Australian Government

MURRAY–DARLING BASIN AUTHORITY

Basin annual environmental watering priorities 2020–21

June 2020

Published by the Murray–Darling Basin Authority
MDBA publication no: 27/20
ISBN (online): 978-1-925762-94-5

GPO Box 1801, Canberra ACT 2601
engagement@mdba.gov.au
1800 230 067
mdba.gov.au

Cataloguing data
Title: Basin annual environmental watering priorities 2020–21, Murray−Darling Basin Authority Canberra, 2020. CC BY 4.0

Accessibility
The Murray–Darling Basin Authority makes its documents and information available in accessible formats. On some occasions the highly technical nature of the document means that we cannot make some sections fully accessible. If you encounter accessibility problems or the document is in a format that you cannot access, please contact us.

Acknowledgement of the Traditional Owners of the Murray–Darling Basin
The Murray−Darling Basin Authority pays respect to the Traditional Owners and their Nations of the Murray−Darling Basin. We acknowledge their deep cultural, social, environmental, spiritual and economic connection to their lands and waters.

The guidance and support received from the Murray Lower Darling Rivers Indigenous Nations, the Northern Basin Aboriginal Nations and our many Traditional Owner friends and colleagues is very much valued and appreciated.

Aboriginal people should be aware that this publication may contain images, names or quotations of deceased persons.

Contents

Executive summary

The Basin annual environmental watering priorities (the priorities) guide the annual planning and prioritisation of environmental watering across the Murray−Darling Basin. They represent the annual steps needed to achieve the long-term environmental outcomes in the Basin-wide environmental watering strategy (the strategy) and through them, the Basin Plan's ecological objectives and targets.

Three years of above-average warm and dry conditions have taken a toll on the Basin's water-dependent ecosystems. During the height of the drought over the 2019-20 summer, native fish died in multiple events, refuge waterholes dried up, bushfire damaged key wetlands of international significance and others suffered a deterioration in their condition. Even in these circumstances, where water was available it made a difference as environmental water holders drew on all available water, coordinated flows and used innovative ways to avoid loss of species and ecosystems.

Significant rainfall in northern and southern catchments in summer and early autumn increased streamflow and connected rivers and floodplains. However, as most of the rainfall was downstream of major public storages, dam levels remain low in many catchments. It is anticipated the above average rainfall over April and into May 2020 will boost inflows, particularly into the Menindee Lakes and storages in the southern Basin.

While there is an increased chance of above average rainfall across the Basin over winter, the prolonged drought and generally low levels of water in public storages have resulted in most catchments being assessed as 'dry'. Under these conditions, the Murray–Darling Basin Authority (MDBA) expects the focus for environmental water holders, planners and managers, as well as river operators, will continue to be on *managing to avoid irretrievable loss, providing drought refuges were possible, and supporting breeding events where they occur naturally*. It may be possible to improve the condition of species and habitat in catchments where carryover volumes are available, particularly in southern catchments where the forecast wetter than average conditions are likely to boost water in storages.

Where held environmental water is available, managing to build the resilience of the Basin's water-dependent ecosystems remains critical, particularly given current and anticipated impacts from climate change. The priorities are set out as rolling, multi-year frameworks to guide environmental watering over the medium-term to achieve the expected environmental outcomes identified in the strategy. Priorities have been prepared for river flows and connectivity, native vegetation, waterbirds, and native fish. Annual guidance is included to help achieve the priorities in 2020–21, based on urgent ecological needs, the condition of Basin catchments and expected water availability.

For the first time, the priorities reflect expected outcomes identified by First Nations people through a project funded by the MDBA and the Commonwealth Environmental Water Office (CEWO) in partnership with Northern Basin Aboriginal Nations (NBAN) and the Murray Lower Darling Rivers Indigenous Nations (MLDRIN).

Management strategies for achieving the priorities are also set out in this report. With limited volumes in storage, coordinating flows across catchments and making the best use of all available water in the system will continue to be important.

Introduction

The Murray–Darling Basin Authority (MDBA) has developed Basin annual environmental watering priorities (the priorities) to guide the planning of environmental watering across the Basin. The priorities are the actions needed to help achieve the Basin Plan's long-term objectives of protecting and restoring the Basin's rivers, wetlands and floodplains set out in the Basin-wide environmental watering strategy (the strategy).

This report has been prepared in consultation with environmental water planners, managers and river operators to assist them in their work which is helping to achieve improvements for the Basin's rivers, wetlands and floodplains.

Under the Basin Plan, the Australian and state governments have recovered water for the environment that sustains Basin communities and benefits the nation. As at 31 March 2020, the Commonwealth environmental water holdings total 2,874 gigalitres (GL) of registered entitlements with a long-term average annual yield of 1,986 GL. This is in addition to environmental water held by Basin states and in The Living Murray portfolio. Between 2013-14 and 2018-19, Basin governments delivered over 15 million megalitres of water to support environmental outcomes across the Basin.

While the 2017 Basin Plan Evaluation showed that there are early signs of local improvement in the environmental condition of the Basin's rivers, achieving broad, system-scale improvements will require many more years of careful management.

The first of the targets in the strategy and the Basin Plan, which aim to measure progress towards the overall environmental objectives for water-dependent ecosystems, is that there is *no loss or degradation* by 30 June 2019. This is followed by *improvements* in subsequent years.

Prevailing climatic conditions are a major influence on opportunities to use water recovered for the environment under the Basin Plan. For much of the period between 2012 (when the Basin Plan took effect) and 2020, dry conditions have dominated the Basin's climate. The Basin experienced its hottest and driest year on record over 2019.

Rainfall in early 2020, in particular across the northern Basin, has increased flows in some catchments and the Bureau of Meteorology is forecasting a 60-75 per cent chance of above-average rainfall across much of the Basin in coming months (as at May 2020).

Parts of the Basin were also affected by the extensive bushfires over the 2019-20 summer. The impact of the fires is yet to be fully understood but water quality and runoff volumes are expected to be affected. While environmental flows may help mitigate downstream water quality problems, they are unable to alleviate impacts in the upper parts of the catchment.

This report has been prepared primarily for environmental water planners, managers and river operators. The MDBA has also prepared a summary for a broader audience.

Overview of the Basin annual environmental watering priorities

The Basin annual environmental watering priorities (the priorities) guide the annual planning and prioritisation of environmental watering across the Murray–Darling Basin. They represent the annual steps needed to achieve the long-term outcomes in the Basin-wide environmental watering strategy (the strategy) and through them, the Basin Plan's ecological objectives and targets. The priorities are a mix of site-specific and broader priorities, reflecting the ecology of species that are the focus of the strategy.

This report has been produced for managers of environmental water (the Commonwealth Environmental Water Holder and Basin states), who will be guided by the priorities outlined in this report when they coordinate environmental watering, including through the Southern Connected Basin Environmental Watering Committee and the Northern Basin Environmental Watering Group.

These are the eighth Basin annual environmental watering priorities prepared in accordance with the requirements of the Environmental Watering Plan (Chapter 8 of the Basin Plan), including consultation with members of the Environmental Watering Working Group representing Basin governments, water holders and managers, First Nations organisations MLDRIN and NBAN, and river operators.

Current conditions

The Murray–Darling Basin experienced the warmest and driest conditions on record in 2019. Annual rainfall averaged across the Basin was 228 mm, or 53% below the long-term average, and mean temperatures 1.86 degrees Celsius above average.

It was the seventh consecutive year that temperatures were well above average for the Basin, with mean temperatures in the top 10% of records for the third year running, and large areas of the northern and eastern parts of the Basin experiencing the highest temperatures on record averaged over the year.

These very warm and dry conditions have generally prevailed across the Basin over the past three years, with rainfall substantially below average for each of the three years of 2017, 2018, and 2019, making this three-year period the driest three years on record for the Basin. Rainfall over the three-year period was 918 mm, 120 mm less than the previous record set for the three-year period of January 1965 to December 1967.

The most extreme rainfall deficiencies over the three years to 31 December 2019, and over 2019 in particular, occurred in the northern Basin. While the southern Basin experienced very hot and dry conditions over this period, conditions were less extreme than in the northern Basin (Figure 1).

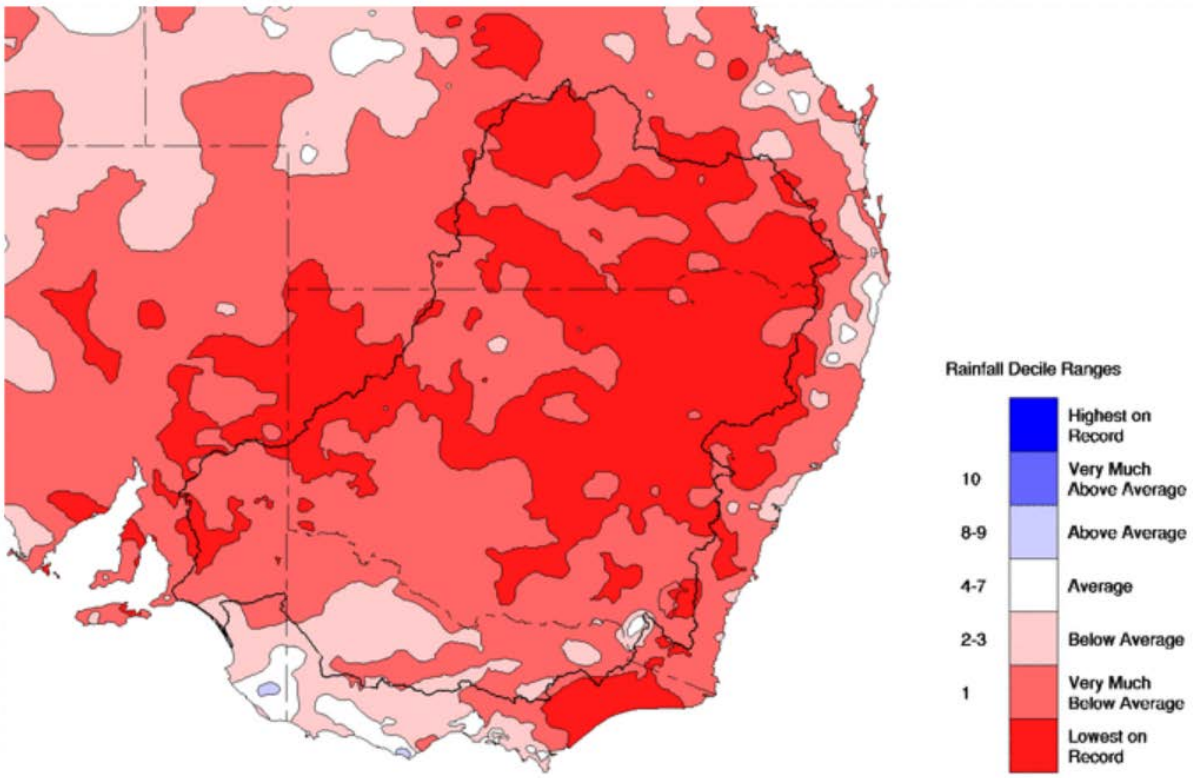

Figure 1 Rainfall deciles for the Murray–Darling Basin from 1 January 2017 to 31 December 2019

These very hot and dry conditions throughout 2019 resulted in further drying of Basin landscapes and the intensification of drought conditions (Figure 2). WaterNSW advised that the drought conditions prior to the rainfall in early 2020 were the most severe on record and were worse than conditions experienced during either the 1940s or millennium droughts.

Wetter conditions prevailed across the Basin in the early months of 2020. Heavy rainfall in the north through February and March 2020 and continuing over autumn resulted in increased flows in many rivers in each of the major tributaries of the northern Basin Barwon–Darling River. This includes over 1,400 GL through the Condamine–Balonne at St George, and more than 1,000 GL in the Warrego River at Cunnamulla. Flows began to arrive at the Menindee Lakes on 10 March and joined up with the River Murray by 20 April 2020. This was the first time in two years that there had been full connectivity along the Barwon–Darling from Mungindi to the River Murray.

Rainfall in April and into early May was also very much above average across large parts of the Basin, particularly in northern NSW and the southern Basin. Rainfall over the summer and autumn months wetted up catchments and will increase the chance of runoff if the forecast wetter conditions arrive. However, the severe rainfall deficiencies that had accumulated over recent years had not been offset at the time of determining the water resource availability scenario for the 2020–21 priorities. Many months of above-average rainfall are required to see a full recovery from the prolonged and substantial long-term rainfall deficiencies and to replenish the low volumes of water in aquifers and public storages across many parts of the Basin.

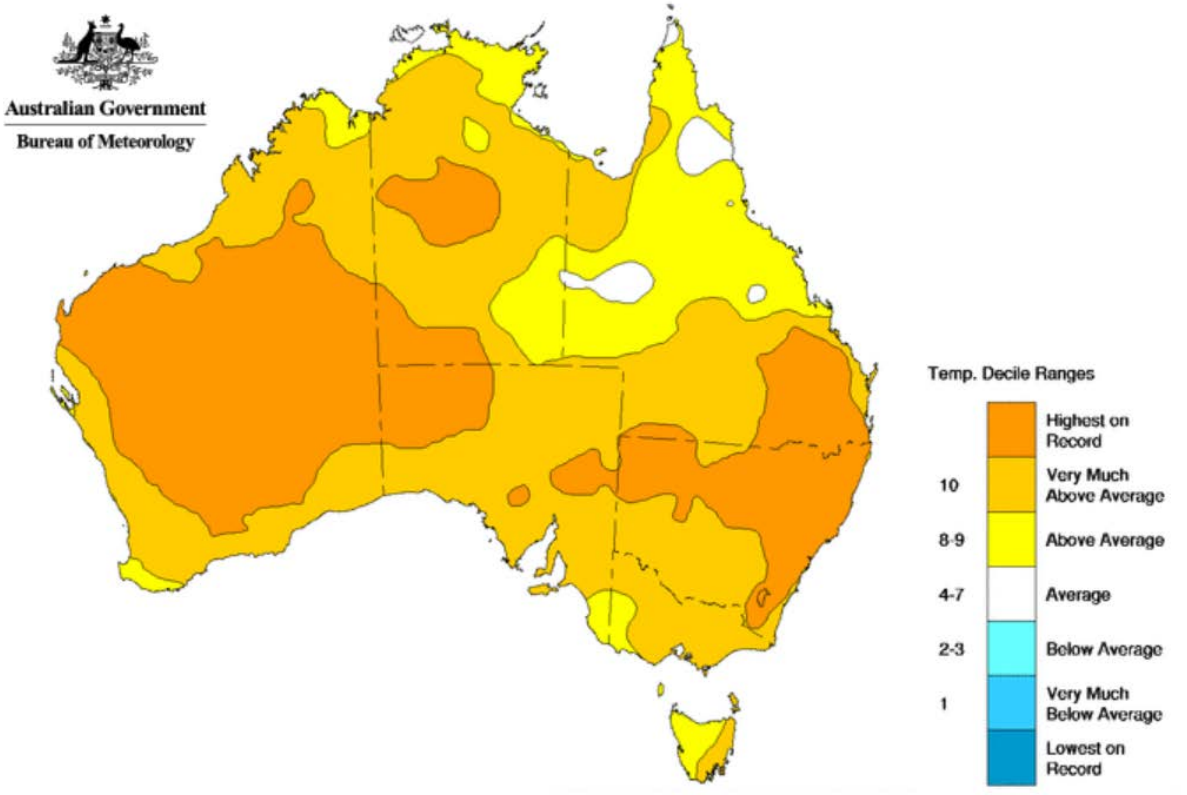

Figure 2 Mean temperature deciles for Australia, 1 January to 31 December 2019

Climate context for 2020–21

The MDBA assesses seasonal conditions for the upcoming water year (the water resource availability scenario) in each Basin catchment based on the past year's climate conditions (rainfall, runoff and soil moisture) and current surface water availability in public water storages in regulated catchments. The Bureau of Meteorology's climate outlook and longer-term forecasts are also considered. In addition, the MDBA consults with environmental water managers.

The objectives sought from providing water for the environment are influenced by seasonal conditions. The priorities are expressed so that they can adapt to the prevailing climatic conditions that will appear throughout the watering year. Identifying which priorities to use will depend on the resource availability scenario and the condition of the area in question.

The results of the assessment of the resource availability scenario for conditions as at 1 May 2020 are as follows:

- the Warrego, Wimmera–Avoca and Loddon were assessed as being 'moderate'
- the Paroo, Condamine–Balonne, Gwydir, Namoi, Macquarie–Castlereagh, Barwon–Darling, Lachlan, Murrumbidgee, Lower–Darling, Murray, Ovens, Goulburn–Broken, Campaspe and Eastern Mt Lofty Ranges catchments were assessed as being 'dry'
- the Moonie and Border Rivers were assessed as being 'very dry'.

More information on this assessment of the water resource availability scenarios is provided in Appendix 1. Of note, the determination of the resource availability scenario for the Wimmera-Avoca

catchment has been based on antecedent climate conditions. The MDBA will be including public water storages that supply the catchment in future assessments. However, it is recognised that the water storage level for Rocklands Reservoir as at 5 June 2020 is at 23% of active capacity. This low storage level is likely to mean the resource availability scenario for the catchment would have been 'dry', rather than the May 2020 assessment of 'moderate'.

Influence of climate forecasts

While seasonal and longer-term climate forecasting are not included in the assessment of water resource availability in the Basin, the MDBA uses this contextual information to provide an indication of changes in water resource availability that may emerge over coming months.

The seasonal outlook issued by the Bureau on 28 May 2020 is for conditions over winter and through to September to be wetter than average across the Basin. The increased chance of wetter conditions and associated cloud cover over the months to September 2020 would be associated with average to cooler-than-average daytime temperatures, along with warmer night-time temperatures across the Basin.

The key climate influences behind the warmer and drier conditions over the second half of 2019— including the strong positive Indian Ocean Dipole (IOD) and the negative Southern Annular Mode (SAM)— returned to neutral by early January 2020. The El Niño–Southern Oscillation (ENSO), which was neutral throughout 2019, remains neutral as at 26 May 2020. However, despite neutral conditions being favoured for the coming months, global climate models suggest ocean temperature patterns in the tropical Pacific may become La Niña-like during spring, with three of the eight models suggesting thresholds could be met or exceeded by October 2020. It should be noted that ENSO predictions made during autumn and early winter tend to have lower accuracy than predictions made at other times of the year. This means that current ENSO forecasts for conditions at these times should be used with some caution.

Four of the six global climate models for the IOD suggest Indian Ocean temperature patterns could become negative from July 2020. A negative IOD typically brings above average winter–spring rainfall to southern Australia. It should be noted that the accuracy of IOD forecasts is also low at this time of the year, with forecast accuracy improving from late autumn. The Southern Annular Mode was also positive in late May. However, it isn't expected to have a significant effect on rainfall during this time due to interactions with other climate drivers and local weather conditions.

Overall, and according to the latest seasonal forecast from the Bureau, there is an increased chance of wetter than average climate conditions over the months ahead which would be associated with average to cooler days but warmer nights. Given the above average rainfall that has already wetted up catchments across large parts of the Basin from mid-January to 1 June 2020, if the outlook for wetter than average conditions over the months ahead is realised, then this could result in further easing of the rainfall deficiencies that accumulated over the three years from 1 January 2017 to 31 December 2019. This possibility would be extended if a La Niña and, or, a negative IOD develop during winter or spring, as this would increase the chance of wetter conditions continuing into spring and early summer.

Basin-wide annual environmental watering priorities

The MDBA has prepared Basin annual environmental watering priorities (the priorities) for river flows and connectivity, native vegetation, waterbirds and native fish. The priorities are set out as rolling, multi-year frameworks to guide environmental watering over the medium-term (i.e. the next 3-5 years) to achieve the expected environmental outcomes identified in the Basin-wide environmental watering strategy (the strategy). This approach recognises that different species and plant communities have varying water needs across life cycles and in different climatic conditions.

The priorities have been developed for each of the resource availability scenarios. For any given time, the priorities are dictated by the current best estimate of the resource availability scenario over the next year. The management outcomes sought will depend upon the prevailing conditions. If conditions change across catchments within the year, the priorities can transition to reflect seasonally appropriate priorities. The framework also provides insight to the likely priorities in the forthcoming water years to assist in future planning.

Annual guidance has also been provided to assist environmental water managers to implement the priorities in the coming water year, based on expected seasonal conditions and emerging issues that need to be supported or ameliorated with environmental water.

While implementation of actions to contribute to these priorities should be straightforward, it will require careful application by water managers. The MDBA's recommended approach is that water managers first have regard to the annual guidance, since it is specific in nature, and second have regard to the multi-year frameworks, as these are general in nature.

Climatic conditions and water availability influence opportunities to improve the health of the Basin's rivers, wetlands and floodplains, although they are not the only influences; physical, operational and policy constraints and land use and pest management also affect what can be achieved. In drought, environmental water holders, as with all water licence holders, are also constrained by low allocations and carry-over quarantined under state entitlement frameworks for critical human water needs.

Implementing the priorities will also require effective use of all water, including water on route to consumptive users. Any watering decision made to meet these priorities will need to consider current operating constraints and include consultation with stakeholders.

Table 1 sets out annual guidance for 2020–21 and the rolling, multi-year priorities. Two new rolling, multi-year priorities are included for riparian and non-woody wetland vegetation to align with the quantified environmental outcomes in the strategy.

For the first time, the MDBA has used guidance from First Nations in developing the priorities. This collaboration provides opportunities for First Nations to influence Basin-scale prioritisation of environmental outcomes, with complementary cultural benefits. It builds on the opportunities that Basin states provide First Nations people to participate in decisions on water for the environment in their particular regions.

The MDBA has identified the current resource availability scenario (see Appendix 1) and will advise if it changes substantially. Planning for the forthcoming water year anticipates dry to very dry

conditions across the Basin. While the outlook is for above average rainfall, in particular for the southern Basin, it is not expected to be enough to redress serious rainfall deficiencies. In some southern catchments, where a small volume of carryover water is likely to be available, and where there has been recent rainfall, it may be possible to improve ecological condition in these regions subject to the extent of winter rainfall.

Providing water to the environment in dry times is critical to protect and restore the long-term condition of the Basin's rivers, wetland and floodplains. Water for the environment is also important for maintaining and, where possible, improving the health and abundance of native fish, waterbirds and native vegetation that rely on a healthy river system.

Given the current conditions and the outlook for coming months, the MDBA expects that the management outcomes for a dry to very dry resources availability scenario will be most relevant in most catchments. Therefore, the MDBA expects that the focus for environmental water managers in 2020–21 will be:

- avoiding irretrievable loss of species and habitat, and providing drought refuges in catchments assessed as having a 'very dry' resource availability scenario
- maintaining the condition of species and habitat where water is available in catchments assessed as having a 'dry' resource availability scenario
- maintaining or improving ecological health, condition and resilience of water-dependent ecosystems in catchments in regulated systems assessed as having a 'moderate' resource availability scenario.

The outcomes sought through these Basin-scale priorities are complemented by outcomes targeted with environmental water at local and regional scales by the CEWH and Basin states.

Table 1 Annual guidance for 2020–21 and the rolling, multi-year priorities for the Murray–Darling Basin

Priorities	Flows and connectivity	Native vegetation	Waterbirds	Native fish
Annual guidance for 2020–21	• Protect drought refuges. • Build ecosystem resilience by providing or enhancing connectivity.	• Maintain core wetland vegetation and refuges. • Avoid critical loss and (where possible) improve vegetation condition in areas where drought conditions persist. • Support and build on watering events that have happened in previous years. • Provide follow-up watering to consolidate improvement in lignum communities at Narran Lakes. • Support growth of ruppia in the southern Coorong.	• Provide follow-up watering to build resilience in the Narran Lakes system or to support waterbird breeding and recruitment. • Provide water to the Macquarie Marshes to support waterbird habitat. • Support productive shorebird habitat and foraging resource availability in the Coorong, Lower Lakes and Murray Mouth.	• Protect or provide flows that protect existing populations, support connectivity and sustain short-lived species recruitment. • Support recruitment from breeding events and subsequent dispersal of new recruits in the northern Basin. • Maintain existing populations and ensure hydrological integrity of flow pulses in the southern Basin rivers.
Rolling, multi-year priorities *The rolling, multi-level priorities for 2019–20 carry forward to 2020–21 with two additional priorities for non-woody wetland and riparian vegetation.*	• Support lateral and longitudinal connectivity along the river system. • Support freshwater connectivity through the Lower Lakes, Coorong and Murray Mouth.	• Allow opportunities for growth of non-woody wetland vegetation. • Allow opportunities for growth of non-woody riparian vegetation that fringes or occurs within main river corridors. • Maintain the extent, improve the condition and promote recruitment of forests and woodlands. • Maintain the extent and improve the condition of lignum shrublands. • Expand the extent and improve the condition of Moira grass in Barmah-Millewa Forest. • Expand the extent and improve resilience of ruppia in the southern Coorong.	• Maintain the diversity and improve the abundance of the Basin's waterbird population. • Maintain the abundance of key shorebird species in the Lower Lakes and Coorong.	• Support Basin-scale population recovery of native fish by reinstating flows that promote key ecological processes across local, regional and system scales in the southern connected Basin. • Improve flow regimes and connectivity in northern Basin rivers to support native fish populations across local, regional and system scales. • Support viable populations of threatened native fish, maximise opportunities for range expansion and establish new populations.

State priorities

Under the Basin Plan, environmental water planning is required at two spatial (Basin-wide and water resource plan area) and temporal (annual and five yearly) scales. For the MDBA, this means publishing a Basin-wide Environmental Watering Strategy and Basin annual environmental watering priorities. For Basin states, this means publishing long-term environmental watering plans and annual environmental watering priorities.

Basin states are required to provide the MDBA with annual environmental watering priorities for each water resource plan area by 31 May each year. The MDBA has received annual priorities from Queensland, New South Wales, Victoria and South Australia that list priorities at a regional scale. The MDBA had regard to these regional priorities as it finalised the Basin priorities.

The 2020–21 Basin state priorities generally complement the Basin annual priorities in this report. This is the result of consultation on the needs and opportunities for environmental watering within the framework provided by the Basin Plan and the Basin-wide environmental watering strategy.

The MDBA and Basin states have different but complementary roles in planning for environmental watering. The MDBA's Basin priorities have a Basin-wide focus. State priorities are more detailed to reflect local and regional interests. Many regional priorities will support and contribute to the expected environmental outcomes outlined in the Basin-wide environmental watering strategy.

First Nations environmental outcomes

First Nation peoples are the original custodians of the Murray−Darling Basin waterways and have lived in the region for approximately 65,000 years. The lands, waters, and biodiversity of the Murray−Darling Basin provide food sources and underpin trade and commerce for First Nations people. They are also fundamental to the spirituality, cultural customs, law and lore of Murray−Darling Basin First Nations, which they have practiced continuously over this period. First Nations people's health and wellbeing is intrinsically linked to, and their culture depends on, the health of Country. Today, approximately 75,000 First Nations people live in the Murray−Darling Basin region, representing approximately 12% of the entire Australian Aboriginal and Torres Strait Islander population.

First Nations people of the Murray–Darling Basin have obligations under their law and lore, and through cultural customs, to care for Country in the Basin. In modern Australia, their legal right to do so is underpinned by a combination of natural justice, international conventions to which Australia is party and under Australian common law, legislation and inter-governmental agreements.

In recognition of this right, and the vast experience and traditional ecological knowledge of First Nations people, the MDBA and CEWO partnered with NBAN and MLDRIN in 2019−20 under the First Nations Environmental Water Guidance (FNEWG) Project. This project provided an opportunity to share information, collaborate and integrate First Nations outcomes directly into current water management to improve the health of Country.

Independent, culturally authoritative and strategic input from First Nations people can improve environmental watering decisions. Environmental water can provide some complementary cultural

benefits, such as supporting the health of culturally significant species or providing opportunities for connecting with Country through ceremony and fulfilling some cultural responsibilities. Managing environmental water in ways that provide complementary outcomes encompassing First Nations people's objectives for healthier rivers and wetlands will improve wellbeing and cultural resilience. It also recognises that First Nation knowledge of Country can contribute to better water management and improved on-ground outcomes.

MLDRIN and NBAN developed their own guidance using different approaches to reflect the differences in climate, water management and cultural diversity in the northern and southern Basin. In recognition that First Nations cannot prioritise one species over another, NBAN identified indicator species that reflect the health of Country. MLDRIN identified shared priorities for waterways and places in need of environmental water, improved flows and connectivity, vegetation, waterbirds and fish, and threats to the cultural health of Country for environmental water planning in 2020–21.

This project provides an important opportunity to continue to strengthen direct engagement with First Nations, through NBAN and MLDRIN, to empower their participation in environmental water planning and delivery. This collaboration will further develop and integrate First Nations knowledge into annual and long-term planning (i.e. the next Basin watering strategy update). In the words of Fred Hooper (NBAN Chair):

> *"The 2020–21 watering year will, for the first time in history, see First Nations' environmental watering objectives acknowledged and incorporated into environmental water management at a federal level. This project exemplifies what it means to follow best practice in co-designing and partnering with First Nations in water planning and management."*

The knowledge collected by NBAN and MLDRIN relates to all 'resource availability scenarios' (see Appendix 1).

Northern Basin

For northern Basin First Nations, environmental watering outcomes describe tangible benefits experienced by First Nations people, which arise from healthy rivers and wetlands that sustain Country in a way that allows for populations of culturally significant species to thrive. The health of Country, including that of rivers and wetlands, is an integral part of First Nations peoples' identity and paramount in First Nations' law and lore, underpinning cultural obligations to ensure that longitudinal connectivity is maintained to the degree that neighbouring Nations downstream have water of a sufficient quantity and quality to meet their spiritual, cultural, environmental, social and economic needs. Achieving First Nations environmental watering outcomes is therefore unassailably necessary, to ensure First Nations peoples' health, wellbeing and cultural resilience.

Over 2019−20, NBAN worked with 16 First Nations to collect more than 10,000 environmental watering objectives at 111 sites across the northern Basin. The information presented below attempts to summarise and contextualise this wealth of information in relation to the northern Basin and across common themes, indicator species and significant sites.

River flows and connectivity

Longitudinal connectivity is part of First Nations' law and lore, at a river-scale and at a Basin-scale. First Nations have a cultural obligation to ensure that neighbouring Nations downstream have water of sufficient quantity and quality to meet their spiritual, cultural, environmental, social and economic needs. In this way, all Basin Nations are interconnected.

First Nations ask that wherever possible, environmental water should be used to connect rivers, nearby wetlands and anabranches to provide opportunities for First Nations people to connect with Country, and that low flows be delivered in years where these connections are not naturally occurring. Special attention should be given to providing opportunities to Nations to fulfil this cultural obligation to downstream Nations. In addition, where possible, environmental water should be used to maintain connectivity within and between river reaches that provide opportunities for connecting to Country.

Indicator species

A key difference between Traditional Environmental Knowledge and Western science is the holistic nature with which First Nations people view ecology, spirituality, and human and animal connection and relationships. For this reason, it is impossible for First Nations to prioritise one species over another when establishing their objectives across the watering priorities themes outlined in this document.

Instead, to identify river-scale priorities, NBAN worked with northern Basin First Nations to identify indicator species. These are species that are endemic to river stretches and if they were seen to be flourishing would provide an indication to First Nations people that the rivers were healthy. When cultural flow indicator species thrive, First Nations people know that Country is healthy, and they experience improved spiritual, cultural, environmental and social conditions as a result. Critically, some of the cultural flow indicator species listed below have not been seen in these river reaches for years.

Each indicator species identified in this document is significant to First Nations people. From the biggest kangaroo to the smallest ant, they are inextricably intertwined with the history and present-day lives of First Nations people. Water in the rivers means water for these species.

For the purposes of assisting modern day Murray–Darling Basin water planning, NBAN Delegates identified the following as indicator species.

Native vegetation

River red gum, Murray lily, cumbungi, lignum, nardoo, lomandra and bulrushes were identified as indicator species in the northern Basin. These species are gathered and used by First Nations throughout the northern Basin and are integral to First Nations people maintaining connection to Country. Where possible, environmental water should be used to support these culturally important species.

Native waterbirds

Native waterbirds such as the pelican, swan, ducks, brolga, bittern, Australian painted snipe, water hen, as well as other non 'waterbird' species such as crows and emu, were identified as indicator species in the northern Basin. As well as being a source of food, many First Nations people have strong connections to these species through stories, song lines, law, lore and ceremony. Where possible, environmental water should be used to support these culturally significant species.

Native fish

Murray cod, yellowbelly (golden perch) and catfish (all species) were identified as cultural indicator species of high cultural importance in the northern Basin. In the words of Aunty Lynette Nixon, Gunggari Nation:

> "*The yellowbelly is important to everybody – we used to be able to catch yellowbellies all the time, but now there are none in the Maranoa, or any of the smaller rivers. We haven't been able to catch them for years. In the past, people would know where to go. It would be lovely to be able to catch some now. Even now with the river running, we can't find any.*"

And in the words of Uncle Peter Harris, Ngiyampaa Nation:

Eel-tailed Catfish

"The eel-tailed catfish on Ngiyampaa Country, can only be found in Booberoi Creek. We grew up fishing and eating them. When we were young, we'd wade through the creek to find the catfish breeding sites, amongst the bulrush and river weed. The catfish(es) would thrash around and cut up our legs, trying to protect their nest and their eggs when we got too close. Once we found the nests, we would protect it, by making sure no one would go into that area of the creek. Later on, we would then put in a line further downstream, and fish for them when they have bred up. They were good tucker. We would protect the breeding of the catfish, so we can always have catfish to eat. With the drought, there's only a few little ones left, but they will come back when there is water." – Peter Harris, Ngiyampaa Nation

Figure 9. Happy times at Murrin Bridge when water was plenty and healthy (1950s).

Special attention should be given to support the recruitment and survival of these species in northern Basin catchments. In particular, catfish recruitment in the Moonie and the Lachlan (Booberoi Creek) catchments, and yellowbelly recruitment in the Warrego and Barwon−Darling catchments.

Important sites

Narran Lakes

Narran Lakes, or Dharriwaa as it is known to Euahlayi people, is of significant cultural importance. Providing environmental water to support breeding and recruitment of ducks, pelicans, herons, ibis and brolgas, and promoting the recruitment of native fish and the growth of submerged vegetation, lignum and river red gums will allow for Euahlayi, Murrawarri, Ngemba, Ngiyampaa and Wayilwan First Nations people to connect to Country, through hunting, meeting and ceremonial gatherings.

Macquarie Marshes

The Macquarie Marshes are a culturally significant site to the Wayilwan and other Nations in the northern Basin. It is a culturally significant site for fishing, hunting, gathering and ceremonies. Due to extended drought conditions there are fewer opportunities for First Nations people to connect to Country. Many culturally important species are declining such as the Australian painted-snipe, wood duck and black duck, river red gums and bulrushes, and Murray cod and yellowbelly. The Macquarie Marshes will benefit from environmental water to protect the extent and promote the recovery of these important species, so that First Nations people can continue practicing activities allowing them to connect to Country.

Southern Basin

In the southern Basin, First Nations environmental watering outcomes describe tangible benefits experienced by First Nations people from the delivery of environmental water on Country. These benefits can include healthy rivers and wetlands that sustain Country in a way that allows for populations of culturally significant species to thrive, improved cultural health of important places or enhanced health and wellbeing of First Nations people. The health of Country is integral to First Nations people's identity, law and lore. Achieving First Nations environmental watering outcomes is essential to ensuring First Nations people's health, wellbeing and cultural resilience.

MLDRIN worked with 16 Nations from across the southern Murray−Darling Basin to collect information about their priorities for environmental water management in 2020−21. Nation delegates, Elders, community members and water advisory committees responded to a questionnaire produced by MLDRIN, with detailed views about where and how water should be delivered to protect important places, significant species and other cultural values.

MLDRIN produced a MLDRIN Member Nations 2020−21 Priorities Report and provides an analysis of the Nations' input to identify areas of common concern and shared priorities. Representatives of 16 participating Nations developed and approved a Southern Basin First Nations Environmental Watering Priorities Statement for 2020−21 to encapsulate the key findings of the report. It is critical to note that, for First Nations in the southern Basin, all waterways, communities and plant and

animal species exist in an interconnected whole. While it is impossible to assign greater importance to one waterway or species, it is possible to identify common concerns and shared objectives.

Southern Basin First Nations Environmental Watering Priorities Statement 2020–21

Representatives of 16 First Nations across the southern Murray–Darling Basin have made information about their priorities for the use of environmental water in 2020–21 available, as part of the First Nations Environmental Water Guidance project.

Nations recognise that Basin Plan targets for environmental water recovery are inadequate to support revival of the ecological and cultural health of our waterways. More must be done to restore the balance.

*First Nations share common concern for **all** major rivers across the region. Notably, multiple Nations submitted priorities relating to the Murrumbidgee, Baaka (Darling River), Lachlan, Campaspe, Murray and Edward–Wakool systems. First Nations understand that declining river health and low flows in one part of the Basin can affect communities and cultural outcomes across the region.*

Nations want to see improvements in water quality and the volume and timing of flows in all major rivers, and particularly in degraded river systems. Improved seasonality of flows, informed by First Nations science and traditional knowledge, is a key to sustaining the cultural health of major waterways. Addressing barriers and constraints, such as barriers to fish movement, is essential to sustain the interconnectivity, which underpins our stories and cultural values. Improving the health of tributary waterways and ensuring adequate flow, is also a key to revitalising major rivers.

Participating Nations' contributions stressed the significance of wetlands, billabongs and floodplains. Nations want to see life return to these culturally significant places through watering activities that create connectivity between rivers and floodplains and restore the hydrological cycles of degraded wetlands, thereby supporting cultural values and resources.

Participating Nations identified key plant and animal species that are most in need of watering in the 2020–21 watering year. These species are all of totemic significance to diverse clans and Nations. Key culturally significant fish such as Murray cod, golden perch (yellowbelly) and catfish were identified as priorities by most Nations. More than half of all contributing Nations highlighted black swans, pelicans and duck species as culturally significant waterbirds that would benefit from environmental watering. Improved health and abundance of old man weed and other medicinal plants were noted as priorities for vegetation, alongside improved outcomes for river red gums, black box, cumbungi and lignum.

Critically, Nations stressed the importance of considering outcomes beyond fish, waterbirds and vegetation. Nations also want to see improved outcomes for aquatic fauna such as turtles, yabbies, mussels, frogs, platypus and rakali (water rat). The contributions also stressed the importance of environmental watering in sustaining healthy populations of important terrestrial fauna such as kangaroo and emu.

Participating Nations have identified a range of key threats to the cultural health of waterways as well as preferences for improved participation in environmental water planning for 2020–21. Water holders should consider these preferences alongside the detailed, locally specific watering objectives produced by Nations. It is essential that water holders continue, and strengthen, direct engagement with First Nations to empower our participation in environmental water planning and delivery.

Plants and animals

Where possible, environmental water should be used to improve the health and abundance of culturally significant plants and animals in the major rivers and adjacent wetlands, anabranches and billabongs. Only Traditional Owners with cultural authority to speak for individual waterways can determine priorities for how environmental water should be used to support specific plant and animal species. In the information submitted to the FNEWG project, multiple Nations identified some key species as priorities for water planning in 2020−21. These shared priorities offer valuable guidance for environmental water planning.

Native fish

A majority of participating Nations identified Murray cod, golden perch (yellowbelly) and catfish as significant species that should be considered as a priority for environmental water management in 2020−21. Other native fish including silver perch, black bream and Macquarie perch were identified as important priorities by multiple Nations.

Native vegetation

Plant and tree species identified as priorities for environment watering by multiple Nations included river red gum, old man weed, black box, cumbungi and lignum. Medicinal plants, as a general category, were identified as a priority by nine of the 16 participating Nations. In addition, key species including kangaroo grass, nardoo, black wattle, native tobacco and phragmites were identified by several Nations.

Waterbirds

More than half of all participating Nations identified pelicans, black swans and duck species as priority waterbird species. Other waterbird species including brolgas, bitterns, darters, shags and white-bellied sea eagle were identified as priorities by multiple Nations.

Aquatic fauna

Multiple Nations identified turtle species, frog species, platypus, freshwater mussels, rakali, macroinvertebrates and crustaceans such as yabbies, shrimp and Murray cray as key priorities for environmental water planning in 2020−21.

Flows and connectivity

Southern Basin Nations expressed priorities for improving river flows and connectivity in 2020−21. Most participating Nations identified priorities relating to:

- improving water quality – including ensuring healthy water, addressing algal blooms, and ensuring swimming and cultural uses can be sustained
- improving the timing and seasonality of flows – including addressing unseasonal flow regimes and incorporating First Nations knowledge and science into delivery planning

- removing barriers and constraints – including addressing the impacts of river regulation and allowing for movement of fish and aquatic fauna to support cultural values and traditional stories
- improving tributary flows – including limiting extractions and reducing pollution to support downstream river health and meet cultural obligations to neighbouring Nations.

Multiple Nations also highlighted priorities relating to restoring wetland hydrology, restoring flows in degraded rivers, improving flows and water quality in major rivers, and improving river and floodplain connectivity.

Technical summaries of the Basin environmental watering priorities

This section of the report describes the rolling, multi-year priorities for river flows and connectivity, native vegetation, waterbirds and native fish. It also includes annual guidance to achieve the priorities for these four themes in the forthcoming water year, having regard to what ecological assets most need watering.

River flows and connectivity

Condition of river flows and connectivity

Unprecedented hot and dry conditions affected parts of the Basin over the three years to mid-January 2020. Parts of the Basin experienced persistent drought, record low inflows, waterholes drying up and intense bushfires followed by ash-water events. These severe conditions were followed by rainfall in early 2020 that resulted in flooding of the major tributaries of the Barwon–Darling, including the Paroo, Warrego, Condamine–Balonne, Moonie, Border Rivers, Namoi, Gwydir and Macquarie–Castlereagh systems. Flows from these systems reached Menindee Lakes in March, with releases through to the lower Darling, joining the River Murray in late April. This was the first time in over two years there has been full connectivity of the Barwon–Darling River from Mungindi to the River Murray.

Flows also reached Narran Lakes supplementing a watering event undertaken by the CWEH. The last time Narran Lakes had experienced a significant watering was in 2013, and the last few years have seen no or very low flows.

Catchments in the southern Basin have also been affected by hotter and drier-than-average climate conditions although not as severe as in the north. Inflows for the River Murray system (excluding Snowy, Darling, intervalley transfers and environmental inflows) were about a third of the long-term average of 9,030 GL and within the driest 10% of years since 1891. This was the third consecutive year that annual inflows have generally been well below the long-term average. Similar to the northern Basin, these severe conditions were followed by above average rainfall over large parts of the southern Basin between mid-January and 7 May 2020—particularly during April and early May—that has seen a rise in streamflow for many catchments. Overall, and despite this modest improvement in inflows, public water storages in the southern Basin have declined two percentage points between 31 December 2019 and 1 May 2020, or down from 38% to 36% (5,789 GL) over the period.

Monitoring is showing that the environmental conditions at some key sites in the southern Basin, including Chowilla floodplain and the Coorong and Lower Lakes, are deteriorating. Environmental water holders are expected to have small carryover allocations to use in parts of the southern Basin in 2020–21.

Annual guidance

The MDBA provides the following guidance to achieve the priorities for river flows and connectivity in 2020–21. These should be used in conjunction with the rolling, multi-year priorities. Both the annual and multi-year priorities are produced in the following sections. Priorities may be site specific or apply more broadly across the Basin, as appropriate.

Protect drought refuges

Given the extreme conditions leading up to 2020, the current resource availability scenario for most catchments is 'dry'. Also, despite recent flows in many parts of the Basin, some areas have not received flows and refuges remain at risk. Under this scenario, the focus for flows and connectivity is to mitigate irreversible impacts associated with periods of extended drought.

Special attention should be given to providing water to critical drought refuges that have dried out or are drying out. Drought refuges are often sections of wetlands that may support vegetation or waterbirds, and in-channel river sections that support fish populations. The thematic sections below provide further information on identification of drought refuges. These may be detected through satellite imagery, on-ground monitoring or monitoring of gauge flows to infer cease-to-flow periods and persistence times being exceeded.

As far as practical, the timings of flows should follow the natural seasonal pattern.

Build ecosystem resilience by providing or enhancing connectivity

Environmental water managers should also aim to capitalise on the flows of early 2020 and forecast higher winter flows in the southern Basin by improving connectivity and building ecosystem resilience. Whenever possible, to focus on important environmental assets that provide habitat and sustain breeding events. For instance, to maintain habitat condition and sustain breeding events to completion at Narran Lakes for waterbirds, and Murray cod in the lower Darling River. In these instances, the priorities for enhancing connectivity will need to be informed by knowledge about the health of native vegetation, waterbirds and native fish, and behaviour specific to the environmental assets, for example, the seasonality of the flows.

Northern Basin

The focus should be on the coordinated delivery and/or protection of environmental water to provide replenishment flows, maintain baseflows and provide connectivity through the Barwon-Darling and into the lower Darling River and the River Murray, providing connection between the northern and southern Basin.

Southern Basin

The focus should be on the coordinated delivery of water to achieve multiple site watering with enhanced return flows at appropriate times of the year to the Coorong and the Lower Lakes, which are at particular risk if the drought continues. This would include transit of any environmental flows from the lower Darling River through the system and out the barrages to the Coorong and Murray Mouth. Flows to the Coorong should aim to maintain continuous flow and connection throughout the year at rates that meet Basin Plan targets at a minimum, to protect important estuarine processes and function.

Rolling, multi-year priorities for river flows and connectivity

The MDBA has included priorities for *lateral and longitudinal connectivity* and *end-of-Basin flows*. These priorities aim to return river flows to a more natural pattern (flow regimes) and re-establish connections along the river, and between the river and its floodplains and estuary (connectivity).

The rolling, multi-year priorities for river flows and connectivity are listed below.

Support lateral and longitudinal connectivity along the river system

The connection between rivers and their anabranches, wetlands and floodplains is referred to as *lateral connectivity*, which is associated with in-channel pulses, bankfull and overbank flow events. These events support a range of ecosystem functions including providing habitat, cycling nutrients and carbon, and providing a natural cue for feeding, breeding and movement – which underpin the food web for native vegetation, waterbirds and native fish.

The connection along a river and between a river and its tributaries is referred to as *longitudinal connectivity.* These flows are usually described in volumetric terms with objectives focused on maintaining enough flow volumes to sustain ecosystem functions that maintain water quality, support movement, import nutrients and export salt and pollutants. Achieving these objectives can be compromised if environmental watering events are re-regulated or not fully protected through the river system.

Environmental water managers and planners should, wherever possible, capitalise on the climatic opportunities to achieve the highest value outcomes possible. Table 2 sets out the rolling, multi-year priorities to support lateral and longitudinal connectivity along the river system.

Support freshwater connectivity through the Lower Lakes, Coorong and Murray Mouth

The Basin Plan provides for environmental water planning and delivery to achieve end-of-Basin outcomes, provide conditions to protect and restore the health of water-dependent ecosystems and ensure they are resilient by reinstating important parts of its natural flow regime.

Environmental water managers and planners should consider the interactions with priorities for native vegetation, waterbirds and native fish, as well as obligations to maintain the ecological character of this Ramsar wetland when working to achieve these end-of-Basin priorities. Focus should be on the coordinated delivery of water to achieve multiple site waterings with enhanced return flows at appropriate times of the year to the Coorong and the Lower Lakes. Table 3 sets out the rolling, multi-year priority framework for end-of-Basin flows.

Table 2 Rolling, multi-year priority framework for lateral and longitudinal connectivity

Rolling, multi-year priority	**Support lateral and longitudinal connectivity along the river system**				
Resource availability scenario	Very dry	Dry	Moderate	Wet	Very wet
Basin annual environmental watering priorities	Coordinate environmental watering across sites to increase longitudinal connectivity in connected catchments. Mitigate irreversible environmental impacts associated with extended drought. Prevent dry spell durations exceeding refuge tolerances.	Maintain natural cycles of wetting and drying. Where possible, maintain baseflow volumes at a minimum 60% of natural levels. Provide replenishment flows to maintain habitat condition and regulate water quality, carbon and nutrients. Use works infrastructure to connect floodplain-wetland ecosystems and manage associated risks.	Coordinate regulated releases with tributary flows (regulated and unregulated) to increase longitudinal connectivity in the Barwon–Darling and Murray rivers. Coordinate regulated releases with timing of tributary flow events to increase flow variability and the frequency of in-channel pulses and bankfull flow events. Extend the duration and magnitude of natural events to promote the movement of biota nutrients, sediments and salt.	Manage water in harmony with natural cues to maximise connectivity and flow variability to reinstate key elements of the flow regime. Provide flow regimes that allow opportunities for high ecological productivity. Supplement unregulated flow events to promote hydraulic diversity and facilitate natural geomorphic processes and groundwater replenishment.	Maximise ecological responses by adaptively managing the recession of high-flow events. Maximise the export of sediments, pollutants and salt. Mitigate water quality impacts associated with natural flood events.

Table 3 Rolling, multi-year priority framework for end-of-Basin flows

Rolling, multi-year priority	**Support freshwater connectivity through the Lower Lakes, Coorong and Murray Mouth**				
Resource availability scenario	Very dry	Dry	Moderate	Wet	Very wet
Basin annual environmental watering priorities	Where possible, mitigate adverse environmental impacts associated with extended dry and drought conditions through the following priorities. Assist the maintenance of Lower Lake levels above sea level (0.4m AHD). Support the maintenance of suitable estuarine conditions around the barrages by managing balance between lake levels and barrage outflows (supporting by additional freshwater inflows where possible). Manage water quality in the Lower Lakes with additional freshwater inflows, having regard to the Basin Plan salinity targets. Where possible, provide flows to Coorong to avoid water quality exceeding tolerances of listed or threatened species.	Manage the levels of the Lower Lakes to ensure discharge to the Coorong and Murray Mouth. Coordinate the management of environmental water with barrage operation to apportion environmental water between sites above and below the barrages. Improve water quality in the Lower Lakes with additional freshwater inflows, having regard to the Basin Plan salinity targets. Assist the maintenance of Lower Lake levels above 0.4m AHD. Manage estuarine conditions around the barrages and in the Coorong's North Lagoon. Facilitate migratory fish movement via barrage fishways.	Manage the levels of the Lower Lakes to ensure discharge to the Coorong and Murray Mouth. Coordinate the management of environmental water with barrage operation to increase the resilience of end- of-Basin ecosystems. Supplement barrage flow events to enhance salt export and maintain estuarine water quality in the Coorong's North Lagoon. Provide seasonal water level variability within the Lower Lakes, and cues for migratory fish movement via flows through the barrages.	Manage the levels of the Lower Lakes to ensure discharge to the Coorong and Murray Mouth. Supplement unregulated barrage flow events to export salt from the Murray–Darling Basin and scour sediments from the Murray Mouth. Assist the maintenance and variability of Lower Lake levels to maximise ecological productivity. Provide seasonal flow variability within the Lower Lakes, and cues for migratory fish movement via flows through the barrages. Where possible, coordinate additional barrage flows to provide a suitable salinity gradient between the North and South lagoons.	Manage the levels of the Lower Lakes to ensure discharge to the Coorong and Murray Mouth. Increase barrage flow volumes to maximise salt export and the scouring of sediment from the Murray Mouth and provision of cues for migratory fish movement. Harmonise barrage releases to provide conditions conducive to high ecological productivity in the Coorong.

Native vegetation

Condition of native vegetation

Record low rainfall across much of the Basin in 2019 has placed many of the Basin's vegetation communities under significant stress. Late summer rainfall in early 2020 provided much needed relief to many catchments, particularly in the northern Basin. However, coverage was patchy and while some areas have responded well to inundation, others remain in critical need.

Despite the dry conditions, targeted use of water for the environment in parts of the southern Basin has buffered the effects of drought at specific sites in high conservation value areas. This has provided patches of improved vegetation condition in the drying landscape, and vital refuge habitat for a range of woodland birds and other animals.

In the northern Basin where rainfall has been particularly low in recent years, management focus has shifted from building vegetation community resilience following natural flooding in 2016, to avoiding critical loss by preventing tree death and other irreversible change in rapidly drying wetlands.

Although recent rainfall has provided some relief to struggling floodplain and riparian vegetation communities, water storage and groundwater levels remain low. While these conditions persist, the priority focus for managing vegetation through the 2020–21 water year is likely to remain on maintaining a base condition to enable these communities to be restored once conditions improve. Where water availability permits, opportunities to build condition in woodland and shrubland communities, and promote flowering and seed set among grasses, herbs and forbs, will provide resilience to protect against the potential for ongoing dry conditions. This is particularly important in the areas and sites identified in the Basin-wide environmental watering strategy, see Tables 4 to 9 below as well.

Annual guidance

The MDBA provides the following guidance to achieve the priorities for native vegetation in 2020–21. The annual guidance acknowledges both site-based and Basin-wide priorities for native vegetation. Site-based priorities target specific species or communities of Basin significance, while Basin-wide priorities focus on the management of species or communities at multiple locations throughout the Basin. Basin-wide priorities should be interpreted and applied at the regional scale based on local conditions.

Maintain core wetland vegetation and refuges

As conditions improve across the Basin, perennial wetlands provide source populations for wetland ecosystems to expand and repopulate ephemeral areas. Ensure core wetland habitat refuges persist through dry periods so they can contribute to the recovery of larger wetland complexes and conservation of threatened species that rely of these wetlands, particularly in fire-affected areas of the Macquarie Marshes.

Avoid critical loss and (where possible) improve vegetation condition in areas where drought conditions persist

Opportunities to provide watering to areas in critical need such as in the Gwydir and Macquarie catchments that did not benefit from rainfall over summer/autumn 2020 should be prioritised to avoid critical loss. In addition, if possible, provide water to the Lower Darling Floodplain and Lower Gwydir for the important lignum communities.

Flows along the Edward-Wakool, Lower-Darling, Barwon–Darling, Gwydir and Lower–Balonne have been well below Sustainable Flow Indicator thresholds, so these areas should be prioritised if possible.

Support and build on watering events that have happened in previous years

Opportunities to build on condition gained from recent watering events to consolidate condition and recruitment outcomes will help to establish resilient vegetation communities over the short to medium term.

Provide follow-up watering to consolidate improvement in lignum communities at Narran Lakes

Watering of Narran Lakes in early 2020 provided much needed support for lignum communities and other high-value waterbird habitat that was in significant decline. Opportunities to provide follow-up watering to Narran Lakes will consolidate condition and resilience benefits from the watering in early 2020, particularly for lignum which requires watering over consecutive years to build condition after prolonged periods without inundation. First Nations Environmental Water Guidance also highlights the need for supporting lignum communities at Narran Lakes in the 2020-21 water year. Opportunities will rely on the occurrence of natural flow events.

Support growth of ruppia in the southern Coorong

While providing adequate inflows to the Coorong to support optimal conditions for ruppia (*Ruppia tuberosa*) in the south lagoon is unlikely in the 2020–21 water year, there are opportunities to support germination and growth in ruppia to help maintain the persistence of this valuable species. For example, actions aimed at managing salinities, particularly in the South Lagoon, will be important. Salinity in the Coorong lagoons in 2019–20 reached the highest levels seen for several years and watering should seek to maintain salinity below critical thresholds to prevent ecological damage and avoid irretrievable loss of key elements of the ecosystem such as ruppia.

Rolling, multi-year priorities for native vegetation

The native vegetation rolling, multi-year priorities focus on opportunities to improve the condition and extent of native vegetation. They address the expected environmental outcomes for native vegetation in the Basin-wide environmental watering strategy and are described below.

Allow opportunities for growth of non-woody wetland vegetation

This priority aims to allow for growth of specific non-woody wetland vegetation at the Gwydir wetlands, Macquarie Marshes and Great Cumbung Swamp. Table 4 sets out the rolling, multi-year priority framework for non-woody wetland vegetation.

Allow opportunities for growth of non-woody riparian vegetation

This priority aims to allow opportunities for growth of non-woody riparian vegetation that closely fringes or occurs within main river corridors. Table 5 sets out the rolling, multi-year priority framework for non-woody riparian vegetation.

Maintain the extent, improve the condition and promote recruitment of forests and woodlands

This priority aims to provide water to maintain healthy forest and woodland vegetation communities, with regular recruitment supporting sustainable river red gum, black box and coolibah populations into the future. Table 6 sets out the rolling, multi-year priorities to maintain the extent, improve the condition and promote recruitment of forests and woodlands.

Maintain the extent and improve the condition of lignum shrublands

The priority aims to provide periodic flooding for lignum shrublands to maintain their extent and improve condition by promoting their growth and supporting reproduction. Lignum shrublands experience a variety of inundation frequencies across the Basin which influences their size and condition. Table 7 sets out the rolling, multi-year priority framework for water-dependent lignum shrublands

Expand the extent and improve the condition of Moira grass in Barmah–Millewa Forest

This priority aims to expand the extent and improve the condition of Moira grass in Barmah–Millewa Forest, which has one of the largest inland plains of Moira grass in Australia.

Barmah and Millewa forests are recognised as internationally significant wetlands under the Ramsar Convention. Millewa Forest forms part of the NSW Central Murray Forests Ramsar site, while Barmah Forest is a separate Ramsar site. These forests also support migratory bird species listed under international agreements (JAMBA, CAMBA, ROKAMBA and the Bonn Convention on Migratory Species). Australia has committed to maintain the ecological character of the Ramsar sites. Moira grass is critical to maintaining the ecological character of Barmah Forest in particular.

In addition to ensuring an appropriate inundation frequency, securing a healthy and sustainable Moira grass population in the Barmah-Millewa Forest requires management of other threats such as impacts from feral animals, particularly horses, and the encroachment of invasive plants onto the floodplain marshlands. Table 8 sets out the rolling, multi-year priority framework for Moira grass in Barmah–Millewa Forest.

Expand the extent and improve resilience of ruppia in the southern Coorong

Ruppia *(Ruppia tuberosa),* a submerged aquatic plant that was once widespread along the length of the southern Coorong, is part of the ecological character of the Coorong, Lake Alexandrina and Lake Albert Ramsar site. Many species in the Coorong, such as black swans and migratory shorebirds, rely on the plant as a food resource. Ruppia also provides habitat for other species in the southern Coorong, such as small-mouthed hardyhead and aquatic invertebrates. Table 9 sets out the rolling, multi-year priority framework for ruppia in the southern Coorong.

Table 4 Rolling, multi-year priority framework for non-woody wetland vegetation

Rolling, multi-year priority	**Allow opportunities for growth of non-woody wetland vegetation**				
Resource availability scenario	Very dry	Dry	Moderate	Wet	Very wet
Basin annual environmental watering priorities	Where possible limit any loss or decline in the current extent and periods of growth for non-woody wetland vegetation. The necessity of this priority is more critical the longer the preceding dry spell.	Where possible limit any loss or decline in the current extent and periods of growth for non-woody wetland vegetation. The necessity of this priority is more critical the longer the preceding dry spell.	Maintain the current extent and periods of growth of non-woody wetland vegetation in line with optimal depth, duration and timing. Where possible provide opportunities for non-woody vegetation to create a seed bank in the soil. The necessity of this priority is more critical the longer the preceding dry spell.	Maintain the current extent and periods of increased growth of non-woody wetland vegetation in line with optimal, depth, duration and timing. Provide opportunities for non-woody vegetation to create a seed bank in the soil. The necessity of this priority is more critical the longer the preceding dry spell. If periods of growth occurred in the previous year, consolidate the growth of new and existing plants.	Maintain and improve (where possible) the current extent and periods of increased growth of non-woody wetland vegetation in line with optimal, depth, duration and timing. Ensure there are opportunities for non-woody vegetation to create a seed bank in the soil. The necessity of this priority is more critical the longer the preceding dry spell. If periods of growth occurred in the previous year, consolidate the growth of new and existing plants.
Basin significant sites	Non-woody wetland vegetation that form extensive stands within wetlands and low-lying floodplains – including Common reed and cumbungi in the Great Cumbung Swamp and Macquarie Marshes, water couch on the floodplains of the Macquarie and Gwydir rivers and marsh club-rush sedge lands in the Gwydir (MDBA BWS 2019).				

Table 5 Rolling, multi-year priority framework for non-woody riparian vegetation

Rolling, multi-year priority	**Allow opportunities for growth of non-woody riparian vegetation that closely fringes or occurs within main river corridors**				
Resource availability scenario	Very dry	Dry	Moderate	Wet	Very wet
Basin annual environmental watering priorities	Where possible limit any loss or decline in the current extent and periods of growth for non-woody riparian vegetation. The necessity of this priority is more critical the longer the preceding dry spell.	Where possible limit any loss or decline in the current extent and periods of growth for non-woody riparian vegetation. The necessity of this priority is more critical the longer the preceding dry spell.	Maintain the current extent and periods of growth of non-woody riparian vegetation in line with optimal depth, duration and timing. Where possible provide opportunities for non-woody vegetation to create a seed bank in the soil. The necessity of this priority is more critical the longer the preceding dry spell.	Maintain the current extent and periods of increased growth of non-woody riparian vegetation in line with optimal, depth, duration and timing. Where possible provide opportunities for non-woody vegetation to create a seed bank in the soil. The necessity of this priority is more critical the longer the preceding dry spell. If periods of growth occurred in the previous year, consolidate the growth of new and existing plants.	Maintain and improve (where possible) the current extent and periods of increased growth of non-woody riparian vegetation in line with optimal, depth, duration and timing. Where possible provide opportunities for non-woody vegetation to create a seed bank in the soil. The necessity of this priority is more critical the longer the preceding dry spell. If periods of growth occurred in the previous year, consolidate the growth of new and existing plants.

Rolling, multi-year priority	Allow opportunities for growth of non-woody riparian vegetation that closely fringes or occurs within main river corridors				
Resource availability scenario	Very dry	Dry	Moderate	Wet	Very wet
Basin significant sites	The MDBA may identify locations and regions based on monitoring, state annual environmental watering priorities, state long-term watering plans, vegetation monitoring outcomes and the Basin-wide environmental watering strategy, to name a few. Areas of non-woody vegetation that closely fringes main river corridors or occur within the main river corridors include (MDBA BWS 2019): Paroo River, Warrego – Warrego, Langlo, Ward and Nive Rivers, Nebine – Nebine Creek, Condamine-Balonne – Condamine, Balonne, Birrie, Bokhara, Culgoa, Maranoa, Merivale and Narran Rivers, Moonie – Moonie River, Border Rivers – Barwon, Dumaresq, Macintyre rivers and Macintyre Brook, Gwydir – Gwydir River, Namoi – Namoi River, Macquarie-Castlereagh – Bogan, Castlereagh, Macquarie and Talbragar rivers, Barwon-Darling – Darling River, Lachlan – Lachlan River and Willandra Creek, Murrumbidgee – Murrumbidgee River, Billabong and Yanco creeks, Lower Darling – Darling River, Great Darling Anabranch and Talywalka Anabranch, Ovens – Ovens River, Goulburn-Broken – Broken Creek and Broken and Goulburn rivers, Campaspe – Campaspe River, Loddon – Loddon River, Murray – Murray, Edward, Kiewa, Mitta Mitta, Niemur and Wakool rivers and Tuppal Creek, Wimmera-Avoca – Avoca, Avon, Richardson and Wimmera rivers.				

Table 6 Rolling, multi-year priority framework for water-dependent forests and woodlands

Rolling, multi-year priority	**Maintain the extent, improve the condition and promote recruitment of forests and woodlands**				
Resource availability scenario	Very dry	Dry	Moderate	Wet	Very wet
Basin annual environmental watering priorities	Identify critical river red gum, black box and coolibah communities to maintain condition or where saplings require water to survive. Where possible, manage or deliver water to these areas. This priority is dependent on the target species and is more critical the longer the preceding dry spell.	Identify important river red gum, black box and coolibah communities to maintain condition or where saplings require water to survive. Where possible, manage or deliver water to these areas. This priority is dependent on the target species and the condition of new recruits and is more critical the longer the preceding dry spell.	Promote growth and improve condition of desirable river red gum, black box or coolibah recruitment, where possible, to ensure their survival. Target low-lying river red gum, black box and coolibah communities adjacent to rivers where water can be delivered to promote growth and improve condition.	Inundate in line with optimal duration, timing and depth to support desirable recruitment and improve condition of river red gum, black box and coolibah communities.	Support inundation in line with optimal duration, timing and depth, as required, to promote desirable recruitment and improve condition of river red gum, black box and coolibah communities.
Basin significant sites	The MDBA may identify locations/regions based on state annual environmental watering priorities, state long-term environmental watering plans, vegetation monitoring outcomes, Basin-wide environmental watering strategy, to name a few.				

Table 7 Rolling, multi-year priority framework for water-dependent lignum shrublands

Rolling, multi-year priority	**Maintain the extent and improve the condition of lignum shrublands**				
Resource availability scenario	Very dry	Dry	Moderate	Wet	Very wet
Basin annual environmental watering priorities	Where possible, limit any loss or decline in condition of lignum shrublands. This priority is more critical the longer the preceding dry spell. Where lignum shrublands have been inundated in recent years, they are likely to be in a reasonable condition to withstand a dry period.	Where possible, limit any loss or decline in condition of lignum shrublands. This priority is more critical the longer the preceding dry spell. Where lignum shrublands have been inundated in recent years, they are likely to be in a reasonable condition to withstand a dry period.	Maintain the condition of lignum shrublands by providing inundation in line with the optimal duration, timing and depth. The necessity of this priority is more critical the longer the preceding dry spell. Where lignum shrublands have been inundated in previous years, they are likely to be in a reasonable condition to withstand a dry period.	Improve the condition of lignum shrublands by providing inundation in line with the optimal duration, timing and depth. Where lignum shrublands have been inundated in previous years, they are likely to be in a reasonable condition to withstand a dry period. The necessity of this priority is more critical the longer the preceding dry spell.	Improve the condition of lignum shrublands by providing inundation in line with the optimal duration, timing and depth. Where lignum shrublands have been inundated in previous years, they are likely to be in a reasonable condition to withstand a dry period. The necessity of this priority is more critical the longer the preceding dry spell.
Basin significant sites	Environmental water managers and planners should prioritise lignum shrublands located within the regions listed in the Basin-wide environmental watering strategy, which are: the Lower Lachlan; Lower Murrumbidgee; Lower Darling; Lower Condamine–Balonne (including Narran Lakes); Lower Gwydir; Macquarie Marshes; lower Border Rivers; and the River Murray from the junction of Wakool River to downstream of Lock 3 (including Chowilla and Hattah Lakes). The MDBA may identify locations/regions based on state annual environmental watering priorities, state long-term environmental watering plans, vegetation monitoring outcomes and the Basin-wide environmental watering strategy, to name a few.				

Table 8 Rolling, multi-year priority framework for Moira grass in Barmah–Millewa Forest

Rolling, multi-year priority	**Expand the extent and improve the condition of Moira grass in Barmah–Millewa Forest**				
Resource availability scenario	Very dry	Dry	Moderate	Wet	Very wet
Basin annual environmental watering priorities	Where possible, limit any loss of Moira grass extent through the operation of forest regulators. The necessity of this action will become more critical the longer the preceding dry spell.	Maintain the condition and extent of Moira grass through the operation of forest regulators. Where possible, aim to improve condition of Moira grass. This action will be more likely in a Dry resource availability scenario (RAS) following Moderate to Very Wet RAS years.	Improve the condition and maintain the extent of Moira grass by providing an opportunity for growth of existing plants. Where possible, aim to increase Moira grass extent by optimising the duration and depth of inundation.	Improve the condition and extent of Moira grass by providing inundation in line with optimal duration and timing. If a flowering event occurred in the previous water year, promote seed germination if/where possible. If seed germination occurred in the previous water year, support the consolidation of growth of new plants.	Improve the condition and extent of Moira grass by providing inundation in line with optimal duration and timing. If a flowering event occurred in the previous water year, promote seed germination if/where possible. If seed germination occurred in the previous water year, support the consolidation of growth of new plants.

Table 9 Rolling, multi-year priority framework for ruppia in the southern Coorong

Rolling, multi-year priority	**Expand the extent and improve resilience of ruppia in the southern Coorong**				
Resource availability scenario	Very dry	Dry	Moderate	Wet	Very wet
Basin annual environmental watering priorities	Where possible, limit loss of ruppia extent through the delivery of freshwater through barrages. Where possible, improve water quality to maintain ruppia habitat conditions and mitigate risks to population health. The necessity of this action will become more critical the longer the preceding dry spell.	Maintain the extent of ruppia through the delivery of freshwater through barrages. Where possible, improve water quality to maintain ruppia habitat conditions and mitigate risks to population health. The necessity of this action will become more critical the longer the flows across the barrages are at lower volumes.	Maintain the extent of ruppia by providing opportunities for growth and support the completion of the plant's life cycle. Where possible, promote ruppia sexual and asexual reproduction by providing inundation in line with optimal duration, timing and depth of flooding. Where possible, improve habitat conditions and salinity gradient in the Coorong to maintain ruppia condition and mitigate risks to population health. This includes considering options to manage the flow regime within the end-of-Basin system to reduce the chance of filamentous	Improve the extent and support the reproduction of ruppia by providing inundation in line with optimal duration, timing and depth of flooding. This includes: Increasing inundation of mudflats over early spring. Reaching peak inundation over late spring/early summer months. Easing drawdown of Coorong water level during mid-late summer. Where possible, operate barrages to enhance optimal ruppia inundation, including slowing the rate at which water levels drop over late spring and early summer. Improve habitat conditions and salinity gradient in the	Improve the extent and support the reproduction of ruppia by providing inundation in line with optimal duration, timing and depth of flooding. Where possible, operate barrages to enhance optimal ruppia inundation, including slowing the rate at which water levels drop over late spring and early summer. Where possible, improve habitat conditions and salinity gradient in the Coorong to maintain ruppia condition and mitigate risks to population health. This includes considering options to manage the flow regime within the end-of-Basin system to reduce the chance of filamentous

Rolling, multi-year priority	Expand the extent and improve resilience of ruppia in the southern Coorong				
Resource availability scenario	Very dry	Dry	Moderate	Wet	Very wet
			algae outbreaks in the southern Coorong.	Coorong to maintain ruppia condition and mitigate risks to population health. This includes considering options to manage the flow regime within the end-of-Basin system to reduce the chance of filamentous algae outbreaks in the southern Coorong.	algae outbreaks in the southern Coorong.

Waterbirds

Condition of waterbirds

Since the Basin Plan commenced, species richness (number of waterbird species) has remained steady. However, abundance (waterbird numbers) has remained very low and breeding has been infrequent. It is important to note that survival of juveniles and recruitment into adults is just as important as breeding, with recent research suggesting juvenile survival is low. While these findings on waterbird abundance are consistent with the prevailing climate, they are sobering in the context of expected environmental outcomes in the Basin-wide environmental watering strategy, which anticipate increased breeding and abundance from 2024.

Restoring waterbird populations in the Murray–Darling Basin must be prioritised, and this should guide where and when water for the environment will be delivered.

Waterbirds depend on wetlands and floodplains to feed, grow and breed – and shelter from predators. Waterbirds are highly mobile and can move from catchment to catchment in search of suitable conditions, however water for the environment is needed to maximise the availability of productive foraging habitat, improve habitat quality and support breeding.

Shorebird numbers fluctuate from year to year. These species rely on multiple international 'staging' sites during their annual migration and are highly specialised foragers, requiring exposed tidal flats for feeding opportunities. Observed long-term declines in these species' abundance could be a result of river regulation locally but could also be due to degradation at these international 'staging' sites.

The priorities for waterbirds are outlined below in two forms: annual guidance and rolling, multi-year priorities. The annual guidance reflects the current resource availability scenario, is place-based and is more specific about the watering action required. The rolling, multi-year priorities cover all resource availability scenarios, are Basin-wide and identify a range of Basin–significant sites where different watering actions can be undertaken. Both types of priorities constitute annual steps towards the expected environmental outcomes in the Basin-wide environmental watering strategy.

Annual guidance

The MDBA provides the following guidance to achieve the priorities for waterbirds in 2020–21.

There are 33 Basin significant sites for waterbirds, many of which can be managed with environmental water. While sites listed below need watering, supply of environmental water is by no means guaranteed. The annual guidance acknowledges both place-based and Basin-wide priorities for waterbirds. Information obtained about specific sites significant to waterbird success guides the setting of priorities, however, it is recognised that waterbirds are opportunistic and require a Basin-wide approach to ensure populations are supported.

Provide follow-up watering to build resilience in the Narran Lakes system or to support waterbird breeding and recruitment

Narran Lakes is a Ramsar-listed wetland and is an internationally significant waterbird site. The site contains a diversity of habitats, including some of the largest expanses of lignum in NSW, as well as riparian forest and woodlands, which provide critical habitat for large colonial waterbird breeding events. Nine colonial species breed at the site, with the site being particularly important for straw-necked ibis, Australian pelican, Australian white ibis, glossy ibis, and royal spoonbill. Narran Lake Nature Reserve supports 40 migratory bird species, including 19 species listed under international agreements. It is a particularly valuable site for plants and waterbirds at critical stages of their life cycles. The lakes support large colonial waterbird breeding events. Situated in the northern Basin, this site is subject to natural events to trigger waterbird breeding outcomes.

A recent watering event has taken place with the CEWH, following on from natural inundation in early autumn. The lakes may benefit from a follow-up watering to build resilience in the system or support waterbird breeding and recruitment. Early observations have shown that while there was a good response in attracting some 30 species of waterbirds, the timing of the flow did not result in a breeding event. Response from insects and frogs were lower than expected and may be a sign that the system will take longer to recover from the long-term drought, as the last significant flow into the lakes occurred in 2012. Due to the drought, the vegetation that waterbirds rely on to survive is dying and slow to respond to flows. Additional flows are vital to support the breeding and foraging habitat (building lignum resilience) for waterbirds, to ensure waterbird outcomes are supported.

Provide water to the Macquarie Marshes to support waterbird habitat

The Macquarie Marshes is a Basin priority for watering given the extended drought conditions, fire damage to the reed beds, commitments under the Ramsar Convention and no delivery of environmental water in winter-spring 2019. The Macquarie Marshes is critically important for supporting waterbird populations in the Basin, as it provides important breeding and foraging habitat for a range of waterbirds, and as a result often has high abundance and large-scale breeding. Some waterbird scientists believe that regional habitat availability influences waterbird survival and that coordinated watering of multiple wetland complexes achieves better outcomes. With the Narran Lakes having received significant inflows from March and continuing at time of publication, watering of the Macquarie Marshes next water year is important in a regional context for providing additional habitat for waterbirds for foraging in spring 2020. Annual aerial and ground surveys have shown that the Macquarie Marshes can support a wide diversity of waterbird species following the delivery of managed flows, including the nationally endangered Australian painted snipe and Australasian bittern, and shorebird species listed under international migratory bird agreements.

The Macquarie Marshes, Gwydir and the Narran Lakes are all wetlands of international importance and are explicitly linked systems in terms of achieving waterbird outcomes in the northern Basin. There is a high co-occurrence of breeding events at Macquarie Marshes and Narran Lakes due to their proximity and the fact that they often get inflows at the same time. Regional habitat availability influences waterbird survival and coordinating water delivery between these three complexes may achieve better outcomes for waterbirds. Macquarie Marshes will have added importance for providing foraging habitats for juvenile colonial waterbirds in 2020–21 if there is any breeding activity in the Narran Lakes from the autumn 2020 event. Additional foraging habitat in the

Macquarie Marshes will ensure there are resources to support waterbird breeding from the Narran Lakes inflows and that the breeding event is supported through to recruitment. The management of these important waterbird sites provides an example of how environmental water managers and water holders are recognising the significance of connectivity for waterbirds at a Basin scale.

Support productive shorebird habitat and foraging resource availability in the Coorong, Lower Lakes and Murray Mouth

The Coorong and Lower Lakes is one of Australia's most important sites for migratory shorebirds and resident waterbirds, and in recent years has supported the greatest waterbird species richness of the Murray–Darling Basin. This site has been the top site for waterbird abundance, species richness and breeding (as measured by the MDBA's significant environmental assets survey) since the Basin Plan commenced and the MDBA expects it will continue to be a vital location for waterbirds in 2020–21.

The four key migratory shorebird species in the Coorong and Lower Lakes are curlew sandpiper, greenshank, red-necked stint and sharp-tailed sandpiper. While the long-term average for abundance (2000 to 2019) of the four key species has been largely maintained at levels seen between 2000 and 2014, analysis has showed that abundance of species which are highly dependent on the important tidal mudflats of the Coorong (such as the curlew sandpiper and the common greenshank) has been declining since 2014.

Monitoring since 2018 is showing an increase in the abundance of the sharp-tailed sandpiper and continued increase in the abundance of the red-necked stint.

Given the current dry resource availability scenario, actions should continue to focus on supporting the productive shorebird habitat and foraging resource availability. Declines in inflows from the River Murray can impact the maintenance of appropriate water levels on the extensive mudflats, so management actions should aim to actively manage water quality and salinity levels and avoid algal bloom events. With an emphasis on the importance of continuous freshwater releases from the barrages to provide nutrients/phytoplankton to support the benthic invertebrate community in Coorong mudflats. Global declines in these migratory species have also been observed over this period, making it difficult to separate the extent to which the decline in numbers at the Coorong was due to environmental conditions in the Coorong relative to factors operating along their migratory flyways.

Rolling, multi-year priorities for waterbirds

The rolling, multi-year priorities for waterbirds address the expected environmental outcomes for waterbirds in the Basin-wide environmental watering strategy. The annual guidance comprises climate appropriate actions, as guided by the resource availability scenario, and monitoring data to move waterbirds outcomes towards those listed in the Basin-wide environmental watering strategy.

Maintain the diversity and improve the abundance of the Basin's waterbird population

Environmental water managers should have regard to the annual priorities at Basin-significant sites identified in the table below. Since it is difficult to predict where waterbirds will accumulate each year, how the priorities are implemented at each site will depend on the condition of habitat as well as how

waterbirds respond to conditions. For example, if breeding occurs naturally, then managers should deliver water to support it. Table 10 sets out the rolling, multi-year priority framework for waterbirds.

Maintain the abundance of key shorebird species in the Lower Lakes and Coorong

This rolling, multi-year priority aims to address the expected environmental outcome for migratory shorebirds in the Basin-wide environmental watering strategy as follows:

Maintain populations of the following four key species: curlew sandpiper, greenshank, red-necked stint and sharp-tailed sandpiper, at levels recorded between 2000 and 2014.

Migratory shorebird abundance is highly dependent on the availability of productive habitat and appropriate water levels. This priority is supported by planning and management actions that:

- provide functional mudflat habitat to sustain shorebird foraging during November–March each year
- create water levels that are suitable for a variety of shorebird species, with most shorebirds preferring to forage at or near shorelines where mudflats are covered with only a few centimetres of water.

Table 11 sets out the rolling, multi-year priority framework for key shorebird species in the Lower Lakes and Coorong.

Table 10 Rolling, multi-year priority framework for waterbirds

Rolling, multi-year priority	**Maintain the diversity and improve the abundance of the Basin's waterbird population** N.B: Consider how selected Basin sites contribute to abundance and maintain the diversity of the Basin's waterbird population as an aggregate.				
Resource availability scenario	Very dry	Dry	Moderate	Wet	Very wet
Basin annual environmental watering priorities	Avoid loss of foraging and roosting habitat at refuge locations. Allow for appropriate drying periods in temporary wetlands to enhance productivity and breeding success in future years.	Maintain foraging and roosting habitat at refuges, as these maintain species richness and abundance in dry years. Support breeding where naturally triggered. Allow for appropriate drying periods in temporary wetlands to enhance productivity and breeding success in future years.	Create mosaic of wetland habitats suitable for functional feeding groups, since a diversity of habitats, including mud flats, inundated vegetation and deeper water, will result in abundant and diverse wetlands. Maintain waterbird breeding habitat in 'event ready' condition by providing environmental water to maintain the distribution, structure and health of native riparian, floodplain and wetland vegetation. Respond to natural biological processes to support small breeding events from nest building through to post-fledging care either by extending the duration of flooding or creating artificial	Create mosaic of wetland habitats suitable for functional feeding groups, since a diversity of habitats, including mud flats, inundated vegetation and deeper water, will result in abundant and diverse wetlands. Support large breeding events from nest building to post-fledging care by extending the duration of flooding and maintaining adequate and stable water depths in colony sites (90-120 days for most species). Ensure a slow draw down of water levels following a breeding event, to limit nest abandonment, avoid incursion by pests such as foxes and pigs and allow more foraging	Support large breeding events from nest building to post-fledging care by extending the duration of flooding and maintaining adequate and stable water depths in colony sites (90-120 days for most species). Ensure a slow draw down of water levels following a breeding event, to limit nest abandonment, avoid incursion by pests such as foxes and pigs and allow more foraging opportunities after eggs have hatched. Extend breeding site inundation until juvenile survival is apparent. Provide environmental water in the year following large breeding events to support the survival of juveniles.

Rolling, multi-year priority	**Maintain the diversity and improve the abundance of the Basin's waterbird population** N.B: Consider how selected Basin sites contribute to abundance and maintain the diversity of the Basin's waterbird population as an aggregate.				
Resource availability scenario	Very dry	Dry	Moderate	Wet	Very wet
			inundation to maintain adequate and stable water depths in colony sites (90-120 days for most species). Ensure a slow draw down of water levels following a breeding event, to limit nest abandonment, avoid incursion by pests such as foxes and pigs and allow more foraging opportunities after eggs have hatched. Extend breeding site inundation until juvenile survival is apparent. Manage over-wintering sites and nearby foraging habitats to support survival of juveniles and sub-adults.	opportunities after eggs have hatched. Extend breeding site inundation until juvenile survival is apparent. Provide environmental water in the year following large breeding events to support the survival of juveniles. Manage over-wintering sites and nearby foraging habitats to support survival of juveniles and sub-adults.	Manage over-wintering sites and nearby foraging habitats to support survival of juveniles and sub-adults.

Rolling, multi-year priority	**Maintain the diversity and improve the abundance of the Basin's waterbird population** N.B: Consider how selected Basin sites contribute to abundance and maintain the diversity of the Basin's waterbird population as an aggregate.				
Resource availability scenario	Very dry	Dry	Moderate	Wet	Very wet
Basin significant sites *Denotes Basin significant waterbird sites that can be managed for environmental outcomes which are also classified as Ramsar sites.	Corop wetlands Fivebough Swamp* Lowbidgee Floodplain Pyap Lagoon River Murray & Euston Lakes Upper Darling River Lower Lakes, Coorong and Murray Mouth Core marsh areas can also act as drought refuges.	Barmah-Millewa* Booligal wetlands Lower Lakes, Coorong & Murray Mouth* Corop wetlands (refuge) Fivebough Swamp* (refuge) Great Cumbung Swamp Gunbower-Koondrook–Perricoota* Gwydir wetlands* Hattah Lakes* Kerang wetlands* Lake Brewster Lowbidgee Floodplain (refuge) Macquarie Marshes* Narran Lakes* Pyap Lagoon (refuge) River Murray & Euston Lakes (refuge) Upper Darling River (refuge)	Barmah-Millewa* Booligal wetlands Lower Lakes, Coorong & Murray Mouth* Corop wetlands Great Cumbung Swamp Gunbower–-Koondrook–Perricoota* Gwydir wetlands* Hattah Lakes* Kerang wetlands* Lake Brewster Lowbidgee Floodplain Macquarie Marshes* Narran Lakes* Pyap Lagoon	Barmah-Millewa* Booligal wetlands Lower Lakes, Coorong & Murray Mouth* Corop wetlands Darling Anabranch Fivebough Swamp* Great Cumbung Swamp Gunbower–Koondrook–Perricoota* Gwydir wetlands* Hattah Lakes* Kerang wetlands* Lake Brewster Lake Buloke Lindsay–Walpolla–Chowilla* Lowbidgee Floodplain Macquarie Marshes* Narran Lakes* Pyap Lagoon River Murray & Euston Lakes	Barmah-Millewa* Booligal wetlands Lower Lakes, Coorong & Murray Mouth* Corop wetlands Darling Anabranch Fivebough Swamp* Great Cumbung Swamp Gunbower–Koondrook–Perricoota* Gwydir wetlands* Hattah Lakes* Kerang wetlands* Lake Brewster Lake Buloke Lindsay–Walpolla–Chowilla* Lowbidgee Floodplain Macquarie Marshes* Narran Lakes* Pyap Lagoon River Murray & Euston Lakes

Table 11 Rolling, multi-year priority framework for key shorebird species in the Lower Lakes and Coorong

Rolling, multi-year priority	**Maintain the abundance of key shorebird species in the Lower Lakes and Coorong**				
Resource availability scenario	Very dry	Dry	Moderate	Wet	Very wet
Basin annual environmental watering priorities	Avoid loss of foraging and roosting habitat at key refuge locations. Where possible manage algal blooms and water quality at key foraging sites.	Maintain foraging and roosting habitat at refuge locations. Support breeding of resident shorebirds and waterbird species where naturally triggered (i.e. maintain isolation from predators). Manage algal blooms and water quality at key foraging sites.	Build productivity of foraging habitat for summer. Support breeding of resident shorebirds and waterbird species where naturally triggered (i.e. maintain isolation from predators). Manage algal blooms and water quality at key foraging sites. Provide functional mudflat habitat to sustain shorebird foraging during November-March each year. Create water levels that are suitable for a variety of shorebird and waterbird species, with most shorebirds preferring to forage at or near shorelines where mudflats are covered with only a few centimetres of water.	Build productivity of foraging habitat for summer. Actively maximise shorebird access to foraging habitat during summer. Support breeding of resident shorebirds and waterbird species where naturally triggered (i.e. maintain isolation from predators). Create mosaic of wetland habitats suitable for shorebirds and waterbirds. Create water levels that are suitable for a variety of shorebird species, with most shorebirds preferring to forage at or near shorelines where mudflats are covered with only a few centimetres of water.	Where possible actively maximise shorebird access to foraging habitat during summer. Provide functional mudflat habitat to sustain shorebird foraging during November to March each year. Support breeding of resident shorebirds and waterbird species where naturally triggered (i.e. maintain isolation from predators). Create a mosaic of wetland habitats suitable for shorebirds and waterbirds. Create water levels that are suitable for a variety of shorebird species, with most shorebirds preferring to forage at or near shorelines where mudflats are covered with only a few centimetres of water.

Native fish

Condition of native fish

The long-term decline of native fish since European settlement has, in the past two years, been punctuated by numerous fish death events. These recent fish death events are believed to have had major impacts on native fish populations. Recent fish death events, combined with mass fish deaths due to blackwater in 2016 (southern Basin) and unprecedented drying of refuge habitats in the northern Basin, have led experts to declare that native fish populations are poorer than in 2003 when an assessment for the Native Fish Strategy found that native fish were at 10% of pre-European levels.

Up until early 2020, drought refuge waterholes on major rivers in northern Basin catchments had been reported as dry, or with water quality so poor that native fish were unlikely to survive. Across the Basin, many emergency actions, including installing aerators and undertaking fish rescues, have occurred to protect species from the impacts of drought and bushfires. Threatened species rescues have allowed the captive maintenance of these critical populations. Currently, conditions have sufficiently improved only for a few reintroductions to have occurred. The remaining captive populations are waiting to be returned to the wild as soon as conditions allow.

Native fish populations are expected to rebuild from their current state when conditions improve. In previous years, water for the environment has enhanced survival and spawning, facilitated movement, maintained critical habitats and increased food availability for native fish. Outcomes can be achieved using consumptive and operational water as well as environmental water. Due to the finite water resource, the coordination of all water within and between catchments is of increasing importance to support native fish populations that operate across large areas.

Many native fish species' life cycle requirements are opportunistically met across a variety of sites in the Basin each year. As conditions change between years, these same requirements may be met at different sites and in different regions. As such, native fish priorities focus on the functions that support native fish life cycle requirements at the Basin scale.

Annual guidance

The MDBA provides the following guidance to achieve the priorities for native fish in 2020–21. The annual guidance and the multi-year priorities generally target specific species (or groups of species) and/or flow regimes at catchment and system scales to support the various life cycle requirements of native fish.

The multi-year priorities provide overarching guidance on the species that need attention and the connectivity and flow coordination required to help achieve the outcomes described in the Basin-wide environmental watering strategy.

Protect or provide flows that protect existing populations, support connectivity and sustain short-lived species recruitment

In catchments across the Basin where the resource availability scenario is 'dry' or 'very dry', cease-to-flow periods are continuing or may return. Prolonged cease-to-flow conditions can have major impacts

on native fish communities. Protecting or providing flows that improve connectivity and reduce cease-to-flow periods will be of importance in:

- northern Basin catchments
- the lower Darling River
- the Lachlan River
- refuges and reintroduction sites for threatened species

The priority for water managers is to maintain water quality and persistence of refuge waterholes. This is best achieved by maintaining base flows where possible. In systems where cease-to-flow conditions continue, or return during 2020−21, protecting resumption of flow events to maintain the maximum number of refuges possible will help to protect existing populations, support connectivity and sustain short-lived species' recruitment. Supporting existing populations in 'very dry' and 'dry' resource availability scenarios is identified in the multi-year priorities for the southern Basin, northern Basin and for threatened species (see below).

Support recruitment from breeding events and subsequent dispersal of new recruits in the northern Basin

Recent natural flow events in some northern Basin tributaries and the Barwon–Darling system have likely triggered breeding of several native fish species. Flow management in the coming water year should also look to support recruitment from these breeding events and subsequent dispersal of new recruits, specifically:

- deliver follow-up flows that provide connectivity between the Warrego and the Barwon–Darling rivers to sustain and disperse new recruits, particularly golden perch, present in the lower Warrego
- actively manage flows likely to create connections between the Barwon−Darling and its intersecting tributaries to ensure connectivity between systems is achieved.

If conditions result in another flow event throughout the length of the Barwon–Darling and golden perch recruit into nursery habitat, such as the lower Darling and Menindee Lakes system, dispersal of young fish from this region into both the southern connected Basin and northern Basin could occur. Again, flows that create connections between systems should be actively managed and protected to capitalise on these system-scale recruitment events, as identified in the multi-year priority for the northern Basin under all resource availability scenarios (see below), as these events occur only once or twice each decade.

Maintain existing populations and ensure hydrological integrity of flows in the southern Basin rivers

In the southern Basin, the highest priority for water managers is to maintain existing populations. To further support populations and improve chances of recruitment in regulated systems, maintaining the hydrological integrity (timing, magnitude and duration) and effectiveness of flows throughout river systems, including transmission through the River Murray to the barrage fishways and Coorong, will:

- provide connectivity within and between systems, and between key habitats
- support recruitment of species, and locations affected by fish death events
- provide end-of-system flows that support diadromous movements.

Flows that protect refuges, maintain river connectivity, increase the nutrient and organic matter supply and support population recovery of native fish in the lower Darling River should also be prioritised.

To ensure hydrological integrity for native fish, particularly those that respond to flows such as golden perch and silver perch, the latest scientific thinking prioritises restoration of landscape−scale flow events. That is, flows moving uninhibited through hundreds of kilometres of river channels, often between catchments. These flow events have largely been lost from the main stem of major rivers in the southern Basin. Regulating structures such as weirs, and large storages where flows are 'taken out' of the main channel and stored for later re-regulation (such as Lake Victoria in the River Murray system), have major impacts on flow integrity and the downstream dispersal and upstream migration of flow-responsive species.

Protecting the integrity of flows during the spawning season in southern Basin rivers is identified as important across all resource availability scenarios in the multi-year priority for the southern Basin (see below). Species that would benefit from maintaining hydrological integrity include golden perch, silver perch and Murray cod.

Rolling, multi-year priorities for native fish

To achieve the expected environmental outcomes for key native fish species in the Basin-wide environmental watering strategy, a variety of flow regimes that improve fish habitats and allow fish to complete their life cycles is needed.

Each rolling, multi-year priority has annual environmental priorities that vary according to the resource availability scenario. Natural flow events can occur under any resource availability scenario and can rapidly change conditions. Under any scenario, environmental water managers and planners, and river operators, should capitalise on opportunities to enhance recruitment and subsequent dispersal of native species that these types of flow events bring.

Support Basin-scale population recovery of native fish by reinstating flows that promote key ecological processes across local, regional and system scales in the southern connected Basin

The regulated conditions in the southern connected Basin provide reasonable, but not ideal, flowing habitats for most of the large-bodied species that live in the main river channels. The highly regulated conditions in the southern Basin have low native fish carrying capacities (due to reduced floodplain connections and high carp numbers) and do not facilitate regular recruitment of many key fish species, meaning that southern Basin native fish populations are struggling over the long-term.

The availability of held environmental water in the southern connected Basin does, however, presents opportunities to support, and in some cases build upon, the populations of native fish species.

This priority focuses on providing a suitable flow regime for species that respond to flows, in river channels and anabranches in the southern connected Basin, including the lower Darling River. By coordinating and linking flows in different rivers, and providing connectivity through the system to the

estuary, recruitment processes that have been interrupted by historical river management can be improved.

Flows that support recruitment processes can also provide food, habitat, and connectivity between habitats. This will promote population recovery of native fish, including the target species of silver perch (Critically Endangered under the *EPBC Act*), Murray cod (Vulnerable under the EPBC Act), golden perch and lamprey over the long-term.

The following flow components are the focus of this priority:

- winter flows for habitat, and connectivity between habitats within channels
- flows that support breeding and productivity in spring and survival in summer and autumn
- flows that support dispersal movements in spring, summer and autumn
- end-of-system flows through the barrage fishways and the barrages.

To achieve population recovery, each of the target fish species has specific recruitment and flow needs, as outlined in Table 12 and detailed in further detail in: Towards a southern connected Basin flow plan: connecting rivers to recover native fish communities. Meeting the recruitment and flow needs for each species will, in turn, benefit the ecology of the river channel and the broader native fish community.

The resource availability scenario across the majority of catchments in the southern Basin means that the highest priority for water managers is to maintain existing populations and to ensure the integrity of flow throughout the River Murray and lower Darling River, including transmission of flows through the barrage fishways.

Table 13 sets out the rolling, multi-year priority framework for population recovery of native fish in the southern connected Basin.

Table 12 Species-specific objectives and flow needs to achieve the multi-year priority for the southern connected Basin

Species	Recruitment Objectives	Flow needs
Murray cod	Support local recruitment in the main channel of the River Murray and lower Darling River, and regulated anabranches and tributaries.	Perennial base flows in anabranches and tributaries Spring rise in anabranches and tributaries Reduced unnatural variability and maintaining levels in anabranches and tributaries
Silver perch and golden perch	Support annual system-scale recruitment in the mid-Murray. Support local recruitment in the lower River Murray, lower Darling River, tributaries and anabranches. Promote movement and dispersal, particularly of juveniles, into tributaries and anabranches.	Perennial base flows in anabranches and tributaries Spring rise in main river channels Variable flow in main river channels Transmission of flows through the system to allow for egg and larvae drift in spring and summer Flows that provide connectivity to off-stream nursery habitat In-channel dispersal flows in spring, summer and autumn throughout the system
Golden perch	Capitalise on episodic system-scale recruitment from the Darling River.	Connectivity between systems for egg and larvae drift Transmission of flows through the system for egg and larvae drift in the Barwon–Darling system Following recruitment events in the Menindee Lakes, provide in-channel dispersal flows from Menindee Lakes into the lower Darling and River Murray system
Short–headed and pouched lamprey	Support system-scale migrations of lamprey from the ocean, through the estuary and into the River Murray to upstream breeding grounds.	End-of-system flows to the Murray River estuary in winter and spring Flow integrity in the lower Murray In-channel dispersal flows throughout the system

Improve flow regimes and connectivity in northern Basin rivers to support native fish populations across local, regional and system scales

The flow regime of the northern Basin rivers is variable. However, in recent times the flow regime has changed considerably, with an increasing number of cease-to-flow events and shorter periods when flows do occur. The changes to the historic flow regime are contributing to the declining ecological health of the Barwon–Darling and resulting degradation of native fish communities.

This priority aims to improve native fish populations in the northern Basin by providing suitable flow regimes and increasing connectivity within and between river systems. This will improve recruitment and spawning of native fish within individual catchments and dispersal into the connected northern and southern catchments.

The northern Basin contains a mix of unregulated and regulated systems, limiting the ability to actively manage and deliver water at certain times of the year and under certain climatic conditions. This makes protecting environmental flows an important management tool.

This priority has three areas of focus, outlined below. Table 14 sets out the rolling, multi-year priority framework for flow regimes and connectivity in northern Basin rivers to support native fish populations.

Increase the frequency of flow types necessary to support native fish

Each flow type in the flow regime (cease-to-flows, base flows, low flows, freshes, bankfull and overbank flows) provides a range of functions and benefits for native fish communities.

Base flows and low flows maintain in-channel habitat, provide drought refuges and maintain water quality. Ideally, base flows and low flows would occur in almost all years, preferably between spring and autumn. However, with the changing flow regime, planned delivery of low flows has become a critical need. Without regular low flows to maintain refuge waterholes of suitable water quality, native fish in the northern Basin will continue to decline.

Small and medium freshes should occur at least once a year in most years, although the past decade has seen very few of these flows in many northern Basin systems. Small and medium freshes allow fish to move between refuge habitats, increase available habitat and productivity, and can support and improve recruitment outcomes.

Management of held environmental water, planned environmental water, environmental stock and domestic flows, and protection of natural flows are all options that can be explored to deliver these flow types, at appropriate times.

The larger freshes and overbank flows tend to be natural events that require protection, rather than be delivered from storages. These flows have major recruitment outcomes and trigger system-scale fish movements and native fish distributions. The frequency of these events is quite low, but their ecological significance is high.

The resource availability scenario across the majority of catchments means that the highest priority for water managers is to ensure refuge waterholes and their water quality are maintained and residence times are not exceeded.

Protect natural recruitment flows to boost native fish populations

Flow events that occur in the northern Basin are crucial for native fish in the Barwon–Darling and connected tributaries. These flows can originate in any one or more of the upper parts of the system, and then flow through the Barwon–Darling River. These types of flow events inundate suitable spawning and recruitment habitat, allow for connectivity, and can lead to large recruitment events, either localised within the valley and/or across the northern connected system.

For some species (e.g. golden perch and silver perch) these flows promote the development of eggs, larvae and juvenile fish, hence the integrity of these larger flows must be maintained. Recent actions

such as embargoes on extraction, active management, and coordination through the newly formed Northern Basin Environmental Watering Group provide a template for improved management and protection of the integrity of the flows, with expected benefits for native fish. Where conditions result in flows throughout the length of the Barwon–Darling and into nursery habitat, such as the lower Darling and Menindee Lakes system, subsequent dispersal of young fish from this region into both the southern connected Basin and northern Basin can occur.

Increase flow connections between the Barwon–Darling and its tributaries

There are benefits for native fish by connecting the Barwon–Darling and its tributaries on a regular basis. Connecting tributaries promotes the movement and recruitment of key native fish species, along with improved dispersal of juvenile and sub-adult golden perch, Murray cod and silver perch into tributary habitats, boosting resident populations.

Flows likely to create connections between the Barwon−Darling and its tributaries, particularly in years following large recruitment events, should be actively managed to ensure connectivity between systems is achieved. This will allow exchange of fish between systems improving the resilience of populations within tributaries, and over time, across the northern Basin.

Support viable populations of threatened native fish, maximise opportunities for range expansion and establish new populations

Almost half of the native fish species in the Murray–Darling Basin are of conservation concern. Several of these threatened fish species have either not been detected or have been detected in low numbers over the past few years. Environmental watering, alongside other measures, is a key action to improve outcomes for threatened fish.

This priority seeks to improve the long-term viability of threatened native fish in the Basin. Actions will be needed over several years, complemented by non-flow measures, to maximise opportunities for threatened species. Achieving this priority will help to meet the long-term outcome sought for threatened fish in the Basin−wide environmental watering strategy.

The focus for managing threatened species is to first protect remaining populations and then increase the areas they occupy. The resource availability scenario across the majority of catchments means that the highest priority for water managers is to focus on protecting existing populations. For example, the following locations have been identified as important populations for Murray hardyhead: Little Frenchmans Creek, New South Wales; Lake Elizabeth, Round Lake, Koorlong wetlands, and Brickworks Billabong, Victoria; and Lyrup Lagoon, Berri Evaporation Basin and Disher Creek, South Australia.

The long-term goal is to reinstate a network of populations that can connect with each other through flows and disperse and colonise habitat more regularly.

To increase the area that threatened species occupy and to build fish populations, steps can be taken in a process that spans multiple years:

- Protect and boost key source populations.
- Support surrogate sites and populations that can start new permanent populations.
- Identify and prepare sites to establish permanent populations.
- Support fish stocked into reintroduction sites and secure their long-term future.

Table 15 sets out the rolling, multi-year priority framework for threatened native fish.

Table 13 Rolling, multi-year prioritiy framework for population recovery of native fish in the southern connected Basin

Rolling, multi-year priority	**Support Basin-scale population recovery of native fish by reinstating flows that promote key ecological processes across local, regional and system scales in the southern connected Basin**				
Resource availability scenario	Very dry	Dry	Moderate	Wet	Very wet
Basin annual environmental watering priorities	Provide base flows, low flows and small freshes. Maintain refuge waterholes to support key populations of native fish. Provide flows through barrage fishways when possible.	Provide base flows, low flows and small freshes; and medium freshes with peak. Provide flows through barrage fishways all year around. Provide flows through barrages in winter and spring.	Provide medium freshes with peak; large freshes; and hydrological connectivity between systems. Provide flows through barrages through winter to Summer.	Provide medium freshes with peak; large freshes; and hydrological connectivity between systems. Provide flows through barrage fishways all year around.	Provide overbank flows (expected rather than targeted); and hydrological connection between systems. Provide flows through barrages year-round.
	Support system-scale migrations of golden perch, silver perch and lamprey. When freshes occur in the spawning period, maintain the integrity of flow through the system to allow eggs and larvae to drift uninterrupted. Provide opportunities for young golden perch and silver perch to disperse following episodic system-scale recruitment events. Increase flow connections between major rivers and their tributaries and anabranches to promote movement and dispersal. Provide flows that protect ecologically important populations of native fish.				

Table 14 Rolling, multi-year prioritiy framework for flow regimes and connectivity in northern Basin rivers to support native fish populations

Rolling, multi-year priorities	**Improve flow regimes and connectivity in northern Basin rivers to support native fish populations across local, regional and system scales**				
Resource availability scenario	Very dry	Dry	Moderate	Wet	Very wet
Basin annual environmental watering priorities	Maintain refuge waterholes and their water quality to support key populations of native fish. Provide base flows which support hydrological connectivity within systems and minimise cease to flow events.	Provide flows that maintain existing populations. Provide base flows, low flows and small freshes which support hydrological connectivity within and between systems and to replenish refuge waterholes.	Provide flows that support connectivity among populations and chances for fish to disperse. Provide small freshes and medium freshes, and support hydrological connectivity within and between systems and to replenish refuge waterholes.	Provide flows that assist in the broad-scale dispersal of fish across all life history stages into new habitats. Provide medium and large freshes and support hydrological connectivity within systems, between systems, and along the length of the Barwon–Darling and into the Menindee Lakes.	Provide flows that assist in the broad-scale dispersal of fish across all life history stages into new habitats. Protect overbank flows and support hydrological connection within and between systems, especially into the Menindee Lakes (to support the needs of the Lower Darling).
	Support system-scale migrations of golden perch and silver perch. When freshes occur in the spawning period, maintain the integrity of flow through the system to allow eggs and larvae to drift uninterrupted. Provide opportunities for young golden perch and silver perch to disperse following episodic system-scale recruitment events. Increase flow connections between major rivers and their tributaries and anabranches to promote movement and dispersal.				

Table 15 Rolling, multi-year priority framework for threatened native fish

Rolling, multi-year priorities	**Support viable populations of threatened native fish, maximise opportunities for range expansion and establish new populations**				
Resource availability scenario	Very dry*	Dry	Moderate	Wet	Very wet
Basin annual environmental watering priorities	Provide flows and/or secure water supplies to protect critical populations of threatened small-bodied fish. Maintain refuge waterholes to support key populations of threatened native fish. Provide base flows which support hydrological connectivity within systems and minimise cease-to-flow events.	Provide flows and/or secure water supplies that protect existing populations of threatened small-bodied fish. Maintain refuge waterholes to support key populations of threatened native fish. Provide base flows, low flows and small freshes which support hydrological connectivity within and between systems.	Provide flows that expand existing populations of threatened small-bodied fish; and prepare new reintroduction sites. Provide lateral connectivity to targeted wetland and floodplain habitats for threatened native fish. Provide medium freshes with peak; large freshes; and hydrological connectivity within and between systems.	Provide flows that expand existing populations of threatened small-bodied fish; and create new reintroduction sites. Provide lateral connectivity to targeted wetland and floodplain habitats for threatened native fish. Provide medium freshes with peak; large freshes; and hydrological connectivity within and between systems.	Provide flows that assist in the dispersal of threatened small-bodied fish into new habitats. Provide overbank flows (expected rather than targeted); and hydrological connection within and between systems.
	When freshes occur in the spawning period, maintain the integrity of flow through the system to allow eggs and larvae to drift uninterrupted. Provide opportunities for young fish to disperse following recruitment events. Increase lateral connections between rivers and wetlands to maintain populations of small-bodied threatened native fish. Provide flows that protect ecological processes that are important to maintain populations of threatened native fish. *Establishing and maintaining surrogate populations will also be necessary under very dry conditions.				

Appendix 1 – Seasonal conditions

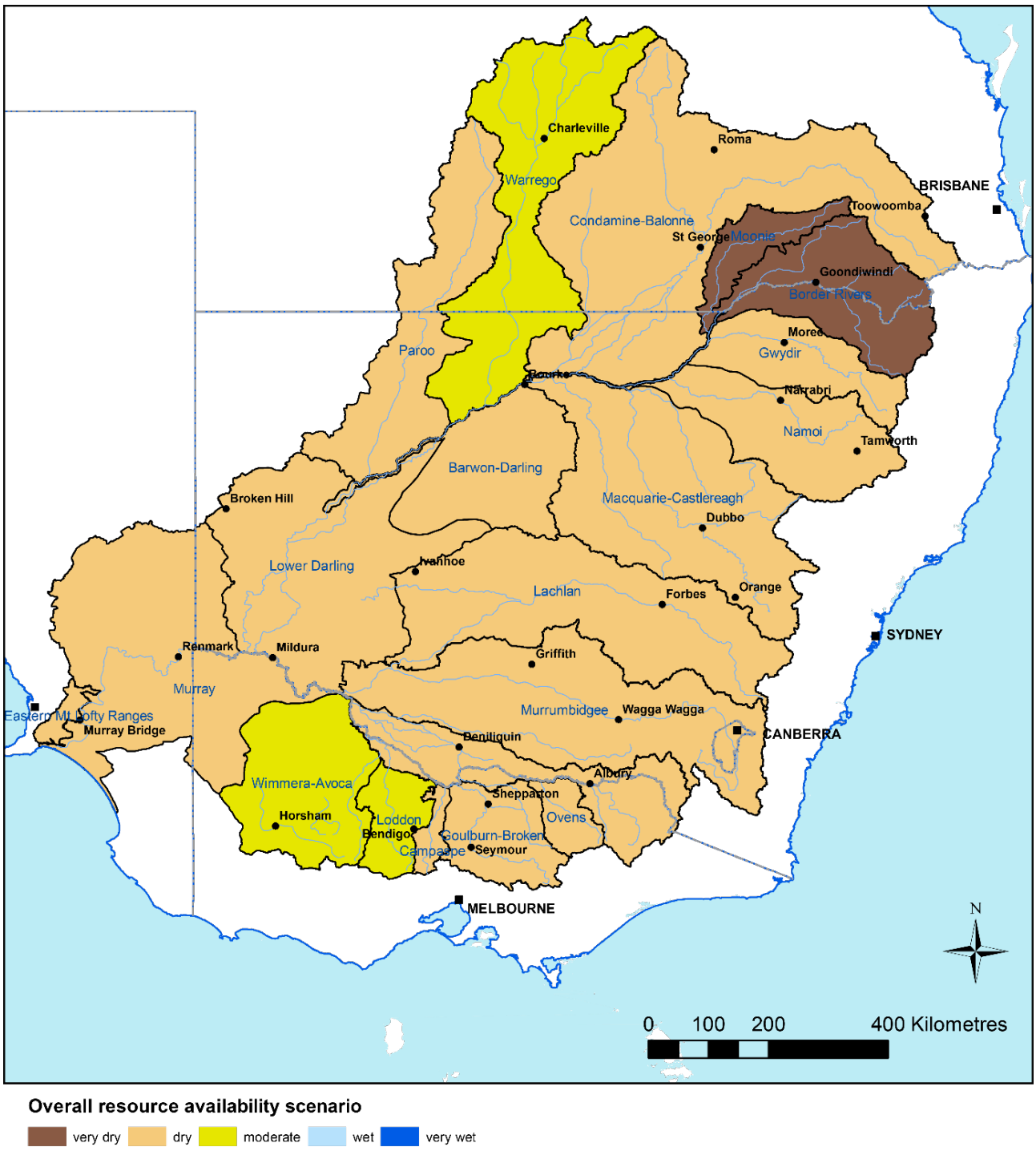

Figure 3 has been produced on the results of the RAS calculation presented in Table 16. Where the RAS is expressed as a range in Table 16 (e.g. 'very dry' to 'dry), the lower value (ie 'very dry', in this example) has been used in the production of the figure. Where the RAS in Table 16 spans three values, the middle value is used in the production of the map (e.g. if the results in Table 16 span 'dry to wet' then, the RAS used in the production of the map would be 'moderate').

Note: See Table 16 below for an explanatory note for the assessment of the RAS for the Wimmera-Avoca catchment.

Table 16 Antecedent climate conditions and water storage levels for the catchments of the Murray–Darling Basin for the year to 1 May 2020[1]; Results of percentile analysis of antecedent conditions and the water Resource Availability Scenario (RAS)[1]

Catchment[2] (Regulated = R; Unregulated = Unreg[3])	Precipitation	Root zone soil moisture	Runoff	Antecedent percentile range	Surface water percentile	Resource Availability Scenario
Border Rivers (R)	0-15%	0-15%	0-15%	0-15%	16-45%	Very dry
Gwydir (R)	16-45%	16-45%	16-45%	16-45%	16-45%	Dry
Namoi (R)	16-45%	16-45%	46-60%	16-45% to 46-60%	16-45%	Dry
Macquarie–Castlereagh (R)	16-45%	16-45%	46-60%	16-45% to 46-60%	16-45%	Dry
Lachlan (R)	16-45%	16-45%	46-60%	16-45% to 46-60%	16-45%	Dry
Murrumbidgee (R)	16-45%	16-45%	16-45%	16-45%	46-60%	Dry
Lower Darling (R)	16-45%	16-45%	16-45%	16-45%	16-45%	Dry
Murray (R)	16-45%	16-45%	16-45%	16-45%	16-45%	Dry
Loddon (R)	61-85%	46-60%	46-60%	46-60% to 61-85%	46-60%	Moderate

Catchment[2] (Regulated = R; Unregulated = Unreg[3])	Precipitation	Root zone soil moisture	Runoff	Antecedent percentile range	Surface water percentile	Resource Availability Scenario
Campaspe (R)	61-85%	46-60%	16-45%	16-45% to 61-85%	16-45%	Dry
Goulburn–Broken (R)	61-85%	16-45%	16-45%	16-45% to 61-85%	16-45%	Dry
Wimmera-Avoca[4] (UnReg)	46-60%	46-60%	46-60%	46-60%	N/A	Moderate [4]
Moonie (UnReg)	0-15%	16-45%	16-45%	0-15% to 16-45%	N/A	Very dry
Barwon–Darling (UnReg)	16-45%	16-45%	46-60%	16-45% to 46-60%	N/A	Dry
Condamine–Balonne (UnReg)	16-45%	16-45%	16-45%	16-45%	N/A	Dry
Paroo (UnReg)	16-45%	46-60%	46-60%	16-45% to 46-60%	N/A	Dry
Warrego (UnReg)	16-45%	61-85%	61-85%	16-45% to 61-85%	N/A	Moderate
Ovens (UnReg)	46-60%	16-45%	16-45%	16-45% to 46-60%	N/A	Dry
Eastern Mt Lofty Ranges (UnReg)	16-45%	16-45%	16-45%	16-45%	N/A	Dry

1. The method for calculating the water resource availability scenario (RAS) is set out in the Guidelines for the method to determine priorities for applying environmental water (MDBA 2012) https://www.legislation.gov.au/Details/F2012L02240/4fdd68b4-f6f1-4fed-978d-29e06bb8b525

2. Based on the best quality data available at the time of writing for public water storages in the Basin. Private water storages have not been included in calculation of the RAS.

3. For unregulated catchments only antecedent climate conditions can be applied to determine the RAS given these catchments either do not have public water storages or have only small water storages that are unlikely to play a role in environmental watering.

4. Determination of the RAS for the Wimmera-Avoca catchment has been based on antecedent conditions. The MDBA will be including public water storages that supply the catchment in future assessments. It is recognised that the water storage level for Rocklands Reservoir at 5 June 2020 is at 23% of active capacity. This low storage level is likely to mean the RAS for the catchment would have been 'dry', rather than the May 2020 assessment of 'moderate'.

Office locations
Adelaide
Albury-Wodonga
Canberra
Goondiwindi
Griffith
Mildura
Murray Bridge
Toowoomba

mdba.gov.au 1800 230 067 engagement@mdba.gov.au