

# South Australia's River Murray Water for the Environment Report 2017-18



## Acknowledgement of the Traditional Owners

The Department for Environment and Water acknowledges and pays respect to the Traditional Owners and their Nations of the Murray-Darling Basin, who have a deep cultural, social, environmental, spiritual and economic connection to their lands and waters.

## Other Acknowledgements

This is the ninth River Murray Water for the Environment Report to be produced by the South Australian Government. It was prepared by staff in the Department for Environment and Water (DEW). The following agencies and organisations are acknowledged for their important role in environmental water management:

- Commonwealth Environmental Water Office (CEWO);
- Murray-Darling Basin Authority (MDBA) including The Living Murray (TLM) program;
- Natural Resources South Australian Murray-Darling Basin (NR SA MDB);
- Local Action Planning Associations (LAP) and Landcare Groups;
- Ngarrindjeri Regional Authority (NRA);
- First Peoples of the River Murray and Mallee;
- Nature Foundation South Australia (NFSA);
- Renmark Irrigation Trust;
- Banrock Station.

## Photography

Cover: Wedge tailed eagle chick at Coppermine wetland on Chowilla floodplain. Photo: Helga Kieskamp

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# Executive Summary

This report provides an overview of environmental watering along the South Australian River Murray during 2017-18. It contains information about the volumes and timing of water delivered, sites watered and outcomes achieved.

Despite 2017-18 being a dry year, around 1,175,000 megalitres of water for the environment were delivered to South Australia. This was equal to 43% of the total water delivered to South Australia. Environmental water was provided by The Living Murray (including River Murray Increased Flows), the Commonwealth Environmental Water Holder and by return flows from the Victorian Environmental Water Holder.

Many significant ecological outcomes were achieved in South Australia due to the delivery of these flows. Monitoring conducted by the South Australian Government, scientists, local community members and landholders has helped evaluate the effectiveness of water delivery, and assisted in setting objectives for future water delivery.

Within the Lower Lakes, Coorong and Murray Mouth, water for the environment delivered to the Coorong estuary in summer resulted in a recruitment event for the estuarine fish, black bream. In winter, flows directed to the Murray Mouth provided cues to stimulate upstream migration of pouched lamprey, a fish that requires passage between fresh and salt water to complete its life cycle.

Weir pool manipulation involved the successful lowering and raising of water levels in weir pools 2, 5 and 6 using water for the environment. Benefits to native vegetation, waterbirds and frogs were recorded in the wetlands and floodplains associated with these events.

Twenty six smaller wetland and floodplain sites, between Renmark and the Lower Lakes, received water for the environment via pumping. Red gum and black box communities were targeted at many sites, and threatened species (including Murray hardyhead, regent parrot and southern bell frog) benefitted from these actions.

The Department for Environment and Water works collaboratively with a range of partner organisations and water holders to ensure the effective delivery of water to South Australia's key River Murray wetland and floodplain assets. Coordination between site managers and water holders in delivering water for the environment is considered essential in achieving outcomes aligned to the Basin Plan, Long-Term Environmental Watering Plans and site-based plans.

**John Schutz**

Chief Executive

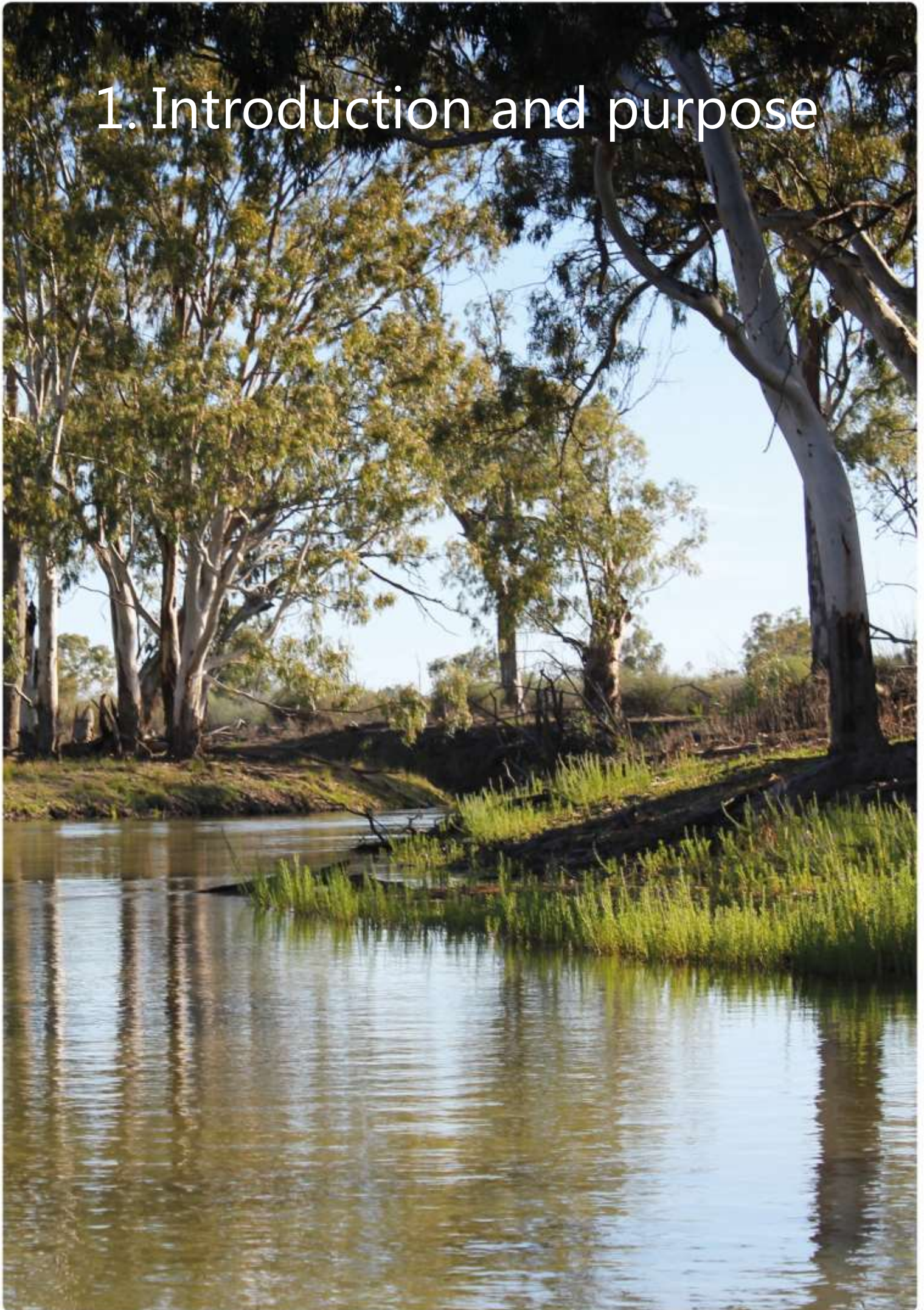
Department for Environment and Water, South Australia

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# 1. Introduction and purpose





The planning, delivery, reporting and evaluation of environmental water within the Murray-Darling Basin in South Australia is coordinated by the Department for Environment and Water (DEW) and undertaken in partnership with other government agencies including the Murray-Darling Basin Authority (MDBA) and Commonwealth Environmental Water Office (CEWO), research organisations, non-government organisations and community groups.

Environmental water delivery to South Australia in 2017-18 was guided by the Long-Term Environmental Watering Plan for the South Australian River Murray (DEWNR 2015) and the Basin-Wide Environmental Watering Strategy (MDBA 2014). These documents provided key targets and objectives for environmental water delivery to South Australia. In addition, site-based environmental watering proposals for the major South Australian assets were developed and submitted to the Southern Connected Basin Environmental Watering Committee (SCBEWC) in early 2017. These proposals formed the basis of the development of the 2017-18 Annual Environmental Watering Plan for the South Australian River Murray (DEWNR 2017) and informed the Annual Basin Priorities developed by the MDBA.

Environmental water delivered to South Australia is primarily from two major environmental water holders: the Commonwealth Environmental Water Holder (CEWH) and The Living Murray (TLM) Program of the MDBA. Additional water for use in South Australia is available from the South Australian Minister for Environment and Water, non-government organisations, and donations from private irrigators. Water may also be provided by the Victorian Environmental Water Holder (VEWH) and New South Wales in the form of return flows from upstream environmental watering actions.

This report is prepared as a summary of environmental watering along the River Murray in South Australia during the 2017-18 year. Its purpose is to provide an enduring and publicly available record of the volumes and locations of all environmental watering, regardless of water holder or manager, undertaken in the region throughout the year. It supplements the detailed and comprehensive reporting undertaken by DEW to meet the requirements of the Murray-Darling Basin Plan (Basin Plan).

This report also meets the South Australian Government's commitment to the Council of Australian Governments (COAG) to publish an annual report on River Murray environmental water use in South Australia for public information sharing (National Water Initiative Policy Guidelines for Water Planning and Management 2010).

Within this document, the following information is provided:

- an overview of river conditions in 2017-18;
- a summary of the environmental watering actions that were undertaken including sites, volumes and approximate timing;
- a summary of key environmental outcomes; and
- a summary of reports that provide detailed information about monitoring and ecological outcomes.

## 2. Overview of flow conditions in 2017-2018



The 2017-18 water year was a dry year. South Australia received entitlement flow, water for the environment throughout 2017-18 and a very brief unregulated flow event in December 2017 peaking at 18,000 ML/day (see Figure 1).

Despite the dry conditions, a number of successful environmental watering events occurred including:

- Lowering of Weir 6 by 18 cm in autumn;
- Raising of Weir 2 by 50 cm and Weir 5 by 45 cm in spring;
- Inundation of temporary wetland/floodplains (including wetlands on the Chowilla Floodplain and sites managed by DEW, Australian Landscape Trust, Banrock Station and Nature Foundation SA (NFSA) via pumping or irrigation);
- Wetting and drying of pool-connected managed wetlands;
- Continuous delivery to the Lower Lakes, Coorong and Murray Mouth (LLCMM); and
- Manipulation of water levels in the Lower Lakes, and barrage and continuous fishway releases.

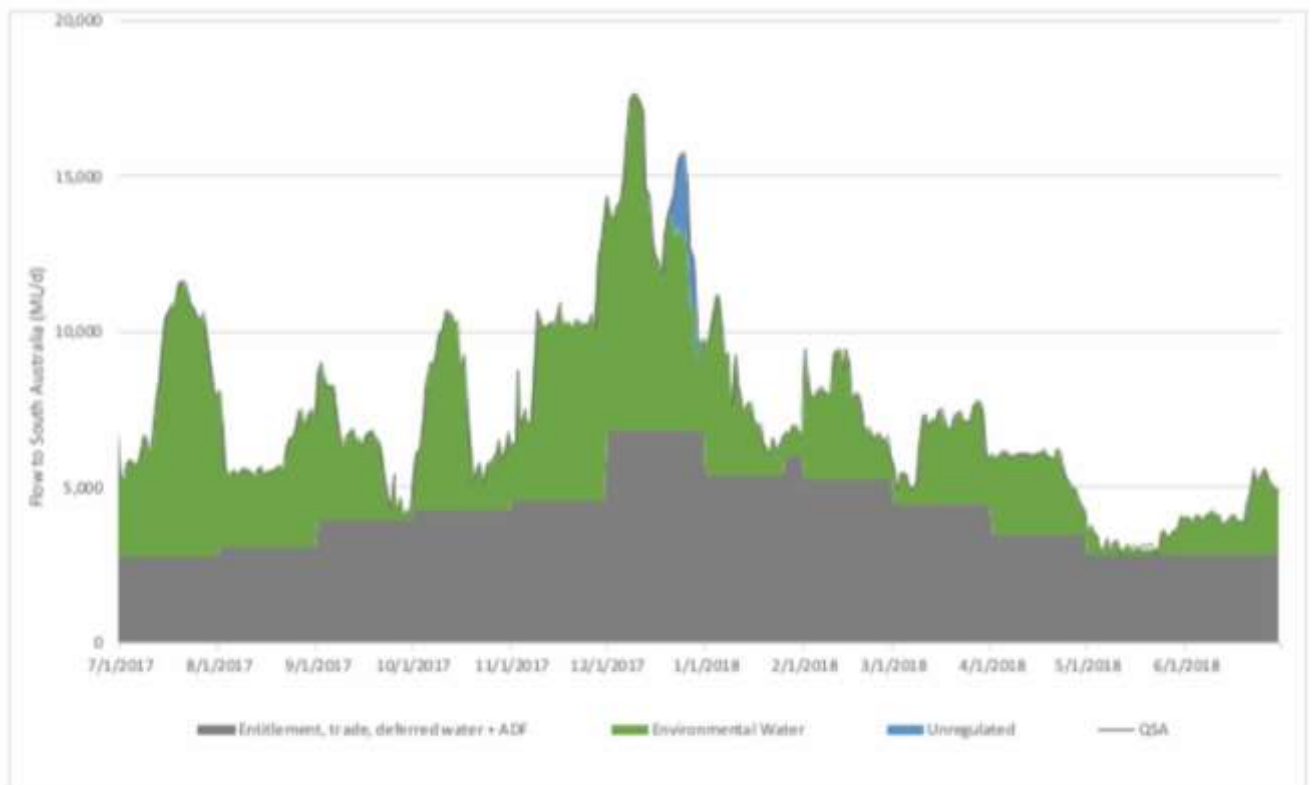


Figure 1. River Murray flows 2017-18



### 3. Environmental water delivery



In total, approximately 1,175,000 ML of environmental water were delivered to South Australia (see Figure 3). The CEWH provided approximately 907,000 ML (including approximately 154,000 ML held on licences in South Australia) and TLM provided approximately 230,000 ML (including 45,000 ML held on licences in South Australia and 53,300 ML of River Murray Increased Flow (RMIF)). South Australia also received approximately 29,000 ML of environmental water in the form of return flows from upstream watering actions undertaken by the Victorian Environmental Water Holder (VEWH) and 9,000 ML from New South Wales (see table 1).

Approximately 42,000 ML of environmental water held by the then South Australian Minister for Water and the River Murray was delivered to pool-connected wetlands, temporary wetlands and the Lower Lakes, Coorong and Murray Mouth. The use of the Minister's environmental water is set out in Table 2.

Planning for environmental water delivery to South Australia is coordinated by DEW staff and is undertaken in consultation with community groups including the Community Advisory Panel for the Lower Lakes, Coorong and Murray Mouth, Chowilla Community Reference Committee, the Scientific Advisory Group for the Lower Lakes, Coorong and Murray Mouth, the Ngarrindjeri Regional Authority and the First Peoples of the River Murray and Mallee.

The planning and delivery of environmental water in the Southern Connected Basin is coordinated by the Southern Connected Basin Environmental Watering Committee (SCBEWC) with representatives from New South Wales, Victoria, South Australia, MDBA, the VEWH, the CEWH and the Commonwealth Government. In addition to providing environmental water to South Australia, the CEWH provided water to the Natural Resources SA MDB Board, NFSA, Renmark Irrigation Trust (RIT) and Banrock Station to undertake local environmental watering projects.

*Table 1. Volume of environmental water delivered to SA from different water holders in 2017-18*

Provider	Volume (ML)
Commonwealth Environmental Water Holder (CEWH)	906,900
The Living Murray (TLM)/RMIF	229,700
Victorian Environmental Water Holder (VEWH) return flows	29,400
New South Wales	9,400
<b>Total</b>	<b>1, 175,400</b>

*Table 2. Use of Minister's environmental water*

Site	Volume (ML)
Nigra Creek/Schillers Lagoon refill	610
Salinity management during Riverine Recovery Program works	10
SA River and Floodplain Infrastructure Implementation Program works	5
Tolderol Wetland top-up	94
Channel and CLLMM	7,098
Pool connected wetlands	33,411



## 4. Outcomes of water delivery





As part of the annual planning process DEW staff prepare site specific watering proposals and a multi-site watering proposal that incorporates all of the environmental watering demands into one set of hydrographs for the water year. The multi-site proposal presents how the greatest benefit may be achieved with the water available under each planning scenario. Delivery of the proposed hydrograph would optimise environmental outcomes and enable multiple benefits to be achieved with the same volume of water. These proposals are provided to the MDBA and CEWO and documented in the South Australian River Murray Annual Environmental Watering Plan (DEW 2018).

Coordination also occurs across the entire Southern Connected Basin but not all demands can be met due to a range of system constraints. Aligning of demands is facilitated by the MDBA through SCBEWC which meets regularly to identify watering opportunities throughout the year.

Across the southern connected basin there is a strong emphasis on the coordination of watering events (see Figure 2). For example, in 2017-18 there was successful alignment of Goulburn pulses with the requirement for the upstream migration of lamprey through the barrages in winter. Watering of the Barmah Millewa Forest in spring has important benefits for SA, with the return flows carrying seeds and nutrients throughout the Murray system.

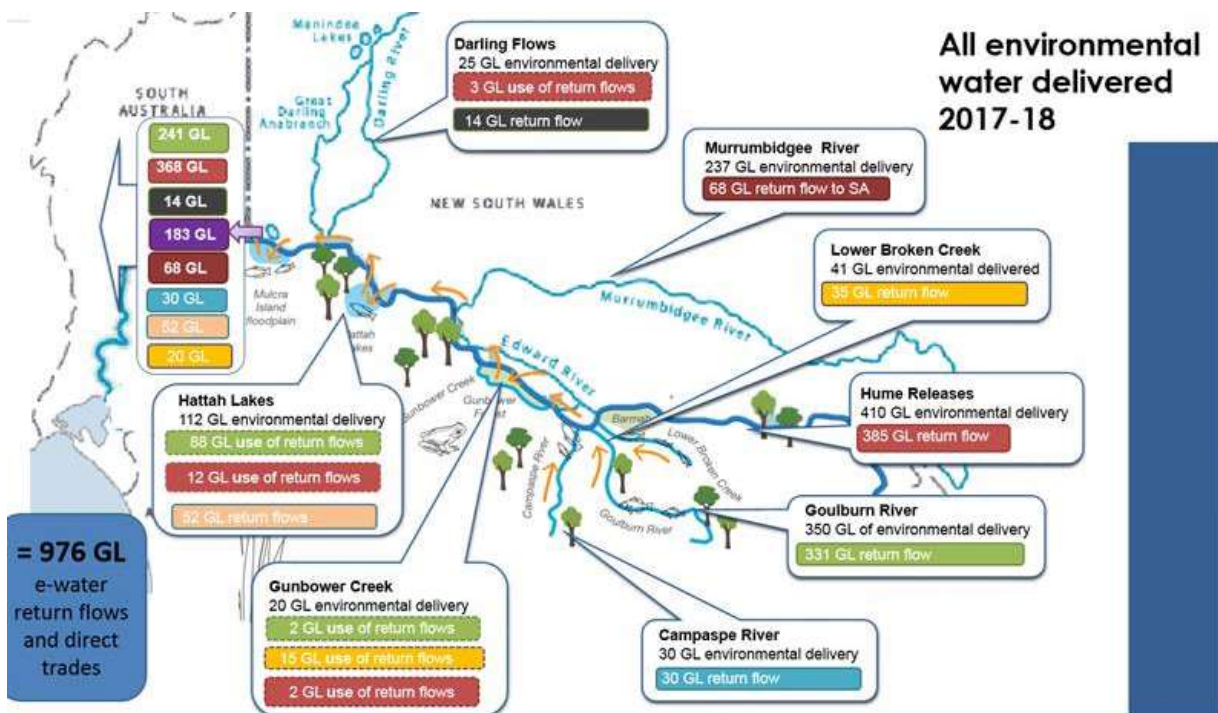


Figure 2. Source of direct trades and return flows to SA from CEWO, VEWH, RMIF and NSW OEH. Source Commonwealth Environmental Water Office.

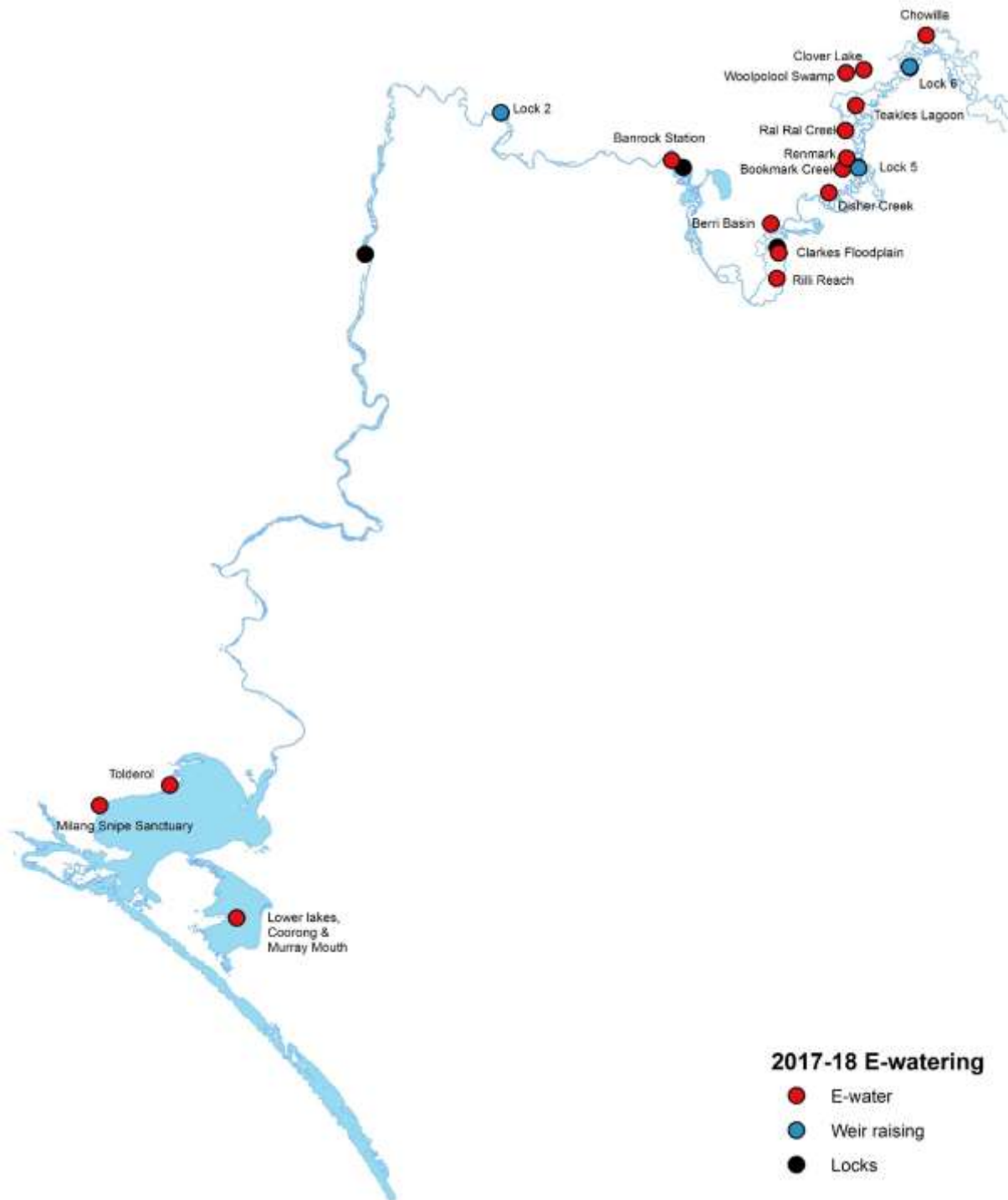


Figure 3. Map of South Australian environmental watering sites

## 4.1 Lower Lakes, Coorong and Murray Mouth

**Location:** The Lakes Alexandrina and Albert ('the Lower Lakes'), Coorong and Murray Mouth Icon Site is at the end of the River Murray in South Australia

**Area:** More than 140,000 hectares

**Environmental water released out of the barrages:** 850,000 ML

**Site Water Manager:** DEW (River Murray Operations)

**Source of water:** CEWH, TLM, VEWH, Minister's Reserve

### Environmental Watering Objectives:

- Winter barrage flows to the estuary and Murray Mouth to facilitate upstream migration of pouched lamprey;
- Spring/summer flows to raise lake levels for wetland health and to allow barrage releases to the estuary to enhance spawning and recruitment of estuarine fish; and
- Autumn lake level drawdown for vegetation and waterbird outcomes and fishway releases for continuous connectivity between fresh and saltwater.

### 4.1.1 Winter flows and lamprey migration

Water for the environment sourced from the Goulburn, Murrumbidgee and Murray rivers delivered multiple benefits across the Southern Connected Basin in winter 2017.

Bank vegetation and native fish outcomes were targeted with winter flows in the Goulburn and Upper Murray regions, and upon arrival at the Lower Lakes, Coorong and Murray Mouth, helped populations of pouched lamprey (see figure 4), a rare and primitive fish, migrate upstream to spawn. Approximately 100,000 ML of water for the environment were released at the barrages to the Coorong and Murray Mouth during July and August 2017; one of the largest managed winter releases in recent years.

Pouched lamprey spend most of their adult life at sea but require freshwater environments to reproduce and grow. During the millennium drought, lamprey numbers declined because they were unable to migrate upstream of the barrages to spawn. Targeted winter environmental watering carried out annually since 2015 at the barrages has enabled lampreys to travel from the Southern Ocean into the freshwater environment of Lake Alexandrina, via the barrages and fishways before migrating upstream to the River Murray. These important winter flows also help flush salt from the river system to the ocean, improve water quality in the estuary and assist in maintaining an open Murray Mouth.





Figure 4. Pouched lamprey. Photo: SARDI Aquatic Sciences

#### **4.1.2 Spring/summer flows to raise Lower Lake water levels for wetland health and enhance barrage releases to the estuary for spawning and recruitment of estuarine fish**

128 southern pygmy perch were recorded across eight sites in the Lower Lakes, indicating successful recruitment in spring (Wedderburn and Barnes 2018). In comparison 14 Murray hardyheads were recorded at five sites, but no Yarra pygmy perch were detected (Wedderburn and Barnes 2018).

Waterbird abundances and diversity around Lake Alexandrina and Albert were higher in 2017-18 than the previous year. The most abundant species were great cormorant, Australian shelduck, grey teal, pied cormorant, Pacific black duck, Australian pelican and straw-necked ibis (Paton *et al.* 2018).

A highlight of spring and summer delivery was the breeding of black bream in the Coorong. The number of juvenile black bream in the Coorong estuary increased in response to environmental water delivery to the Lower Lakes and Coorong in summer 2017-18. Black bream is an estuarine fish species, and as such, its recruitment success is strongly affected by connectivity between freshwater, estuarine and marine environments, salinity regimes and productivity transported from upstream. The black bream population in the Coorong has been in severe decline since the late 1980s, with few to no juveniles recorded in recent years.

In October 2017, commercial fishers alerted DEW staff to the fact that they had observed adult female black bream below the barrages, in good condition and ready to spawn. Through a collaborative effort between the Lower Lakes, Coorong and Murray Mouth Community Advisory Panel, Scientific Advisory Group, CEWO, TLM program and river operators, black bream were identified as a priority for securing water for the environment.

Between October 2017 and February 2018, around 500,000 ML of water for the environment was provided to South Australia by the CEWH which supported black bream spawning and recruitment. Barrage operations during this period were critical in creating a salt wedge, which is an area where freshwater sits above salt water. Salt wedges are needed to keep black bream eggs and larvae buoyant and provide food for larval fish to develop and grow.

SARDI Aquatic Sciences undertook monitoring in the Coorong to assess the salt wedge conditions and the recruitment success of black bream. In April 2018, 102 baby black bream were detected; the largest number recorded for a number of years. These results indicate that the freshwater flow delivered via the barrages had created the perfect nursery conditions for spawned eggs, aiding larval development and successful recruitment (Ye *et al.* 2018).

There is still a long way to go before these baby black bream are mature and can help rebuild the population in the Coorong. However, the findings from the monitoring demonstrate the importance of environmental water delivery to the Lower Lakes and Coorong to support reproduction and recovery of key species. The monitoring results and learnings from barrage operations will help inform future decisions on how to make best use of water for the environment.



Figure 5. Young-of-the-year Coorong black bream, captured in April 2018. Photo: SARDI Aquatic Sciences





Figure 6. Monitoring salt wedge conditions downstream of Goolwa Barrage – spring 2017. Photo: Adrienne Rumbelow

#### **4.1.3 Autumn lake level drawdown for vegetation and waterbird outcomes and fishway releases for continuous connectivity between fresh and saltwater.**

The managed draw-down of lake levels in autumn 2018 led to the exposure of fringing lakeshore mudflats around Lake Alexandrina, which supported germination and the successful recruitment of aquatic and littoral vegetation (Nicol *et al.* 2018). The exposed mudflats encouraged migratory waders to forage for food and may have provided much needed supplementary food that was otherwise inadequate in the hypersaline and degraded Coorong South Lagoon.

The abundance of congolli and common galaxias fish sampled at the barrage fishways remained high in 2017-18. Over 90% of all individuals sampled were newly recruited young-of-the-year, indicating high levels of recruitment, facilitated by connectivity between fresh and saltwater (Bice and Zampatti 2018).

Barrage bays were closed a total of 23 days during 2017-18, mostly to minimise the risk of seawater incursion during reverse head conditions. All barrage fishways remained open 100% of the time. The Murray Mouth remained open for the entire year with the assistance of dredging.





*Figure 7. Vegetation response to water level lowering below Lock 1. Photo: Kate Mason*

## 4.2 Chowilla Floodplain

**Location:** The Chowilla Floodplain spans the South Australia – New South Wales border and forms part of the Chowilla Floodplain and Lindsay-Wallpolla Islands Icon Site and Riverland Ramsar site.

**Area:** 17,781 hectares

**Environmental water use:** Nil in 2017-18

**Site Water Manager:** DEW (River Murray Operations)

### Environmental Watering Objectives:

- The successful high level Chowilla regulator operation in spring 2016 inundated approximately 7,650 hectares of floodplain and wetlands and the subsequent natural flooding further extended the inundation to over 12,000 hectares of the Chowilla Floodplain. Following this, the planning for 2017-18 focussed on further broad scale environmental watering to consolidate the benefits from the previous year to build floodplain health and resilience. The ability to implement a high level operation in 2017-18 was dependent upon River Murray flows to SA reaching around 35,000 ML/d.
- Given the dry conditions that emerged in 2017-18, with flows to SA over spring remaining below 12,000 ML/day, the proposed regulator operation was not undertaken. Under the dry water availability scenario the focus of water management was on managing seasonal variation in flow through Pipeclay and Slaney inlet weirs, to optimise fishway operations and provide a range of benefits through the anabranch. This action did not require the delivery of additional environmental water. The variable operation of the inlet weirs supported the following ecological outcomes:
  - Mobilise carbon and nutrients from the riparian zones to support aquatic food webs
  - Reinststate variability in hydraulic conditions
  - Improve in-stream habitat availability and flow conditions to support habitat requirements and recruitment of Murray cod
  - Optimisation of fishways on Pipeclay and Slaney weirs
  - Improve soil moisture availability in the riparian zone to improve condition of established trees along permanent creeks and to support ongoing growth of seedlings and saplings of river red gum and cooba established along permanent creeks in response to flooding and environmental watering in recent years

The further high level Chowilla regulator operation proposed for spring 2017 aimed to consolidate the benefits to tree condition on the floodplain – in particular the condition of black box in the mid elevation areas of the floodplain. While flows to SA were insufficient to undertake this watering, the monitoring showed that the positive tree condition and regeneration response to the managed inundation and natural flooding in the previous year, was sustained (see Figures 8-11). Profuse flowering of black box and river red gum trees persisted through 2017 and early 2018.



*Figure 8. Profuse flowering of black box trees persisted on the Chowilla Floodplain into 2017-18 following the managed inundation and natural flooding the previous year. Photo: Jan Whittle*





*Figure 9. River red gum seedling and understorey vegetation persisting in Werta Wert wetland. Photo: Jan Whittle*





*Figure 10. Coppermine Waterhole on the Chowilla Floodplain at the end of October 2017. Water was retained in a number of wetlands on the floodplain through much of 2017 following the extensive flooding in late 2016. Photo: Jan Whittle*



*Figure 11. Chestnut-rumped thornbill feeding its horsfield's bronze-cuckoo "young" (cuckoos are brood parasites, laying their eggs in the nest of other birds) on the Chowilla Floodplain. Photo: Helga Kieskamp*

## 4.3 Weir pool manipulation

**Location:** Weir pools 2, 5 and 6 including associated wetlands and floodplains

**Area:** 1,232 hectares (weir pool raising)

**Environmental water use:** 3,484 ML (weir pool raising)

**Site Water Manager:** DEW (River Murray Operations/Major Projects)

**Source of water:** CEWH

### Environmental Watering Objectives:

#### Weir pool lowering objectives:

- Test procedures and validate models
- Increase bank habitat for riparian vegetation species to colonise/occupy
- Improve riparian habitat to provide benefits for macroinvertebrate, fish, waterbird species, and to improve water quality
- Assist with bank stability and sedimentation issues, by providing a period of time (during draw-down) when banks can dry out

#### Weir pool raising objectives:

- Improve condition of lower floodplain vegetation
- Provide temporary floodplain and wetland habitat
- Increase water level variation to encourage bacterial rather than algal dominance of biofilms and improve food resource quality for consumers

### 4.3.1 Weir Pool Lowering

From 13 July to 3 August 2017, lowering trials at Weir Pools 2 and 5 were undertaken to achieve environmental outcomes, test administrative processes and raise public awareness of weir pool lowering. The levels achieved were approximately 8 cm below normal pool level. Monitoring focused on recording salinity, water quality and water level. Data recorded during the event is available on [www.waterconnect.sa.gov.au](http://www.waterconnect.sa.gov.au). As anticipated for lowering trials of this small scale and duration, there were no discernible water quality responses observed or reported.

In 2018, weir pool lowering operations at Lock 6 commenced on 21 May and concluded on 23 June (shaded section of Fig. 13 below). Water levels at Lock 6 reached 18 cm below normal pool level on 7 June, but were only briefly held at this level due to concerns regarding access to irrigation offtakes. The water level was again raised up to 16 cm where it was held for about a week, prior to returning back to normal pool level.





Figure 12. Lock 6 Weir pool lowering - winter 2018

Monitoring of the Lock 6 lowering event included surface water salinity and water quality, hydraulics, groundwater levels and salinity and photopoint monitoring.

In-channel salinity response was consistent with modelled estimates with no salinity spikes recorded. Salinity readings reported to DEW by Lindsay Point irrigators indicated that there was very little change in salinity during the weir pool lowering, with the Mullaroo Creek regulator being managed by the MDBA to maintain a flow of 600-700 ML/day down the Mullaroo and into the Lindsay River during the event. Salt Creek and Punkah Creek in the Chowilla Floodplain showed local spikes in salinity during water level lowering, with spikes of up to 400 EC above the “ambient level” being recorded. This is a typical response to changing water levels in these creeks, which sit within a high salinity groundwater area and are connected to saline backwaters, and therefore, quite volatile. Furthermore, it is worth noting that following weir pool lowering the salinity level in these creeks settled at a level about 100 EC below where they had been prior to the event (see Fig. 13).

EC @25C (uS/cm) Near Bed



Figure 13. Measured salinity in Salt Creek from Sept 2017- Sept 2018. Lock 6 WPL period indicated by shaded section. (Source: waterconnect.sa.gov.au)

In-channel water quality parameters were monitored and assessed by SA Water. Advice from SA Water confirmed that the few observed water quality parameter exceedances (levels considered by SA Water to warrant attention) were linked to water quality coming across the border and not localised weir pool lowering (Sam Loveder, pers comm, 4/9/2018).

Photopoint monitoring did not detect a strong plant germination response in the exposed littoral zone. This may be partly attributed to the relatively short duration of the lowering event. Advice from SARDI Aquatic Sciences suggests that a longer duration of lowering and an earlier commencement will likely elicit a stronger response. In addition, experience in weir pools upstream have indicated that plant response becomes stronger over consecutive years of lowering. Nonetheless, photopoints did reveal some plant germination, as well as invertebrate activity and the deposition of organic matter (floating and aquatic plants) on the exposed bank.

Two cameras, programed to take photos of the littoral zone every half hour, as well as being activated by movement, showed a succession of waterbird activity as the water level changed. Dabbling ducks were initially recorded, followed by waders foraging for macroinvertebrates and small fish, which were then replaced by large piscivorous species as the water level increased further. This is indicative of the dynamic and highly productive habitats generated in the littoral zone by the lowering and raising of water levels as shown in Figures 14-16.

Additional water pool lowering events that had been planned at Lock 2 and 5 weir pools in winter 2018 were cancelled due to the identification of several pumps that had very little if any capacity to maintain water access during lowering events of any magnitude. Further detailed investigations will be undertaken to better characterise this risk prior to any further attempt to lower these weir pools.

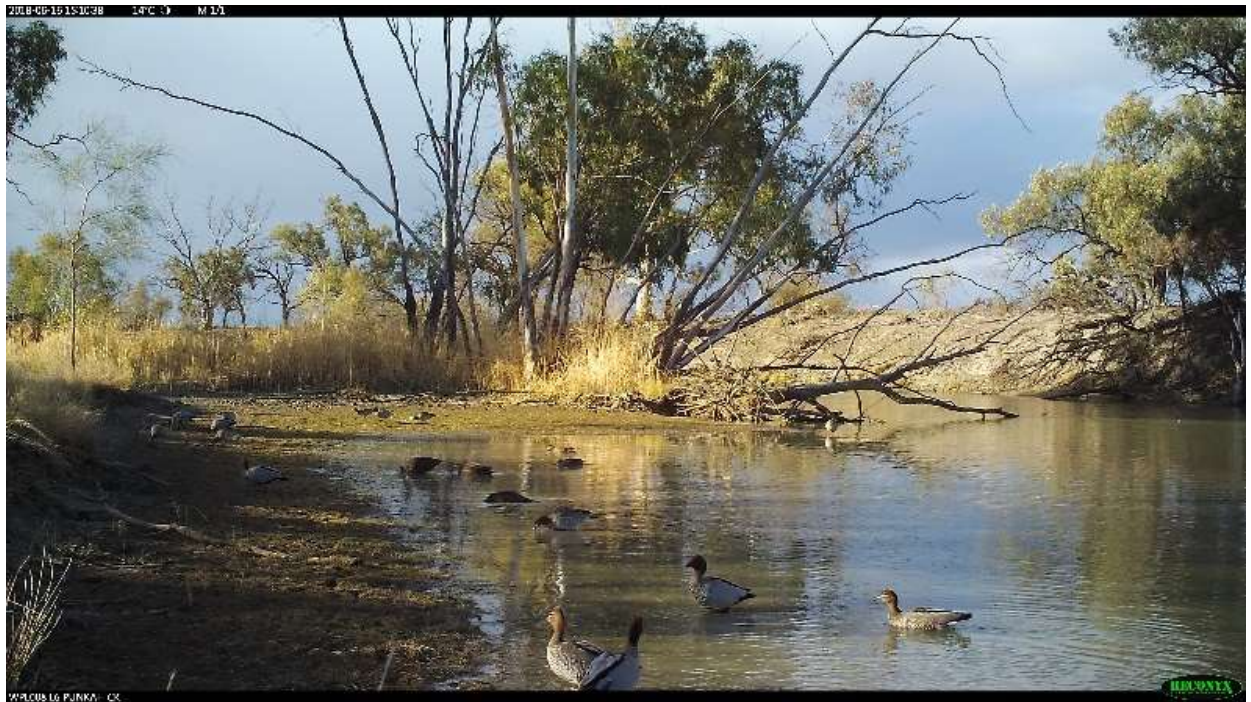


Figure 14. Dabbling ducks during weir pool lowering. Photo: Dan Hanisch



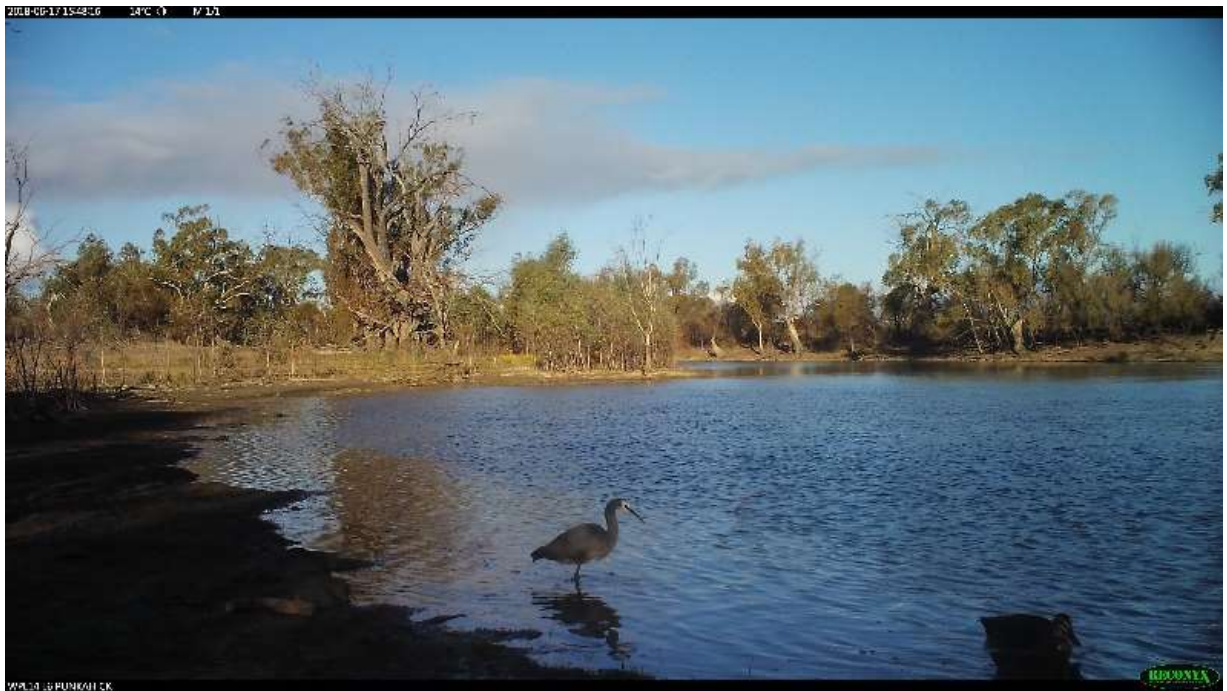


Figure 15. Waders as water levels increased. Photo: Dan Hanisch





Figure 16. Piscivores feeding in the newly re-inundated littoral zone. Photo: Dan Hanisch

### 4.3.2 Weir Pool Raising

After the return to normal pool level in early August 2017, weir pool raising commenced at Weir Pool 2 and Weir Pool 5. The raising event saw Weir Pool 2 raised 0.50 metres and Weir Pool 5 raised 0.45 metres above normal pool level.

The raising events commenced on 14 August 2017, and maximum levels were reached early in September. Water levels were then held at the maximum for a month until draw-down commenced in early October (Table 3). Water levels were returned to normal pool level by 26 October 2017. Flow at the South Australian border throughout the raising event varied between approximately 5,700 ML/day and 10,700 ML/day. Approximately 1,200 hectares of additional habitat were inundated as a result of the weir pool raising events, which was supported by the provision of approximately 3,500 ML of environmental water from CEWH. Changes in the area of inundation at Weir Pool 2 can be seen by comparing satellite imagery (available through Sentinel Hub Playground) during and after the weir pool raising event (Figure 17-19).

The lowering and raising of Weir Pools 2 and 5 in 2017 followed on from raisings at the same reaches in 2015 and 2016. Weir Pool 2 was also raised in 2014. These weir pool manipulations assist with re-introducing a degree of inter-annual water level variability to the River Murray in South Australia with a range of benefits, including helping to restore ecological function within its area of influence. Some of the hydrological and ecological benefits expected from the raising were:

- increased in-channel water-level variability leading to:
  - enhanced diversity in the riparian vegetation;
  - increased availability of temporary seasonal habitats;
  - stimulation of germination and hatching from sediments; and
  - improved riverine and wetland productivity.
- creation of a wetting and drying regime in low-level wetlands;
- improved hydrological connectivity of anabranch channels;
- creation of small scale inundation events in low lying floodplain habitats to enable feeding, breeding and recruitment opportunities for flood-dependent biota; and
- promotion of cycling of carbon and nutrients within the river, anabranches, floodplain and wetlands.

DEW's Natural Resources SAMDB Regional Wetlands Team assisted in measuring the ecological response to weir pool manipulation through the use of cameras at the Templeton and Whirlpool Corner wetlands near Lock 5. The cameras captured positive responses from water birds and vegetation. They also captured some unexpected sights, including an emu and chicks enjoying a midday bath and an echidna exploring the wetland. Anecdotal observations of the benefits of weir pool raising included an abundance of frogs (spotted grass frog, eastern sign bearing froglet and long-thumbed frog) calling during a daytime visit to Paringa Paddock wetland. Additional inundated habitat at Lakes Merreti and Woolpolool was visited by a variety of waterbirds such as waterfowl, ibis, spoonbills, and black-tailed native hens.



Table 3. Description of weir pool raising events in 2017

Lock Reach	NPL (mAHD)	Magnitude of raise		Timing				Duration (days)			
		Water level (m AHD)	Height above NPL (metres)	Start date	Date reach max	Date start drawdown	Date return to NPL	Filling phase	At max level	Drawdown phase	Total days
5	16.30	16.75	0.45	14/8/17	3/9/17	4/10/17	26/10/17	20	31	22	73
2	6.10	6.60	0.50		6/9/17	4/10/17		23	28		



Figure 17. Weir Pool 2 reach on 31 July 2017<sup>1</sup>, approximately two weeks prior to the raising event (image source: <https://apps.sentinel-hub.com/sentinel-playground>)

<sup>1</sup> During July Weir Pool 2 was lowered to 0.08 m below normal pool level



Figure 18. Weir Pool 2 reach on 4 October 2017, at the height of the raising event (image source: <https://apps.sentinel-hub.com/sentinel-playground>)



Figure 19. Weir Pool 2 reach on 7 January 2017, approximately two months post raising event (image source: <https://apps.sentinel-hub.com/sentinel-playground>)





Figure 20. Emu family at Templeton Wetland captured via a time-lapse monitoring camera installed by Natural Resources SAMDB Wetlands Team



Figure 21. Echidna at the Templeton Wetland captured via a time-lapse monitoring camera installed by Natural Resources SAMDB Wetlands Team



## 4.4 River Murray wetlands

Wetland	Site Manager
Bookmark Creek	Natural Resources SA MDB
Berri Basin	Natural Resources SA MDB
Disher Creek	Natural Resources SA MDB
Tolderol	Natural Resources SA MDB
Banrock	Banrock Station
Calperum	Nature Foundation SA
Ral Ral Creek	Nature Foundation SA
Clover Lake	Nature Foundation SA
Woolpoolool Swamp	Nature Foundation SA
Teakles Lagoon	Nature Foundation SA
Woolenook Bend Complex	Nature Foundation SA
Milang Latham Snipe Sanctuary	Nature Foundation SA
Clarkes Floodplain	Nature Foundation SA
Rilli Reach	Nature Foundation SA
Adjacent Ral Ral Creek	Nature Foundation SA
Johnson's Waterhole	Renmark Irrigation Trust
Jane Eliza Woodlot	Renmark Irrigation Trust
Adjacent Bookmark Creek	Renmark Irrigation Trust

Table 4: River Murray wetlands watered in 2017-18

### 4.4.1 Natural Resources South Australian Murray-Darling Basin

**Locations:** Bookmark Creek; Berri Basin; Disher Creek, Tolderol

**Area:** 231 hectares

**Environmental water use:** 2,884 ML

**Source of water:** CEWH, Tolderol water licence and Minister's Reserve

### **Environmental Watering Objectives:**

- The ecological objectives of watering the priority wetlands include supporting black box, river red gum and lignum floodplain communities. Watering aimed to provide habitats for waterbirds, support the nationally threatened regent parrot and provide breeding opportunities for the nationally threatened southern bell frog.
- Water for Disher Creek and Berri Evaporation Basin is critical for supporting populations of Murray hardyhead, a nationally threatened small-bodied fish. Tolderol Game Reserve Wetland is a constructed wetland complex of approximately 200 ha, and is part of the Ramsar listed Lower Lakes and Coorong region. Management of the site is supported by a group of dedicated volunteers. Tolderol is an important waterbird site with a total of 86 wetland dependent bird species observed since 2014, including 22 species of conservation significant and 15 EPBC-listed migratory wading bird species. Bookmark Creek is a small anabranch creek that bypasses Lock 5, and provides important flowing habitat for aquatic fish species.



*Figure 22. Tolderol wetland. Photo: Kate Mason*

Partners of the watering program include numerous private landholders, Ngarrindjeri Regional Authority, First Peoples of the River Murray and Mallee, Birds SA, Conservation & Hunting Alliance of SA, Signal Point Riverine Environment Group, Fleurieu Birdwatchers, the Conservation and Wildlife Research Trust and wetland community groups.

### **Environmental Watering Outcomes:**

#### ***Berri Evaporation Basin and Disher Creek***

In 2017-18, 1312 ML of environmental water were delivered to ensure that the water quality at Disher Creek and Berri Evaporation Basin were managed within the preferred salinity range (5,000 – 35,000  $\mu\text{S}/\text{cm}$ ) for Murray hardyhead. Management included the operation of infrastructure at Berri Evaporation Basin and Disher Creek, and the pumping of 50 ML of environmental water at Disher Creek in February 2018. 5 Murray hardhead were captured in March 2018 at Berri Evaporation Basin, indicating an increase in abundance in comparison to November 2016, February 2017 and November 2017 surveys, when no fish were caught. The numbers captured in Disher Creek in

February 2018 totalled 1892 individuals; the most caught since February 2016 when similar abundances were captured.



*Figure 23. Murray hardyhead sampled during fish monitoring at Disher Creek in November 2017.  
Photo: James Donaldson*



*Figure 24. A Murray short-necked turtle hatchling found during fish monitoring at Berri Evaporation Basin.  
Photo: James Donaldson.*



### **Tolderol**

1124 ML of environmental water were pumped into Tolderol wetland in 2017-18. During summer and early autumn there was an abundance of shorebirds visiting Tolderol wetlands with more than 2500 individuals recorded on multiple events between January and April 2018. Abundances were sustained throughout the key wader season with many over-wintering juveniles and adults observed throughout winter. Among the species were the sharp-tailed sandpiper, curlew sandpiper and 13 other migratory shorebird species. Many thousands of whiskered terns, cape barren geese and several species of ducks were observed using the wetland. Spotted crakes, breeding black swans, 2 endangered Australasian bitterns (likely a breeding pair) were also observed as were Pacific golden plovers, red-necked stints, red-kneed dotterels and red-capped plovers.



*Figure 25. Bird watching at Tolderol. Photo: SAMDB NR Wetlands Team*

### **Bookmark Creek**

448 ML of environmental water were delivered to Bookmark Creek in 2017-18, allowing continuous flow through the site for the whole year. Fish surveys undertaken in October 2017 and March 2018 recorded 7 native species at three sites including a pouched lamprey. Bird surveys revealed 20 species in March 2018 and 26 species in the June 2018. Species of conservation significance observed at the site include Australasian darter and little egret. Salinity along Bookmark Creek remained relatively fresh, and was indicative of freshwater from the River Murray flowing through the system.



*Figure 26. Bookmark Creek, June 2018 Photo: SAMDB NR Wetlands Team*



*Figure 27. Pouched lamprey sampled during fish monitoring at Bookmark Creek in October 2017. Photo: Naomi Prunckun*





Figure 28. Bookmark Creek community fish survey March 2018. Photo: Sam Hardy

#### 4.4.2 Banrock staff

**Location:** Banrock Station Wetland plus additional basin

**Area:** 1,375 hectares

**Environmental water use:** 3,384 ML

**Source of water:** Banrock wetland licence and CEWH

##### **Environmental watering outcomes:**

The highest number (160 individuals) of moulting Australian shelducks was recorded since 1999 and the highest number of freckled ducks was recorded since 2008. There was year-round breeding colonies of more than 500 cormorants, ibises and spoonbills. Regent parrots were regularly observed in small flocks. Six frog species were recorded with high frog abundances. Lignum growth accelerated during the watering period and there was flush of growth and flowering over an extended time. Herbaceous floodplain species responded well with the native liquorice dramatically increasing in abundance. The common nardoo responded well to the seasonal water, forming localised dense ground cover.

#### 4.4.3 Nature Foundation SA

**Location:** Calperum, Ral Ral Creek, Clover Lake, Woolpoolool Swamp, Teakles Lagoon, Woolenook Bend Complex, Milang Latham Snipe Sanctuary, Clarkes Floodplain and Rilli Reach.

**Environmental water use:** 4,945 ML

**Source of water:** CEWH



## **Environmental watering outcomes:**

### ***Calperum***

Six species of frogs were recorded across the three sites watered at Calperum in 2017-18. Fifty-one species of birds were identified, with the most species rich site being Merreti East Floodplain. The highest density of bird numbers in one survey (2000 individuals) were reported at Lake Clover. Tree health condition of mature black box trees on the south-west edge of Woolpolool Swamp showed a strong and positive response to the watering activity, although due to their poor pre-watering condition, they are still considered to be in poor condition. Trees on the north dune of Woolpolool Swamp showed an increase in foliage density.

### ***Gurra Lyrup Lagoon***

The Lagoon filling helped to promote and sustain food sources for waterbirds, and to provide bird populations with roosting, feeding and breeding habitat to supplement habitat diversity across the Lower Murray region. Waterbirds are an indicator for the presence of water-plants, fish and frogs.



*Figure 29. Various waterbirds at Lyrup Lagoon Photo: NFSA*

### ***Pike River***

Several species of frogs experienced breeding events in 2017-18 at Pike River site. Long-lived native vegetation such as lignum, nitre goosefoot, black box, river cooba and river red gum continued to improve in condition as a result of the watering.

### **Riversleigh**

Opportunistic bird surveys indicated a positive response by waterbirds as soon as the lagoon was filled, with black swans breeding. Watering also increased food sources, such as slender knot weed. Observations indicated that black box responded early (3-4 weeks after the watering event) with green tip growth. Other responses included lignum, which had significantly greened up, and growth of black box saplings as a result of the watering.

### **Clark's Floodplain**

Watering on the elevated floodplain resulted in new growth of the black box seedlings.



*Figure 30. One of the many seedlings at Clark's Floodplain showing new growth following watering. Photo: April 2018 NFSA*

### **4.4.4 Renmark Irrigation Trust**

**Location:** Floodplain adjacent Renmark - End Namoi Street (Adjacent Ral Ral Creek), Johnson's Waterhole (End David Street), Jane Eliza Woodlot (Off Ral Ral Ave/Gregory Way), Twenty-sixth Street (Adjacent Bookmark Creek), End Nelwart Street (Adjacent Bookmark Creek)

**Area:** 84 hectares

**Environmental water use:** 337 ML

**Source of water:** CEWH



### **Environmental Watering Objectives**

- Halt the decline and possible death of mature long lived plant species (eg. river red gum, black box, river cooba and lignum)
- Maintain existing regeneration and provide opportunities for future regeneration of long lived plant species
- Reduce soil salinity to disadvantage samphire and promote regeneration of less salt tolerant floodplain and aquatic plant species
- Increase diversity and abundance of waterbirds and frogs through aquatic habitat improvements
- Improve connectivity between watering sites and adjacent floodplain and waterway.

### **Environmental Watering Outcomes**

The watering at Johnson's Waterhole in 2017-18 saw an increase in bird life, with 7 species of duck observed during the watering period including: hundreds of grey teal, 2 musk ducks, 12 pink-eared ducks, 2 hardheads, 9 freckled ducks and 6 Australasian shovelers. There has been an increase in vegetation density on the fringes of the watering hole. An increase in frog activity was observed at the watering site located at the end of Nelwart Street.



*Figure 31. Site 15 after watering 5/7/18 Photo: Renmark Irrigation Trust*





*Figure 32. Site 15 before watering 2016 Photo: Renmark Irrigation Trust*

## 5. Monitoring



Information on the response to environmental watering is gathered through a number of existing monitoring programs, including:

- The CEWH Long Term Intervention Monitoring Project, which collects data along the SA River Murray Channel;
- Condition and intervention monitoring at the Chowilla Floodplain and Lower Lakes, Coorong and Murray Mouth Icon Sites through the MDBA's The Living Murray (TLM) Program;
- Monitoring by NGOs;
- Monitoring associated with weir pool raising, which is coordinated by DEW; and
- Monitoring of selected South Australian River Murray wetlands and floodplain areas undertaken by the Wetlands and Floodplain team of Natural Resources SA Murray-Darling Basin (SAMDB) in partnership with Local Action Planning and Landcare associations and community groups.

Monitoring reports are produced for many of these projects and Appendix 1 provides a list of the reports that are available for 2017-18. Monitoring synthesis reports are published for the weir pool raising project and for TLM icon sites and these reports are published on WaterConnect ([www.waterconnect.sa.gov.au](http://www.waterconnect.sa.gov.au)) and the MDBA website ([www.mdba.gov.au/publications](http://www.mdba.gov.au/publications)), respectively. Reports for the CEWO Long Term Intervention Monitoring Project are published at <https://www.environment.gov.au/water/cewo/catchment/lower-murray-darling/monitoring>.



*Figure 33. Collecting fyke net at the Lower Lakes. Photo: Owen Love*



## 6. References



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# 7. Appendices





## 7.1 Appendix 1. List of monitoring reports

### Literature

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- Ye, Q., Bucater, L., Lorenz, Z., Giatas, G. and Short, D. (2018). Monitoring salt wedge conditions and black bream (*Acanthopagrus butcheri*) recruitment in the Coorong during 2017-18. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2018/000685-1. SARDI Research Report Series.

## 7.2 Appendix 2. Glossary

Term	Meaning
<b>ADF – Additional Dilution Flow</b>	Flow provided in addition to Entitlement Flow to help manage salinity in the River Murray
<b>AHD - Australian Height Datum</b>	Height above sea level
<b>Annual exceedance probabilities (AEP)</b>	A 90% AEP reflects that 90% of the historical records for annual river flow indicate that this flow rate was achieved; therefore there is a 90% chance of receiving at least this flow in any year
<b>BWEWS</b>	Basin Wide Environmental Watering Strategy
<b>CEW</b>	Commonwealth Environmental Water
<b>CEWH</b>	Commonwealth Environmental Water Holder
<b>CEWO</b>	Commonwealth Environmental Water Office
<b>DEW</b>	SA Department for Environment and Water
<b>EC</b>	A measure of water salinity
<b>ECD</b>	Ecological Character Description
<b>EF – Entitlement Flow</b>	The flow South Australia is entitled to receive under the Murray-Darling Basin Agreement
<b>EPBC Act</b>	Environmental Protection and Biodiversity Conservation Act (Commonwealth) 1999
<b>EWR</b>	Environmental water requirement - the water regime needed to sustain the ecological values of aquatic ecosystems and biological diversity at a low level of risk.
<b>FPRMM</b>	First Peoples of the River Murray and Mallee Region - native title holders in the Riverland, South Australia, including areas of the River Murray around Renmark, Berri, Barmera, Waikerie and Morgan.
<b>GL</b>	Gigalitres – a measure of volume, where a gigalitre equals 1,000 megalitres or 1,000,000,000 litres.
<b>HEW</b>	Held environmental water – defined within Section 4 of the <i>Water Act 2007</i> .
<b>KNYA</b>	Kungun Ngarrindjeri Yunnan Agreement.
<b>LLCMM</b>	Lower Lakes, Coorong and Murray Mouth
<b>Longitudinal connectivity</b>	Water is allowed to travel the full length of the river and is not captured in storages – this allows distribution of seeds, fish and nutrients down the length of the river
<b>LTIM</b>	Long Term Intervention Monitoring
<b>Lower Lakes</b>	Lakes Alexandrina and Albert
<b>LTWP</b>	Long Term Environmental Watering Plan (Basin Plan Chapter 8 requirement)
<b>MDBA</b>	Murray Darling Basin Authority
<b>ML/d</b>	Megalitres per day

<b>Term</b>	<b>Meaning</b>
<b>NRA</b>	Ngarrindjeri Regional Authority - the peak regional organisation of the Ngarrindjeri people, descendants of the original indigenous inhabitants of the lands and waters of the Murray River, Lower Lakes and Coorong and adjacent areas.
<b>PEW</b>	Planned Environmental Water
<b>Pool connected wetland</b>	A wetland that can be connected to the main River channel when South Australia is receiving its Entitlement and normal operating pool levels are being maintained.
<b>PPM</b>	Pre-requisite policy measure - constraints that coincide with the unimplemented policy measures identified in s7.15 of the Basin Plan.
<b>QSA</b>	Flow at the South Australian border. Unless otherwise stated, flow rates (or discharges) are expressed with respect to flow at the South Australian border.
<b>Ramsar Convention</b>	An international convention that recognises important wetlands that meet defined criteria
<b>SCBEWC</b>	Southern Connected Basin Environmental Watering Committee - a multi-jurisdictional committee that provides advice on the coordinated delivery of environmental water.
<b>SDL</b>	Sustainable diversion limit – defined in the Basin Plan as the long-term average sustainable diversion limit.
<b>Spilt Storage Right</b>	SA must store water for future drought conditions. If the place of storage fills then this stored water will spill and be delivered to SA for environmental use.
<b>Tailwater</b>	Water located immediately downstream from a hydraulic structure, such as a dam (excluding minimum release such as for fish water), bridge or culvert.
<b>Temporary wetland</b>	A wetland basin that is not connected to the main River channel when South Australia is receiving its Entitlement flows and normal operating pool levels are being maintained.
<b>TLM</b>	The Living Murray Program – a long-running collaborative programme between the Murray-Darling Basin Authority and partner governments aimed at restoring the health of the River Murray system by recovering 500 gigalitres of water and constructing major water management structures at six environmental icon sites.
<b>Unregulated flow</b>	Water received in South Australia above legislative requirement and not traded
<b>VEWH</b>	Victorian Environmental Water Holder.
<b>WRP Area</b>	Water Resource Plan Area – water planning units identified for the purpose of implementing the Basin Plan. The water resource plan areas are listed in Chapter 3 of the Basin Plan.



