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MURRAY–DARLING BASIN AUTHORITY

Basin annual environmental watering priorities 2023–2024

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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 Murray–Darling Basin Authority (MDBA) has developed Basin annual environmental watering priorities (the priorities) to guide the planning of environmental watering across the Basin in 2023–2024. Historical and current annual priorities can be accessed here.

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 for environmental water holders and managers, water planners, and river operators, and has been prepared in consultation with the Basin states and the Commonwealth Environmental Water Holder (CEWH).

During summer of 2022–23, the Basin experienced the largest natural flows in more than 10 years. Flooding continued to affect parts of the Murray and Darling-Baaka rivers in western New South Wales and South Australia following on from extensive flooding across the Basin during Spring. A third consecutive year of high rainfall in many catchments has improved connectivity across large areas of the Basin. Storages are close to full in the north and south. In wetter catchments across the Basin, there have been good responses to high inflows, with extensive waterbird breeding at key sites, vegetation growth, including at the Coorong, and recruitment of native fish.

Not all responses have been equally positive in the Basin. Whilst in the Southern Basin vegetation communities such as lignum (*Duma florulenta*) shrublands, ruppia (*Ruppia tuberosa*) communities, and bird foraging and nesting habitats have improved in condition, some negative responses have been observed in other areas. Widespread flooding in the Central Basin around the Darling-Baaka has contributed hypoxic blackwater events and significant fish death events.

The availability of water for the environment in these wet conditions provides an opportunity to build on the gains of the past year, achieve Basin-scale outcomes and build resilience for drier times. With a return to more stable conditions throughout autumn, the MDBA's guidance for environmental water use in 2023–2024 is summarised below.

In wetter catchments, improve the health and resilience of water-dependent ecosystems by:

- Enabling growth, reproduction and large-scale recruitment for a diverse range of flora and fauna
- Maintaining environmental assets and ecosystem functions, including by allowing drying to occur consistent with natural wetting-drying cycles
- Slowing recession and supporting native fish with good water quality
- Promoting higher floodplain-river connectivity
- Supporting high-flow river and floodplain functions.

In moderate and drying catchments, maintain ecological health and ensure environmental assets maintain their basic functions and resilience by:

- Enabling growth, reproduction and small-scale recruitment for a diverse range of flora and fauna
- Promoting low-lying floodplain-river connectivity
- Supporting medium-flow river and floodplain functions
- Supporting the survival and viability of threatened species and communities
- Supporting native fish through connectivity
- Maintaining environmental assets and ecosystem functions, including by allowing drying to occur consistent with natural wetting-drying cycles
- Maintaining refuges.

Overview of the Basin annual environmental watering priorities

Introduction

The MDBA is required under the Basin Plan to provide advice that assists the Commonwealth Environmental Water Holder (CEWH) and Basin States to meet the Plan's environmental objectives. 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 expressed at a mix of geographic scales from site-specific to Basin-wide, reflecting the ecology of species that are the focus of the strategy.

The priorities represent the areas environmental water managers should focus on for the year ahead to help achieve the desired long-term outcomes for the Basin environment as described in the Strategy. The guidance provided by the priorities helps federal and state environmental water holders across the Basin, who make decisions about when, where and how much water is provided for the environment.

Multi-year priorities, referred to as 'rolling priorities', are also provided to address areas where the pattern of environmental watering is important across multiple years. These work together with the annual priorities. The priorities are complemented by state priorities, which have a catchment or local focus, and water provided for the environment by the Commonwealth Environmental Water Holder and The Living Murray (TLM).

This year, the method for determining priorities has been improved by novel analysis of the vulnerability of ecosystems and the biota that depend on them. Key findings of this analysis have been noted in the priorities for native vegetation and waterbirds.

Current conditions and climate context for 2023–2024

Prevailing climatic conditions are a major influence on opportunities to use water recovered for the environment under the Basin Plan.

After the three years of above-average warm and dry conditions to early 2020, the Basin has now experienced three consecutive years of above-average rainfall, which has supported the Basin's recovery from drought.

According to the Bureau of Meteorology, the Basin experienced mostly average or lower than average rainfall in April, with above average rainfall experienced in April in some areas (refer Figure 1). For May–July, below average rainfall is highly likely, and the longer-term outlook is that a El Niño is likely to develop later in 2023. This means that drier and warmer conditions are expected throughout the 2023/24 environmental watering year. Despite the drying conditions, above average soil moisture and full storages, particularly in the Southern Basin, means that dry conditions will be buffered through water availability.

Public water storages across the Basin were 90% on 10th May, similar to the 88% at the corresponding time last year.

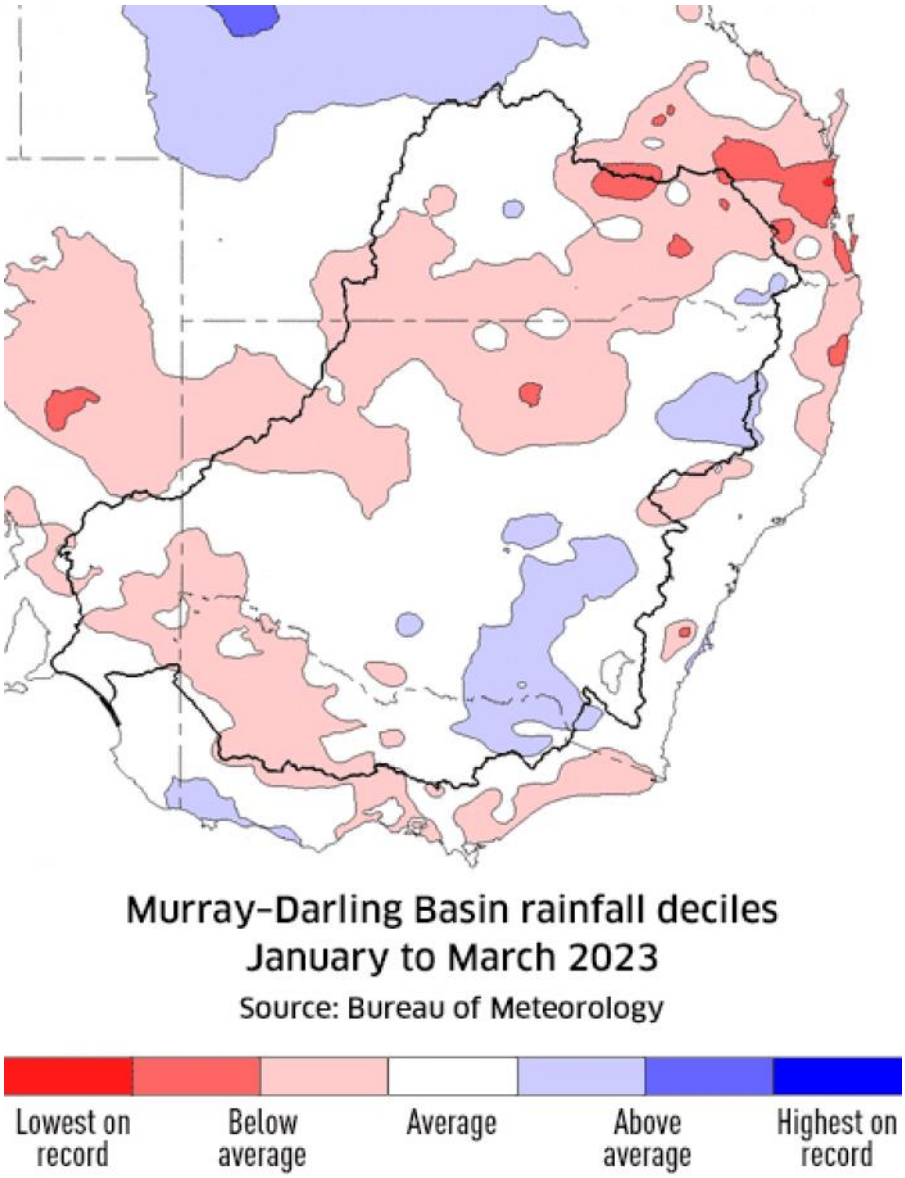

Figure 1:Murray–Darling Basin rainfall deciles for January to March 2023 (Source: Bureau of Meteorology)

Seasonal conditions are always a major influence on the objectives sought from providing water for the environment. The MDBA assesses the likely 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. Also considered is the Bureau of Meteorology's climate outlook and longer-term forecasts. In addition, the MDBA consults with environmental water holders and managers.

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 of 4 May 2023 are as follows:

- **Very wet**: Barwon–Darling, Border Rivers, Gwydir, Namoi, Macquarie–Castlereagh, Lachlan, Murrumbidgee, Lower Darling, Murray, Campaspe, Goulburn–Broken, and Loddon
- **Wet:** Condamine–Balonne, Warrego, Moonie, Ovens, and Wimmera–Avoca
- **Moderate:** Paroo and Eastern Mount Lofty Ranges.

More information on this assessment is provided in Appendix 1.

Basin annual environmental watering priorities for 2023–2024

Basin annual environmental watering priorities and guidance for environmental water holders has been prepared for river flows and connectivity, native vegetation, waterbirds, and native fish.

In catchments experiencing wetter conditions, the 2023–24 focus for water for the environment is to connect rivers to improve the health and resilience of water-dependent ecosystems by:

- Enabling growth, reproduction and large-scale recruitment for a diverse range of flora and fauna
- Promoting higher floodplain-river connectivity
- Supporting high-flow river and floodplain functions.

In catchments experiencing moderate and drying conditions, the 2023–24 focus for water for the environment is to maintain ecological health and ensure environmental assets maintain their basic functions and resilience by:

- Enabling growth, reproduction and small-scale recruitment for a diverse range of flora and fauna
- Promoting low-lying floodplain-river connectivity
- Supporting medium-flow river and floodplain functions
- Supporting the survival and viability of threatened species and communities
- Maintaining environmental assets and ecosystem functions, including by allowing drying to occur consistent with natural wetting-drying cycles
- Maintaining refuges.

Table 1 below sets out the rolling, multi-year priorities for each ecological theme. The full list of rolling multi-year priorities for targeted outcomes under each ecological theme are found in the Basin-wide-environmental watering strategy. Table 2 sets out annual guidance for 2023–2024. Further context for the priorities for each theme is provided below, including First Nations environmental watering priorities.

Rolling multi-year watering priorities

Table 1: Rolling multi-year watering priorities

Watering Priorities	Flows and connectivity (FC)	Native Vegetation (V)	Waterbirds (B)	Native Fish (F)
Basin – Rolling Priorities (multi-year) (R)	**RFC1.** Manage water to maximise lateral and longitudinal connectivity along the river systems and provide opportunities for high ecological productivity. **RFC2.** Support freshwater connectivity through and between the Lower Lakes, Coorong and Murray Mouth.	**RV1**. Allow opportunities for growth of non-woody wetland vegetation. **RV2.** Allow opportunities for growth of non-woody riparian vegetation. **RV3.** Maintain the extent, improve condition and promote recruitment of forests and woodlands. **RV4.** Maintain the extent and improve the condition of lignum shrublands. **RV5.** Expand the extent and improve the condition of Moira grass in Barmah–Millewa Forest. **RV6.** Expand the extent and improve resilience of *Ruppia tuberosa* in the southern Coorong.	**RB1.** Maintain the diversity and improve the abundance of the Basin's waterbird population. **RB2.** Maintain the abundance of key shorebird species in the Lower Lakes and Coorong.	**RF1.** Support Basin-scale population recovery and resilience of native fish by reinstating flows that promote ecological processes across local, regional and system scales in the southern connected Basin. **RF2.** Improve flow regimes and connectivity in Northern Basin rivers to support native fish populations across local, regional and system scales. **RF3.** Support viable populations of threatened native fish, maximise opportunities for range expansion and establish new populations.

Annual guidance 2023–2024

Table 2: Annual guidance for 2023–24 to achieving the Priorities

Watering Priorities	Flows and connectivity (FC)	Native Vegetation (V)	Waterbirds (B)	Native Fish (F)
Annual Guidance – North (AN)	**ANFC1**. Support cross-border and inter-valley connectivity opportunities (where necessary, coordinate through NBEWG). **ANFC2.** Manage water recession at sites where there is an active bird breeding event (e.g. Narran Lakes, Gwydir Wetlands, Macquarie Marshes).	**ANV1.** Support riparian vegetation in key wetlands of the Northern Basin. **ANV2.** Support continued recovery of lignum shrublands at Narran Lakes and other key sites in the Northern Basin. **ANV3.** Provide flows to support core wetland vegetation at key sites in the Macquarie Marshes. **ANV4.** Support inundation of the Warrego Floodplain.	**ANB1.** Continue to support colonial nesting waterbird breeding and recruitment in the Narran Lakes, Macquarie Marshes and Gwydir Wetlands. **ANB2.** Support foraging and nesting of waterbirds by ensuring shallow-water and shoreline habitat.	**ANF1.** Water to support building resilience of native fish populations, productivity, and refuge waterhole habitats. **ANF2.** Provide water to support recruitment and subsequent dispersal of juveniles to improve native fish populations. **ANF3.** Provide water to support both lateral and longitudinal connectivity to allow for dispersal and building resilience and recovery in native fish populations. **ANF4.** Provide small pulses (freshes) to support productivity and movement of native

Watering Priorities	Flows and connectivity (FC)	Native Vegetation (V)	Waterbirds (B)	Native Fish (F)
				fish including at reintroduction sites of relocated fish.
Annual Guidance – South (AS)	**ASFC1.** Piggyback off high-flow events to deliver additional water **ASFC2.** Coordinate and plan event releases to achieve multiple benefits along the length of the Murray (coordinate through SCBEWC). **ASFC3.** Increase flows to the Coorong to improve water quality and trigger cues for migratory fish movement.	**ASV1.** Provide flows to meet critical inundation requirements for river red gum and black box communities. **ASV2.** Provide flows to low-lying wetlands to support germination and growth of Moira grass and other non-woody vegetation communities. **ASV3.** Support wetland and riparian habitats through targeted inundation and drying as needed**.** **ASV4.** Manage flow to promote recruitment and establishment of seedlings and improve health of riparian vegetation via drying or wetting as needed.	**ASB1.** Maintain foraging and roosting habitat at refuge locations. Support breeding and recruitment where naturally triggered. **ASB2**. In moderate conditions, maintain waterbird breeding habitat in 'event ready' condition. Support breeding where it is naturally triggered. Where conditions permit, trigger and provide ongoing support for breeding and foraging across functional groups, including the wetlands of the Lachlan (Lake Brewster and	**ASF1**. Provide water for the lower Darling-Baaka and Murray to support immigration following fish deaths and support the survival and dispersal of young cohorts of Murray cod and golden perch (including if required in the Darling Anabranch). **ASF2.** Ensure winter and spring flows through the barrages and barrage fishways to support migration and progressive recovery of diadromous lamprey and congolli. **ASF3.** Maintain fast-flowing habitats to cue and facilitate movement

Watering Priorities	Flows and connectivity (FC)	Native Vegetation (V)	Waterbirds (B)	Native Fish (F)
		ASV5. Promote growth and encourage reproduction of *Ruppia tuberosa* by managing water and salinity levels.	Booligal wetlands) and Lowbidgee (Gayini and Nimmie-Caira) that have shown a strong response to natural flows. **ASB3.** Maintain waterbird habitat including productive shorebird habitat and foraging availability in the Lower Lakes, Coorong and Murray Mouth – allowing for varying requirements within the different habitats offered by the Coorong and Lower Lakes.	and recruitment of native fish. **ASF4.** Provide off-channel habitat to support the entire life cycle of threatened small-bodied native fish including at reintroduction sites of translocated threatened fish.

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. Adopting a multi-scale approach recognises that the environmental objectives of the Basin Plan require a mix of local and Basin-scale actions, and that the riverine ecosystem response is based on both real-time flow events and long-term flow trends.

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 2023–2024 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 Resource Availability Scenario (RAS) forecasts used for annual watering priorities sometimes vary between the MDBA scenarios (Appendix 1) to those provided by individual states. The RAS calculation for MDBA the scenarios can be found here. 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 needs. Many regional priorities will support and contribute to the expected environmental outcomes outlined in the Basin-wide environmental watering strategy.

Flows and connectivity

Over the past three years, three consecutive La Niña events have brought significant rainfall to the Basin. The 22/23 water year saw the historic opening of all the operational barrages near the Murray Mouth in South Australia. For the first time in decades, the Murray was free flowing from the Yarrawonga Weir to the sea. The culmination of the last three years has resulted in beneficial longitudinal and lateral connectivity.

However, challenges remain across the Basin. With the increased rainfall and river levels there has been an influx of nutrient-rich organic material. While this material acts as a food resource to support the maintenance of animal populations, the abundance of organic material poses a risk to water quality. For example, low levels of dissolved oxygen have negatively impacted fish populations in parts of the Basin.

Water quality is monitored, and results communicated, by individual Basin state governments. Management of water quality is a responsibility shared between multiple parties, including resource managers and river operators, and is not the sole responsibility of environmental water holders. However, in instances where an alert is issued for poor water quality and water is available, water managers should consider options available to help mitigate these risks such as providing dilution flows for fish refuge. Forums including the Southern Connected Basin Environmental Watering

Committee (SCBEWC) and the Northern Basin Environmental Watering Group (NBEWG) should be used where large-scale coordination would be beneficial. If river conditions are appropriate, NBEWG should consider the delivery of a coordinated flow event across multiple catchments to provide flows to the Barwon–Darling in Spring or other times of the year as appropriate.

An emerging challenge faced by water managers in the Northern Basin is the increased efficiency of water delivery. Previously, the need to transport water through the river system often resulted in incidental environmentally beneficial baseflow, but the increased efficiency has reduced this baseflow. Environmental water managers in the Northern Basin should consider how increased efficiency may impact their delivery strategy.

Storages are still very full across the Basin, sitting at 90% as of 10 May 2023. However, the Bureau has issued an El Niño watch, and from December 2022 to March 2023, rainfall deficiencies were recorded across parts of the Basin. Where possible, water managers should look for opportunities to piggyback on natural flows, particularly where timing of events would result in reconnecting off-channel habitat to enhance recruitment and dispersal. Water managers should seek opportunities to protect and restore ecosystem functions of water-dependent ecosystems that maintain populations, especially for species where establishment requires clustered, sequenced flows, building off conditions of previous years.

First Nations environmental watering

The MDBA recognises the ongoing connection to Country of First Nations people across the Basin, and respectfully acknowledges Traditional Owners and Custodians, as well as the role of First Nations science, expertise, knowledge and values in achieving healthy river systems.

The health of the Murray–Darling Basin benefits from meaningful partnerships with First Nations and their active involvement in water planning, coordination, and delivery from the local to Basin scale. Across Basin governments, there are many current examples of First Nations influencing or participating in all stages of management of water for the environment. This was not the case 10 or even 5 years ago.

Historically, to address First Nations environmental watering objectives, the MDBA and CEWH have partnered with the Northern Basin Aboriginal Nations (NBAN) and the Murray Lower Darling Rivers Indigenous Nations (MLDRIN) under the First Nations Environmental Water Guidance (FNEWG) Project. This project provided an opportunity to share information, collaborate and include First Nations outcomes directly into current water management to improve the health of Country. The MDBA expects to continue with this work of First Nations engagement via the Basin-wide Watering Strategy to be progressed over the second half of 2023.

MLDRIN and NBAN developed their own guidance for environmental water managers using different approaches to reflect the differences in climate, water management and cultural diversity in the northern and Southern Basin. Efforts to further develop First Nations' environmental watering objectives for annual and long-term planning, have been hampered by COVID-19 and resource constraints.

While 2021–22 years saw many COVID-19 restrictions lifted, there were still challenges related to the pandemic and community engagement. It was not until the latter part of the 2022 water year that greater on-country engagement occurred. The hybrid approach of virtual and face to face contact provided both challenges and opportunities that people are still adapting to. First Nations

representatives have however, participated in meetings of SCBEWC and NBEWG that focus on deciding how and when to provide water for the environment.

The MDBA also coordinates The Living Murray (TLM) Program, which includes funding for management, monitoring, and First Nations engagement at key icon sites along the River Murray. A network of Indigenous facilitators operates across icon sites (as well as other Indigenous rangers employed via jurisdictions) to help engage with local First Nations groups, inform water for the environment planning, and monitor the outcomes of water use.

In addition to this, the MDBA has reported on First Nations participation in environmental watering as part of its obligations under Section 175 of the Water Act 2007 (Cwlth). More detailed information on how First Nations have been involved in planning for the delivery of environmental water can be found in the First Nations participation in water for the environment 2021–22 report.

The MDBA, CEWH and Basin governments remain committed to strengthen direct engagement with First Nations to empower their participation in environmental water planning and delivery.

Native vegetation

The Murray–Darling Basin consists of a variety of flood-dependent native vegetation communities. They range from persistent Eucalyptus dominated forests and woodlands, to temporary meadows of grasses, sedges, and forbs. These communities are shaped by the flow regimes, with some requiring permanent water, seasonal inundation, or occasional flooding such as those communities high up on the floodplain. This makes them a good indicator to determine the effectiveness of environmental watering. However, other factors also shape the vegetation communities found in the Basin, for example grazing animals, invasive plants, and land use.

Vegetation holds value intrinsic to itself and the communities of the Basin, as well as providing habitat for many species in the Basin including birds, fish, frogs, insects, and many threatened species. For example, reedbeds provide critical functions as habitat for animals with specialised breeding requirements. At the Great Cumbung Swamp wetland complex, inundation over the last three years has resulted in a dramatic recovery, including its extensive beds of common reed (*Phragmites australis*) and river red gum (*Eucalyptus camaldulensis*). Their recovery has resulted in the first official record of the southern bell frog (*Litoria raniformis*) in 50 years and the first records of the endangered Australasian bittern (*Botaurus poiciloptilus*) in 20 years.

In the Yanco Creek system, delivery of water for the environment supports resident bat species (e.g., *Myotis macropus*) by maintaining the condition of trees that they roost in. At Narran Lakes (Dharriwaa) vegetation, particularly lignum (*Duma florulenta*), provides habitat for colonially nesting waterbird species. To help support this vegetation and waterbird breeding, the Commonwealth Environmental Water Holder entered into an arrangement to release water from private on farm storages into Narran Lakes (Dharriwaa) via the Narran River. Providing this additional water has built on the past few years of good flows to continue to support vegetation that waterbirds rely on for breeding both in this season and future years.

The Murray–Darling Basin is home to many threatened species of plants listed either under federal or State legislation. Under federal legislation (*Environment Protection and Biodiversity Conservation Act 1999*), there are at least 187 species of plants that have at least some of their expected range in

wetlands and floodplains. Threatened species, such as Darling Lily (*Crinum flaccidum*) and Lagoon Nightshade (*Solanum lacunarium*) (both listed in Victorian State legislation) at Lake Wallawalla, Victoria, have responded well to the good conditions.

Long durations of inundation can drown less tolerant species, especially if the foliage is also underwater. In Clark's Floodplain, South Australia, some ground cover was drowned but receding floodwaters have already resulted in the emergence of new seedlings. Vegetation that was not drowned such as some lignum (*Duma florulenta*), black box (*Eucalyptus largiflorens*), and dryland tea tree (*Melaleuca lanceolata*) have had access to water and been able to grow, flower and set seed.

Despite the previous years of wet conditions across the Basin, the Bureau of Meteorology is predicting a return to dry conditions with an El Niño watch issued in 2023. Collaboration with other natural resource managers will be critical to ensuring that environmental water delivery achieves its intended outcomes for vegetation. This often occurs in the form of managing animal species that impact vegetation particularly through directly grazing on species, or through unintended consequences such as trampling, pugging, and rooting. The proliferation of pest plant species can smother native species as can the encroachment of native woody species into areas outside their historical range. For example, in the Northern Tablelands government and landowners are working together to manage native riparian vegetation, habitat of the Booroolong frog (*Litoria booroolongensis*). Management actions include not just the delivery of water, but also controlling invasive weeds and feral pigs that impact the riparian habitat. In Lindsay Mulcra Wallpolla, the First Nations people of the Millewa–Mallee are looking at trialling exclusion plots to inform vegetation management.

Due to the widespread flooding, many sites have been inaccessible for regular monitoring undertaken by various State Governments and researchers. Overall, though, three consecutive wet years has boosted vegetation condition at various locations across the Basin. In Barmah–Millewa Forest; Gunbower Forest; Koondrook–Perricoota Forest; the Great Cumbung Swamp; Narran Lakes; Chowilla floodplain; Pike floodplain; and Katarapko floodplain, vegetation condition has improved. Priority should be given to build-on or maintain the benefits of the previous wet years. This can be achieved by maintaining good condition of established plants and by supporting new seedlings where they occur, so that they recruit into the adult population. There is also an opportunity to focus on improving threatened plant species condition.

Some areas would benefit from a period of drying, allowing water managers to conserve water for later use or target other outcomes. For example, riparian vegetation of the Goulburn is currently in good condition and may not require an immediate flow to maintain that condition. Similarly, many locations in South Australia are expected to benefit from a drying phase.

In the Lower Lakes, Coorong, and Murray Mouth, priority for environmental water delivery should be used to facilitate complete lifecycles of *Ruppia tuberosa*. A long, extended spring-early summer peak is preferred over a short/sharp hydrograph in order to allow flowering, seed-setting (sexual reproduction), and the production of turions (asexual reproduction). Disturbance to *R. tuberosa* while it is reproducing should be minimised so that the seedbank, and therefore viability of the population, is sustained. *R. tuberosa* provides food and habitat for other species (e.g. Chestnut Teal – *Anas castanea*) and the multiple outcomes that can be achieved from maintaining *R. tuberosa* make it a high priority.

The Vulnerabilities report (Hale et al 2023) presents a method of determining 'vegetation' and 'waterbird' vulnerability across the Basin (see Appendix 2). For vegetation in 2021, sites with higher vulnerability can be seen across the Basin using this interactive map. While updating of the results and further refinement of this technique are needed, environmental water managers may find that the results highlight areas for further consideration.

In summary, the last few years of rain and flooding have had provided improved vegetation condition in many locations. Full reservoirs across the Basin provide environmental water managers with access to water to maintain improved vegetation condition, and to consolidate positive outcomes in the 2023–24 water year.

Waterbirds

Waterbird populations are effective indicators of general ecosystem health in the Basin, with more than 120 species supported across the Basin at nationally and internationally important wetland sites. Since the 1980s, when a waterbird population peak was recorded, the population has declined.

Throughout 2022 and early 2023, La Niña driven rain events caused wet conditions to continue throughout extensive parts of the Basin. Flooding inundated wetlands including Narran Lakes (Dharriwaa), Macquarie Marshes, Gwydir, the Lachlan Valley, Lower Murrumbidgee, Murrumbidgee and Barmah–Millewa Forest, promoting large scale breeding of colonial waterbirds. These ideal conditions have resulted in increased species richness, as well as an increase in the number of birds observed nesting and breeding. Colonial waterbirds need specific conditions to complete their breeding cycle and the past two years' conditions have been ideal. Large waterbird colonies have bred because of natural flow and this has been supported by targeted environmental watering to maintain water levels and encourage adult birds to remain nesting.

During 2022 – 23, the high natural inflows combined with flood operations resulted in limited environmental watering delivery. Maintaining water levels at the required duration and flow for colonial breeders at wetland sites can be challenging, while the end-of-system must support shorebirds with appropriate depth for mud flat foraging habitat. Innovative approaches have been developed to secure better outcomes for waterbirds, and these actions should continue in 2023–24 where conditions allow for it.

For many months in 2022, the Commonwealth Environmental Water Holder (CEWH), researchers, and water managers worked together to keep water levels stable at the Ramsar-protected Narran Lakes (Dharriwaa) to support breeding colonies. This successful breeding event resulted in a high diversity of waterbirds recorded at the site across 2022–23. Innovative environmental water approaches continued to be developed to secure better outcomes for waterbirds during this period, ensuring that key wetlands were able to sustain the high numbers of waterbirds during the breeding events. In a rare opportunity to support waterbird breeding at Narran Lakes (Dharriwaa) two years in a row, the CEWH delivered environmental water to the site in February 2023. Recent counts identified 44 waterbird species and estimates of more than 20,000 nests, including four threatened species (black-necked stork, brolga, freckled duck and blue-billed duck), straw-necked ibis, royal spoonbills and large pelican colonies. Environmental water ensures water levels remain stable to ensure bird breeding makes it to completion. Where possible, environmental water managers should support adult and juvenile birds from recent events to ensure recruitment into the adult population.

Record numbers of waterbirds took advantage of the wetter conditions across the Basin and extensive breeding was recorded at Lake Brewster (Lachlan Valley) and Gayini wetlands (Lower Murrumbidgee), Narran Lakes (discussed above), Gwydir and Macquarie Marshes. Water for the environment was delivered to the Macquarie Marshes between February and March 2023 to support the remaining nesting waterbirds colonies through to completion. As conditions dried over Summer, it was important that environmental water managers supported the breeding event to completion. It is estimated that more than 50,000 waterbirds nested in the Murrumbidgee valley and over 84,000 waterbirds in the Lachlan valley over the 2022–23 breeding season. Banded pelicans, tracked through the NSW DPE and UNSW pelican banding program in the Lachlan River catchment, have been discovered as far north in the Basin as Narran Lakes, a journey of more than 400 kilometres. Knowledge of waterbird movement is important for water managers to understand their movement triggers and foraging needs.

There is an increased chance of below average rainfall for most of the Basin from autumn 2023, with long-range forecasts predicting a return to El Niño conditions. Environmental water managers should support adult and juvenile bird after recent breeding events where possible. It will be important to actively manage sites in 2023–24 to support large numbers of waterbirds and ensure their foraging needs are met. This requires balancing differing waterbird habitat requirements, including shallow water colonial waterbirds (e.g. spoonbills), diving feeders (e.g. colonial cormorants and pelicans) and filtering feeding species (e.g. ducks) in supporting refuge habitat where possible.

For waterbirds in 2021 the Vulnerabilities report (Hale et al 2023) (see Appendix 2) suggests that vulnerability was highest for colonial nesters, cryptic waders and filtering feeding species with lower levels of recovery in the return to wetter conditions. Environmental water managers may find these results highlight areas for further consideration.

While extensive flooding has benefited waterbirds across most areas of the Basin, the recent flooding in the Coorong, Lower Lakes and Murray Mouth has not been as beneficial to the shorebirds and waders that rely on this Ramsar site. Endangered Fairy Terns nesting at the South Lagoon in January 2023 were affected by the flooding, causing the birds to abandon their nests. In other areas, Fairy Terns were susceptible to predation. Reduced access to foraging sites also affected other species of migratory waders reliant on the end-of-system. Water levels remained high in the Coorong and Lower Lakes through to the beginning of autumn 2023, limiting foraging habitat availability for migratory species. Waterbird numbers were low in comparison to recent years; however pelican and black swan numbers were reported to have increased during 2022 and early 2023.

Environmental managers will need to continue to ensure that barrage flows are managed adaptively to allow for the varying requirements of different Coorong and Lower Lakes habitats, including for suitable water depth for shorebird foraging.

Native Fish

The Basin contains more than 68 species of native fish, including freshwater, estuarine, marine, and migratory fish. Many of these species are unique to the Basin, having ecological characteristics that reflect the diversity and distinctiveness of aquatic habitat and flows.

The past water year saw overbank flooding across much of the Basin, leading to the exceedance of major flood levels in many areas of the Basin. These large flood events have stimulated recruitment of many native fish species in many areas but limited recruitment in other species and areas. For example, recent data collected from the annual Murray Darling Basin Fish Survey showed positive trends in recruitment for the long-lived flow specialist species golden perch (*Macquaria ambigua*) in the Northern Basin, and Murray cod (*Maccullochella peelii*) showing some improvements in population abundance in the Southern Basin. However, the overbank flooding in many areas saw mobilisation of organic matter and nutrients leading to anoxic blackwater events and subsequent fish deaths.

As the third consecutive year of La Niña draws to a close, water delivery in the 2023–2024 water year should prioritise the provision of flows to capitalise on the recruitment observed in recent years and provide suitable habitat for movement and survival of a range of species and life-stages. This will help to achieve robust and resilient populations and aid the recovery from fish deaths, before drought conditions return.

Under the short-term moderate to very wet conditions forecast in most catchments for May (Appendix 1), albeit a longer term drier outlook throughout winter and spring, water managers should supplement existing flows and provide strategic sequential flows to capitalise on recent recruitment and build resilience in native fish populations.

Well-timed, sequential flows following large flood events are vital to build native fish population resilience, particularly after strong recruitment events. Rare recruitment of flow-dependant species such as golden perch has been observed in several systems within the MDB (such as the Southern Basin Victorian tributaries, the Murrumbidgee, Edward–Wakool, and Lower Murray). Where recruitment of flow-dependant species has been observed, sequential flows in these systems (and connecting systems) will support productivity and foraging opportunities. This will aid growth and survival of juvenile fish, support habitat connectivity and dispersal opportunities for juveniles to move through and between connected systems and assist with colonising areas where recruitment is poor.

Recent monitoring from the CEWH Flow MER program has indicated very low numbers of Murray cod in the Warrego Barwon Darling junction selected area from 2019–2022. The MDBA's Murray–Darling Basin Fish Survey also detected very low numbers of Murray cod across many Northern Basin valleys. To build up Murray cod populations, the provision of base flows to maintain nesting habitat, followed by spring/summer freshes and recessions to encourage recruitment, dispersal and foraging, are needed to support recruits into maturity. To protect adult populations in drought refuges, baseflows are important to maintain water quality, depth and food supply. Supporting freshes (where possible) can then build on baseflows to allow the movement of fish between refuges and assist with population recovery following fish deaths.

Diadromous and estuarine fish species such as pouched and short-headed lamprey (*Geotria australis*, *Mordacia mordax*), congolli (*Pseudaphritis urvillii*), black bream (*Acanthopagrus butcheri*), and greenback flounder (*Rhombosolea apirine*) have benefited from several years of hydrological connectivity in the Lower Lakes and the Coorong. Species-specific targets set in the Lower Lakes, Coorong and Murray Mouth (LLCMM) Icon Site Environmental Water Management Plan for black bream and greenback flounder were able to be met for the first time in 2022. Providing flows to

meet water level and salinity targets in the Lower Lakes, estuary and Coorong to maintain and build black bream and greenback flounder populations will support recruitment of these species, helping to meet these species-specific targets in future years.

Whilst conditions generally supported high levels of habitat connectivity, nutrient mobilisation and recruitment, it must be acknowledged that some systems have experienced poor water quality which has led to large-scale fish deaths. Flows in the Lower–Darling Baaka system and River Murray downstream of Hume Dam are important to support fish movement and recruitment to restore fish populations impacted by large-scale fish deaths in these areas.

It is uncertain how populations of threatened species have been affected by the floods, with some evidence of distribution downstream achieved through overbank flows. Appropriate flows to known populations of threatened species and translocation sites to maintain appropriate water levels, flows and water quality should be considered to maintain remaining populations. Supplementing natural flooding will assist movement and/or recruitment of native fish, including for previously translocated and/or threatened species. Delivery of water to new or existing translocation sites is encouraged to support the continued efforts to return small-bodied fish species to river and wetland systems of the Basin.

Appendix 1 – Resource Availability Scenario

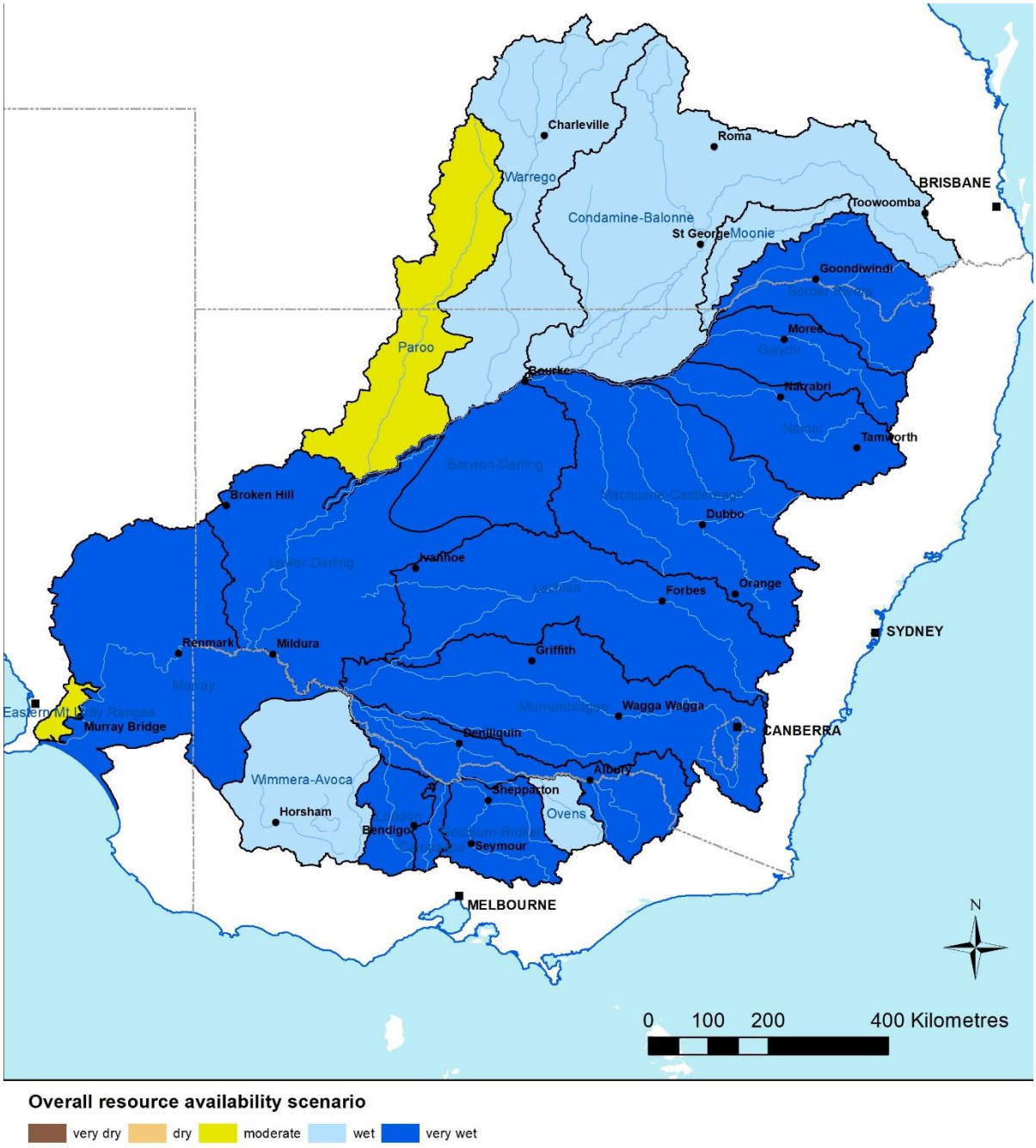

Figure 2: Water Resource Availability Scenario as at 4 May 2023 (Source: MDBA) One of the key steps in developing the environmental watering priorities is determining the water resource availability scenarios (RAS). The MDBA calculates the RAS using the Guidelines for the method to determine priorities for applying environmental water. The calculation is based on indicators of antecedent climate conditions over the previous year (rainfall, runoff and soil moisture) and surface water availability in public dams of regulated systems.

Appendix 2 – Assessing Vulnerability for use in Determining Basin-scale Environmental Watering Priorities

The planning and prioritisation of environmental water is a key step to achieving the long-term environmental outcomes of the Basin-wide environmental watering strategy. The method for determining Basin annual environmental watering priorities is constantly improving and aims to consider a wide range of factors including vulnerability of ecosystems and the biota that depend on them.

The Vulnerabilities report (Hale et al 2023) presents a method of determining 'vegetation' and 'waterbird' vulnerability across the Basin, where vulnerability is a combination of 'condition' and 'stress'. The results of the condition, stress and vulnerability assessments are then displayed in two different ways, spatially as a map or temporally in a table. For future Basin Environmental Watering Priorities, it is intended that the method is used to assess vulnerability for waterbirds and native vegetation with the available input data and to provide a scientific evidence base for annual watering prioritization.

For the vegetation component vulnerability is calculated using indicators of condition (tree stand condition, vegetation cover and "greenness") and three stress indicators (time since last inundation, inundation extent and soil root zone moisture). Data sources for condition indicators for native vegetation include a combination of the MDBA Tree Stand Condition tool, NDVI, WIT time series metrics from Geoscience Australia, and BOM data for soil moisture. The most recent data available is for 2021, where vulnerability is most evident in the Lower Murray (from Chowilla onwards) and Lower Darling (from Wilcannia). While inclusion of up-to-date results and further refinement of this technique are needed, water managers may find that the current results highlight areas for further consideration. An accessible map is available at Vegetation Vulnerability to assist.

For the waterbird component, the Vulnerabilities report provides valuable information on different elements that impact waterbird populations in the Basin by reporting on vulnerability of functional groups of waterbirds (e.g. shorebirds). The stress indicators for waterbirds are based on remotely sensed metrics (NDVI, soil moisture, time and extent since last inundation) which is updated to the most recent year (2022). The stress score assesses impacts on waterbirds when their basic lifecycle requirements are not met (e.g. the condition and stress of required habitats). The condition score illustrates how waterbirds respond during dry years versus wetter years, and relative recoverability following long dry events based on abundance, breeding and species richness. Waterbird vulnerability is then the combination of condition and stress for each functional group (and species) at the Basin scale. The most recent year for which the waterbird vulnerability assessment could be applied was 2021, where colonial nesters, cryptic waders and filtering feeding species showed highest vulnerability with lower levels of recovery in the return to wet conditions. The assessment can also be applied at a species level, for example, Australasian darter, Australian shoveler and

brolga, being representatives of three different functional groups and three different levels of vulnerability. All three species were more vulnerable in dry years, however recovery for Australasian darter was slower than for the other two species.

Vital habitats were identified using High Ecological Value Aquatic Ecosystems (HEVEA) criteria applied to the BWS important waterbird wetland complexes. Using this criteria, the highest-ranking wetlands for colonial nesting waders were the Lowbidgee floodplain and Macquarie Marshes, closely followed by Booligal wetlands, Kerang wetlands and Lake Cowal. While updating of results and further refinement is needed, water managers may find that the results highlight areas for further consideration.

For more information see the full report.

Hale, J., Brooks, S., Campbell, C. and McGinness, H. (2023). Assessing Vulnerability for use in Determining Basin-scale Environmental Watering Priorities. A Report to the Commonwealth Environmental Water Office, Canberra. Assessing Vulnerability for use in Determining Basin-scale Environmental Watering Priorities (dcceew.gov.au)

Office locations – *First Nations Country*
Adelaide – *Kaurna Country*
Canberra – *Ngunnawal Country*
Goondiwindi – *Bigambul Country*
Griffith – *Wiradjuri Country*
Mildura – *Latji Latji Country*
Murray Bridge – *Ngarrindjeri Country*
Wodonga – *Dhudhuroa Country*

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