

**Watering Action Acquittal Report**

**Lower River Murray channel, Coorong, Lower Lakes and Murray Mouth 2019-20**

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| Basin Plan Region: SA Murray | Reporting period from: July 2019 – June 2020 |
| EAD asset: Lower River Murray, Lower Lakes, Coorong and Murray Mouth (ID: 20214)  *Note: Lower Murray wetlands covered by separate acquittal reports.* | |
| Water Use Minute: 10095 | Related Use Minutes (If applicable): n/a |
| Watering Action Reference (WAR): 10095-02 | |
| Watering Schedules: Coorong, Lower Lakes and Murray Mouth (CLLMM) Watering Schedule 2019-20 | |
| CEWO Officers: Anthony Moore, Michelle Campbell, Lucy Carlile | Source of operational monitoring data: MDBA (delivery of direct trades and return flows to SA): DEW barrage dashboard; CLLMM accounting spreadsheet |
| Acquittal report approved by: | Sean Kelly 8/9/20 |

**1. Final volumes delivered (as measured at the SA border)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Source** | **Approved Volume (ML)** | **Delivered Volume (ML)** | **Delivered Volume at the Barrages (ML)** 5 |
| Cth direct trades | 100,000 – 150,000 | 100,000 | 685,169 |
| Cth held SA allocation1 | 161,417 | 151,727 |
| Cth return flows (physically delivered)2 | n/a | 498,354 |
| *Cth sub-total* | n/a | *750,081* |
| Other3,4 | n/a | 52,373 RMIF  23,467 TLM  45,026 TLM (Ent)  60,196 VEWH | Accounted at SA border. Not accounted at barrages. |
| **TOTAL** | **n/a** | **931,1436** | **n/a** |

1. The Commonwealth’s held SA allocation totalled 161,417 ML in 2019-20. 9,690 ML was used for wetland watering in SA (see separate acquittals), with the remaining 151,727 ML accounted for as delivered to River Murray channel, Lower Lakes and Coorong (includes 352 ML used for net losses associated with Lock 2 and 6 weir pool manipulation).
2. The return flows figure represents the volume of return flows that is reported as having been physically delivered across the SA border from 1 July 2019 to 30 June 2020 from upstream watering actions.
3. Note that this table is not an authoritative source of contributions from states or other parties.
4. RMIF = River Murray Increased Flows, TLM = The Living Murray; VEWH = Victorian Environmental Water Holder
5. Barrage flows in 2019/20 were 100% Commonwealth Environmental Water.
6. Across the water year, the held environmental water volume delivered to SA of 940,833 ML (includes all e-water holders, CEW/TLM allocation and 9,690 ML for SA wetlands) made up approximately 39 per cent of the total flow at the SA border (2,388,671 ML).

**2. Expected outcomes of watering actions at the catchment (asset) scale**

The following expected outcomes relate to the water use approved via WUM 10095:

Lower River Murray

* Maintaining current species diversity, extending distributions and improving breeding success and numbers of short, moderate and long-lived native fish species by:
  + Increasing the presence of fast flowing fish habitat along the River Murray and, where feasible, increased lateral connectivity with anabranches and low elevation floodplain wetlands.
  + Providing in-stream habitat for fish and potentially supporting recruitment of fish by increasing the availability of food resources and habitat during periods where flows would be unnaturally low.
  + Improving the body condition of mature fish during winter/spring (‘pre-spawning conditioning’) and providing opportunities for spawning during spring (subject to appropriate seasonal conditions).
  + Maintaining sufficient flows through the barrage fishways to provide connectivity between the River Murray channel, Lower Lakes and Coorong enabling the seasonal movement of diadromous fish species.
  + Maintaining suitable habitat conditions (salinity) for estuarine fish species within the Coorong North Lagoon.
  + Contributing to the maintenance of critical habitat, water quality and the provision where possible of localised refuge sites as required.
* Maintaining the extent and condition of riparian and in-channel vegetation by:
  + Increasing periods of growth for non-woody vegetation communities that closely fringe or occur within the River Murray channel, anabranches and low elevation floodplain wetlands.
  + Protecting the current extent of *Ruppia tuberosa* by supporting suitable habitat conditions (salinity and water levels) within the Coorong South Lagoon to promote growth and survival of newly established plants over successive years.
  + Maintaining the diversity, condition and extent of aquatic and littoral vegetation in the Lower Lakes.
  + Maintaining the extent and condition of inundation dependent river red gum, black box, lignum and non-woody vegetation within low-lying areas of floodplain, with scale of contribution subject to seasonal conditions.
* Maintaining current species diversity, extending distributions and improving breeding success and numbers of water dependent bird species by:
  + Supporting suitable habitat conditions and food resources for waterbird growth and survival, maintenance of population condition and diversity along the River Murray valley and within the Coorong lagoons.
  + Supporting waterbird breeding events if seasonally appropriate.
* Contributing to riverine functioning by:
  + Supporting primary and secondary production along the River Murray through the mobilisation and transport of nutrients, carbon cycling and biotic dispersal.

Environmental watering also contributes to the Basin Plan’s water quality and salinity management plan by increasing the transport and export of salt and nutrients through the Murray Mouth and reducing the risks associated with hypoxic dissolved oxygen levels and algal blooms.

To maximise the extent to which Commonwealth environmental water contributes to Basin-wide environmental outcomes, environmental water use is coordinated with the delivery of all water (including other environmental and consumptive waters) and follows natural cues to guide watering actions.

Coorong, Lower Lakes and Murray Mouth:

Given the critical role of freshwater flow to the Coorong in avoiding ecological harm and supporting ongoing recovery, the primary water use objective was to deliver Commonwealth environmental water into the Coorong via a hydrological regime that:

* in dry conditions, aims to maximise estuarine habitat by prolonging barrage releases to support water levels and improve water quality in the north lagoon, in order to:
  + protect habitat conditions to maintain benthic invertebrate food resources for annual migratory waders within the Coorong.
  + protect habitat for native fish and facilitate movement.
  + potentially reduce peak salinity in the Coorong in summer-autumn to reduce the risk of irreversible damage to Coorong species including *Ruppia tuberosa.*

Environmental water delivered to the CLLMM also supports the following outcomes in the Lower Lakes:

* Export salt from the Lower Lakes.
* Maintain water quality for a healthy Lower Lakes ecology, which also benefits consumptive water users.
* Maintain minimum water levels to protect against ecological damage and be consistent with Basin Plan objectives.
* Maintain the health of fringing vegetation.
* Provide habitat for native fish, frogs and colonial waterbirds.

Weir pool manipulation – Weir Pools 2 and 6:

The ecological objectives for the weir pool raisings at Weir Pools 2 and 6 under a ‘Moderate’ scenario were:

* Growth and expansion of littoral vegetation including *Juncus, Cyperus gymnocaulos, Schoenoplectus validus*;
* Understorey plant community sustained and productive;
* Create diverse and productive biofilm and macroinvertebrate communities;
* Provide breeding habitat for small fish (in littoral vegetation) and reed-dependent waterbirds;
* Groundwater exchange with river and relieve soil salinity stress in littoral zone;
* Contribute to in-channel flows during drawdown in late spring to assist in delivering water to the Coorong, Lower Lakes and Murray Mouth (CLLMM).

Under the ‘Near Average’ and ‘Wet’ scenarios the ecological objectives were:

* Wetland inundation, connectivity and production
* Health, growth and reproduction of floodplain vegetation
* Access for aquatic fauna to floodplain and wetland habitats, particularly during key breeding and foraging periods
* Transfer of particulate organic matter from the floodplain to the river channel

**3. Hydrograph showing water delivery to South Australia 2019-20**

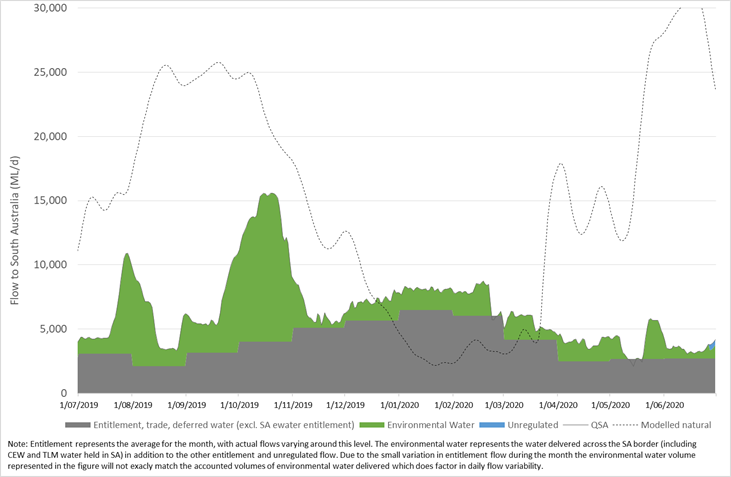


Figure 1: Environmental water delivery to South Australia in 2019-20 (Source: MDBA River Murray Operations) *Note: environmental water has been ‘pooled’ in this graph to reflect that e-water portfolios are being managed to collectively achieve environmental outcomes. Unregulated flow to SA in 2019-20 was limited to a very small volume at the end of the year.*

A close up of a map

Description automatically generated

Figure 2: Lower Lakes water levels and barrage flows during 2019-20 (Source: Data from WaterConnect (lake levels) and DEW (barrage flows); chart compiled by CEWO)

**4. Summary of watering actions**

| **Dates (start / end)** | **Target asset / WAR** | **Flow component type and target duration/ inundation extent** | **CEW volume delivered to SA** | **Expected outcomes** | **Actual delivery details and any operational issues that may affect expected outcomes (see ‘5’ for further detail)** | **Observed hydrological outcomes** |
| --- | --- | --- | --- | --- | --- | --- |
| 1 July 2019 to 30 June 2020 | [South Australian River Murray and Coorong](javascript:searchResults.editAssetInformation(%202058%20)) (10095-02) | River Murray channel – base flows and freshes  CLLMM – continuous barrage flows into the Coorong | 750,081 ML  (i.e. 749,729 ML to CLLMM and 352 ML for weir pool losses) | Refer to ‘2’ above | * Return flows from environmental watering upstream, particularly Goulburn and Barmah Millewa Forest were delivered to South Australia from late winter through spring. Small return flows from Victorian tributaries also occurring in autumn. * With upstream watering events largely concluding by late summer, additional Commonwealth environmental water was delivered to South Australia over summer and autumn (direct trade) to enable continuous barrage releases while protecting water levels in the Lower Lakes. | Water delivery to the CLLMM could be described as continuous baseflows to provide connection between the Lower Lakes and Coorong (fishways at a minimum open at all times), punctuated with two pulses in winter and spring associated with return flows from upstream actions. A number of key periods can be defined and are described further below. Where conditions allowed, baseflows were preferentially released through barrage bays adjacent to fishways to strengthen attractant flows and guide fish to fishways.  See Attachment A for detailed CLLMM accounting. |
| **Key events within the annual regime described above.** | | | | | | |
| July-August 2019  ***Winter pulse*** | River Murray channel and Coorong | Small winter fresh through the barrages for diadromous fish | 178,630 ML at SA border (included in above total)  195,555 ML through barrages | Fish habitat and condition, riverine function, lamprey and congolli migration, Coorong water quality/habitat suitability, increase lake levels in advance of spring pulse | * Return flows from the Goulburn winter fresh reached South Australia in late July with a pulse above 10,000 ML/day QSA for about five days. Flows tapered off through the first two weeks of August (see Figure 1). * As this water reached the lower lakes in early August, additional bays were opened alongside fishways at Tauwitchere and Goolwa to attract and encourage fish species including lamprey and congolli to migrate. Releases were generally around 1,400-5,000 ML/day (gate openings were generally 4 at Tauwitchere, 1 full + 2 partial gates at Goolwa).to end August, with periodic barrage closures due to reverse head conditions. * A single larger ‘pulse’ totalling 35GL over the barrages (Goolwa, Mundoo and Tauwitchere) was delivered over three days in early August to stimulate fish responses and improve water quality in the North Lagoon. These releases were undertaken in response to local climatic conditions, taking advantage of anticipated swell and wind impacts to maximise water movement along the North Lagoon. * Lake levels rapidly increased from 0.65m AHD at the start of July to exceed 0.8m in mid-August. | |
| September 2019-November 2019  ***Spring pulse*** | River Murray channel and Coorong | ‘Southern Spring Flow’ – spring fresh for 6-8 weeks across southern-connected basin | 344,093 ML at SA border (included in above total)  364,340 ML through barrages | Coorong water quality, estuarine habitat, fish habitat and condition, riverine function and productivity, lamprey and congolli migration, lower lakes fish recruitment | * Return flows from the Murray and Goulburn coordinated spring freshes began reaching the SA border in mid-September. QSA increased from 5,300 ML/d on 18 September up to a short peak of 11 days above 15,000 ML/d during 12-23 October. * Additional barrages were opened from late September in response to increasing flows from the river and rising lake levels as the spring pulse arrived. During mid-late October up to 37 gates were open, primarily at Tauwitchere and Ewe Island. * The Lower Lakes levels increased from 0.75m on 24 September to ~0.85m by the 25 October. * Once the peak had passed, barrage releases were reduced to retain spring pulse water in the lakes, in order to maintain steady low flows to the Coorong for as long as possible into summer. | |
| December 2019 – February 2020 | River Murray channel, Lower Lakes and Coorong | Base flows in river, fishway flow and connection through barrages | 125,553 ML at SA border (included in above total)  14,566 ML through barrages | Protect assets and avoid damage in the river channel, Lower Lakes and Coorong. | * The delivery of 100GL direct trade commenced in December. This water allowed fishways to remain open however was not sufficient to provide for any additional open gates due to extremely hot and dry conditions causing the lake levels to drop rapidly. * Fishway-only releases were maintained despite the rapidly falling lake levels (Figure 2). | |
| March – June 2020 | River Murray channel, Lower Lakes and Coorong | Base flows and opportunistic pulses through the barrages | 101,804 ML at SA border (included in above total)  110,708 ML through barrages | Coorong water quality, estuarine habitat, fish habitat and condition, riverine function and productivity | * Opportunistic releases to the Coorong (in addition to base releases) were made in April-June in response to water levels and weather conditions. Automated gates at Tauwitchere, Goolwa and Ewe Island were used to deliver pulses of additional water during ‘windows’ when conditions were most conducive to releases that would benefit the Coorong (ranging from a few hours to several days). | |
| July – October  ***Lower Murray Weir Pool Manipulations*** | Floodplains and River Murray channel within the influence of Locks 2 and 6 | Weir pool raising and lowering | Total net use = 352 ML | See Section 2 above | * The weir pool at Lock 2 was raised to 0.52m above normal pool level during July/August. The fill volume was 5,639 ML. Raising commenced on 13 July and reached the maximum height on 19 August. * Raising was also attempted at Lock 6, commencing on 5 August. However flow rates were insufficient to support the action and after reaching a maximum of 0.28m above normal pool level on 13 August, the pool was returned to normal level by 18 August. 1,502 ML was used in the attempted raising, of which 1,499 was returned in the lowering (3 ML of net losses were accounted against this action). * The weir pool at Lock 2 was lowered from 20 September to reach normal pool level on 23 October. This was slightly earlier than planned to align with the receding spring pulse. The return volume was 5,290 ML (349 ML of net losses were accounted against this action). | |

**5. Explanation of actual delivery details**

*Delivery to South Australian River Murray*

* Return flows were delivered to South Australia from Commonwealth environmental watering (and other events) upstream, particularly Goulburn (winter and spring), Barmah-Millewa Forest (spring) and small volumes from Victorian tributaries including Lower Broken and Campaspe (refer to individual acquittal reports for the upstream objectives of these actions).
* The integrity of the Southern Spring Flow was maintained down the length of the river as much as possible through the weirs and lower lakes and out the barrages.
* With the bulk of the water from upstream watering events reaching South Australia by late-spring, an additional 100 GL of Commonwealth environmental water was delivered across December to May via ‘direct trade’. A summer direct trade has been a key component of environmental water use in South Australia in recent dry years to avoid damage and protect the CLLMM asset. This action enabled continuous releases and open fishways while protecting water levels in the Lower Lakes.
  + The proposed direct trade volume of 100-150 GL was reviewed several times through late spring/summer to determine the volume needed for the CLLMM and whether there was potential to set aside some water for additional carryover into 2020/21. Modelling of barrage flows and lake levels demonstrated that any reductions below 100 GL increased the risk of both reducing flow to the Coorong and the Lower Lakes ecology being impacting through low levels; based on this assessment 100 GL was considered an appropriate volume.
* The full Commonwealth’s held South Australian allocation (minus the 9,690 ML SA CEW allocation set aside for wetland watering) was delivered as a contribution to River Murray base flow proportional to the monthly entitlement flow. This approach was taken based on outlooks from the Portfolio team that indicated allocations would very likely reach 100%, despite allocations early in the year being below 50%. Allocations increased sufficiently to provide for full allocation volumes to be delivered across all months of the year.

*Delivery to Coorong, Lower Lakes and Murray Mouth*

* The key water delivery actions in the CLLMM in 2019-20 were to provide continuous baseflows to maintain connection between the Lower Lakes and Coorong (fishways at a minimum open at all times), plus elevated releases (pulses) for particular outcomes including diadromous fish migration (winter) and building resilience in the Coorong by maintaining estuarine habitat and conditions (spring/early summer).
  + Total barrage flows for the year were 685 GL, with the majority of flows occurring July-November (560 GL) during the winter and spring pulses;
  + Continuous baseflows were maintained throughout the year, however there was an extended period from mid-December to late-February during which flows were restricted to fishways only.

*Barrage configurations*

* The CEWO/DEW schedule included an operational strategy to prioritise 70% of flows out of Tauwitchere barrage to maximise the benefit to the Coorong. Due to the physical location as the most south-easterly barrage, flows from Tauwitchere are more likely to be retained in the North Lagoon (rather than exit via the Murray Mouth) and thus have more potential to contribute to lower salinity, better water quality and associated outcomes in the Coorong.
  + Actual proportions in 2019-20 were 69% Tauwitchere (includes Ewe Island), and 31% from other barrages (including 23% Goolwa).
  + During the winter and spring pulses there were periods in which the Ewe Island automated gates were the most responsive option for making additional releases when all auto gates at Tauwitchere were already open. For this reason Ewe Island releases have been considered part of the 70% split.
  + Ecologically, the barrage splits during 2019-20 likely maximised the CEW contribution to achieving outcomes in the CLLMM, including managing water quality and salinity, food web productivity, fish movement and migration, estuarine fish nursery habitat, wading bird foraging habitat and helping to keep the Murray Mouth open.
* The objective to release 70% out of Tauwitchere remains a strong guideline to inform barrage configurations and 2019/20 demonstrated it is achievable even in dry years, as long as there is sufficient water available to meet basic requirements at other barrages. Indications are that the strategy is helping to maximise the benefits of environmental water in the North Lagoon.
* In August/September 2019, SA DEW raised concerns that lower flows from Goolwa were leading to sediment build-up in the channels on the Goolwa side of the mouth and uneven scouring on the Young Husband peninsula (Tauwitchere side) at the mouth. CEWO maintained that to maximise ecological benefits in the North Lagoon, releases of Commonwealth environmental water needed to remain primarily from Tauwitchere and requested that any water released from Goolwa specifically to manage sediment be accounted as water other than CEW. At that time, lake levels were high and CEW represented only around 10% of the water available within the Lower Lakes. No changes were made to configurations and the issue was apparently resolved shortly afterwards when higher spring pulse flows arrived.

*Strategic barrage releases for North Lagoon outcomes*

* To maximise the benefit for the Coorong from the limited water that was available, barrages through autumn and winter were strategically managed to take advantage of favourable weather systems. Through consultation between DEW, CEWO and SA Water, pulses of environmental water were released to the north lagoon for several days in advance of forecast westerly wind and swell events. Combined with tidal action and a good head difference between the lakes and the Coorong, weather systems pushed a series of freshwater releases down the Coorong towards the south lagoon.
  + As per previous years, this strategy positively contributed to salinity and water quality outcomes, with detectable responses at water quality monitoring stations along the Coorong, proving to be an effective approach for maintaining areas of estuarine habitat and favourable salinities in the North Lagoon with relatively small volumes under dry conditions. This management strategy and the role of automated gates (see below) was highlighted in a CEWO media release in May 2020 <https://www.environment.gov.au/cewo/media-release/wind-waves-wi-fi>
  + Coorong water levels often rise during autumn which reduces the head difference with the lakes and can make releases difficult. However, this was not a major issue this year as water levels generally remained low and provided a long window of opportunity for autumn and winter releases.
  + Commercial fishers and community members provided numerous anecdotal reports of positive ecological responses to these actions, including fish and invertebrate species being detected much further down the Coorong (moving with the fresher water). Community support for and involvement in identifying opportunities for these actions was a major positive outcome in 2019/20.
* 2019-20 also saw the automated gates at Tauwitchere and Goolwa being increasingly used to maximise the efficient use of environmental water and get the best outcomes from the limited water resources available. The automated gates allow releases to be much more responsive to conditions, opening and closing to maximise retention of the water in the Coorong based on head difference and tides. The capacity to take advantage of short periods when conditions were conducive to releases meant that barrages closures for reverse head (when Coorong water level is higher than the lakes) were shorter, with flow to the Coorong more consistently maintained.

**6. Risks, sensitivities and adverse impacts (including any lessons learned for future delivery)**

*Challenges meeting end-of-system environmental demand*

* Drought continued to impact the end of the system in 2019-20. Average barrage flows across the past three years were ~650 GL per year; just one-third the 3-year rolling average minimum target of 2000 GL/yr set out in the Basin Plan. Water for the environment has been critical in maintaining end of system flow, connection, salt export and avoiding ecological collapse, however it is becoming increasingly clear that strong recovery of the Coorong from the Millennium Drought will require much more water than the system has received in recent years.
* For example, despite many positive outcomes achieved, flows for the past several years have not been enough to support key Basin Plan outcomes such as spawning and recruitment of estuarine species (e.g. black bream) or to promote recovery of *Ruppia* in the South Lagoon. Fishway-only flows through the barrages this summer were also not sufficient to prevent Coorong salinities exceeding maximum thresholds, leading to stress on the ecosystem.
* Similarly, flow conditions in the Lower Murray river channel have not supported recruitment for flow-cued spawning fish since 2012.
* The 2017-2020 drought period has demonstrated that the most important role of water for the environment in the Lower Murray and CLLMM in similar conditions is to provide a crucial ‘life support’ function. Beyond this, the recovered volumes of water for the environment appear unlikely to be sufficient to support end-of-system environmental demands alone, and true recovery may require an extended period of more ‘normal’ conditions of higher flows from the river.
* Thus, future water delivery in similar conditions should strongly prioritise water use to protecting existing assets and avoiding damage. Success in achieving more ambitious outcomes (e.g. spawning, building populations or expanding ranges) will largely be driven by unregulated events that provide the bulk of the required volumes. Management will need to be mobile and responsive to conditions to ensure water for the environment complements these opportunities in the most effective way.

*Transparency of SA deferrals*

* In April 2020, SA made a previously unannounced decision to defer 17 GL for Critical Human Water Needs in that month. The deferral had not been proposed in any previously provided monthly deferral plan, which aim to provide information on planned deferrals 12 months in advance.
* The CEWO raised concerns about the decision, primarily the lack of advance communication and potential concerns about perceived substitution with CEW which was being delivered in April both by direct trade and as return flows from Victorian catchments. To ensure all CEW reaching SA was prioritised towards achieving targeted CLLMM outcomes, an order for a minimum of 98 GL (estimated minimum volume reaching SA) was placed for delivery through the barrages from April-June.
* Subsequent correspondence from Jody Swirepik to Ben Bruce outlined the CEWO’s concerns about the need for greater transparency regarding deferrals and the decision-making process. Ben Bruce’s response outlined that the deferred water was from consumptive underuse in SA and thus had no impact on the environment or Lower Lakes, however he committed to working together to improve transparency and making future deferral plans public.
* The “*SA deferred water storage and delivery plan*“ is now available publicly on the DEW website and updated monthly at <https://www.environment.sa.gov.au/topics/river-murray/south-australias-storage-right>.
* Barrage flows April-June met the CEWO order at exactly 100 GL.

*Lower Lakes Science Review*

* In 2019, the Advisory Committee on Social, Economic and Environmental Sciences (ACSEES) recommended that the Murray–Darling Basin Authority appoint an independent panel of scientific experts to:
  + review the existing science relating to the management of the Lower Lakes and Coorong,
  + identify advantages and/or implications of called-for changes, and
  + note the knowledge gaps to fill to accurately plan for future climate change.
* The Review was released in May 2020, concluding that the weight of evidence points to the Lower Lakes being largely fresh prior to European settlement, with moderate tidal influence and incursion of seawater during periods of low Murray River inflow (Chiew et al 2020).
  + The review states that “removing the barrages would not result in any water savings if the targets informed by science and modelling and envisaged under the Basin Plan are to be met.”
  + It found that water management of the Coorong, Lower Lakes and Murray Mouth (CLLMM) has been informed by sound science, and that current volumes are necessary to maintain Ramsar ecological character and to meet the targets set under the Basin Plan.
  + The review highlighted the importance of environmental water in building resilience and maintaining ecological function in the Lower Lakes and Coorong, particularly during drought conditions. The report also recognised that most of the environmental water delivered to the CLLMM has been used for upstream environmental watering actions.
* While the report is generally supportive of current management, it has not significantly changed the public debate about the potential for reclaiming water from SA to provide to upstream users:
  + Some people hold the view that historical condition is largely irrelevant and does not justify attempting to maintain a ‘largely freshwater’ condition in a heavily modified system that is also projected to be significantly impacted by climate change. Current targets and condition objectives that are associated with maintaining a freshwater condition in the Lower Lakes continue to be criticised as inappropriate for future management.
  + Alternative engineering solutions, such as Lock Zero at Wellington, were referred to but were not included in the modelling of system responses. As such, the report does not present any information to counter or refute claims of water savings from installing Lock 0 and allowing the Lower Lakes to become an estuary.

**7. Preliminary observed ecological outcomes**

*River Murray channel outcomes*

* Outcomes for the River Murray channel are primarily monitored via the Lower Murray MER project, with the 2019-20 report due late 2020. Given the continued dry, low flow conditions, the in-scope priorities for the year related mainly to avoiding damage and protecting the environment from harm.
* Preliminary results show that CEW again contributed positively to a range of outcomes in the river channel, including increasing lotic (flowing water) habitat, reducing the risk of low dissolved oxygen, transporting microinvertebrates (food for fish larvae) from upstream catchments, contributing to the majority of salt export and maintaining a continuous connection to the Coorong estuary (Ye pers. comm 2020).
* CSIRO monitoring of the Southern Spring flow in 2019/20 indicated environmental watering significantly increased carbon and nutrients in the river below the Barmah-Millewa floodplain but this did not persist along the river channel (Rees et al. 2020). The Lower Murray experienced an increase in zooplankton abundance as the spring pulse passed, particularly rotifers, which are known to be a preferred prey item for larval native fish (Furst et al. 2020).
* Juvenile Murray cod were detected for the 6th year in a row indicating successful recruitment. It is believed that water for the environment is contributing to this outcome by supporting favourable conditions but the mechanism is not well understood. This question is now being explored in research by the Lower Murray MER team (Bucater 2020).
* No recruitment of golden or silver perch was detected in 2019-20, suggesting the Southern Spring Flow of 2019 was not sufficient to provide the full range of favourable recruitment conditions in the Lower Murray (Ye pers. comm 2020). No significant recruitment of these species has been recorded in the Lower Murray since 2012. Fish ecologists suggest that flows to South Australia of >20,000 ML for several weeks may be required to generate the flowing water habitat needed to support significant recruitment of these species in this region (Ye et al. 2020).

*Coorong water quality*

* Pulsing flows using automated gates and favourable conditions was an effective way to influence salinities with limited water resources, particularly in the North Lagoon. Detectable decreases in salinity were observed at North Lagoon salinity monitoring stations following all pulsed events, with the strongest responses associated with larger storm events.
* Algae blooms which have been a concern in the Coorong in recent years were not reported to be a major issue in 2019-20.
* For the first time in several years, South Lagoon salinity exceeded the maximum salinity management threshold of 100 ppt. The threshold was exceeded during December when barrage flows fell to fishways only, generally climbed above the threshold to reach a maximum of nearly 130 ppt, then quickly dropped below the threshold in April once higher releases resumed. North Lagoon salinity also briefly exceeded the 45 ppt management threshold set out in SA’s Long-term Watering Plan. It should also be noted that the South Lagoon threshold of 100 ppt is generally related to supporting *Ruppia tuberosa* recovery but is otherwise well above the tolerable range for most Coorong species.
* The short-term impacts of high salinity this year were not measured, however it is believed that salinities above the management thresholds are detrimental to Coorong species and would be expected to hinder recovery of the ecosystem.
* While there is a natural cycle of higher summer salinity and lower winter salinity in the Coorong driven by sea water influx and evaporation, it is clear that freshwater flows are critical and extended periods at fishways-only (such as Dec-Feb this year) increase the risk of salinities exceeding the ecologically healthy range.
* The $60m South East Flows Restoration project was completed in 2018-19 and thus, tor the first time in 2019-20, delivered some modest flows to the Coorong South Lagoon and wetlands in the South East. Total discharge from Salt Creek to the Coorong during 2019-20 was 8.8 GL, with flows managed through the Morella and Salt Creek fishways to promote fish passage (de Jong pers comm. 2020). The project is expected to provide a median volume of 26.5 GL (range of 5-45 GL) to the South Lagoon annually over the long-term and is expected to make a strong contribution to maintaining water quality in the South Lagoon, complementing flows from the river.

*Lower Lakes Vegetation*

* Vegetation communities in the CLLMM region continue to show good signs of recovery from the impacts of the Millennium Drought (Nicol pers. comm 2020).
* TLM monitoring indicates that annual lake level variability (0.5m-0.9m) has encouraged a range of native species to re-establish on the shores of the Lower Lakes and Goolwa channel. Species richness has generally increased over the past 10 years (Nicol et al. 2019).
* Researchers recommend seasonal water level fluctuations between +0.9 and +0.5 m AHD to maintain this recovery trend, though minimums of 0.5m are not necessary every year.

*Diadromous fish*

* Lamprey were detected moving through the barrages during winter and spring and subsequently during upstream movements. Numbers in 2019-20 were among the highest since monitoring commenced.
  + 45 pouched and 16 short-headed lamprey were recorded and tagged in fishway surveys during winter/spring 2019-20, with pouched lamprey mainly moving during July and August and short-headed lamprey during September and October.
  + Some individuals were subsequently tracked on their spawning migrations as they passed PIT tag readers at locks along the river, including pouched lamprey up to Lock 8 (726km upriver) and one short-headed lamprey to Lock 10 (825km upriver).
  + Lamprey were recorded moving through the barrage fishways and beyond even under low-moderate flow conditions.
  + Lamprey monitoring in 2019-20 was jointly funded through TLM and CEWO’s MER program. SARDI produced a summary report (Bice et al. 2020) available at <https://www.environment.gov.au/water/cewo/publications/lamprey-migration-lower-river-murray-cew-delivery-2019>
* Congolli were the most abundant small-bodied fish in TLM monitoring surveys in the Lower Lakes in 2019-20, for the first time since surveys began in the mid-2000’s (Wedderburn pers. comm 2020).
  + This is a fantastic bounce back for a species that was devastated during the Millennium Drought. Its recovery is due to environmental flows restoring and maintaining the connection between the Lower Lakes, the Coorong estuary and the sea, which is essential for the survival of native fish such as congolli.
  + Congolli spend different parts of their lifecycle in fresh water and salt water. The adult females live in fresh water most of the year round. Each winter they swim downstream to the Coorong estuary and Southern Ocean to breed. In late spring and summer, juvenile congolli migrate back upstream via fishways at the barrages, to complete their lifecycles in the freshwater of the Lower Lakes.
  + When the River Murray stopped flowing to the Coorong from 2007 to 2010, fish couldn’t access the salt water of the Coorong and the Southern Ocean to breed and congolli populations crashed. There were concerns they would become locally extinct.
  + Congolli are a key prey for larger fish such as mulloway, golden perch and for fish-eating water birds like pelicans and cormorants, so their recovery is likely to have very positive flow-on effects for other parts of the Coorong ecosystem.

*Estuarine fish*

* CEWO did not undertake any monitoring of estuarine fish in 2019-20.
* Due to the rapid reduction to fishway-only flow after the spring pulse, flow conditions to support black bream recruitment did not occur.
* Anecdotal reports from commercial fishers suggest that the spring flow and continuous barrage flows were beneficial to many estuarine species.
* More information on the status of estuarine fish populations in the Coorong will become available later in the year when TLM monitoring reports are released.

*Small-bodied threatened fish*

* Spring TLM monitoring found that Murray Hardyhead and Southern Pygmy Perch spawned strongly in the Lower Lakes in 2019-20, with high water levels and newly recovered fringing and submerged vegetation providing quality habitat during the winter and spring pulses. Populations of both species were also found to be establishing in new areas within the lakes.
* Otolith aging indicated that spawning of Southern Pygmy Perch aligned with the winter pulse (not spring as expected), whereas Murray Hardyhead spawned during the spring pulse.
* Subsequent monitoring in autumn found that the rapid fall in lake levels to 0.5m during late summer and autumn negatively impacted Southern Pygmy Perch in particular, with limited recruitment and poor body condition reported. Murray Hardyhead on the other hand had recruited well. Fish ecologists believe that while a minimum lake level of ~0.5m is not ideal, both species would be expected to persist without decline if that level is unavoidable in dry periods. When conditions allow, a higher minimum of >0.6m has been recommended to support strong population recovery.

*Other Coorong and Lower Lakes outcomes*

* Preliminary results from monitoring of waterbirds in the Coorong and Lower Lakes indicate low numbers of shorebirds including migratory waders. Birds that were present were observed spending up to 80 percent of their time foraging, potentially indicating low food abundance within the mudflats.
* Breeding of pelicans was detected in the South Coorong, however the colony was much smaller than usual. Good breeding of straw-necked ibis and pied cormorants were detected around Lake Alexandrina and Lake Albert.
* Additional information on CLLMM outcomes, including fish, waterbirds, macroinvertebrates and vegetation, will become available when TLM reports are released later in the year.

*Weir pool manipulation outcomes*

* At Lock 2 approximately 350 hectares of additional inundation was achieved.
* Lock 6 water surface area was only increased from 518 Ha to 540 Ha (22 Ha increase) as the event needed to be curtailed due to falling QSA impacting on the ability to maintain adequate flows over the Lock.
* Monitoring was undertaken to assess the influence of the Lock 2 weir pool raising on micro-invertebrate communities and water quality.
  + Weir pool manipulation contributed to increases in microinvertebrate densities and increases in microcrustaceans, including cladocerans, copepods and copepod nauplii, all important food resources for fish such as juvenile Murray cod and golden perch.
  + This was primarily evident in early September when the weir pool had been at maximum height for approximately one month.
  + The results also provided some evidence of increases in densities downstream during weir pool lowering. The study highlighted that weir pool manipulation can be used to promote the development of abundant and more microcrustacean dominated communities within localised areas of the Lower Murray River with potential for downstream contributions (Furst 2019).
* There was no evidence of impacts on water quality associated with the Lock 2 weir manipulation. Parameters included dissolved oxygen levels (93% to 112% saturated), pH (7.2 to 8.1), conductivity (114 and 232 µS.cm-1), temperature (13 and 22 °C), and turbidity (24 and 54 NTU) (Furst 2019).

**8. Communications and stakeholder engagement undertaken as part of the watering actions (including with First Nations people)**

*Engagement in the CLLMM*

* Decisions on the use of Commonwealth environmental water in the CLLMM were based on annual planning undertaken by the CEWO and DEW, with input provided by community, scientists and river/infrastructure operators via:
  + The CLLMM Community Advisory Panel (CAP) and Scientific Advisory Group (SAG), including a joint meeting of the CAP and SAG in November 2019.
  + The Barrage Operations Advisory Group, which meets regularly to confirm operational arrangements relating to the barrages.
  + Discussions at other fora such as the LTIM/MER Selected Area Working Group meetings and DEW’s Environmental Flows Reference Group.
  + See [Coorong, Lower Lakes and Murray Mouth 2019-20 operations](http://spire.environment.gov.au/spire/886887/753619/160516/_layouts/DocSetHome.aspx?id=/spire/886887/753619/160516/2091/Coorong,%20Lower%20Lakes%20and%20Murray%20Mouth%202019-20%20operations&Source=http%3A%2F%2Fspire%2Eenvironment%2Egov%2Eau%2Fspire%2F886887%2F753619%2F160516%2F2091%2FForms%2FSPIRE%2520Library%2520View%2Easpx&DefaultItemOpen=1) on SPIRE for DEW monthly reports, including details on consultation and recommendations from CAP and SAG.
* CEWO officers attended all meetings with the CAP and SAG to present key challenges, lessons learned and future water delivery plans, and receive advice and feedback from the groups.
* Management of CEW over the summer months for lake level and barrage releases was a key discussion point at the joint CAP/SAG meeting in November 2019. Different management scenarios were put to the group and ecological objectives assessed against each scenario to facilitate discussion and a transparent decision-making process. This discussion was informed by modelling of barrage flows, lake levels and salinity levels.

*Public communications*

* Throughout 2019-20, the following tweets were made in relation to the CLLMM and Lower Murray:

|  |  |  |
| --- | --- | --- |
| 10 Jul | Freshwater flows are the heartbeat of the Murray – they help plants, animals and improve water quality. Without them, the river’s lifeblood stops flowing. The #SouthernSpringFlow is now underway.  @VicEWH  @NSWDPIE\_Water  @SAEnvirWater  @MD\_Basin\_Auth  More: https://bit.ly/2XE5na3 | Image |
| 08 Aug | Good news! [@SA\_PIRSA](https://twitter.com/SA_PIRSA) SARDI scientists caught 7 more lampreys at Goowla. Why good? Since the drought sightings have been rare, but thanks to water for the environment we are seeing more = [#RiverMurray](https://twitter.com/hashtag/RiverMurray?src=hash) is healthier. \*lampreys were tagged & quickly released [@MD\_Basin\_Auth](https://twitter.com/MD_Basin_Auth) [@theCEWH](https://twitter.com/theCEWH) |  |
| 13 September | Come and talk with us at #RiverlandFieldDays! Here's our Local Engagement Officer Michelle Campbell discussing the Southern Spring Flow with students from Glossop High School today.  Check out the latest update on the flow at https://bit.ly/2kaHgSu | Image |
| 22 May | Releasing #WaterForTheEnvironment into the Coorong, SA has become whole lot easier.  When wind and waves move towards the Coorong, opening automated gates on the barrages reduces salt levels in the  @RamsarConv  site, improving fish and bird habitat.  https://bit.ly/2WQQ2FJ | Image |

**9. Compliance with the Basin annual environmental watering priorities**

The watering actions covered by this acquittal report contributed to the following Basin annual watering priorities:

* Improve connectivity between freshwater, estuarine and marine environments and improve habitat conditions in the Coorong by optimising and managing inflows through the Lower Lakes and into the Coorong.
* Support Basin-scale population recovery of native fish by reinstating flows that promote key ecological processes across local, regional and system scales for the southern connected Basin.
* Support viable populations of threatened native fish and maximise opportunities for range expansion and the establishment of new populations.
* Improve the abundance and diversity of the Basin’s waterbird population.

|  |  |  |  |
| --- | --- | --- | --- |
| **10. Additional questions** | **Yes** | **No** | **N/A** |
| Have volumes recorded in Section 1 been checked for consistency against final record in the EAD? | X |  |  |
| Has all summary operational monitoring been entered into the EAD? | X |  |  |
| Have details of risks which eventuated, sensitivities for future actions or any adverse publicity been recorded? | X |  |  |
| Has a hydrograph been obtained for this action showing daily release from source? | X |  |  |
| Was this action part of an intervention monitoring project? | X (Lower Murray) |  |  |
| Were field observations undertaken and recorded throughout the action? | X |  |  |
| Were photos or photo point monitoring collected throughout this action? | X |  |  |
| If so, have any photos been provided to stakeholder engagement team? | X |  |  |
| **Additional comments:** | | | |

**11. References**

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