South Australia's River Murray Environmental Watering Report 2011-2012

Government of South Australia
Department of Environment, Water and Natural Resources

Australian Government

MURRAY–DARLING BASIN AUTHORITY

Acknowledgements

This is the fourth *River Murray Environmental Watering Report* to be produced by the South Australian Government. It was prepared by staff in the Department of Environment, Water and Natural Resources (DEWNR) formed through the amalgamation of the former Department for Water (DFW) and the former Department of Environment and Natural Resources (DENR) in July 2012. The following agencies and organisations are also acknowledged for their important role in environmental water management:

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- SA Water
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Pink-eared Ducks at Molo Flat

Photo Callie Nickolai

1. INTRODUCTION

This report meets the South Australian Government commitment to the Council of Australian Governments (COAG) to publish an annual report to provide transparency and accountability for River Murray environmental water use in South Australia.

A summary of the sources and volumes of environmental water used along the River Murray in South Australia during 2011-12 is presented, along with a synopsis of the ecological outcomes achieved through the use of this water.

During 2011-12, the former Department for Water (DFW) (now the Department of Environment, Water and Natural Resources - DEWNR) successfully negotiated for the provision of large volumes of environmental water in comparison to the volumes available in previous years. As a result, some of the environmental water requirements (EWRs) of the floodplain, river channel and Lower Lakes, Coorong and Murray Mouth (Lester *et al.* 2011b, Gibbs *et al.* 2012) have been achieved during this period.

Management of environmental water was coordinated internally by DFW, while environmental water bids, trades, delivery, accounting and monitoring were undertaken in partnership with other government agencies including the Murray-Darling Basin Authority (MDBA) and the Commonwealth Environmental Water Office (CEWO), research organisations and community groups.

Photo Michelle Benison

Pelicans at Lock 1

2. Environmental Water Planning and Objectives

The annual environmental planning process for 2011-12 commenced in early 2011. Key stakeholders and the community were engaged in this process. River Murray flow forecasts for South Australia in March were for a return to Entitlement Flow (1850GL/year) by June 2011.

It was agreed that the Lower Lakes, Coorong and Murray Mouth (LLCMM) Icon Site was a high priority for receiving environmental water, continuing recovery from the many years of drought.

Barrage releases were identified as an important watering action under all flow conditions, with the following key objectives:

- maintain and enhance hydrological connectivity between Lake Alexandrina and the Murray estuary, as well as between the Coorong estuary and the ocean environment, and provide water for ecological and biological functions
- maintain salinity levels in Lake Alexandrina below 1,000 EC and salinity levels in Lake Albert below 1,800 EC, while maintaining lake levels within a target ecological operating-envelope
- manage barrage releases to reduce salinity in the South Lagoon, while maintaining target Coorong water levels

Photo Qifeng Ye

- provide fish passage through the barrages between the Lower Lakes, Coorong and marine environment with a minimum outflow of 1,000,000 ML for the year
- promote recruitment of flora and fauna, particularly diadromous, freshwater and estuarine fish species.

Other wetland and floodplain sites in South Australia were selected using criteria developed by the MDBA Environmental Watering Group for prioritising environmental watering actions for the use of The Living Murray (TLM) water. These criteria include the amount of environmental benefit for the volume of water, the risk of not applying water, environmental risks associated with watering, and the certainty/likelihood of benefit and cost.

The use of environmental water to create a flow pulse within the main river channel during spring was also identified as an important action for 2011-12. The objectives of the spring pulse were to:

- consolidate benefits of the previous high flows
- improve hydraulic conditions in the river channel and increase water level variations
- support recruitment of large bodied native fish species, particularly Golden Perch *Macquaria ambigua* and Silver Perch *Bidyanus bidyanus*
- inundate small areas of temporary wetlands below each of the six locks
- maximise ecological benefits for the river system while delivering water to the LLCMM.

The spring pulse proposal involved the creation or enhancement (depending upon flow conditions) of a spring flow pulse of up to 15,000 ML/day for a period of up to three months between October and December, with the main peak occurring in November. Construction activity on the Chowilla regulator would be impacted if flows exceeded 17,000ML/day; therefore, environmental water releases could not be used to create flows above this threshold until construction was completed.

3. SUMMARY OF THE WATER YEAR

Between March and October 2011, flows increased considerably from those forecast during the 2011-12 planning phase. This altered watering priorities at both the Basin and State scale. Unregulated flow continued into the new water year and flow to South Australia was approximately 35,000 ML/day at the end of September 2011.

Instead of focusing on delivery of environmental water during Entitlement Flow, it was necessary to undertake additional work to identify options for enhancing an unregulated flow event. Initial watering proposals developed for TLM and Commonwealth Environmental Water Holder (CEWH) were progressively refined as flow conditions evolved.

South Australia continued to work collaboratively with the other Basin states and environmental water holders towards agreement for a multi-site watering action utilising the large volumes of TLM and CEWH water that were available. The Multi-Site Environmental Watering Trial (MSEWT) exposed some policy and operational issues associated with enhancing an unregulated flow event, including constraints related to the ability to physically deliver the water and manage the accounting aspects. Further work will occur during coming years to address these constraints. The MSEWT was able to be continued in a modified format despite these constraints.

Securing water for barrage releases was the highest priority action. Unregulated flow provided sufficient volume to meet the 1,000,000 ML/year barrage release target that was set early in the year. It was then agreed that additional environmental water could further reduce salinity in the Coorong South Lagoon and facilitate ecological recovery following the drought. The release of environmental water from upstream storages was sought to achieve a November 2011 spring pulse and provide for barrage releases throughout summer. A TLM watering proposal to pump water to above pool wetlands located on the Chowilla floodplain also remained a priority.

From 24 November 2011 to June 2012, return flows from CEWH actions in the Goulburn River and Broken Creek were traded to South Australia. This provided important channel benefits as well as water releases at the barrages for Coorong objectives.

Commencing 6 January 2012, action was taken to manage recession from the peak flow experienced during the Christmas-New Year period. The objective was to maintain above Entitlement Flow at the border. This action ceased on 3 February 2012 (due to constraints to delivering environmental water during unregulated flow periods). The return to higher flows from December 2011 meant that no further environmental water was required in South Australia.

In the north of the Basin, two significant rainfall events occurred in late November and early December 2011, resulting in increased flow to the Darling River and releases from Menindee Lakes. During March 2012, much of the southern Basin received record high rainfall. Releases from the major storages (including physical spills) combined with high inflow from a number of major rivers that flow into the River Murray upstream of Wentworth, resulting in an unregulated flow event.

Photo Kirsty Wedge

Fish monitoring

Water Sources

There are two major environmental water holders providing environmental water to South Australia:

- CEWH holds around 1,065,000 ML of water entitlements in the southern connected Basin (as of 31 December 2012)
- TLM under the MDBA holds 479,900 ML of water entitlements for use at the six icon sites in the Murray-Darling Basin.

Additional environmental water is also available through:

- the Class 9 wetland entitlement of 200,000 ML (available under the South Australian Water Allocation Plan for the River Murray Prescribed Water Course) for use by pool connected wetlands. A portion of this is held on licence for 31 pool connected wetlands that are actively managed through regulators
- private donations.

Photo Kirsty Wedge

Water Delivery to South Australia

Figure 1 shows that the peak flow at the South Australian border was approximately 60,000 ML/day on 3 April 2012. It also shows the flow to South Australia with and without the inclusion of environmental water trade. South Australia experienced above Entitlement Flow for 354 days of the year.

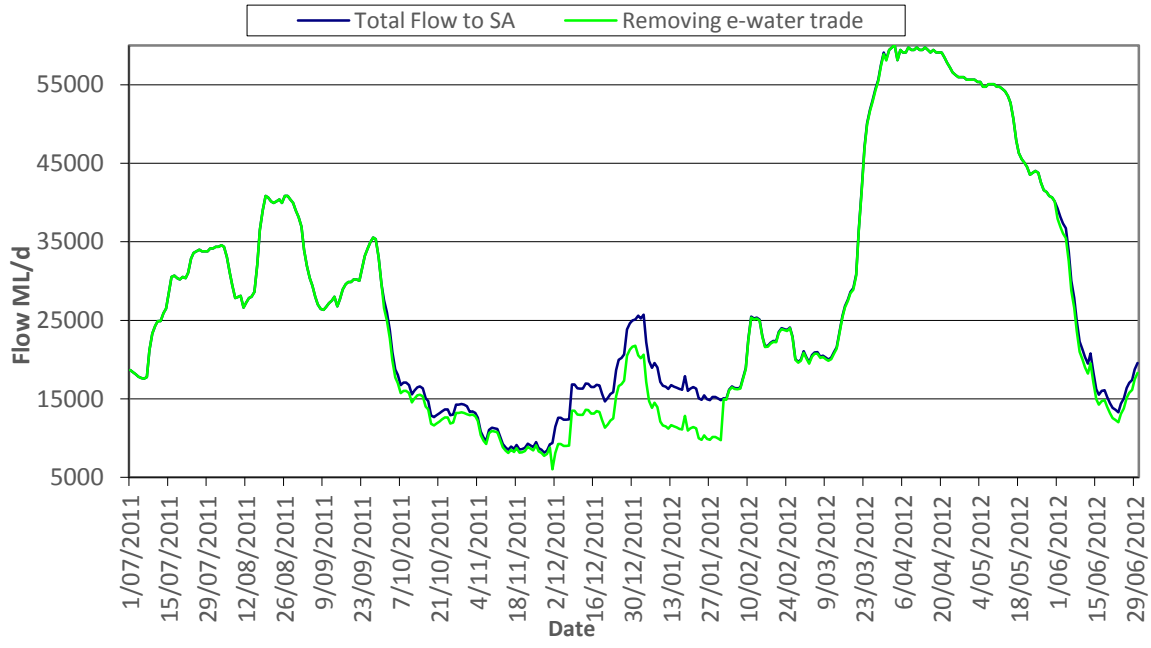

Figure 1 : Flow to South Australia 2011-12

A summary of higher flows during the autumn flow peak is shown in Table 1 below.

Table 1: Summary of Flow to South Australia – Statistics for Autumn 2012 Peak

Flow magnitude (ML/day)	Duration (days)
>40,000	71
>45,000	59
>50,000	54
>55,000	43
>60,000	1

During 2011-12, South Australia received 467,806 ML of environmental water for River Murray wetlands, floodplains and the LLCMM site (Table 2). This included water from three sources: TLM, CEW and private donations. Due to the unregulated flows received, there was no need to report against water use on the Class 9 licences.

Table 2: Environmental Water Delivered to South Australia in 2011-2012

Source	Site		Total Volume ML
CEW	Channel and LLCMM	328,156	328,756
	Berri Evaporation Basin	600	
TLM	LLCMM	135,800	138,750
	Chowilla (Coombool Swamp)	2,994	
Private Donation	Berri Evaporation Basin		300
Total			**467,806**

All pool-connected wetlands may access unregulated flows. During 2011-12, the 31 managed wetlands were still recovering from years of drought and management regimes were under review. Therefore, the wetlands were kept open for the year to maximise ecological outcomes. As above Entitlement Flows were received for most of the year, the managed wetlands were able to access unregulated flow and did not have to be managed within the water volume held on the Minister's licence.

Delivery of South Australia's River Murray Environmental Water Requirements

A key objective of environmental water management is to deliver the Environmental Water Requirements (EWRs) that have been developed for the South Australian River Murray floodplain and channel, and the LLCMM site. The EWRs for the floodplain and channel focus on key floodplain habitats and fauna breeding, and are listed in Gibbs *et al.* (2012). The EWRs for the LLCMM focus on water level and water quality metrics and are listed in Lester *et al.* (2011b). Both sets of EWRs were used to assess potential ecological outcomes based on modelling of water recovery scenarios under the MDBA Basin Plan. A preliminary assessment of the achievement of EWRs during 2011-12 is provided below.

Floodplain and Channel EWRs

Floodplain and channel EWRs describe a flow regime in terms of flow magnitude, duration, frequency and timing. The timing metric for these EWRs indicates that the optimal timing for peak flow delivery is between June and February. Records of actual flow to South Australia in 2011-12 show that the main flow peak occurred between late March and early June - not the optimal time to maximise ecological outcomes.

When the combination of flow magnitude, timing and duration metrics for each floodplain EWR is assessed, only one EWR can be considered to have been met during 2011-12, despite the good flows overall. This EWR relates to the target for spawning and recruitment by native fish characterised as flow-cued spawners (Table 3). This EWR was met by flows greater than 15,000 ML/day that occurred between December 2012 and the end of February 2012 (duration 84 days), which also coincides with the timing of the delivery of Commonwealth environmental water to South Australia (6 January – 3 February 2012).

Flow to South Australia remained above 15,000 ML/day beyond February; however, this is outside the timing specified by the EWR. Monitoring of the Golden Perch *Macquaria ambigua* spawning and recruitment response was undertaken by SARDI Aquatic Sciences through a project funded by the CEWO. The results of this project have not yet been published. Preliminary results indicate that successful spawning of Golden Perch was detected in the Lower Murray and extended into summer with the flow pulse delivered by Commonwealth environmental water (Ye pers. comm. 2011-12).

Table 3: Channel EWR met during 2011-12

Target	Target flow rate (ML/day)	Duration (days)	Timing	Average frequency
Support spawning and recruitment by native fish characterised as flow-cued spawners (i.e. Golden Perch *Macquaria ambigua* and Silver Perch *Bidyanus bidyanus*)	15,000	60	Oct - Feb	1 in 3 (max interval 5 years)

Coorong, Lower Lakes and Murray Mouth EWRs

The CLLMM EWRs (Table 4) are based on the barrage outflow volumes required to maintain critical water quality thresholds in Lake Alexandrina and the Coorong South Lagoon. Data currently available indicates that all the EWRs relating to barrage outflow were met, as the total indicative flow out of the barrages in 2011-12 was approximately 7,000,000 ML. As barrage outflows in 2010-11 were in excess of 11,000,000 ML for the year, the average frequency required for the higher 10,000,000 ML outflow volume EWR has also been met (Table 4).

Surface water salinity within Lake Alexandrina was below the 1,000 EC threshold for the entire year, apart from a short spike due to a reverse-head event in late June 2012. In terms of average annual surface water salinity, the Lake Alexandrina salinity EWRs have been met for 2011-12.

Table 4: Coorong, Lower Lakes and Murray Mouth EWRs Achieved During 2011-12

Target	Environmental Water Requirement
Lower Lakes - Maintain desired ecological character of Lower Lakes through managing water quality	Lake Alexandrina salinity <1,000 EC for 95% of all years
	Lake Alexandrina salinity <1,500 EC for all years
Coorong and Murray Mouth - Maintain current frequency of ecosystem states associated with high flows	Barrage outflow – 6,000 GL/yr, 1 in 3 years
	Barrage outflow – 10,000 GL/yr, 1 in 7 years

4. Multi-Site Environmental Watering Trial

Under TLM, the First Step decision was developed on the basis that water available should be managed so as to maximise environmental outcomes by re-using it at multiple sites. MSEWTs are an important element in the effort to improve river health and arrest environmental decline across the Murray-Darling Basin. During 2011-12, the MSEWT was aimed at maximising environmental outcomes and informing development of new water accounting methodologies and policies to enable efficient and effective long-term use of environmental water.

South Australia received a large percentage of its environmental water during 2011-12 as part of the MSEWT developed and coordinated by the MDBA through the Environmental Watering Group and Water Liaison Working Group. The MSEWT was a cooperative arrangement between a number of environmental water holders and managers. They included The Living Murray, Barmah–Millewa Environmental Water Allocation (Victoria/New South Wales), New South Wales Adaptive Environmental Water and Victorian Environmental Water Holdings.

The multiple use of environmental water raises a range of complex river operations and water accounting issues, including protection of return flows and calculation of losses from return flows. Consequently, the Basin Officials Committee agreed to several deviations from the Murray-Darling Basin Agreement to address these issues and enhance ecological outcomes from the MSEWT.

The 2011-12 MSEWT was the second trial to be undertaken by the MDBA. Releases of environmental water as part of this trial commenced in September 2011 and final releases occurred in February 2012. The trial focused on delivering outcomes in the Barmah-Millewa Forest and the LLCMM but also benefited other ecological assets including the River Murray channel.

Photo Kirsty Wedge

Red-necked Avocet

5. Lower Lakes, Coorong and Murray Mouth

The environmental watering objectives for the LLCMM site for 2011-12 proposed in the environmental watering plan were met. The increased flow to South Australia from both regulated and unregulated sources had a positive impact on salinity levels in the Lower Lakes, and resulted in significant volumes being discharged through the barrages. This lowered salinity levels in the Coorong and contributed to keeping the Murray Mouth open. There has been continuous flow through the barrages to the Coorong since September 2010.

DFW Icon Site staff worked with DENR staff to deliver a comprehensive monitoring program at the LLCMM site. The ecological impacts as the system responded to further inflows was documented. Monitoring was funded through The Living Murray and Murray Futures programs.

As environmental and unregulated flows moved down the river, approximately 10,000 threatened small-bodied fish were successfully reintroduced into nine sites across the Lower Lakes. Importantly, there were recaptures of both Southern Pygmy Perch *Nannoperca australis* and Southern Purple-spotted Gudgeon *Mogurnda adspersa* indicating that they had survived the reintroduction. Additionally, there was an indication of recruitment for Southern Pygmy Perch, suggesting that reintroductions of this species have been successful (Bice *et al.* 2012a, Wedderburn and Barnes 2012).

Photo Kirsty Wedge

Increased barrage flows improved fish passage, extended the connectivity period between the Lakes, Coorong and ocean, recharged nutrient levels, maintained the freshwater and estuarine environments and kept the Murray Mouth open. Salinity levels in the Lakes dropped significantly from those recorded in 2010-11, as shown in Figure 2. Lake Albert averaged approximately 5,000 EC (compared to 7,000 EC in 2010-11) while Lake Alexandrina's levels were generally below 550 EC (as shown in Figure 3) with the exception of some spikes due to backflow events.

Unfortunately, water levels in the Coorong were unable to be maintained over summer to facilitate recruitment of *Ruppia tuberosa*, a keystone aquatic plant species for the Coorong. A return to regulated flow conditions in late November-early December 2011 led to a decline in barrage releases and Coorong water levels. This meant that germinated plants were exposed before they had completed flowering and seeding, resulting in failure to complete their life cycle and replenish the seed bank (Paton and Bailey 2012).

Increased recruitment of diadromous fish (which are migratory between fresh and salt water – e.g. Congollis *Pseudaphritis urvillii*, Common Galaxias *Galaxias maculates*) were recorded in comparison to previous years at the barrage fishways (Bice *et al.* 2012b). A marked increase in species such as Smallmouthed Hardyhead *Atherinosoma microstoma* were recorded in Coorong South Lagoon, facilitated by lower salinities. However, some estuarine species, such as Black Bream *Acanthopagrus butcheri*, are yet to show any evidence of recovery (Ye *et al.* 2012). Increased waterbird abundance in the Coorong was dominated by piscivores (fish-eating species).

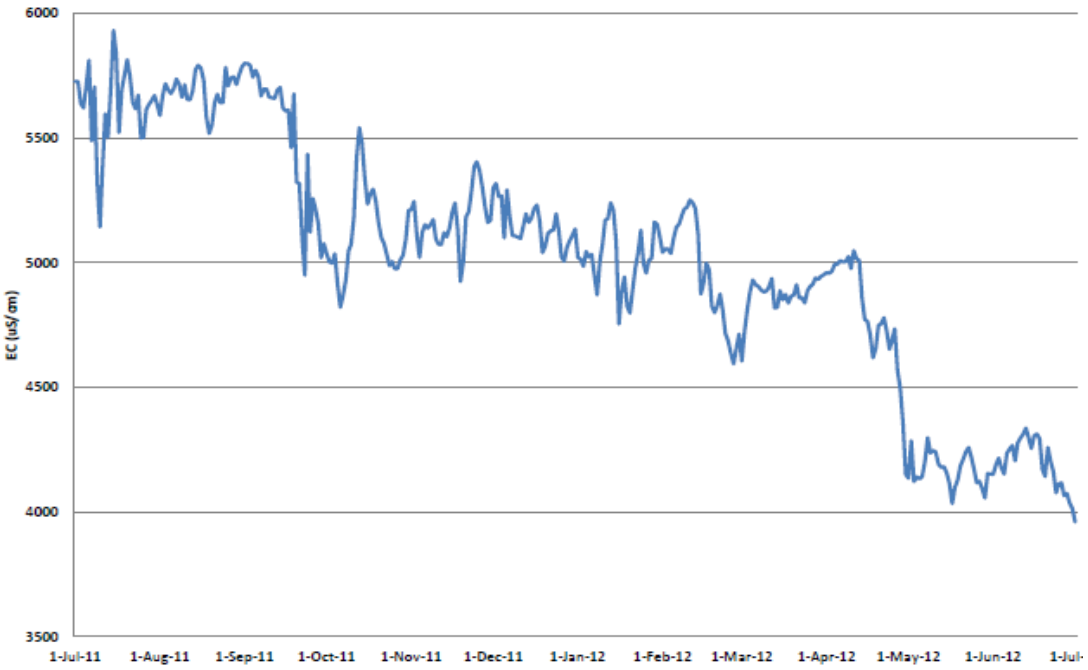

Figure 2: Lake Albert Average Daily Salinity, July 2011 – June 2012

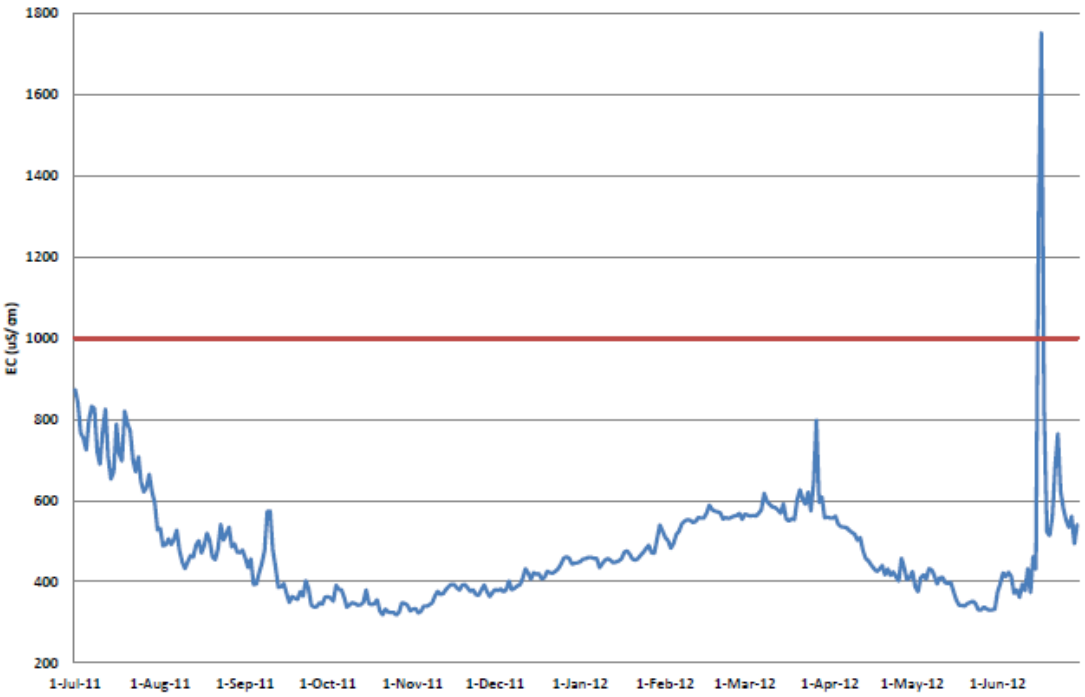

Figure 3: Lake Alexandrina Average Daily Salinity, July 2011 – June 2012

6. CHOWILLA

During the planning process, several wetlands were prioritised for environmental watering. Prior to the high flow event in summer 2011, some temporary banks were decommissioned or breached to allow natural flooding of these sites. As significant flows into South Australia continued into autumn 2012, many sites were naturally inundated reducing the need for pumping. However, Coombool Swamp (refer results below) required water delivery via pumping to improve ecological health as it was not inundated and was showing signs of increasing salinity.

Photo Jan Whittle

Coombool Swamp

Monitoring Results from 2011-12 Watering at Chowilla

Coombool Swamp is a large wetland that sits at a high elevation at the north of the Chowilla floodplain. It only commences to fill naturally when flow in the River Murray is around 70,000 ML/day. Flows of this magnitude under natural conditions used to occur almost every second year. Following river regulation and the millenium drought, the Swamp was deprived of water for many years and became a highly stressed ecosystem.

In 2009, Coombool Swamp received an initial environmental water allocation. The site received 'top up' watering in 2011-12, consolidating benefits from previous environmental watering and the natural flooding that occurred with the 2010-11 high flow event.

Environmental watering has significantly improved the health of River Red Gums *Eucalyptus camaldulensis*, Lignum and Black Box *Eucalyptus largiflorens* at the site. Following the 2011-12 watering event, over 1,200 waterbirds were recorded including Freckled Duck *Stictonetta naevosa* (listed as vulnerable in South Australia).

Chowilla Works and Measures

Works underway on the Chowilla floodplain will enable large areas of the floodplain to be inundated at frequencies similar to natural conditions. The works involve construction of a major regulator on Chowilla Creek, as well as complementary minor infrastructure works and important upgrades of weirs on Pipeclay and Slaney creeks which will incorporate fishways.

Depending on flow conditions, these works will allow 30-50 percent of the floodplain (approximately 5,000-9,000 ha) to be inundated to help restore floodplain health. Construction began in January 2010 but was stalled in October 2010 following high flows. It resumed in May 2012 with completion expected in 2014.

7. Other Wetlands and Floodplains

Ecological responses were observed within other wetlands and floodplains along the South Australian River Murray as a result of environmental watering. These included the presence of large-bodied native fish within wetland habitats, recruitment of River Red Gums *Eucalyptus camaldulensis* and Black Box *Eucalyptus largiflorens*, and frog and bird breeding events.

Keeping wetland regulators open during this water year enabled removal of accumulated salt, with the sustained high flows flushing the salt downstream and out through the Murray Mouth.

Large numbers of birds were observed around the wetlands including Eastern Great Egrets *Ardea modesta*, Australian Pelicans *Pelecanus conspicillatus,* Little Pied Cormorants *Microcarbo melanoleucos,* Little Black Cormorants *Phalacrocorax sulcirostris,* Pied Cormorants *Phalacrocorax varius* and Great Cormorants *Phalacrocorax carbo*.

Photo Ben Samy

Brenda Park

Berri Evaporation Basin

In late 2010, this site was extensively flooded and completely connected to the river via Eckerts Creek (Bank B) and Bank C Creek. During October 2011, as River Murray flows were receding, salinity levels in the Berri Saline Water Disposal Basin and Bank C Creek rose significantly, measuring between 25,000-30,000 EC. This caused a large scale fish kill of Common Carp *Cyprinus carpio*, which subsequently led to a blue green algae bloom and very low dissolved oxygen levels.

It therefore became necessary to buffer these water quality conditions with an influx of fresh water to protect the remnant Murray Hardyhead *Craterocephalus fluviatilis* fish population. Water was sourced from a private donation and the CEWH and this ensured improved conditions.

After environmental watering, salinity within the Berri Evaporation Basin and Bank C Creek reduced to between 7,000-9,000 EC – see 'before' and 'after' photographs.

The Murray Hardyhead is listed as endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*, critically endangered under the Action Plan for South Australian Freshwater and endangered under the International Union for the Conservation of Nature's Red List, due to population decline and local extinctions.

Photo Lara Suitor

Berri Evaporation Basin
Before, Jul 2011

Photo Lara Suitor

Berri Evaporation Basin
After, Mar 2012

Photo Chris Bice

Murray Hardyhead

Murray Hardyhead *Craterocephalus fluviatilis* are considered to be relatively short-lived, being largely an annual species, although some individuals have been recorded to survive into their second year. If recruitment fails over one year, it could result in a population's failure to survive.

Reasons for its decline are unknown, but are suspected to include increased salinisation, habitat degradation, altered flow regimes and impacts of alien species.

Historically, Murray Hardyhead populations were fairly widespread in the Murray-Darling Basin. They now have restricted and declining distributions within Victoria and South Australia, occurring in only a few wetlands and saline basins along the Lower Murray and Lower Lakes.

The Berri Saline Water Disposal Basin and the Bank C Creek habitat are home to one of five remaining Murray Hardyhead populations within South Australia. The maintenance of the Berri Saline Water Disposal Basin population is a key strategy to ensure the survival of the species in the Lower Murray. During autumn 2012 Murray Hardyhead were caught within the site for the first time in one and a half years. The Murray Hardyhead can generally tolerate a wide range of salinities (~5,000-33,000 EC) (Wedderburn *et al*. 2007); however, 6,000 - 12,900 EC reflect salinities at which successful breeding and recruitment in the wild has been observed (Ellis 2005).

8. Conclusions and Lessons Learned from 2011-12

The 2011-2012 year was markedly different to previous years in terms of planning and prioritising for environmental water, with many new issues arising due to high flow conditions. The need to revisit watering proposals was challenging, particularly with many uncertainties surrounding natural flow conditions, environmental water releases for upstream watering actions and approvals for watering in South Australia. This highlights the need for State water managers and water holders to be flexible and adaptive throughout the environmental water management process.

The River Murray experienced good flows for a second year in a row with a peak of around 60,000 ML/day. However, the timing of the flow peak occurred in autumn which is historically unusual. The high natural flow, together with the increasing volume of environmental water, built on the ecological recovery experienced in the previous year.

A thorough annual environmental water plan was developed using potential flow scenarios, and based on comprehensive consultation. However, the constantly changing river conditions meant that ongoing revisions to the preferred delivery patterns were necessary and the emphasis was on real time management of flows.

Looking ahead, the MDBA Basin Plan will be a major driver for environmental water management in the future. Chapter 8 of the Basin Plan describes the Basin Environmental Watering Plan. The state has a number of responsibilities under this plan including development of a long term plan and annual environmental watering priorities.

The Basin Plan provides some good opportunities for improved environmental outcomes in South Australia. For the first time, the surface water, groundwater and environmental resources of the Murray-Darling Basin will be managed as a whole, consistent with a single, legally enforceable plan.

Photo Kate Mason

Morgan's Lagoon

There is an ongoing need for close collaboration across DEWNR, and with water managers from Victoria and New South Wales, the MDBA and CEWO to ensure the very best ecological outcomes for the River Murray now and in the future. Ongoing multi-site watering trials will also need to be a part of this process to maximise the effective use of available environmental water.

A summary of lessons learned from several years of environmental watering was listed in the 2012-13 Annual Environmental Watering Plan for the South Australian River Murray. Key lessons learned during 2011-12 include:

- timing of water delivery is critical to achieving ecological outcomes in the Coorong
- real time management is essential to obtain the best outcomes from environmental watering
- policy constraints need to be addressed to maximise environmental outcomes from delivery of environmental water.

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