will assist in the planning and management of environmental flows by predicting the duration, extent and depth of inundation at various water volumes and providing an indication of the likely ecological response of key species to watering events.


The NSW Wetland Recovery Program was a $26.8-million program jointly funded by NSW and the Australian Government’s Water for the Future–Water Smart Australia Program. During the course of the program from 2005 until June 2010, a total of 9383 ML of environmental water was purchased. The program also invested in wetland research, management tools, wetland management plans, grazing projects, weed control and infrastructure projects to recover water and improve environmental water flow in the Gwydir Wetlands and Macquarie Marshes. Further information on the achievements of the program is available at [www.wetlandrecovery.nsw.gov.au](http://www.wetlandrecovery.nsw.gov.au).

The Living Murray was established by the Murray–Darling Basin Ministerial Council, in partnership with the Australian, NSW, Victorian, South Australian and Australian Capital Territory governments to return up to 500,000 ML of water to improve the environmental health of six ‘icon’ sites along the Murray River. In NSW, water was recovered from the southern Murray–Darling Basin, including the regulated water sources of the Murrumbidgee, Murray and Lower Darling rivers. The NSW Government contributed $115 million to this program, along with investments from its partners. Over 221,487 ML was recovered from within NSW for The Living Murray, more than 45% of the total water recovered under the program.
A total of 9248 megalitres (ML) was added to the NSW water holdings in 2010–11 through the purchase and recovery of high security, general security and unregulated water, bringing the cumulative total to 351,747 ML.

Cumulative environmental water holdings recovered to 30 June 2011 by program and valley (ML)

<table>
<thead>
<tr>
<th>Regulated water source</th>
<th>NSW RiverBank</th>
<th>Rivers Environmental Restoration Program¹</th>
<th>NSW Wetland Recovery Program¹</th>
<th>The Living Murray</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HS²</td>
<td>GS¹</td>
<td>SA³</td>
<td>UR⁵</td>
</tr>
<tr>
<td>Gwydir</td>
<td>–</td>
<td>7,798</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Macquarie</td>
<td>–</td>
<td>19,926</td>
<td>28</td>
<td>–</td>
</tr>
<tr>
<td>Lachlan</td>
<td>1,000</td>
<td>24,097</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Murrumbidgee</td>
<td>–</td>
<td>22,507</td>
<td>5,679</td>
<td>5,937</td>
</tr>
<tr>
<td>NSW southern Murray–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Darling Basin⁷</td>
<td>–</td>
<td>1,000</td>
<td>74,328</td>
<td>5,707</td>
</tr>
</tbody>
</table>

Subtotal per program 1,000 74,328 5,707 5,937 30,178 563 3,164 8,081 1,302 221,487

Total 351,747

Note: This table is an operational record and it may be necessary to incorporate some minor adjustments across the programs and valleys when the data is verified by audit.

1 The Rivers Environmental Restoration Program and NSW Wetland Recovery Program were jointly funded by the NSW and Australian Governments.

2 HS = High security: shares are likely to receive close to 100% of their allocation in most years.

3 GS = General security: allocation varies depending on inflows and storage levels

4 SA = Supplementary access: subject to event-based announcements

5 UR = Unregulated entitlement: available water is not regulated by a major storage. For many valleys, water sharing plans for unregulated water sources have not yet been completed and licences are administered under the Water Act 1912


7 Includes water recovered from the Murray, Murrumbidgee and Lower Darling valleys for the benefit of the Murray River (The Living Murray).
The Gwydir Valley encompasses a catchment of 26,596 square kilometres and contains a mosaic of wetland types from semi-permanent marshes and waterholes to floodplain woodlands which are only inundated during large floods. The Gwydir River branches into the Gingham (north) and Lower Gwydir (central) watercourses and the Mehi, Mallowa and Moomin systems (south).

**Gwydir Valley environmental watering event sites 2010–11**

The Gingham system supports river red gum forests, coolibah woodlands and extensive grasslands of water couch, lignum, river cooba, cumbungi and spike rush. It provides critical breeding habitat for waterbirds which nest in colonies, such as egrets, herons, cormorants, spoonbills, ibis and darters, as well as other waterbirds such as ducks, swans, grebes, coots and swamphens.

Similarly, the Lower Gwydir Watercourse supports river red gum forests, river cooba, water couch marsh, marsh club-rush sedgeland and common reeds, while open water lagoons provide feeding habitat for nesting colonies, especially ibis and spoonbills.

The Mehi, Mallowa and Moomin systems support coolibah and river red gum forests which act as a riverine corridor, together with river cooba and lignum vegetation communities.

Noteworthy in all these areas are species listed under international agreements, including the barn swallow, black tern, Caspian tern, cattle egret and common tern. The Gwydir Wetlands also supports the state’s largest stand of marsh.
club-rush sedgeland, listed as critically endangered under the NSW Threatened Species Conservation Act 1995, and a rare species of freshwater snail discovered in the wetlands in 2010. Downstream of Copeton Dam, the aquatic ecosystem of the Gwydir River is part of the Darling River endangered ecological community listed under the NSW Fisheries Management Act 2004 and home to several threatened native fish species, including silver perch, olive perchlet, purple-spotted gudgeon and the Murray–Darling population of eel-tailed catfish.

Wetland sites in the Gingham and Lower Gwydir watercourses are listed under the Convention on Wetlands of International Importance (the ‘Ramsar Convention’). The listing covers parts of three private properties – ‘Windella’, ‘Crinolyn’ and ‘Goddard’s Lease’ – and a fourth property, ‘Old Dromana’, which was purchased by the NSW Government under the Rivers Environmental Restoration Program and declared the Gwydir Wetlands State Conservation Area in February 2011.

Traditionally, the Gwydir Wetlands is the country of the Gamilaroi people with over 160 cultural heritage sites recorded, including burial sites, scarred trees and stone artefacts. The wetlands have supported cattle and sheep grazing since the late 1830s and this was later joined by the dryland cropping and irrigation which developed in the 1970s.

Regulation of the Gwydir River and associated water extraction since the 1970s has affected the wetland flooding regime. This, along with land management activities and channel modifications, has contributed to a dramatic decline in both the area and health of wetland vegetation and the diversity and numbers of native waterbirds and fish species. In addition to their impact on flow regimes, weirs and other barriers restrict the movement of fish and other aquatic species as well as having an impact on critical processes, such as fish spawning.

**Catchment condition in 2010–11**

The Gwydir catchment was one of the few catchments in NSW that did not experience substantial flooding in 2010–11. However, late winter rains and river flows, a proportion of which were protected for the environment, combined with 22,783 ML of environmental water to produce the largest and most extensive inundation in the region since 1998. The wet conditions allowed an increase in general security allocations from zero in July 2010 to 83% in March 2011 with almost 50 GL of additional water allocated to the Environmental Contingency Allowance stored in Copeton Dam.

**Watering aims**

For 2010–11, the primary aim for the Gwydir Valley was to support, where possible, between six and eight months of continuous wetland inundation across a large portion of the Gwydir Wetlands, including critical refuge areas for fish and waterbird species. This prolonged duration of watering aimed to provide the conditions required to allow restoration of the wetland system and support the ecological processes that underpin the completion of life cycles for many wetland species.
## Water delivery

Water delivered in the Gwydir Valley during the 2010–11 environmental watering year

<table>
<thead>
<tr>
<th>Location</th>
<th>Start date</th>
<th>Finish date</th>
<th>NSW</th>
<th>CEW(^1)</th>
<th>EWA(^2)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gwydir and Gingham Wetlands above Gingham Bridge and the ‘Goddard’s Lease’ Ramsar site (1)</td>
<td>1 Aug 2010</td>
<td>3 Aug 2010</td>
<td>–</td>
<td>3,056</td>
<td>–</td>
<td>3,056</td>
</tr>
<tr>
<td>Gwydir Wetlands – Whittakers Lagoon – Mehi River (2)</td>
<td>10 Dec 2010</td>
<td>12 Dec 2010</td>
<td>70</td>
<td>–</td>
<td>–</td>
<td>70</td>
</tr>
<tr>
<td>Gwydir Wetlands system (3)</td>
<td>19 Jan 2011</td>
<td>21 Mar 2011</td>
<td>4,657</td>
<td>10,000</td>
<td>5,000</td>
<td>19,657</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td>4,727</td>
<td>13,056</td>
<td>5,000</td>
<td>22,783</td>
</tr>
</tbody>
</table>

Note: The location numbers in the table relate to the watering event sites marked on the map.

1. CEW = Commonwealth environmental water
2. EWA = Environmental water allocation accrued under the Water Sharing Plan for the Gwydir Regulated River Water Source 2002
Ecological outcomes

Widespread inundation yielded successful results for waterbird breeding, and the restoration of vegetation and recharge of soil moisture. Inundation covered over 10,000 hectares of remnant wetlands and watercourse vegetation across the Gingham and Lower Gwydir (Big Leather) watercourses.

In the early part of 2010–11, prolonged mild daily temperatures during spring together with a continuing supply of water provided exceptional growing conditions for coolibah woodlands, lignum and cooba stands. Evidence of the recruitment of these species was observed during end-of-season monitoring fieldwork, with young seedlings and vigorous new growth in existing stands across the wetlands system.

The large stand of marsh club-rush sedgeland in the Gwydir Wetlands State Conservation Area produced an abundance of flowers in September 2010, not seen to the same extent since late 1990. Monitoring of wetland vegetation response in March 2011 indicated that the area of the stand had grown by at least 10%.

Completion of the Gingham Homestead supply pipeline in March 2011 generated 985 ML of high security water savings, intended to benefit the wetlands in the Gingham Watercourse. A water access licence will be issued for these savings during 2011–12. The improved piped delivery system replaces the Gingham stock and domestic open channel, which was constructed in the 1970s.

This season, initial rehabilitation works saw water flow to wetland areas along the watercourse that had not been well inundated since 1998. As a direct result of reconnecting old flow paths in the wetland system, a flock of 300–400 magpie geese successfully fledged juveniles in June 2011. In addition, two black-necked stork chicks were successfully fledged and later observed feeding independently in the wetlands. This Gingham wetland restoration project will provide environmental water to at least 3000 hectares of wetlands, which will improve core wetland ecosystem health.

Although large-scale colonial waterbird nesting was absent in the Gwydir this year, many generalist waterbird species were observed nesting across wetted areas, including purple swamphens, dusky moorhens, masked lapwing, black-winged stilt and many varieties of duck. Another positive outcome was the reported sighting by a local bird watching group of comb-crested jacana at Whittakers Lagoon, a bird listed as vulnerable in NSW.

Water plans

The following plans determine or help decide how environmental water is allocated and managed in the Gwydir Valley:

- Water Sharing Plan for the Gwydir Regulated River Water Source 2002
- RiverBank Water Use Plan for the Gwydir Water Management Area
- Environmental Watering Plan for the Gwydir Valley 2010–11

Marsh club-rush sedgeland, a critically endangered ecological community, sets seed in the Gwydir Wetlands State Conservation Area.
Spanning 75,000 square kilometres, the Macquarie River catchment sends its flows through distributary streams and extensive floodplain wetlands onto the Darling Riverine Plain. The main Macquarie River channel forms the Macquarie Marshes north of Warren, which extends through to the Barwon River and includes a range of wetlands from semi-permanent marshes and lagoons to ephemeral wetlands.

The northern part of the marshes contains extensive areas of common reed and river red gum woodland, with open water areas like Loudens and Sinclairs lagoons which are fringed by black box and coolabah woodlands. The area incorporates the northern section of Macquarie Marshes Nature Reserve and private lands along Bora Channel, Ginghet Creek and the lower Macquarie River.

The vegetation of the southern marshes includes the same communities as those found in the northern marshes as well as additional large areas of water couch meadows and mixed marsh communities. Several wetlands in the south marsh have undergone significant changes, with erosion and scouring disconnecting some floodplain wetland systems from the main channels and causing loss of wetland vegetation in systems previously characterised by extensive common reedbeds and open water lagoons. The southern marshes include the southern section of Macquarie Marshes Nature Reserve and private lands with significant parts of Monkeygar Wetlands, Mole Marsh, Monkey Swamp, Buckinguy Swamp and the Marebone area.

In the east, the marshes include Long Plain Cowal, Dusty Swamp, Marthaguy Creek and the Gum Cowal–Terrigal Creek systems. This area is characterised by open riparian lagoons, and river red gum and river cooba woodlands on riparian floodplain areas. Large areas of Myall woodlands occur on the upper floodplains, along with black box and coolabah woodlands.
All three areas of the marshes sustain important habitat for waterbird breeding, especially for species that nest in colonies: four species of egrets, herons, cormorants, spoonbills, ibis and darter. They also host a range of breeding waterbirds, including terns, ducks, swans, grebes, bitterns and stilts. The areas provide a summer harbour for various migratory wader species, including godwits, sandpipers and Latham’s snipe.

The northern, southern and eastern areas of the marshes provide habitat for various bird species listed as endangered or vulnerable under the NSW Threatened Species Conservation Act 1995 (TSC Act): the brolga, magpie goose, Australian painted snipe, Australasian bittern and blue-billed duck. Also listed under the TSC Act are two local endangered ecological communities: the coolibah–black box woodland and the Myall woodlands, along with numerous mammals, amphibians and plants. Two endangered fish species – the Murray cod (listed under Commonwealth legislation) and the silver perch (NSW legislation) – are found in the marshes.

Macquarie Marshes Nature Reserve and part of the privately owned property ‘Wilgara’ are listed under the Convention on Wetlands of International Importance (the ‘Ramsar Convention’). These areas are of particular importance as they have historically supported some of the largest waterbird breeding events in Australia’s recorded history and provide essential breeding and feeding habitat for hundreds of species of animals and plants.

Over 500 cultural heritage sites are recorded in the Macquarie Marshes, which lies within the traditional country of the Wailwan people. They include carved trees, ceremonial and burial sites, oven mounds, scar trees and stone artefacts.

Agricultural use of the Macquarie Marshes began in the early to mid-1800s with the establishment of large pastoral leases primarily for grazing. Large-scale irrigation in areas mostly upstream of the marshes began in the 1970s following construction of Burrendong Dam in 1967. The regulation of flows through the construction of dams and weirs has altered the water regime of the marshes.

**Catchment condition in 2010–11**

At the commencement of the 2010–11 watering year, the Macquarie Marshes had experienced 10 years of less than average inflows and no large-scale flooding since 2000. The result of this prolonged dry period was an overall reduction in the extent of wetland vegetation, colonisation by terrestrial chenopods (perennial shrubs and annual or perennial herbs) in areas previously occupied by wetland vegetation, and a severe decline in the health of river red gums, including the death of large stands in the driest areas. As well as changes in wetland vegetation, large-scale breeding of colonial waterbirds had not occurred since the beginning of the drought.

During this dry period, the application of environmental flows in conjunction with tributary flows maintained wetland vegetation in moderate to good condition in only the wettest areas of the marshes.

During 2010–11, one of the wettest years on record and boosted by environmental water delivery of over 199,310 ML, inundation of Macquarie Marshes peaked at 175,000 hectares in January 2011.

**Watering aims**

Due to the significant rainfall in 2010–11, a key watering objective was to improve, extend and restore healthy and resilient ecosystems in over 20,000 to 30,000 hectares of the Macquarie Marshes. Water delivery aimed to benefit large tracts of stressed river red gum woodlands and forests in the northern marshes, which in turn would benefit large areas of water couch, common reed and mixed marsh in both the northern and southern marshes. Environmental watering also aimed to support significant colonial bird breeding and native fish recruitment and aid fish dispersal by maintaining flows through the Gum Cowal–Terrigal system.
Water delivery

Water delivered in the Macquarie Valley during the 2010–11 environmental watering year

<table>
<thead>
<tr>
<th>Location</th>
<th>Start date</th>
<th>Finish date</th>
<th>ML of water delivered</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>North, South and East Macquarie Marshes (1)</td>
<td>1 Sep 2010</td>
<td>15 Apr 2011</td>
<td>NS 33,321.5 CEW 26,888.4 EWA 139,101</td>
<td>199,310.9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td>NS 33,321.5 CEW 26,888.4 EWA 139,101</td>
<td>199,310.9</td>
</tr>
</tbody>
</table>

Note: The location numbers in the table relate to the watering event sites marked on the map.
1  CEW = Commonwealth environmental water
2  EWA = Environmental water allocation accrued under the Water Sharing Plan for the Macquarie and Cudgegong Regulated Rivers Water Source 2003

Burrendong Dam reached 100% capacity by October 2010 and peaked in December 2010 at 150% capacity. The Environmental Water Allowance held in the dam provided flows of 139,101 ML to the Macquarie Marshes and all water access licences for the Macquarie and Cudgegong valleys received 100% of entitlement. Supplementary licence allocations contributed 1452 ML (NSW) and 2104 ML (Commonwealth) to the watering event. Due to significant inflows to storages in 2010–11, the Macquarie and Cudgegong water sharing plan recommenced in July 2011.

Ecological outcomes

Hundreds of thousands of colonial waterbirds congregated in the Macquarie Marshes where the extended inundation from winter through to autumn allowed many species to raise several broods of chicks.

A straw-necked ibis colony in the southern area of the marshes successfully completed two cycles of breeding, with 35,000 nests observed in the first cycle and 70,000 in the second. Egrets (including great, intermediate and little) also successfully completed two cycles of breeding with more than 50,000 nests observed at the height of the second cycle.
Other waterbirds observed breeding in the marshes in 2010–11 included herons (rufous night herons, white-faced and white-necked herons, and a handful of pied herons), magpie geese, cormorants (four species), black swans, brolgas, Eurasian coots, ducks (such as freckled, pink-eared and plumed whistling ducks), grebes (great-crested, hoary-headed and Australasian), purple swamphens, dusky moorhens, black-tailed native hens and black-shouldered stilts. Other interesting sightings included red-necked avocets, blue-billed ducks, cattle egrets and migratory sharp-tailed sandpipers.

The common reed beds in the southern and northern marshes are in very good condition. There was a vigorous response from the water couch and mixed marsh, and the restoration of some reed and water couch was evident in other areas of the marshes. The river red gum canopy has generally shown an increase in density in large areas of the northern marshes and some germination has occurred in areas of degraded river red gum. There was also an observable decline in terrestrial chenopods in areas that were historically occupied by wetland vegetation and some re-emergence of wetland species.

The flood conditions in the valley and inundation of the floodplain areas in the marshes resulted in good frog breeding events but mixed outcomes for native fish populations. Positive outcomes included opportunities for fish to move and disperse as river systems became connected to adjacent systems such as Marthaguay Creek and the Castlereagh, Bogan and Barwon rivers. In addition, researchers noted the presence of juvenile catfish in the Gum Cowal–Terrigal system, a species not recorded in the area since 1989. However, the longer duration of the flood through the warmer months created ideal conditions for recruitment of introduced carp species, a situation mirrored in other valleys, where high numbers of both adult and juvenile carp were recorded toward the end of summer.

**Water plans**

The following plans determine or help decide how environmental water is allocated and managed in the Macquarie and Cudgegong Valley:

- RiverBank Water Use Plan for the Macquarie River
- Environmental Watering Plan for the Macquarie Valley 2010–11
The sight, sound and smell of a large congregation of breeding waterbirds is fascinating for anyone privileged enough to witness the event. When chicks fledge successfully, a wetland is functioning as it should: providing plenty of secure nesting sites, water and food.

Waterbirds are important social and ecological indicators of wetland condition. Communities connect with healthy wetlands because they provide valued services, such as nurseries for recreational fisheries, opportunities for tourism and support for sustainable grazing.

Ibis, egrets, Australian pelicans, herons, spoonbills and cormorants breed in colonies that can number over 50,000 nests, sometimes twice this. These large colonial waterbird breeding events are dependent on the availability of water and are limited to just a few wetlands across Australia, with many of the most important breeding sites in NSW. Wetlands are targeted for the delivery of environmental water, particularly where waterbird colonies are active and the regulation of waterways has influenced natural water flow and wetland flooding. Stable water levels are critical for successful waterbird breeding, particularly by ibis species. Rapid falls in water cause adults to abandon breeding and rapid rises can drown nests.

Records of the location, size, developmental stage and breeding success of waterbird colonies and water flows provide essential information to help to continually refine the delivery of environmental water.

Since 2008, OEH has explored methods for monitoring the breeding activities of waterbirds in key wetlands including estimating the number of nests. These are counted using high-resolution digital images taken from above that are sharp enough to identify nests 30–40 centimetres in size. The images are taken from light aircraft, adjusted and stitched together to produce a seamless coverage of whole colonies. Individual nests are recorded and, where possible, assigned to a particular species. This method works well for species that nest in lignum and reed beds and on islands but is less reliable for those nesting in trees where the canopy obscures the nests.

Solar-powered cameras installed within breeding colonies are being trialled by OEH to provide real-time monitoring of waterbird events via the internet. Remote monitoring of colony conditions supports decision-making on water delivery, avoiding the need for frequent field trips and human disturbance of breeding colonies. The use of cameras also has great potential for researchers investigating waterbird breeding behaviour.

For the 2010–11 season, over 250,000 nests of straw-necked, glossy and Australian white ibis, royal spoonbill and great, intermediate and little egrets were counted across Narran Lakes, the Macquarie Marshes, and wetlands in the lower Lachlan, lower Murrumbidgee and mid-Murray. In addition, the nests of thousands of rufous (nankeen) night heron, little pied, little black and great cormorants, darters, Pacific heron, yellow-billed spoonbill, magpie geese and many other species of waterbirds were counted from ground surveys.

Field observations revealed low mortality levels and little activity by predators and scavengers. Consequently, the vast majority of these nests produced fledged young that have now entered the adult populations.
The Lachlan is one of the most variable river systems in Australia with a catchment of 90,649 square kilometres, and three areas of particularly high ecological value that are listed in the Directory of Important Wetlands in Australia: the Booligal Wetlands, Great Cumbung Swamp and Lachlan Swamps.

Lachlan Valley environmental watering event sites 2010–11

The Booligal Wetlands complex is made up of numerous small wetlands and swamps, including Booligal, Merrimajeel and Murrumbidgil swamps. The Booligal Wetlands support lignum, river red gum, black box and river cooba vegetation communities and is also known for the large number of colonial waterbirds that breed and forage in the area, mostly ibis species and royal spoonbill. Breeding by the Australasian bittern, blue-billed duck and freckled duck – all listed as vulnerable under the NSW Threatened Species Conservation Act 1995 (TSC Act) – occurs in the area. The wetlands also provide habitat for species, such as the great egret, glossy ibis and sharp-tailed sandpiper, which are listed under various international migratory bird agreements.

The Great Cumbung Swamp is a good example of a terminal NSW reed swamp. It also acts as a drought refuge during dry conditions and contains common reed and river red gum communities interspersed with patches of black box and lignum. The swamp and its floodplain support one of the largest stands of river red gum in NSW. The Australasian bittern, blue-billed duck and freckled duck are found within the swamps and are listed as vulnerable under the TSC Act. Several other waterbirds listed under international agreements are also found within the swamp, including the eastern great egret, glossy ibis, common greenshank, Latham’s snipe, white-bellied sea-eagle, and sharp-tailed sandpiper.
The Lachlan Swamps area encompasses Ita Lake, Lake Waljeers, Lake Bullogal and Peppermint Swamp, which support stands of black box, river cooba, river red gum, lignum and nitré goosefoot. When Lachlan Swamps is flooded, it is known to support a large number of waterbirds, including great egret colonies. The swamps also support many species listed as vulnerable, including the blue-billed duck, brown treecreeper, grey-crowned babbler, magpie goose and freckled duck and two listed plant species, the Mossgiel daisy and Menindee nightshade.

The lowland section of the Booligal Wetlands complex, the Great Cumbung Swamp and Lachlan Swamps are all listed as endangered ecological communities under the NSW Fisheries Management Act 2004.

In addition to these nationally significant wetlands, OEH has prioritised the delivery of environmental water to several smaller lagoons upstream in the mid-Lachlan anabranches near Condobolin and downstream near Booligal. These lagoons are representative of many hundreds along the river and are vital for maintaining river health. When flooded, they provide important habitats for waterbirds, fish and aquatic plants. The particular sites chosen for watering have strategic importance and are also highly valued by landholders. One supports a population of the endangered purple-spotted gudgeon, another hosts a breeding pair of the vulnerable brolga, and others support diverse aquatic plant communities which supply seed sources for riparian and wetland areas further downstream.

During extended periods of low water availability, such as those the Lachlan has experienced over the past decade, targeted watering of these smaller wetlands provided an opportunity for broader recovery of the river system when wetter conditions returned as they did in 2010–11. This approach to environmental water management is particularly important as the Lachlan Valley has many dams, weirs and other regulating features which have changed the hydrology and ecology of the area. These changes have decreased the inundation of wetlands and floodplains, resulting in greater fragmentation of aquatic habitats.

**Catchment condition in 2010–11**

Prolonged dry conditions continued in the Lachlan Valley until September 2010 when rainfall and storage inflows to Wyangala Dam enabled general security licence holders to receive their first allocation since October 2005. In January 2011, general security licence allocations increased to over 100% as the dam reached its highest level since 2000. Significant flows occurred downstream of Wyangala, replenishing the lower Lachlan creeks.

After seven years of suspension, the Lachlan water sharing plan recommenced in July 2011, ending drought management arrangements in the valley and bringing back the plan’s environmental flow provisions.

**Watering aims**

The Lachlan Valley began 2010–11 with initially zero and then very low water allocations to general security access licences. For this reason, the primary aim was to avoid damage to key habitats and ensure their capacity to recover. This was achieved by improving vegetation condition and enhancing foraging and nesting habitat for waterbirds along the Merrowie Creek system, including Cuba Dam and downstream to Lake Tarwong, which had not been inundated since 2000. Another important aim was to support the successful completion of large colonial waterbird breeding events in the Booligal Wetlands and on the Merrowie Creek system at Cuba Dam.
### Water delivery

Water delivered in the Lachlan Valley during the 2010–11 environmental watering year

<table>
<thead>
<tr>
<th>Location</th>
<th>Start date</th>
<th>Finish date</th>
<th>NSW</th>
<th>CEW¹</th>
<th>EWA²</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Merrowie Creek and Cuba Dam (1)</td>
<td>13 Oct 2010</td>
<td>19 Oct 2010</td>
<td>1,312.5</td>
<td>–</td>
<td>–</td>
<td>1,312.5</td>
</tr>
<tr>
<td>Merrimajeel Creek – Booligal Wetlands (2)</td>
<td>28 Oct 2010</td>
<td>20 Dec 2010</td>
<td>560.8</td>
<td>1,877.6</td>
<td>–</td>
<td>2,438.4</td>
</tr>
<tr>
<td>Merrowie Creek – Lake Tarwong ibis breeding event (3)</td>
<td>16 Nov 2010</td>
<td>14 Dec 2010</td>
<td>864.4</td>
<td>2,145</td>
<td>–</td>
<td>3,009.4</td>
</tr>
<tr>
<td>Merrowie Creek – Lake Tarwong (4)</td>
<td>11 Jun 2011</td>
<td>30 Jun 2011</td>
<td>781.3</td>
<td>2,447</td>
<td>–</td>
<td>3,228.3</td>
</tr>
<tr>
<td>Murrumbidgil Swamp – Lake Merrimajeel (5)</td>
<td>11 Jun 2011</td>
<td>30 Jun 2011</td>
<td>92.5</td>
<td>252.5</td>
<td>–</td>
<td>345</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td>3,611.5</td>
<td>6,722.1</td>
<td>–</td>
<td>10,333.6</td>
</tr>
</tbody>
</table>

Note: The location numbers in the table relate to the watering event sites marked on the map.

1  CEW = Commonwealth environmental water
2  EWA = Environmental water allocation accrued under the Water Sharing Plan for the Lachlan Regulated River Water Source 2003

### Ecological outcomes

This year brought great results with flows reaching areas that had not received water since the beginning of the drought. In Merrimajeel Creek, a combination of stock and domestic replenishment flows, discretionary environmental water and translucent flows saw water fill Murrumbidgil Swamp and partially fill Lake Merrimajeel at the end of the creek.

The Booligal Wetlands experienced one of its largest and most successful waterbird breeding events with approximately 120,000 young straw-necked ibis successfully fledged. This included approximately 1000 pairs of glossy ibis scattered throughout the colony. A range of other waterbirds, including grebes, cormorants, freckled ducks with ducklings, blue-billed ducks and hardheads, nested in the areas of the colony. Royal spoonbill and white ibis hatchlings were also observed scattered throughout the colony.

Flows travelling down Merrowie Creek successfully filled Lake Tarwong and associated channels for the first time in over 10 years, bringing new growth and flowering of drought-stressed river red gums at the lake. Lignum in the Booligal Wetlands and along Merrowie Creek above Cuba Dam responded to the wetter conditions, with vigorous growth and active flowering providing good conditions for 10,000 pairs of straw-necked ibis. Aquatic plants, such as milfoil, azolla and nardoo, also established along the creeks and the calls of several species of frogs were recorded, including the beeping froglet, the vulnerable Sloane’s froglet, and the giant banjo and spotted marsh frogs.
In December 2010, flows into Lake Brewster initiated a very successful pelican breeding event on the banks of the outflow channel and wetlands. More than 4000 eggs and young were observed to April 2011, making this one of the largest pelican breeding events in NSW for over five years. OEH, State Water and the NSW Office of Water prevented high flows in the river from entering the lake during the breeding period which avoided flooding of the nests and allowed aquatic plants to continue developing in the outflow wetland. Most of the 37,000 ML of foregone storage continued down the river and contributed to overbank flows downstream of Lake Brewster and base flows that benefited environmental assets including the Great Cumbung Swamp.

Water plans

The following plans determine or help decide how environmental water is allocated and managed in the Lachlan Valley:

- Water Sharing Plan for the Lachlan Regulated River Water Source 2003
- RiverBank Water Use Plan for the Lachlan Water Management Area
- Environmental Watering Plan for the Lachlan Valley 2010–11
- Lachlan Environmental Water Management Plan.
The Murrumbidgee catchment covers 81,527 square kilometres including a 1,690-kilometre stretch of river and its surrounding wetlands and a number of national parks, nature reserves and conservation areas with important wetland values. The catchment has one of the most diverse terrains in NSW, ranging from the alpine areas of Kosciuszko National Park and the Monaro Plains through to the grazing and grain belts of the south-west slopes and the shrublands and grasslands of the semi-arid western Riverina.

**Murrumbidgee Valley environmental watering event sites 2010–11**

For OEH’s environmental water planning purposes, the Murrumbidgee is split into two broad areas: the mid-Murrumbidgee and the lower Murrumbidgee floodplain, known as the ‘Lowbidgee’.

The Lowbidgee incorporates the Nimmie–Caira and Redbank systems, including Yanga National Park. Vegetation communities typically found in the Lowbidgee include river red gum, black box, common reed, cumbungi, river cooba, nitre goosefoot, cane grassland and chenopod shrublands. The area supports numerous species listed under the Commonwealth Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act): Murray cod, painted snipe, red-necked stint, regent honeyeater, regent parrot, superb parrot, austral pipewort, chariot wheel, slender darling pea, Menindee nightshade and southern bell frog. The Lowbidgee has several birds, fish, reptiles, mammals and plants listed under the NSW Fisheries Management Act 2004 (FM Act) and Threatened Species Conservation Act 1995 (TSC Act), and various international agreements. The Murrumbidgee River is also part of the endangered ecological community of the lower Murray River Catchment declared under the FM Act.
The mid-Murrumbidgee wetlands are listed under the Directory of Important Wetlands in Australia. Dominant vegetation communities in the area include river red gum, black box, spike rush, water lilies and water ferns. The area supports five species listed under the EPBC Act: trout cod, plains wanderer, superb parrot, southern bell frog and floating swamp wallaby-grass. Several species of birds, fish, reptiles, mammals and plants found in the mid-Murrumbidgee are also listed under the FM and TSC Acts and various international agreements.

There are numerous cultural heritage sites within the Murrumbidgee Valley. Tuckerbil Swamp, which contains an ancestral burial ground, is of significance to the Wiradjuri people. Many indigenous families, who belong to the Narrungadera Wiradjuri community, still live within the Riverina and maintain a strong connection to the land and such wetlands as Fivebough and Tuckerbil swamps, both listed under the Convention on Wetlands of International Importance (the ‘Ramsar Convention’).

The Murrumbidgee catchment contains 26 storage or diversion structures under NSW operation, making it one of Australia’s most regulated with substantial impacts on the water regime and availability of water to floodplains and wetlands.

**Catchment condition in 2010–11**

The previously dry conditions in the Murrumbidgee Valley catchment gave way to significant rainfall during spring and summer. The increased tributary inflows allowed general security allocations and supplementary access to commence in September 2010 with allocations to all users steadily increasing through to December when full allocations to general security users were declared for the first time since 1996.

Environmental water allocations delivered approximately 185,000 ML under the suspended Murrumbidgee water sharing plan, which recommenced in July 2011.

**Watering aims**

The priority for 2010–11 environmental watering was to improve the condition of the native vegetation communities and maintain and complete any bird breeding events. Watering aims were to retain and improve the condition of wetland vegetation, black box, river cooba and river red gum forests, create and sustain bird breeding events, and encourage the population of the threatened southern bell frog to expand.
Water delivery

Water delivered in the Murrumbidgee Valley during the 2010–11 environmental watering year

<table>
<thead>
<tr>
<th>Location</th>
<th>Start date</th>
<th>Finish date</th>
<th>ML of water delivered</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>NSW</td>
</tr>
<tr>
<td>South Yanga (1)</td>
<td>1 Jul 2010</td>
<td>26 Aug 2010</td>
<td>2,057.6</td>
</tr>
<tr>
<td>Lowbidgee – numerous rookeries (2)</td>
<td>4 Aug 2010</td>
<td>15 Oct 2010</td>
<td>–</td>
</tr>
<tr>
<td>North Redbank (4)</td>
<td>5 Aug 2010</td>
<td>20 Oct 2010</td>
<td>–</td>
</tr>
<tr>
<td>Yanga Lake (5)</td>
<td>18 Aug 2010</td>
<td>18 Sep 2010</td>
<td>428</td>
</tr>
<tr>
<td>Fiddlers Creek (6)</td>
<td>18 Aug 2010</td>
<td>5 Oct 2010</td>
<td>3,194</td>
</tr>
<tr>
<td>Mid-Murrumbidgee DIWA Wetlands (Wagga to Hay) and Junction Wetlands (downstream of Balranald) (8)</td>
<td>5 Sep 2010</td>
<td>7 Sep 2010</td>
<td>–</td>
</tr>
<tr>
<td>Turkey Flats (9)</td>
<td>14 Sep 2010</td>
<td>15 Sep 2010</td>
<td>–</td>
</tr>
<tr>
<td>Condoulpe Box Wetlands (10)</td>
<td>13 Oct 2010</td>
<td>22 Oct 2010</td>
<td>–</td>
</tr>
<tr>
<td>Barrenbox Swamp (11)</td>
<td>25 Oct 2010</td>
<td>9 Nov 2010</td>
<td>–</td>
</tr>
<tr>
<td>Paika Lake (13)</td>
<td>16 May 2011</td>
<td>29 Jun 2011</td>
<td>–</td>
</tr>
<tr>
<td>Murrumbidgee/mid- Murrumbidgee Wetlands (14)</td>
<td>14 Jun 2011</td>
<td>25 Jun 2011</td>
<td>11,859.9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>17,539.5</strong></td>
</tr>
</tbody>
</table>

Note: The location numbers in the table relate to the watering event sites marked on the map.

1 CEW = Commonwealth environmental water
2 EWA = Environmental water allocation accrued under the Water Sharing Plan for the Murrumbidgee Regulated River Water Source 2003
3 TLM = Water sourced from The Living Murray coordinated by the Murray–Darling Basin Authority

Ecological outcomes

The environmental flows and the subsequent overbank floods of late 2010 revived vegetation, triggered and sustained numerous major waterbird breeding events, and enabled partial recovery of the populations of southern bell frogs in some wetlands.

In the Lowbidgee, inundation of the Nimmie–Caira wetlands saw the establishment of large ibis rookeries (approximately 60,000 in total) at Telephone Bank Swamp and Eulimbah Swamp and a smaller rookery at Nap Nap Swamp. Other species recorded at these sites included threatened species such as freckled ducks, Australasian bittern and blue-billed ducks. Recolonisation by the southern bell frog of several wetlands, including Nap Nap and Suicide swamps, is promising for the recovery of this threatened species.
Significant capital investment in infrastructure by OEH and the contribution of thousands of dollars and hundreds of project hours in-kind by landholders were essential in reconnecting a long isolated water delivery system using natural creek lines to carry environmental flows to Paika Lake and nearby Charax Swamp. This was the first time this large lake had received water in over a century. Paika is the only site in the Lowbidgee that has an island as well as deep and shallow water habitats, making it ideal for a wide variety of waterbirds and other wetland fauna. Property Vegetation Plans are also being developed for the lake and the cultural significance of the area documented through the Aboriginal Use and Values project under the Rivers Environmental Restoration Program.

Similarly, the southern section of the Balranald Shire Common wetlands received water for the first time in over a decade using new OEH-funded infrastructure, which enabled water to be delivered through wetlands on the privately owned property ‘Baupie’.

A large egret and heron rookery established itself at Steam Engine Swamp on another private property ‘Paika East’ in a breeding event larger than any previously recorded with approximately 2000 egret, heron and cormorant nests.

Yanga National Park received significant inflows which combined to completely inundate the southern section of the park and fill Yanga Lake before early November, providing the most comprehensive watering to the area since at least 2000. River red gum, lignum and black box vegetation all demonstrated clear improvement in condition. Southern bell frogs were heard calling from Piggery Lake and several pairs of blue-billed ducks observed breeding on Yanga Lake. Two large waterbird rookeries, consisting primarily of cormorants, egrets and herons established in Yanga National Park, with nests collectively numbering between 4000 and 5000.

In the mid-Murrumbidgee, natural flows along with environmental water deliveries filled hundreds of wetlands and inundated thousands of hectares of fringing river red gum forest along the river system in the most significant wetland filling event in this region since at least 1996. Results have been mixed for the reestablishment of aquatic vegetation in the majority of wetlands following an average of 10 years without inundation. However, river red gums have responded positively and the endangered southern bell frog has been rediscovered in several wetlands near Darlington Point.

**Water plans**

The following plans determine or help decide how environmental water is allocated and managed in the Murrumbidgee Valley:

- Water Sharing Plan for the Murrumbidgee Regulated River Water Source 2003
- RiverBank Water Use Plan for the Murrumbidgee Water Management Area
- Environmental Watering Plan for the Murrumbidgee Valley 2010–11.
The Murray River makes up part of the border between NSW and Victoria. The river stretches 1700 kilometres and includes a large anabranch system, the Edward–Wakool system, which collectively creates an intricate network of waterways. The NSW portion of the Murray and Lower Darling valleys has an area of 14,490 square kilometres, containing a mosaic of wetland types from ephemeral wetlands to permanently wet lagoons and rivers.

Murray and Lower Darling valleys environmental watering event sites 2010–11

NSW Central Murray State Forests and the Barmah–Millewa State Forest are listed under the Convention on Wetlands of International Importance (the ‘Ramsar Convention’). Within NSW, the Millewa Forest (part of which lies in Murray Valley National Park), Koondrook–Perricoota Forest, the eastern section of Chowilla Floodplain, and the River Murray Channel are icon sites under The Living Murray program. Watering of these sites is coordinated by the Murray–Darling Basin Authority and undertaken in conjunction with the states.

The Murray and Lower Darling valleys support one of Australia’s largest stands of river red gum forest, as well as river cooba, black box, lignum, common reed, Moira grass, spike rush and giant rush communities. The following species found in the valleys are listed under the Commonwealth Environmental Protection and Biodiversity Conservation Act 1999: Macquarie perch, Murray cod, trout cod, painted snipe, regent honeyeater, superb parrot, small scurf-pea, mountain...
Swainson-pea, floating swamp wallaby-grass and southern bell frog. There are also numerous fish, birds, mammals, reptiles and plants listed under the NSW Fisheries Management Act 2004 (FM Act) and Threatened Species Conservation Act 1995, and various international agreements. The Lowland Murray River has also been declared an endangered ecological community under the FM Act.

A large proportion of wetlands on the NSW River Murray floodplain are located on private property. Within the Murray catchment and surrounding areas, more than 968 cultural heritage sites have been recorded. The majority of these occur within the Milawa Forest (Cummergunja people), Werai Forest (Deniliquin people) and the eastern portion of Koondrook Forest (Cummergunja and Moama people). Cultural heritage sites include scar trees, burials, shell middens and oven mounds.

Many activities have had an impact on the ecological values of the Murray catchment, including river regulation, livestock grazing, fishing, water diversions and timber harvesting. River regulation and, in particular, the historic overallocation of the water resource have reduced the extent and condition of floodplain wetlands.

**Catchment condition in 2010–11**

Dry conditions continued in the Murray Valley until August 2010. Heavy rainfall events from September onwards resulted in record high summer inflows totalling 6700 GL (excluding the Snowy and Darling rivers), more than double the previous summer inflow record of 3000 GL in 1992–93. Consequently, extended periods of supplementary water were declared and full allocations granted to general and high security users in both the Murray and Lower Darling valleys.

**Watering aims**

The dramatic change from drought to very wet conditions gave rise to the opportunity to conduct a number of watering events aimed at improving and maintaining the condition of a large area of wetlands within the NSW Murray Valley. More specifically, watering events aimed to prevent further decline in stressed wetland vegetation communities, including river red gums, black box and lignum, as well as increase and maintain the abundance and diversity of understorey wetland vegetation communities. Other aims included restoration of natural conditions for ephemeral floodplain wetlands by reinstating a wetting/drying cycle, supporting large-scale bird breeding events, enhancing spawning opportunities for native fish, and improving habitat for wetland-dependent fauna, including endangered species such as the southern bell frog and regent parrot.
Water delivery

Water delivered in the Murray and Lower Darling valleys during the 2010–11 environmental watering year

<table>
<thead>
<tr>
<th>Location</th>
<th>Start date</th>
<th>Finish date</th>
<th>NSW</th>
<th>CEW¹</th>
<th>EWA²</th>
<th>TLM³</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grand Junction (1)</td>
<td>11 Aug 2010</td>
<td>20 Aug 2010</td>
<td>357.5</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>357.5</td>
</tr>
<tr>
<td>Darling Anabranch (2)</td>
<td>13 Sep 2010</td>
<td>26 Oct 2010</td>
<td>5,000</td>
<td>6,580</td>
<td>–</td>
<td>13,820</td>
<td>25,400</td>
</tr>
<tr>
<td>MIL private property wetlands⁴ (3)</td>
<td>26 Sep 2010</td>
<td>24 Dec 2010</td>
<td>540</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>540</td>
</tr>
<tr>
<td>Barmah–Millewa Forest, Lower Lakes, Coorong and Murray Mouth (4)</td>
<td>29 Sep 2010</td>
<td>1 Mar 2011</td>
<td>10,000</td>
<td>–</td>
<td>219,000</td>
<td>199,056⁵</td>
<td>428,056</td>
</tr>
<tr>
<td>Boeill Creek Floodplain (5)</td>
<td>9 Nov 2010</td>
<td>14 Dec 2010</td>
<td>12.5</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>12.5</td>
</tr>
<tr>
<td>‘Comersdale’ wetland (6)</td>
<td>20 Nov 2010</td>
<td>28 Nov 2010</td>
<td>66</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>66</td>
</tr>
<tr>
<td>Tueloga Wetland (7)</td>
<td>26 Nov 2010</td>
<td>10 Dec 2010</td>
<td>20</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>20</td>
</tr>
<tr>
<td>Wakool River (8)</td>
<td>1 Jan 2011</td>
<td>3 Feb 2011</td>
<td>–</td>
<td>18,667</td>
<td>–</td>
<td>–</td>
<td>18,667</td>
</tr>
<tr>
<td>Wanganella Swamp (9)</td>
<td>31 Jan 2011</td>
<td>1 May 2011</td>
<td>13,001.5</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>13,001.5</td>
</tr>
<tr>
<td>Jimmaringle and Cochran Creek (10)</td>
<td>6 Apr 2011</td>
<td>2 May 2011</td>
<td>2,457</td>
<td>1,100</td>
<td>–</td>
<td>–</td>
<td>3,557</td>
</tr>
<tr>
<td>Bingerra Creek (11)</td>
<td>26 May 2011</td>
<td>30 May 2011</td>
<td>90</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>90</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td>31,544.5</td>
<td>26,347</td>
<td>219,000</td>
<td>212,876</td>
<td>489,767.5</td>
</tr>
</tbody>
</table>

Note: The location numbers in the table relate to the watering event sites marked on the map.

1   CEW = Commonwealth environmental water
2   EWA = Environmental water allocation accrued under the Water Sharing Plan for the NSW Murray and Lower Darling Regulated Rivers Water Sources 2003
3   TLM = Water sourced from the The Living Murray coordinated by the Murray–Darling Basin Authority
4   The Murray Irrigation Limited (MIL) Private Wetlands Project is a collaborative effort between government, private landholders and the irrigation industry. It has been listed as one of the Top 25 Australasian Ecological Restoration Projects by the Global Restoration Network.
5   The TLM contribution to the Barmah–Millewa watering event consisted of water contributed from the Murray–Darling Basin Authority, NSW and Victoria.

Ecological outcomes

Watering in the Murray and Lower Darling valleys has been very successful this year with many waterbird and fish species taking advantage of the wet conditions and visible improvements in both the condition and recruitment of new plants in vegetation communities.

High system flows enabled large-scale watering events to occur within the valleys. The Barmah–Millewa Forest was inundated across approximately 80% of the forest for a substantial number of months, attracting approximately 7000–10,000 pairs of colonial nesting waterbirds and other species in a breeding event that was considered the best in the valley for over a decade.
The area experienced a significant blackwater event from mid-November 2010 to mid-March 2011, with dissolved oxygen levels falling to below one milligram per litre. Effects of the blackwater included large numbers of Murray crayfish crawling out of the affected water, the death of yabbies and shrimp, and a reduction in the abundance of small- and large-bodied fish (predominantly native species) and spawning and recruitment by most fish species. It is still unclear why the abundance of large-bodied fish decreased. It may be that the fish moved to other areas within the system with better water quality or they might have died. If the latter, it is thought it could take years for fish populations to recover.

The Darling Anabranch, located west of the Lower Darling River, received its first flow event since 2001, connecting it with the Murray River for the first time since 2000. Continuing supplementary flows delivered water to the majority of Anabranch lakes, including Lake Nearie Nature Reserve. Biological monitoring of the flow events is ongoing, although initial results indicate a good response by native fish species, including evidence of recruitment by both the spangled and golden perch. Four frog species have been identified, including the green tree frog, and up to 75% of the plant species identified were natives.

Smaller scale projects, such as watering of Bingerra Creek, have produced positive biological responses. River red gums showed new growth and increased canopy density, while lignum exhibited a flush of new growth and flowers. A great diversity of native aquatic plants flourished, with species such as nardoo, sneezeweed, water ribbons, spike rush, small knotweed, water primrose and water milfoil recorded. Several frog species were also observed, including Peron’s tree frog, the eastern banjo frog, spotted marsh frog, barking marsh frog, eastern sign-bearing froglet and common eastern froglet.

The supply of environmental water to Tueloga Wetland and the wetland on the private property ‘Comersdale’ off the Wakool River provided foraging habitat for several bird species, such as the red-kneed dotterel, Australian wood duck, grey teal (with young), azure kingfisher, white-faced heron and a pair of Pacific black ducks with young. The wetland vegetation response at ‘Comersdale’ showed an increase in canopy density and new growth of red river gum, black box and river cooba.

Wanganella Swamp is a regionally significant wetland for waterbird species. High flows in the Billabong Creek system triggered a large-scale bird breeding event in October 2010. Adaptive Environmental Water was used to extend the flow duration and maintain water levels during periods of low flow to support the breeding of up to 13,000 pairs of straw-necked ibis and a number of other species, including Australian white ibis, spoonbills, Baillon’s crake, black swans, numerous duck species and brolgas.

**Water plans**

The following plans determine or help decide how environmental water is allocated and managed in the Murray Valley:

- Water Sharing Plan for the NSW Murray and Lower Darling Regulated Rivers Water Sources 2003
- Environmental Watering Plan for the Murray Valley 2010–11
- The Living Murray Annual Environmental Watering Plan 2010–11
Blackwater events

For the first time in more than 15 years, the late spring and summer floods of 2010–11 inundated floodplains rich in organic matter, such as wetlands dominated by river red gums, resulting in extensive ‘blackwater’ events.

Blackwater is a natural by-product of the rapid breakdown of accumulated organic material by microscopic organisms during flooding. While this process performs a valuable ecological service by returning nutrients to the river system, which in turn supports the growth of many aquatic organisms, severe blackwater events can cause the rapid depletion of dissolved oxygen in the water to levels unsuitable for fish and other aquatic fauna.

Blackwater events had a significant impact in the Murray, Edwards, Wakool and Murrumbidgee rivers when dissolved oxygen fell below critical levels for extended periods from December 2010 through to February 2011. Community members reported dead and dying native fish, including large Murray cod, as well as Murray crayfish and yabbies crawling out of the water at many locations along these rivers.

While the flooding was triggered by natural rainfall events, river managers were able to mitigate these impacts to a limited extent by releasing water into the rivers from upstream dams to oxygenate and dilute the blackwater. In the Murrumbidgee, for example, a more severe blackwater event than that of December was anticipated when major flood conditions recurred in January. Regional water managers commenced a dilution flow on 25 January using 17 GL of environmental water allowance.

A further 58 GL of Commonwealth environmental water supported the dilution flow and provided suitable habitat for wetland-dependent species downstream of Maude Weir. The aim was to achieve a flow rate of 4 to 5 GL a day below the weir and then gradually lower it as water quality improved. Regular monitoring of oxygen levels informed decisions about the optimal daily release rates which continued until the end of March. This achieved a very successful outcome with oxygen levels remaining above critical levels and no fish deaths reported.

In some cases, few watering options are available to managers and other responses are needed. In December 2010, with the Edward River under threat of a blackwater event, NSW agencies worked with the community to relocate native fish to areas of better water quality.

Regular flooding limits the build-up of organic matter and reduces the incidence of blackwater. However during extended periods of drought, low water availability limits the ability to manage this risk. River and environmental water managers remain vigilant to the possibility of blackwater events and continue to plan for, and mitigate, any impacts through innovative management responses.

During December 2010, NSW agencies worked with the Edward River community to relocate native fish to areas of better water quality.
The management and delivery of environmental water by OEH relies on the cooperation of a number of NSW agencies, the Australian Government and other partners. OEH would like to acknowledge the contribution of the following partners.

The **Commonwealth Environmental Water Holder** (CEWH) manages environmental water holdings purchased by the Australian Government and contributes environmental water to events undertaken by OEH and its partners. The NSW and Australian Governments work cooperatively to ensure the best environmental outcomes in managing environmental water through a Memorandum of Understanding between OEH and the CEWH.

The **Department of Sustainability, Environment, Water, Population and Communities** leads implementation of national water reforms and administers the Australian Government’s Water for the Future—Water Smart Australia Program.

The **NSW Department of Trade and Investment, Regional Infrastructure and Services** (formerly Industry & Investment NSW) remediates weirs, levees, banks and other water infrastructure, and provides special technical and policy advice to water recovery and environmental water use projects and plans, particularly in areas of on-farm water use efficiency, floodplain forest, fisheries and wetland management.

The **NSW Office of Water** is responsible for implementing the *Water Act 1912* and *Water Management Act 2000*, determines water availability, manages flow events in unregulated and regulated rivers, monitors water use, and implements and monitors the outcomes of rules-based planned environmental water under water sharing plans. The NSW Office of Water is an agency within the Department of Trade and Investment, Regional Infrastructure and Services.

**State Water** manages river operations and water delivery in regulated river systems across NSW.

**Other partners** with significant roles in environmental water management in NSW include:

- private landholders, many of whom provide access to their properties, advice and on-ground support to OEH during watering events
- the 13 catchment management authorities who work with regional communities to respond to key natural resource management issues facing their catchments
- environmental water advisory groups who provide expert knowledge, including local knowledge and experience when advising OEH on managing environmental water
- Murray–Darling Basin Authority, which is the Australian Government agency responsible for managing the water resources within the basin, including responsibility for preparing a Basin Plan and coordinating the management of water recovered for The Living Murray icon sites
- Natural Resources Commission of NSW which provides independent advice to NSW Government agencies on managing the state’s natural resources, including progress towards meeting the statewide natural resource targets
- Murray Irrigation Limited, one of the largest irrigation companies in southern NSW, whose infrastructure assists with the delivery of environmental water for a number of projects within the mid-reach of the Murray Valley.