

Australian Government



The 2020 Basin Plan Evaluation



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Errata

Errors have been identified in the following;

- **Figure 6 (p21)** graphic contains data for whole of Australia instead of the Murray–Darling Basin.
- Figure 7 (p21) graphic presents median flows instead of mean (average) flows.
- Figure 29 (p75) graphic includes data related to number of agricultural businesses irrigating.

These figures have been revised and updated in this current version of the document.

Images

Front cover: River Murray at Hattah Lakes, Victoria Right: Fires on the Brindabella Ranges, Australian Capital Territory

First Nations acknowledgement

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.

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Ultimately, responsibility for information provided and views set out in this report is entirely the MDBA's and does not necessarily reflect the position of the Australian Government or contributors.

The 2020 Basin Plan Evaluation





Image: MDBA Chair, Sir Angus Houston AK, AFC (Ret'd)

Foreword

More than 20 years ago, a critical journey began to rebalance the scales and bring water use back to more sustainable levels in the Murray–Darling Basin. Our river environment – and therefore it's communities and industries – were in trouble. All governments decided to act in the national interest. Together, we embarked on a bipartisan water reform journey not seen anywhere else in the world. The significance of that statement cannot be underestimated.

While this massive reform – including the more recent Basin Plan – has been rolled out, many other factors have come into play, and compounded the impacts of change. Climate change, drought, technological change, the ageing workforce, a global pandemic and changing consumer trades are all taking their toll and some Basin communities feel like they're no longer in control of their future. Having spent time working on a farm, I have lived through drought and the resulting uncertainty and am familiar with this unique feeling of vulnerability.

While travelling and listening to Basin communities I have heard and seen these stories. This feeling of vulnerability concerns us all.



Image: Hume Dam on the River Murray, New South Wales

You could be forgiven for wondering – is all this water reform worth it? Are we seeing the benefits? This Evaluation presents a good opportunity for us all to reflect, review and adapt.

We have come a long way. Working collaboratively, we've set up the world's first sustainable water management system. We've got catchment-scale plans which guide how water is shared and used in each catchment. Compliance frameworks are in place to monitor water take activities to make sure it's legal and fair. Also, a significant portion of water has been recovered for the environment and is being used for environmental benefit, which ultimately benefits us all.

The reform is working and needs to continue, but we need to take every opportunity to reflect, learn and adapt. We also need to keep our ears and eyes open to how Basin communities and industries are faring. If they felt they've been dealt out of their future, we need to deal them back in. This Evaluation is designed to give space to reflect, adjust and change as new information and science becomes available and we learn more about sustainably managing the natural asset Basin communities rely on. Priority areas have been identified through the evaluation process and it will take all Basin governments, communities and change makers working together to maintain our momentum.

This Evaluation has made 12 recommendations to facilitate this progress and the MDBA has committed to 6 priority areas designed to increase collaboration and continue our road of reform.

We know drought, climate change and other factors are taking their toll. The scale and pace of change presents challenges for adjustment, but it's in Australia's interest to rebalance the scales and create a sustainable longterm footing for industries and communities and the environment we live in. We must continue to work together to preserve one of Australia's greatest natural assets.



MDBA Chair, Sir Angus Houston AK, AFC (Ret'd)

The 2020 Basin Plan Evaluation



To maintain a healthy river system, water resources in the Murray–Darling Basin need to be managed carefully to meet the challenges of agricultural growth, population changes and increasing climate extremes.



More than one million square kilometres



Home to 2.2 million people



More than 50 First Nations



77,000 kilometres of rivers, including 4 of Australia's longest



30,000 wetlands, 16 internationally recognised and contain Australia's largest river red gum forest (66,000 hectares)



9,200 irrigated agriculture businesses generating almost \$9 billion gross value of irrigated agricultural production



\$8 billion tourism industry annually



120 species of waterbirds and more than 50 native fish species





Executive summary

The Murray-Darling Basin is crucial to Australia's economy, home for many Australians, and contains a rich diversity of natural environments that are unique in Australia and the world.

The Basin Plan, established in 2012 under the *Water Act 2007,* is one of Australia's most ambitious and complex reforms. It was developed to rebalance the system and respond to the severe pressures the Millennium drought placed on the Basin's rivers.

The Basin Plan is the commitment all Basin governments made to work collectively towards a sustainable and healthy river system. It seeks to establish enduring arrangements that leave enough water in the rivers to sustain natural ecosystems. The Basin Plan aims to achieve a sustainable healthy system for the benefit of all users – the environment, communities, cultural and recreational users, as well as irrigated and dryland agriculture. The Plan is made under Commonwealth law, requiring ongoing cooperation and commitment from 6 governments – 4 states, one territory, and the Australian Government.

Image: Barwon River, New South Wales

Context for the Evaluation

The 2020 Basin Plan Evaluation (the Evaluation) is conducted 8 years after the Basin Plan came into effect and 3 years since the 2017 Evaluation – it is the **most extensive review built into the Basin Plan.** The Evaluation assesses progress in implementing the Basin Plan and considers the best available evidence to determine if outcomes from the Plan are being met at a Basin-scale. The Evaluation also identifies a number of areas of improvement for future water use and management in the Basin.

The Evaluation has drawn upon **expertise and analysis from a wide range of sources** – including from the science community, independent advisors, the Australian Government, Basin state governments, and stakeholders from communities and industries. Perspectives of Basin communities on the Plan have been drawn primarily from the 3 independent reviews commissioned by the Australian Government on aspects of water management in the Basin (The ACCC Murray-Darling Basin water markets inquiry; the Interim Inspector General's study into the impact of lower inflows on state shares; and the independent assessment of social and economic conditions in the Basin led by Robbie Sefton).

The MDBA has also **built in several independent check points** to validate results and ensure that the Evaluation is a **comprehensive assessment of implementation progress and outcomes** at the Basin-scale.

The Evaluation shows the **Basin Plan is achieving important outcomes**. Progress and measurable environmental outcomes have been observed at the Basin-scale. These outcomes should be acknowledged and celebrated, as the road of reform has been complex and challenging. **Water for the environment is now a secure and enduring element of the system**, and this water is being used strategically on important environmental sites across the Basin and throughout the river system. The Evaluation also highlights that the shift in water allocation under the Basin Plan has been **challenging for some communities**, particularly where the impacts of water reform have coincided with other major economic and social changes. Supporting the resilience and adaptive capacity of Basin communities, particularly smaller irrigation-dependent communities that are heavily impacted by changes associated with the Basin Plan and water reforms, must be a priority.

As well as taking stock of implementation progress, the Evaluation looks ahead and considers the task of renewing the Plan. It is clear that a substantial shift in focus and effort is needed to adapt water management in the Basin to climate change – which will reshape water availability and use in the Basin.

The unprecedented dry and warm conditions and the associated record low inflows in the Basin are an important warning sign to Basin communities, interest groups and governments. Without the environmental flows provided for by the Basin Plan, the already devastating environmental impacts, such as the Lower Darling fish deaths, would have been worse. The Basin Plan and water management arrangements in the Basin will need to be responsive to climate extremes in the future.

Governments, industries and communities must work to improve their climate resilience and adapt their use and management. The Basin will be drier, warmer and subject to more climatic extremes. This will result in Australia needing to make some difficult choices in the Basin as the desired outcomes of all stakeholders cannot be achieved. This challenge is something the Basin's stakeholders must confront immediately, with the adaptive management of water resources under the Basin Plan playing a supporting role. A key lesson from the initiation and implementation of the Basin Plan is the need for these difficult choices to be made with Basin communities and stakeholders – not for them.

The Evaluation identifies the need to provide **First Nations with a clearer pathway** to achieve enhanced cultural outcomes in the Basin, as well as to clarify their involvement in water resource management. There has been good progress to date, but continued commitment is needed. This will require targeted support and changes by governments in partnership with First Nations.

Finally, there is a pressing need for **further investment** in dedicated long-term science and monitoring to support adaptive management in the Basin. The Evaluation has identified significant gaps in the information and modelling tools required to assess the effectiveness of the Basin Plan. The Evaluation has highlighted climate change risks, additional threats and implementation challenges that will require improved knowledge. Over the past 8 years the investment in science and monitoring has been patchy, and this has affected river and system managers' ability to effectively manage short and long-term challenges. The \$20 million investment in the Murray-Darling Water and Environment Research Program and initiation of the Basin Science Platform is significant, however, longerterm commitments will be required.



The 2020 Basin Plan Evaluation major findings

The major findings of the Evaluation are discussed below, under the themes of:

- --- Implementation of the Basin Plan
- --- Environmental, social and economic outcomes
- --- First Nations
- --- Climate resilience and adaptation
- --- Science and monitoring.

Implementation of the Basin Plan

Most elements of the Basin Plan are now in place and are improving sustainable and adaptive water management in the Basin:

- --- Sustainable diversion limits
 - The sustainable diversion limits (SDLs) on how much water can be taken out of the natural system are guiding water use and management. The limits cover surface water and groundwater use.
 - These limits build on the Cap¹ governments put on diversions in 1995.
 - At the time of the Basin Plan's development, knowledge of the northern Basin and some groundwater areas needed improvement. The review of the northern Basin has helped to overcome significant knowledge gaps and resulted in improved SDLs. The northern Basin review identified the need to better target effort and to ensure other actions were in place that support the health of the northern Basin river systems and communities. This resulted in commitment to the Northern Basin Toolkit measures.

- --- Water for the environment
 - Addressing overuse of the Basin's water resources has progressed. More than
 2,100 gigalitres of water is now held and managed by the Basin's environmental water holders. This significant volume of water is being applied across the Basin to achieve healthy river system outcomes.
 - The environmental water management frameworks that guide how this water is applied are in place. There is evidence that management arrangements for environmental watering have been improved and have been made more practical since the Basin Plan was made in 2012. Communicating the aims and processes for management of water for the environment remains a challenge and needs improvement.

--- Water resource plans

 Water resource plans are in place for Queensland, South Australia, Victoria and the Australian Capital Territory. These plans are important as they establish limits at the catchment or local scale by clearly outlining how much water can be taken from the system, how water will be made available for the environment, how water quality standards will be met and how water management arrangements for extreme weather events will work.

--- Compliance

 Compliance arrangements were fast-tracked as a result of community concerns and public scrutiny. Basin governments worked together to agree and implement a Compliance Compact. Basin state governments are continuing to make progress against their Compliance Compact commitments.

¹ In 1995, the Murray–Darling Basin Ministerial Council introduced the Murray–Darling Basin Cap on Surface Water Diversions (the Cap) to protect and enhance the riverine environment and protect the rights of water users. The Cap introduced long-term limits on how much water could be taken from rivers in 24 designated river valleys.

--- Water monitoring and accounting

- There have been significant improvements in water metering, monitoring and accounting.
 Further improvements are required to build public confidence that all water being traded, used for consumptive or environmental use is accounted for and all players have a fair system.
- --- Water trade
 - The southern Basin water market is wellestablished and demonstrates the ability of water markets to support the movement of water resources to their highest value use.

Most elements of the Basin Plan are now in place and are improving sustainable and adaptive water management in the Basin.

- The remaining water resource plans from New South Wales are significantly delayed from the June 2019 target set in the Plan. These plans are crucial to future management in the northern Basin, including connectivity, floodplain harvesting and critical human water needs. Achieving accredited water resource plans at the Basin-scale is essential to achieving Basin Plan outcomes.
- Most water resource plans experienced delays in assessment and accreditation, some of which can be attributed to the highly prescriptive nature of the legal obligations associated with the accreditation process, and the need for the MDBA to provide guidance on addressing requirements.

- Sustainable Diversion Limit Adjustment Mechanism (SDL Adjustment Mechanism) projects will reduce the amount of water that needs to be recovered from the consumptive pool. Constraints projects will help water reach important floodplains and improve river management for water users. There is a growing risk that some projects will not be completed by 2024, with associated calls for deadlines to be amended.
- There are a range of projects in the northern Basin that also need to progress to development and delivery on the ground. This includes the licensing and measurement of floodplain harvesting and overland flows, and the roll-out of remaining 'Northern Basin Toolkit' measures.
- Water management in the Basin is complex and difficult for water users, communities and the general public to navigate. The National Water Initiative identifies the need for community partnerships and adjustment. There has not been enough consistent and coordinated effort by the Basin governments and the MDBA in helping water users to work within the new framework. The recently announced Water Information Portal should help, but this will need to be complemented by informed engagement and capacity builiding.
- As water markets grow and water management systems mature, regulatory arrangements must evolve. It is clear that greater and more practical information is needed to support water users' participation in the market.

Environmental, social and economic outcomes

- The Basin Plan is having a significant and positive impact on the Basin environment. This has been crucial for sustaining water-dependent ecosystems during the recent drought, but is unlikely to be sufficient to achieve long-term outcomes unless further implementation and other actions are fasttracked.
 - The Basin Plan has protected flow regimes across much of the southern Basin, including base and fresh flows in some rivers. Positive ecological responses have resulted from this water for the environment.
 - In the regulated rivers of the northern Basin, the Basin Plan has protected some rivers from the worst impacts of the unprecedented drought. Implementation of the Basin Plan has been associated with improvements to flow regimes. This includes reductions in the effects from the severity and duration of dry spells and protection of the first flows after much-needed rainfall. This has, however, only been possible in regulated rivers where water can be delivered from storages.

- The Basin Plan has enabled delivery of water for the environment to support the Coorong, Lower Lakes and Murray Mouth ecosystems through the drought, substantially avoiding the environmental degradation that occurred during the Millennium drought.
- The Basin Plan is unable to effectively support many floodplain and wetland ecosystems until implementation of critical improved water infrastructure and river operating rules are in place. These are committed to be delivered through the package of projects to adjust limits, including supply and constraints projects. Also needed is the accreditation of all water resource plans as these set the rules on how much water can be taken from the system on an annually, ensuring the SDLs are not exceeded over time. The plans also set the rules for management of water for the environment.
- The major fish death events in 2019 demonstrate the need for whole-of-system management and are a stark reminder of the potential impacts that full implementation of the Plan seeks to mitigate.
- Basin governments and the Basin Plan need to continue to adapt and improve approaches to managing water quality and salinity, particularly in the context of low or no-flow conditions.



Image: A wetland in Barmah-Millewa Forest

- During a period of rapid change for many Basin communities, the Basin Plan has contributed to some positive social, economic and cultural change in the Basin. There has been significant variation in this contribution, and important differences in the distribution of impacts on communities, ranging from significant negative impacts on some small regional communities to generally positive impacts on most other Basin communities.
 - There are multiple inextricably-linked drivers shaping conditions in communities. The largest drivers include forces of climate, globalisation, changes in the structure of the Australian economy, changes in population and demographics, and farm consolidation as well as innovation and technological changes in agriculture.
 - Water recovery and the various approaches used to recover water have had mixed impacts on people, businesses and communities in the Basin. Lessons from the various approaches to water recovered for the environment and their flow-on impacts to communities should be considered by governments in future efforts to move consumption to sustainable levels in the Murray-Darling river systems.
 - Water trade rules implemented through Basin reforms are supporting ongoing improvement to water markets (primarily surface water) across the Basin. Key Basin Plan implementation activities have supported improving the efficiency and effectiveness of markets. The improvements sought to enhance drought resilience, facilitated moving water to its highest value use, and assisted with the transition to the new SDL limits.
 - Market transparency and performance have improved across the Murray-Darling Basin through actions implemented by Basin state governments, some driven by the Basin Plan trading rules. However, there remains a lack of transparency and timeliness of market information. When this is addressed it is expected the performance of the water market will be significantly improved for the benefit of all market participants.

- The timing, location and volume of demand is changing, and this is affecting communities and water delivery across the whole Basin. In the southern Basin this has had varying impacts on communities, river operations and the environment.
- There is evidence to suggest that much of the past funding to support communities to adapt to water reform could have been better targeted, particularly for those smaller communities that have had more water recovered through direct buybacks or that did not receive on-farm irrigation upgrades.
- The complexity of the water policy and management system and the number of different government agencies involved is confusing and has worn down community confidence in some regions. This is also a major barrier for effective and coordinated engagement with water users and Basin stakeholders.
- The Basin Plan is not sufficient on its own in achieving healthy and resilient ecosystems in the Murray-Darling Basin. Other practical actions are needed to work alongside the Basin Plan and effective water management. Coordinated natural resources management policies, pest and weed management, regional development and structural adjustment, agricultural industry innovation and diversification, and land use planning and innovation are all essential to deliver prosperous and healthy communities, industries and environments in the Basin.

First Nations

- The involvement of First Nations in water resource planning and delivery in the Basin began prior to the Water Act 2007 and the Basin Plan. The Basin Plan has formalised some of these partnerships and provided further opportunities for inclusive decision-making.
- The Basin Plan builds on work undertaken by the states and has provided additional opportunities for First Nations to play an active role in water planning.
- Looking ahead, there are opportunities to strengthen First Nations' water access for social and cultural outcomes. There is also considerable opportunity to further draw on and learn from First Nation knowledge and understanding of the river systems and natural resource management.

Image: Basket weaving as part of Ringbalin 2010



Climate resilience and adaptation

- ••• The Basin's climate is changing. Evidence shows the climate of the Basin is likely to be warmer, drier and to include more frequent and severe droughts and extreme weather events.
- The shift in climate will significantly challenge water availability, use and management and result in flow-on impacts to communities, industries and the environment. These changes pose the greatest risk to achieving the Basin Plan's desired social, economic and environmental outcomes.
- The first 8 years of Basin Plan's implementation have tested the policy in extreme climate conditions. There have been both large-scale floods and record dry conditions. The floods resulted in successful fish breeding and vegetation growth, along with blackwater events, and a range of both positive and negative community impacts. This was contrasted with the Basin's driest 3-year period on record (2017-2019), which saw record low inflows, towns running out of water, mass fish deaths, extensive bushfires and significant water quality issues.
- Implementation of the Basin Plan has improved the ability of the Basin and its stakeholders to respond to increased climate challenges, particularly when compared to the over-allocated pre-Basin Plan levels. However, if the Basin is to be resilient to the changing climate all water users will need to adapt to less inflows and new management approaches will be required to ensure the Basin remains healthy and productive. This is the key challenge for the next phase of water use and management in the Basin.
- Advancing knowledge, improving information to support decisions and adopting innovations will all be needed to support water users, river operators and government agencies in the future.

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Science and monitoring

- Science and monitoring play an important role in managing a complex social-ecological system like the Basin. Understanding the interactions of ecological, hydrological, social and economic factors is critical to water policy and the ongoing adaptive management of water in the Basin.
- Vast amounts of research, information and data has been used to support Basin Plan implementation. Information is sometimes fragmented, patchy and at times conflicting due to the varying spatial scales of Basin monitoring programs. There is a need for an improved monitoring framework, similar to a State of the Environment approach that supports consistent Basin-scale information, as identified in a number of independent reviews of Basin management.
- Ongoing investment is required to enable development and implementation of long-term, adaptive science and monitoring programs.
 Collaboration between Basin governments will be needed to drive the programs' ability to capture and communicate information at a whole-of-Basin, catchment and asset scale. Recent investment in this area by the Australian Government and the collaborative investment in the Basin Science Platform will help in the development of this framework.
- Effective partnerships between scientists, water managers and community groups must be prioritised to collaboratively develop a hierarchy of objectives within an adaptive management framework.



Image: Waterbird monitoring in Reedy Swamp, Victoria

The 6 priority areas for the future

Focus for the future

All Basin governments, communities and change makers must work together to improve the health and productivity of the Murray–Darling Basin. The Evaluation has pinpointed several priority areas for these efforts.



Image: The Coorong and Murray Mouth, South Australia

1. Implementing the Basin Plan

Focus and attention from all governments is needed to ensure continued progress on Basin Plan implementation and supporting measures, for the benefit of all Australians – we must work together.



Image: Hume Dam at 4% capacity, New South Wales



Governments, industries and communities must work to improve their climate resilience and adapt their use and management.



Image: Vineyard in Rutherglen, Victoria

3. Strengthening focus and support to enable social and economic outcomes

A key lesson from the initiation and implementation of the Basin Plan is the need for these difficult choices to be made with Basin communities and stakeholders not for them.

4. Establishing a clear and committed pathway for First Nations social and economic outcomes

There is a need to provide First Nations with a clearer pathway to achieve enhanced cultural outcomes in the Basin, as well as to clarify their involvement in water resource management.

5. Integrating water management with other activities to achieve environmental restoration

Basin governments need to work with communities to develop clear priorities and a framework for integrating water within broader natural resource management.



Image: Fishway in the Barwon River, Brewarrina, New South Wales



Image: Waterbirds at Narran Lakes, New South Wales

6. Advancing science and monitoring

Strategic investment in science, a structured framework for monitoring and smart collaboration between Basin governments is essential to ensure ongoing continuous improvement at a Basin scale.



Image: Water quality monitoring near Euston, New South Wales

Recommendations



Image: The Coorong and Murray Mouth, South Australia

1. Implementing the Basin Plan

The Evaluation shows the Basin Plan is achieving positive outcomes – measurable environmental outcomes have been observed at the Basin-scale, and some good local projects involving communities and industries. Many of the major elements of the Basin Plan are now in place and are improving sustainable water management. Some critical elements, however, still lag in implementation. Until all components of the Basin Plan are operational, the full benefits for Basin communities and the nation cannot be delivered.

- Recommendation 1 Basin state governments and the Australian Government need to urgently commit to delivering significant Basin Plan projects. These include the SDL Adjustment Mechanism projects, 'Northern Basin Toolkit' measures and the remaining water resource plans, which are yet to be accredited. All are complex initiatives and governments need to continue to work in partnership with local communities to design and implement.
- Recommendation 2 There is still scope for Basin governments to propose new and innovative approaches to achieving the long-term sustainable limits for water use in the Basin.
 As Basin governments and communities engage on completing the remaining elements of Basin Plan implementation it will be vital to show how these new approaches could contribute to delivery of sustainable water use limits.

MDBA commitment:

The groundwork must start soon to devise an approach for the 2026 Basin Plan Review, including meaningful community and other stakeholder involvement in the process. The MDBA will work with Basin governments and stakeholders to take this forward, focusing on the long-term sustainable health of the Basin.



2. Adapting to climate challenges and increasing resilience

The climate of the Basin is changing and water managers, communities, industries and the environment will need to adapt to a hotter and drier climate future. A key cross-cutting theme from this Evaluation is the need for all water managers and users to plan and adapt to the changing climate for the long-term future of the Basin.

- Recommendation 3 Basin governments should improve sharing of knowledge, tools and innovations that are critical to support climate adaptation and water management. Information and science on future water availability and trends must be shared widely to support businesses, communities and industries plan to be proactive, adapt and diversify.
- Recommendation 4 Basin governments and the MDBA need to prepare to adapt the Basin Plan in 2026 to incorporate future climate scenarios and trends. This means improving existing tools and developing new frameworks for Basin-scale management. An agreed work program should be established and shared publicly.
- Recommendation 5 Basin water users, managers, First Nations and community groups need to plan for the future climate. As well as Basin-wide assessment, local climate opportunities and risks should be given attention along with implications, trade-offs and adaptation priorities.

MDBA commitment:

The MDBA will facilitate the sharing and coordination of information on Basin climate adaptation. The MDBA will bring water managers together with communities, industries, First Nations and governments to explore strategies. The MDBA will focus effort and investment to improve access to science and evidence for all stakeholders to contribute to enhancing climate resilience and adaptation in the Basin.



3. Strengthening focus and support to enable social and economic outcomes

This Evaluation and recent reviews highlight an urgent need for targeted and focused support for communities in the Basin, particularly smaller, irrigation-dependent and remote communities. This requires meaningful engagement to customise support and provided improved information.

Basin communities are experiencing rapid change driven by many factors, of which water availability is only one.

Recent commitments by Basin government water ministers to work collectively to share information, the Australian Government's \$35 million Hydrometric Network and Remote Sensing in the north and the Australian Government's Murray–Darling Communities Investment Package will improve information access and respond to some of the community concerns about information and engagement.

 Recommendation 6 - Basin governments and the MDBA need to work in partnership with industry, First Nations and other water users to ensure water information is more accessible, understandable and timely, in order to create a more transparent, effective, practical operating environment for water users.

- Recommendation 7 Basin governments and the MDBA must commit to working with Basin communities on water management to boost meaningful and coordinated two-way engagement.
- Recommendation 8 Basin governments need to strengthen policies and programs that support communities and industries to adapt and prosper including but going beyond water-focused programs. Investment in collecting social and economic data at Basin and regional scales is required to shape well designed and targeted support for communities and industries. There are opportunities to stimulate regional development and prosperity through facilitating adjustment, and underpinning agricultural development including research and development, First Nations policies, infrastructure investment and land use planning.

MDBA commitment:

In collaboration with the Australian Government, experts and researchers, the MDBA will help improve social, economic and cultural data collection and analysis. Through its regional network, the MDBA will disseminate this information to support community planning processes.



Image: Fishway in the Barwon River, Brewarrina, New South Wales

4. Establishing a clearer and committed pathway for improved First Nations social and economic outcomes

There are more than 50 First Nations in the Basin and the MDBA and Basin governments value and respect their significant knowledge of the Basin and its ecosystems. Better involvement and support is needed for First Nations people to benefit from their cultural and economic connections with Basin rivers and floodplains. There is also an opportunity to learn and incorporate First Nations' knowledge into Basin water use and management.

- Recommendation 9 First Nations, Basin governments and the MDBA should develop a practical pathway for the use of water for cultural and economic outcomes. This should build on current knowledge and fast-track initiatives, such as the \$40 million water entitlements project for First Nations.
- Action should be focused on short-term practical activities, as well as build the foundations for enhanced First Nations outcomes in the longer term.

MDBA commitment:

The MDBA commits to working with First Nations to identify practical options that enhance First Nation outcomes as work proceeds on the review of the Basin Plan in 2026.

The appointment of a First Nations Authority member will help the MDBA collaborate with First Nations to enhance of our knowledge of the Murray–Darling and apply this to water management.



Image: Waterbirds at Narran Lakes, New South Wales

5. Integrating water management with other activities to achieve environmental restoration

Sustainable water management needs dedicated water for the environment as achieved through the Basin Plan, to work alongside natural resource management. Increased targeted investment and support for actions that complement water management including catchment soils and vegetation health and control of pests and weeds. These activities do not replace the need for environmental flows, but support and complement outcomes, including improved resilience and adaptation to climate change.

Recommendation 10 - Basin governments need to work with communities to develop clear priorities and a framework for broader natural resource measures. Increased investment and support for additional measures can be driven by governments, industries and communities, and it is important that increased effort is targeted and integrated with environmental watering.

MDBA commitment:

The Basin Watering Strategy that guides use of water for the environment will be updated in 2022 and will now also consider inclusion of broader natural resource management, social, cultural outcomes.

MDBA will develop this new strategy involving Basin communities, experts and Basin governments.



Image: Water quality monitoring near Euston, New South Wales

6. Advancing science and monitoring

Greater investment in science and monitoring is badly needed to support the management of a complex river system like the Basin. The Evaluation has identified gaps in monitoring while emerging risks, including climate change, will require improved knowledge to support adaptation. Basin governments need to collaborate and invest more in long-term science and monitoring programs as well as short-to-medium-term intervention monitoring to support understanding and appropriate responses to Basin conditions and changes in them over time.

 Recommendation 11 - Basin governments should prioritise higher levels of continuing strategic investment in science and monitoring.

The new Australian Government Murray–Darling Water and Environment Research Program and the Basin governments' Science Platform provide a much needed foundation for an improved, enduring Basin science program.

Any framework and program of investment must be long-term, transparent and embed continuous improvement. The investment should also cement enduring collaborative relationships between researchers and managers to improve use of the best available science to water management. Recommendation 12 - Science and monitoring information must be made more accessible for all Basin stakeholders to improve the communication of Basin outcomes to the broader Basin community.

MDBA commitment:

The MDBA will develop an improved Basin-wide monitoring framework which considers social, cultural, economic and environmental themes. The MDBA will work with Basin governments and researchers to clearly identify roles and responsibilities and ensure integration of monitoring programs and improved access to data and information. The MDBA will take an active role in facilitating access and application of information.

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Introduction

The 2020 Basin Plan Evaluation is conducted 8 years since the inception of the Basin Plan and 3 years after the last Evaluation in 2017. This report fulfils legislative requirements for the Murray-Darling Basin Authority (MDBA) to prepare 5-yearly reports on matters listed in Schedule 12 of the Basin Plan (section 13.14) and to prepare an annual report on the effectiveness of the Basin Plan (*the Water Act 2007*, s 52A(1)). The information in this report informed advice the MDBA provided to the Murray-Darling Basin Ministerial Council on the impacts of the Basin Plan, as required by section 49A of the *Water Act 2007*.

The Basin Plan's monitoring and evaluation program requires 5-yearly reporting on the outcomes and effectiveness of the Basin Plan. It reports on the changing context in the Basin, the effectiveness of the Basin Plan in achieving its purpose, the outcomes that are being observed from hydrological and environmental to social, economic and cultural outcomes. The Evaluation considers the impacts of the Basin Plan and identifies areas for focus in the future.

Image: Campaspe River, Victoria

The approach is guided by the required questions set out in the Basin Plan. It provides an opportunity to reflect on the past 8 years and look forward to the future.

This 2020 Basin Plan Evaluation also builds on the 2017 Evaluation. A summary of the findings and recommendations from this interim Evaluation is available on the MDBA's website.

Evaluation approach

The MDBA has drawn on considerable independent expert advice throughout all stages of this evaluative process. This analysis, expert advice and feedback has come from the science community, independent advisors, the Australian Government and state governments, as well as Basin community and industry representatives.

At the time of this Evaluation there were several highprofile reviews being undertaken in the Basin which sought stakeholder input. The MDBA has drawn on the input made to these other reviews, particularly the independent panel assessing social and economic conditions in the Basin led by Ms Robbie Sefton, as well as the work of the Interim Inspector-General for the Murray-Darling Basin and the Australian Competition and Consumer Commission (ACCC). The Evaluation considers Basin Plan implementation across a range of themes and examines the outcomes (illustrated in light blue in Figure 1):

- --- Hydrological, water quality and environmental outcomes:
 - southern Basin
 - northern Basin
 - end of system
 - floodplains and wetlands
 - water quality and salinity.
- --- Social, economic and cultural outcomes.



Figure 1: Key elements of the Basin Plan Evaluation - Source: MDBA

Basin Plan Evaluation questions

- 1. To what extent has the intended purpose of the Basin Plan (set out in section 20 of the *Water Act 2007*) been achieved?
- 2. To what extent have the objectives, targets and outcomes set out in the Basin Plan been achieved?
- 3. How has the Basin Plan contributed to changes to the environmental, social and economic conditions in the Murray–Darling Basin?
- 4. What, if any, unanticipated outcomes have resulted from the implementation of the Basin Plan?

- 5. How could the effectiveness of the Basin Plan be improved?
- 6. To what extent were the actions required by the Basin Plan suited to meeting the objectives of the Basin Plan?
- 7. To what extent has the program for monitoring and evaluating the effectiveness of the Basin Plan contributed to adaptive management and improving the available scientific knowledge of the Murray-Darling Basin?

A focused evaluative approach occurred for each theme and this report draws out the overarching findings and conclusions from this work. This overarching report should be read in conjunction with the suite of detailed supporting technical reports, including:

- The detailed evaluations of environmental and water quality outcomes contained in the themed reports for:
 - southern Basin
 - northern Basin
 - end of system
 - lateral connectivity
- ••• The detailed evaluation of Basin Plan contribution to social, economic and cultural outcomes.
- ••• The evaluation of progress in implementation of the Basin Plan.

In addition, the changing context of the Basin was considered. MDBA engaged CSIRO and the Bureau of Meteorology to provide expert advice and analysis on the changing climate. This analysis is also being released as part of this Evaluation in the following technical reports:

- ••• Trends and historical conditions in the Murray– Darling Basin – Bureau of Meteorology
- --- Hydroclimate Futures for the Murray–Darling Basin CSIRO
- ••• Vulnerabilities to climate change in the Murray– Darling Basin – MDBA.

For themes that have a mature adaptive management framework, including objectives and targets, the Evaluation has implemented a consistent approach to reporting performance and applying confidence ratings: (Illustrated below in Table 1 and 2).

Performance scale

The 2020 Basin Plan Evaluation has adopted 6 performance ratings for key outcome areas which aim to help determine Basin condition indicators and the role of the Basin Plan plays in contributing to these indicators.

Evaluation ratings are labelled 1-6, with 1 being the lowest performance rating and 6 being the highest performance rating

This Evaluation also adopts a confidence scale which aims to transparently illustrate the confidence in data reliability and role of the Basin Plan.

Expert Advice

The MDBA applied the performance and confidence scales to each aspect of the evaluation. Ratings were shared with technical experts who helped to refine ratings and strengthen evaluation findings.

What is data reliability?

For data to be reliable or fit for purpose it must provide a dependable indication of system condition or response.

High data reliability - data is fit for purpose and has appropriate spatial and temporal coverage.

Moderate data reliability - data has some uncertainty in its representation of the system or some limitations in spatial and/or temporal coverage.

Low data reliability - data has limitations in its ability to describe the system and in spatial and/or temporal coverage. Table 1: Confidence (data reliability) rating scale



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Table 2: Performance rating scale

6	••••• 5	• • • • • • • • • • • • • • • • • • •						
Condition of indicators								
Indicators are all showing positive trends since implementation of the Basin Plan and/or all indicators have improved from baseline conditions.	Indicators are mostly showing positive trends since implementation of the Basin Plan and/or improvement from baseline conditions.	Indicators are mostly stable and/or showing no decline from baseline. The remaining indicators are mostly showing a positive trend and/or improvement from baseline conditions. OR there are a mix of positive and negative results, but on balance of probability are slightly more positive than negative						
Effectiveness of the Basin Plan in contributing to outcomes								
 The evidence suggests that mechanisms of the Basin Plan (as per program logic) are having a positive impact towards expected outcomes. Mechanisms of the Basin Plan (as per program logic) are being used effectively to contribute to achieving expected outcomes. There is evidence of outcomes being achieved at local, regional and Basin scales (as appropriate). In cases where there has been no progress towards expected outcomes there is evidence outcomes suggesting that external factors (including prevailing climate conditions) have influenced outcomes and/or the ability to provide opportunities to achieve outcomes. Learning and adaptive management has clearly occurred, improving actions and subsequent positive impacts on outcomes over time. There are no limitations or barriers (excluding external factors) to the Basin Plan achieving long-term objectives. No areas requiring improvement have been identified 	 Same as 6, however there may be: Some minor limitations in the scale and/ or longevity of outcomes being achieved, and/or Some minor limitations or barriers (excluding external factors) to the Basin Plan achieving long-term objectives and hence minor opportunities for improvement. 	 The evidence shows the results are mixed but on balance of probability are slightly more positive than negative. In some cases, the evidence suggests that the mechanisms of the Basin Plan are having some positive impact towards expected outcomes, while in other cases, they are not. There may be some limitations in the scale and/or longevity of outcomes being achieved. There may be some evidence of external factors (including prevailing climate conditions) influencing progress towards expected outcomes and/or the ability to provide opportunities to achieve outcomes. There may also be some cases where mechanisms are not being used effectively to achieve outcomes. There are some moderate limitations or barriers (excluding external factors) to the Basin Plan achieving long-term objectives. Improvements or change are required in some areas. 						
•••••• 3	••••• 2	• • • • • • • • • • • • • • • • • • •						
---	--	---	--	--	--	--	--	--
Condition of indicators								
Indicators are mostly stable and/or showing no decline from baseline. Remaining indicators are mostly showing a negative trend and/or decline from baseline conditions. OR there is a mix of positive and negative results, but on balance of probability these are slightly more negative than positive.	Indicators are mostly showing trends that are negative since the implementation of the Basin Plan and/or a decline from baseline conditions.	Indicators are all showing negative trends since implementation of the Basin Plan and/or a decline from baseline conditions						
Effectiveness of the Basin Plan in contributing to outcomes								
 Same as 4, however: The evidence shows the results are mixed, but on balance of probability are slightly more negative than positive. There are limitations in the scale and/or longevity of some outcomes being achieved. 	 The evidence suggests that mechanisms of the Basin Plan are not having a positive impact towards most of the expected outcomes. There are cases where mechanisms of the Basin Plan are not being used effectively to contribute to achieving expected outcomes. There are significant limitations in the scale and/ or longevity of most outcomes being achieved. There may be some evidence of external factors (including prevailing climate conditions) influencing progress towards achieving expected outcomes. There may be some evidence of adaptive management occurring. There are some significant barriers or limitations (excluding external factors) to the Basin Plan achieving long-term objectives. Extensive improvement or change is required. 	 There is evidence that suggests the mechanisms of the Basin Plan have not had any positive impacts on expected outcomes. Mechanisms of the Basin Plan are not being used effectively to achieve expected outcomes are being achieved even at local scales. The lack of positive impact on outcomes does not appear to be driven by factors external to the Basin Plan. Mechanisms of the Basin Plan are not enough for achieving long-term objectives. Fundamental improvement or change is required. 						

Background on the Basin Plan

Through the latter half of the 20th century, the rivers of the Murray–Darling Basin were showing signs of serious degradation. Dramatic declines in fish populations, the world's longest blue-green algal bloom, and declining water security for communities across the Basin were signals that changes were needed to how water was taken and used in the Basin.

The Basin Plan guides the management and sharing of water in the Basin. It is intended to achieve a healthy and productive Basin by restoring elements of the surface water and groundwater function and associated environmental condition. The Plan was built on the National Water Initiative (2004), which describes Australia's collective approach to water management, and the *Murray–Darling Basin Agreement*, which sets out how Basin state governments share the water resources of the southern Basin. The development of a Basin Plan was legislated in the *Water Act 2007* and agreed to by governments in 2012.

At its heart, the Basin Plan sets the amount of water that can be taken from the Basin each year, while leaving enough for rivers, lakes and wetlands, and the plants and animals that depend on them. The Basin Plan is a partnership between all Basin governments including the Australian Government, New South Wales, Queensland, South Australia, Victoria, and the Australian Capital Territory.



Figure 2: History of water reform in the Murray-Darling Basin

Ultimately, the Basin Plan aims to achieve a sustainable healthy system for the benefit of all users – the environment, communities, cultural and recreational users, as well as irrigated and dryland agriculture. It builds on past water management reforms and includes a suite of elements that together aim to achieve a healthy and productive Basin (Figure 3). The timeline for implementation is set out in Figure 4.

The Plan involves investment of almost \$13 billion and commitment from the Australian Government and Basin state governments to implement the policy and manage the Basin's water resources. The Plan aims to establish a sustainable, long-term and adaptive management framework for the Basin water resources by:

- setting specific objectives for environmental outcomes, water quality and salinity, sustainable diversion limits, and trading in the water market
- implementing an Environmental Management
 Framework, Water Quality and Salinity Management
 Plan, water resource plans and water trading rules

 supporting improvements to governance, partnerships with First Nations, monitoring and evaluation and risk management within and alongside the Plan.

The Basin Plan makes these changes to the existing water, land and related governance systems of each partner state and territory government that operates within the wider water management, social and economic systems of the Basin. It is a key contributor to improving outcomes in the Basin.

However, it is also important to recognise the limitations of water management and of the Basin Plan as a driver of change. The Plan's impact on the environment is restricted to specific areas of the riverine, riparian, wetland, floodplain, non-artesian groundwater aquifers and estuarine ecosystems of the Basin. The Basin Plan also has only a very limited role as a driver of wider social and economic progress for communities in the Basin (see Figure 5).



Figure 3: Key elements of Basin Plan implementation



Basin Plan explained



Water entitlements

Water entitlements are rights to an ongoing share of water within a system. The financial value of a water entitlement is determined by the water market (which operates like any other free market) and is subject to change.



Water resource plans

Water resource plans set the rules on how much water can be taken from the system, ensuring sustainable diversion limits are not exceeded over time. Each plan sets out the rules for how water is used at a local or catchment level, including new limits on how much water can be taken from the system, how much water will be made available to the environment, and how water quality standards can be met.

Water recovery

The water that needs to be recovered from industries and irrigators to ensure there is enough water to sustain the Murray-Darling Basin's natural ecosystems. Once the water is recovered, it is then used to achieve environmental outcomes for the benefit of all Australians.



Sustainable Diversion Limit Adjustment Mechanism

The Basin Plan sets sustainable diversion limits, which is how much water can be used in the Murray-Darling Basin.

To provide flexibility, the Basin Plan includes a mechanism to adjust limits through a range of projects that will modernise the river system.



Supply projects

Supply projects are improved ways to manage the Basin's rivers to more efficiently deliver water for the environment. Projects include environmental works, such as building or improving river or water management structures, and changes to river operating rules, which achieve environmental outcomes, with less water.



Constraints projects

These projects aim to overcome some of the physical barriers that affect the delivery of water in the system. Constraints projects can include changes to physical features, such as crossings and bridges. They can also change river operating practices and rules. They could allow water managers more flexibility in releasing and moving water through the system.



Efficiency projects

These are activities that change water use practices and save water for the environment. Projects can include upgrading irrigation systems, lining water delivery channels or installing water meters, along with water productivity improvements in manufacturing or irrigated agriculture, or changes to urban water management practices to reduce water.



Water for the environment

Water is allocated to Commonwealth and state environmental water holders, who make decisions about when, where and how much water is released for the environment with measurable environmental outcomes in mind.

- Held environmental water water is allocated to Commonwealth and state environmental water holders across the Basin, who make decisions about when, where and how much water is released for the environment, and with measurable environmental outcomes in mind.
- Planned environmental water water that needs to remain in the river system to sustain unique plants, animals and iconic landscapes that are an essential part of the river ecosystem.



Water trade and water markets

Water in the Murray–Darling Basin can be bought and sold, either permanently or temporarily. This water is traded on markets – within catchments, between catchments (where possible) or along river systems. This form of trading allows water users to buy and sell water in response to their individual needs. Water trading has become a vital business tool for many irrigators.



Water allocations

Water allocations are the amount of water distributed to users (water entitlement holders) in a given year. Allocations against entitlements change according to rainfall, inflows into storages and how much water is already stored. Allocations can increase throughout the year in response to changes in the system.



Water licences

Water is allocated to irrigators based on water availability and rules set out by different Basin state governments. Each state has developed its own set of licences and rules around how to allocate water to their entitlement holders. This means allocations, water orders and delivery of water all work in a different way from state to state.



Floodplain harvesting

Floodplain harvesting is when the water that flows across the floodplains during a flood is collected and used later. New South Wales and Queensland are currently introducing new arrangements to measure, account for and license this kind of water use.

Figure 5: The Basin Plan explained

The changing context for the Basin Plan

The context for implementation of the Basin Plan has continued to shift since 2012.

A warmer and drier future climate is much more certain. This means that long-term water availability consistent with the long-term climate record is unlikely, challenging the Basin Plan objectives.

Agriculture in the Basin has continued to grow strongly, however, many water-dependent communities have not been able to capture the benefits of buoyant market and investment conditions. These communities are at further risk as trends in economic consolidation, demographic changes, fluctuations in commodity prices and high water prices further concentrate water use into specific industries and locations.

The aim of the 2020 Basin Plan Evaluation is not to provide a comprehensive assessment of the condition of the Basin environment, communities and economy. Detailed information on these conditions has been used as the reference point for considering the contribution of the Basin Plan and can be found in the extensive technical reports. This section notes the **long-term context** for the Basin Plan and identifies **several consequential shifts since 2012**.

Long-term context

Climate

The Basin's climate features enormous spatial and temporal variability, ranging from sub-tropical in the north, to semi-arid in the west, to temperate in the south. Average rainfall across the region ranges from more than 2,100 millimetres in the highland areas in the southeast to less than 300 millimetres in the semiarid areas in the west. Flow regimes across the Basin experience large year-to-year variability on top of seasonal differences (Bureau of Meteorology 2020).

Floods and drought will continue to shape and challenge Basin communities, economies and the environment. The driest times create the greatest pressure. It was the experience of the Millennium drought and overuse of water resources that was the trigger for the Basin Plan to be developed and agreed to by Basin governments.

Environment

The Basin covers 14% of the Australian land mass. The 23 rivers and more than 30,000 wetlands of the Basin support a vast array of plants and animals in ecosystems that depend on a regular or intermittent supply of water. These water-dependent environments have evolved to function in the extremes that characterise the Australian climate – drought and flood, heat and cold. The rivers, wetlands, floodplains and groundwater aquifers play an important role in providing good quality water to natural and created environments that depend on water, as well as to communities and agriculture.

The Basin needs to have rivers with regular flows of variable volume to transport sediment, salt and nutrients through the system and out to sea. A certain amount of flooding is required so that floodplains receive water; importantly, this flooding also ensures that wetland plants can 'filter' the water by extracting carbon and nutrients, for the benefit of plants and aquatic animal species and to provide downstream environments and water users with good quality water. Groundwater needs to be maintained to support river levels, water quality and to sustain vegetation and ecosystems.

Communities and the economy

Nearly 2.2 million people call the Basin home. The Basin is not a single 'community': it is a large and diverse region that includes cities, towns, and rural areas (Schirmer et al. 2019). This diverse set of communities are experiencing economic trends in common with similar urban and regional communities around Australia.

Agriculture within the Basin is influenced by a range of factors in addition to water reform. Access to infrastructure and services is a key determinant of community wellbeing. Smaller communities, and outer regional and remote communities, typically have poorer infrastructure and services compared with larger regional centres and cities. Similarly, these communities have less access to high-speed, reliable internet and mobile phone reception relative to communities outside the Basin.

Other contributing factors that are all features of Basin communities that are shared with other Australian towns and cities include (Sefton Review 2020):

- --- ageing population
- a reduction in manufacturing and agricultural employment and growth in health and social services occupations
- --- areas of high unemployment and in many areas, persistent workforce shortages
- --- differences in access to health and education services
- ••• growth in the populations of larger centres and decline in many small and remote places.

Gross regional product (GRP) in the Basin is mainly driven by the services sector, accounting for 44% and 54% in the northern Basin and southern Basin respectively (Burgan et al. 2015). This includes education, tourism, healthcare and social services, and professional services. Agriculture accounts for 9% of GRP in the south and 8% of GRP in the north. These proportions vary widely across the Basin with 4 regions relying on agriculture for over half their gross regional production (Conargo, Karoonda, West Wimmera, and Carrathool). Agriculture makes up more than 20% of GRP for 44% of northern Basin local government areas and 41% of southern Basin local government areas.

Trends in commodity prices are major factors affecting the relative profitability of irrigated enterprises. There have been significant shifts in commodity prices over the life of the Basin Plan. The Independent panel on the socio-economic conditions in the Basin provides a detailed analysis of these trends, including strong prices for almonds, wine and citrus, significant volatility in milk prices and a decline and subsequent recovery of rice contract prices.

There has been a continuing trend of farm consolidation and improved technology that drives changes in the social and economic fabric of communities – particularly where these changes require fewer people to work onfarm. This shift is not new to the Basin or to agriculture. The result is greater efficiency and productivity on-farm, which enhances Australian farmers' ability to compete in global markets (Productivity Commission 2017a). However, these changes lead to lower employment opportunities occurring the entire way along the agricultural supply chain. It is noted that these trends are being observed globally and reflect the natural and necessary evolution of the agricultural sector and the requirement to stay competitive and grow over time.

Within the Basin's diverse communities and industries, there are some that depend directly on water resources for their prosperity and way of life. For example:

 15% of Australia's Indigenous population lives in the Basin (Sefton Review 2020) and more than 50 First Nations are the original inhabitants of the Basin. First Nations have a spiritual obligation to care for surface water and groundwater resources, as part of their commitment to caring for Country. Water management in the Basin needs to be shaped by First Nations and will benefit from supporting caring for Country.

- ••• Up to 50% of Australia's irrigated agriculture that is produced in the Basin, including major horticulture, rice, cotton and dairy industries, is made possible through access to significant amounts of groundwater and surface water. For some smaller communities in the Basin, these industries represent their main source of economic activity (MDBA 2018).
- Tourism in the Basin is closely connected to the river, and communities are habitable and livability is improved through access to water. Nature-based activities (including fishing, water and outdoor sports) were the second highest overall expenditure (behind other social activities) in the Basin during the past 4 years.

Inevitably, changes to water management under the Basin Plan are experienced most directly by the communities and sectors of the economy that are most connected to, and dependent upon, water resources.

Water infrastructure, governance and institutions

The Basin Plan is part of an ongoing process of water reform initiated by the National Water Initiative in 2004. The Plan was enacted to deliver specific reforms within an existing set of water management infrastructure, governance arrangements and institutions dedicated to managing water. These have been created progressively by governments since the development and economic use of water resources began in the 1800s.

Water infrastructure has a crucial influence on the challenges faced in water management and is also the pathway to achieving better outcomes. The infrastructure that has been built to manage flows varies widely among rivers. A regulated river has large dams, weirs and other infrastructure, which allow water to be captured, stored and controlled. This infrastructure provides some flexibility in managing water, but also has implications for the timing, duration, frequency and volume of flows, as well as the quality of water in the system, and all these can impact upon environmental outcomes. Water in unregulated rivers can only be accessed by capturing overland flows before they reach the river or by pumping flows directly from the river when water levels and rules permit. Bores throughout the Basin enable access to groundwater, some of which is connected directly to surface water.

The southern Basin, centred on the River Murray, is a highly regulated system whereas the northern Basin, flowing into the Darling with some exceptions, is largely unregulated. This means that in the south a large proportion of inflows is held in storages under licences for environmental or economic uses and is released independently of rainfall to meet the needs of water owners and managers. Water reform has significantly increased the proportion of this 'held' water that is owned by governments and can be released for environmental and other purposes. This is a primary mechanism for achieving better outcomes in the south, alongside plans, sustainable diversion limits and other reforms.

Compared to the rivers in the southern Basin, the northern Basin river system is characterised by a highly variable flow regime, in which prolonged periods of no-flow or low-flow are periodically interrupted by high-flow events that connect the entire river system. In addition, the proportion of flow regulated by dams is much lower than in the southern Basin. In the northern Basin, most water for the environment is planned, by placing rules on what can be taken via overland flow diversion or pumping from a watercourse. Groundwater is also a key source of water for communities and irrigation, as well as sustaining baseflows in rivers and supporting ecosystems. While there is some water 'held' for environmental and other purposes in the north, the rules set out in plans and enforced by governments for surface and groundwater are the primary mechanism water managers can use to improve environmental, social and economic conditions.

The state governments own most of the water that can be used in the Basin and provide entitlements, or licences, to water users be they irrigators or environmental water holders. The Commonwealth Environmental Water Holder also owns a portion of water for the environment. The Murray–Darling Basin Agreement specifies the way water in the regulated southern Basin is shared between New South Wales, South Australia and Victoria, and each state decides how to allocate their share of water to entitlement or licence holders. Entitlements and allocations can be bought and sold on the water market. All of these management arrangements existed prior to the Basin Plan.

The Basin Plan is premised on the MDBA and Basin state governments working together to collectively manage the Basin as a whole. The MDBA has a particular role in developing and helping guide implementation. Agencies from Basin state governments and the Australian Government lead the substantive implementation of many aspects of the Plan, including through development of water resource plans and sustainable diversion limit adjustment projects, long-term watering plans and water quality management plans.



Image: Yarrawonga Weir on the River Murray, New South Wales

Context since 2012

The context for the Basin Plan is changing. This section draws out several areas of change that have major implications for the effectiveness of the Plan and have shaped the outcomes to date of the Basin Plan reforms, as well as the major findings of this Evaluation.

The Evaluation has sought to identify the positive and negative impacts that have arisen directly from the work to implement the Basin Plan. This is a complex task with numerous interactions at different scales. It is not always possible to distil simple cause and effect relationships. Many issues in the Basin and in water management have only been partially shaped by the Basin Plan.

Climate

Finding

The climate is changing, challenging water availability, use and management and resulting in flow-on impacts to communities, industries and the environment. These changes will continue and pose the greatest risk to achieving the Basin Plan's desired social, economic and environmental outcomes.

The Basin has recently experienced a very severe, and in some areas unprecedented, drought. The evidence that the Basin will experience a warmer and drier future, with more climate extremes because of climate change, is now much more certain than when the Plan was developed.

Since the Basin Plan was approved in 2012, the climate has varied from extremely dry to wetter than average, although the latter was only in 2015-16. Each subsequent year from 2012 through to 2015-16 was steadily drier and hotter (Figure 6). Wetter conditions emerged in May 2016, with above average rainfall and inflows occurring across much of the Basin (MDBA, 2017).

Recent decades, however, have seen unusually low rainfall affect most of the normally wetter parts of the Basin, particularly during the cool season (May to October) (Bureau of Meteorology, 2020). A long-term decline in cool-season rainfall is affecting annual inflows to the River Murray system (Figure 7). Data from the Bureau of Meteorology (2020) shows that over these past 3 years almost the entirety of the Basin had below average rainfall, with some catchments recording their lowest rainfall on record.

Since the Basin Plan development, it is clear that the climate context for the Basin Plan is changing. There is a longer record indicating recent drying trends and greater scientific certainty in relation to climate change and its potential future impacts on the Basin (Zhang et al. 2020). The Bureau of Meteorology has informed this Evaluation by providing long-term historical climate conditions and trends (see *Vulnerabilities to climate change in the Murray-Darling Basin*).

> Figure 6 (top): Annual mean temperature anomaly, Murray–Darling Basin Source: Bureau of Meteorology Figure 7 (bottom): Reduction in long-term average inflows to the River Murray Source: MDBA



Reduction in long-term average inflows to the River Murray



At the time of the Basin Plan's development, the CSIRO advised the MDBA that while climate change was a known risk, the Basin Plan should use the longest possible climate record for hydrologic modelling to encapsulate a range of climate conditions (Chiew et al. 2009). Guided by this advice, the 114-year climate history (1895-2009) was used as the climate baseline for the Basin Plan modelling. As a result, the measured historical variation and long-term averages were built into the design of the Plan. The CSIRO has since developed hydroclimate metrics (climate indicators) and these are illustrated in Figures 8, 9 and 10. This has informed scenarios that visualises how the climate might play out in the Basin, and help improve the policy and management arrangements adapt to these possible future settings.

The CSIRO advised Murray–Darling Basin water managers of 6 plausible scenarios, and to use Scenario B as a guide for policy and management decisions, but not without consideration of other modelled scenarios. Scenario B is illustrated using the hydroclimate metrics in Figure 9.





Figure 8: CSIRO hydroclimatic metrics for the Murray–Darling Basin Source: CSIRO/MDBA

The Basin Plan provides a framework for adapting water management to climate change threats and the imperative to do this was built into the Plan.² Management arrangements, along with the environments, industries, businesses and communities that have depended on the historical hydrology of the Basin for their development and survival, must also change as the Basin adapts to climate change.

2 See for example Basin Plan 6.06 or 8.07

More detailed discussion on the climate challenges facing the Basin can be found in the following technical reports, which are included as supporting documents to the Evaluation:

- ••• Trends and historical conditions in the Murray-Darling Basin
- --- Hydroclimate Futures for the Murray-Darling Basin
- Vulnerabilities to climate change in the Murray-Darling Basin

Warmer and drier climate scenario (Scenario B)

Guided by latest climate science projections (for 2046-2075). These scenarios are compared to the historical record (1895 to present)



Figure 9: Visualisation of Scenario B – the more plausible climate scenario for the Basin Source: CSIRO/MDBA

Overview of plausible climate change scenarios

Legend Scenario A: Scenario H_D: Scenario B: Scenario B_D: Scenario C: Scenario C_D: Changes to Positive change (slight, 0-10%) Warmer and much drier climate with Warmer and Historic climate Warmer and drier Warmer and temperature and Warmer and wetter climate with more severe drier climate climate with more much drier rainfall are fixed Positive change (not quantified) droughts severe droughts climate more severe inputs to determine No change More plausible droughts scenario outcomes Negative change (not quantified) Negative change (slight, 0-20%) Temperature (+2°c) Negative change (moderate, 20-50%) Negative change (large, >50%) $\overline{}$ Rainfall **Potential evaporation** _ $\overline{}$ Soil moisture Climate $\mathbf{\nabla}$ $\mathbf{\nabla}$ $\overline{}$ Mean annual flow _ V _ _ ▼ Flow sequencing $\overline{\mathbf{v}}$ **Overbank flows** $\mathbf{\nabla}$ _ $\mathbf{\nabla}$ Freshes $\mathbf{\nabla}$ _ $\mathbf{\nabla}$ **Replenishment flows River flows** _ $\overline{}$ $\overline{}$ Baseflows Data courtesy of \wedge \wedge \wedge \wedge Cease-to-flow nIII \wedge Dry spells \wedge CSIRO

Guided by latest climate science projections (for 2046-2075). These scenarios are compared to the historical record (1895 to present)

Figure 10: Overview of plausible climate scenarios for the Murray–Darling Basin Source: CSIRO/MDBA

Agriculture in the Basin

Finding

The overall economic performance of agriculture in the Basin has been strong, but the benefits of this growth are being experienced to differing degrees by the different industries and communities in the Basin.

The most recent national data shows that the gross value of irrigated production in the Basin has continued to grow since 2012. The value of irrigated production in 2018 is around 12% higher in real terms than in 2000–01. Over the same time period, the value of dryland agricultural production in the Basin grew by around 22% in real terms (Marsden Jacobs Associates 2019a).

Underlying trends in commodity prices are major factors affecting the relative profitability of irrigated enterprises. High returns to high-value horticulture such as almonds, and for cotton, combined with low interest rates, has driven expansion and entitlement acquisition in these industries (ACCC 2020).

Between 2010–11 and 2017–18, there have been significant changes in the location of production across the southern Basin:

- almond production increased in Victoria, South Australia and New South Wales by \$205 million, \$29 million and
 \$7 million respectively
- ••• fruit production in Victoria decreased by \$656 million, while it increased in South Australia by \$258 million
- pasture production in South Australia decreased by \$19 million, while it increased in Victoria by \$208 million (ACCC 2020).

The Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) predicts that water use will continue to shift between regions and locations, even with no further changes in land use. High prices for water will continue to reshape patterns of water consumption in the future (Goesch et al. 2020).

Climatic challenges will further accelerate these changes in the Basin with significant implications for industries and communities (Gupta et al. 2020). In dry years there is forecast to be just enough water to maintain horticultural plantings, with dairy and rice decreasing by up to 55% and 32% respectively. Prices for water are forecast to be up to 50% higher in a future market under the dry climate scenario. Average water use declines by around 18% in the Goulburn-Broken region and around 7% in the Murrumbidgee. The gross value of irrigated production in the Basin, as a whole is forecast to decrease by 4.1%, with communities dependent on industries such as dairy and rice experiencing much more significant declines in local economic activity.

Since the Basin Plan was agreed to, geographic and industrial shifts in the use of water in the Basin have reshaped the use and economic benefits from water in the Basin, creating a situation where some communities and industries are experiencing pressure.

These forces for change will be reinforced and accelerated by a drying climate, challenging Basin industries, communities and governments to work together to become more adept at anticipating and adapting to find new pathways for communities whose local economies are most affected.



Image: Corey Jones' buffalo dairy farm, Mypolonga, South Australia. Credit: Corey Jones

Case study: Innovation required to adapt to changing water availability

The Evaluation has identified that since implementation of the Basin Plan changes in the agricultural sector have accelerated, and this has coincided with declining water availability due to climate change and water recovered for the environment. These changes have been associated with increases in the price of water. Despite these challenges, over the whole Basin irrigated production has increased.

This result has emerged due to farmers adapting to the changing circumstances and innovating to ensure they sustain their businesses.

When innovative farmer Corey Jones made a bold business decision to start milking buffalo instead of dairy cows, maximising the efficiency of water use was at the forefront of his thinking and planning for the future.

Now age 29, Corey grew up on his parents' dairy farm at Mypolonga in South Australia with a genuine passion for agriculture and farming. However, the dairy closed in the 2000s as the Millennium drought took hold and part of the water licence was sold off to pay off debt. In about 2011, Mr Jones started laying the foundations for his current business enterprise, which he shares with wife Mollie, where they sell buffalo milk to a variety of cheesemakers based in Sydney, Melbourne, Adelaide and the Adelaide Hills.

Mr Jones said the property was basically 'barren' with no pastures to feed livestock and laser levelling was needed to run water efficiently.

'I started in about 2011 making improvements for 3 years while working off-farm, when the dairy was doing nothing.

'By 2014 I had 30 buffalo and have expanded to about 260 head. We milk anywhere from 50 to 100 all-year-round.

'I don't want to waste any water because it's so valuable and the laser levelling makes the farm way more efficient.'

Corey's innovation and adaptation have enabled his business to grow and this will provide a foundation for further adaptation as markets and the climate continue to change.



Image: Darter spreading its wings, Barmah-Millewa Forest

Achieving its purpose

Finding

The Basin Plan is, to a large extent, delivering on Australia's commitments in relevant international agreements.

Environmental objectives and water resource plan requirements have been established. Management of water in the Basin is increasingly aligned to these objectives and plans.

Environmentally sustainable limits on the quantities of groundwater and surface water that can be taken have been established.

Water is clearly moving to higher value uses in the Basin as intended in the Basin Plan framework, supported by clearly defined property rights (water entitlements).

Establishing sustainable limits of take for water in the Basin is yet to be fully achieved. Further progress in implementation is required to meet this crucial purpose of the Plan, the details of which are described in the following section.

The 2020 Basin Plan Evaluation examines whether the Basin Plan is meeting its purpose, which is set out in Section 20 of the *Water Act 2007*. The Basin Plan promotes integrated management of the Basin's water resources in a way that enables the objectives of the *Water Act 2007*, providing 7 specific statements of purpose for the Basin Plan.

Table 3 provides an overview of the progress and areas for further work and improvement documented in the remainder of the Evaluation.

Table 3: Findings in relation to meeting the purpose of the Basin Plan

Note: See 2020 Basin Plan Evaluation - Plan implementation evidence report for further information.

1. Giving effect to relevant international agreements (to the extent to which those agreements are relevant to the use and management of the Basin water resources).	Substantial progress Eight international agreements are relevant to the Basin Plan, such as the Ramsar Convention. The Basin Plan is meeting this purpose although not all international agreement obligations have been completely achieved.		
2. The establishment and enforcement of environmentally sustainable limits on the quantities of surface water and groundwater that may be taken from the Basin water resources (including by interception activities).	Substantial progress The Basin Plan has established sustainable diversion limits, and the MDBA has begun monitoring compliance with these limits.		
3. Basin-wide environmental objectives for water-dependent ecosystems of the Murray- Darling Basin and water quality and salinity objectives.	Met The Environmental Management Framework, Basin Watering Strategy Plan and Water Quality and Salinity Objectives are in place.		
4. The use and management of the Basin water resources in a way that optimises economic, social and environmental outcomes.	Substantial progress The Basin Plan is designed to achieve a more optimal and sustainable distribution of water between consumptive uses and the environment and its wider social and economic benefits. However, there is a lack of specificity on the social and economic goals and desired outcomes.		
5. Water to reach its most productive use through the development of an efficient water trading regime across the Murray-Darling Basin.	Met There is clear evidence of water moving to higher value uses in the Basin.		
6. Requirements that a water resource plan must meet if it is to be accredited or adopted.	Met Requirements for water resource plans have been established and are being used in the accreditation of plans.		
7. Improved water security for all uses of Basin water resources.	Substantial progress Substantial progress has been made through setting sustainable diversion limits, accrediting water resource plans and progressing adjustment projects. However, this objective will not be achieved until implementation of these components of the Basin Plan is complete.		



Image: River Murray at sunset, Mildura, Victoria

Contribution to outcomes and progress in implementation of the Basin Plan

This section outlines the extent to which the objectives, targets and outcomes set out in the Basin Plan have been achieved. The results are organised into 3 groups:

- 1. hydrological, environmental and water quality outcomes
- 2. social, economic and cultural outcomes
- 3. Basin Plan implementation.



Hydrological, environmental and water quality outcomes

The evidence of contribution of the Basin Plan to hydrological, environmental and water quality outcomes is provided below, with the pathway to the contribution and outcomes detailed in 5 sections:

- --- restoring southern Basin rivers
- ••• restoring northern Basin rivers
- ••• improving the Murray–Darling end-of-system outcomes
- ••• watering the floodplains and wetlands of the Basin
- --- improving water quality and salinity.

Major finding

The Basin Plan is having a significant and positive impact on the Basin environment. This has been crucial for sustaining water-dependent ecosystems during the recent drought but is unlikely to be sufficient to achieve long-term outcomes unless further implementation and other actions are fast tracked.

- The Basin Plan has protected flow regimes across much of the southern Basin, including base and fresh flows in some rivers. There is good evidence of the positive ecological responses that resulted from providing water for the environment.
- In the regulated rivers of the northern Basin, the Basin Plan has protected some rivers from the worst impacts of the unprecedented drought. Implementation of the Basin Plan has been associated with improvements to flow regimes, including reductions in the severity and duration of dry spells and protection of the first flows after the needed rain. This has, however, only been possible in regulated rivers where water can be delivered from storages.
- The Basin Plan has enabled delivery of water for the environment to support the Coorong, Lower Lakes and Murray Mouth ecosystems through the drought, substantially avoiding the environmental degradation that occurred during the Millennium drought.
- The Basin Plan's capacity to effectively support floodplain and wetland ecosystems will be constrained until the implementation of critical constraints projects is completed. Also needed is the accreditation of all WRPs as these set the new rules on how much water can be taken from the system on an annual basis, ensuring the sustainable diversion limits are not exceeded over time.
- Delays in the completion of some river operating rules and water infrastructure projects to be delivered through the SDL Adjustment Mechanism supply projects will delay the achievement of environmental objectives and create uncertainty among irrigation communities.
- The major fish death events in 2019 demonstrate the need for whole-of-system management and are a stark reminder of the impacts that full Basin Plan implementation seeks to mitigate.
- Basin governments need to continue to improve their practical on-ground approaches to managing water quality and salinity, particularly in the context of low or no-flow conditions.

Overview of southern connected Basin



Figure 11: Overview of the the River Murray system and tributaries Source: MDBA



Restoring southern Basin rivers

Contribution of the Basin Plan to outcomes

The status of implementation means that the Basin Plan is not yet fully operational in the southern Basin. New South Wales water resource plans are yet to be accredited, and Queensland, Victorian, South Australian and the Australian Capital Territory water resource plans have only been formally in operation from 2019. The SDLAdjustment Mechanism projects (projects to adjust the limits) are in various stages of progression. The complex projects are running behind schedule and progress towards achievement of their associated environmental outcomes has also been delayed. The 2020 Basin Plan Evaluation considered the latest hydrological data and available evidence of the contribution of the Basin Plan to the maintenance of water quality and to the health of riverine and riparian environments. While there is still more to do in implementation, water for the environment, in alignment with the Basin Plan, is now a substantial feature of the system and is having an observable impact on the hydrology and ecology of the southern Basin rivers and ecosystems.

Table 4 summarises the Evaluation assessment, noting that at this phase of the Plan's implementation the targets were to improve hydrological function and avoid further degradation of key components of the riverine ecosystems.



Image: Aerial view of the River Murray downstream of Albury, New South Wales

Table 4: 2020 Evaluation assessment of outcomes in the southern Basin

	Condition		Contribution of the Basin Plan	
Indicator	Performance rating	Confidence	Performance rating	Confidence
	$\bullet \bullet \bullet \bullet \circ \circ$		$\bullet \bullet \bullet \bullet \bullet \circ \circ$	
Hydrology	4	High	5	Medium
Hydrology indicators have mostly remained stable or improved. Environmental water has played an important role in these findings.	Hydrology indicators including freshes, base flows and transmission of flows have remained stable or improved since implementation of the Basin Plan, with some variability across catchments.	4 of 5 indicators assessed. Gauge data analysed to compare to pre- Basin Plan baseline.	The evidence suggests that mechanisms of the Basin Plan are having a positive impact towards ensuring no degradation in hydrology. There are some limitations in achieving moderate and large freshes.	4 of 5 indicators assessed. Evidence primarily from the Commonwealth Environmental Water Holder's long-term intervention monitoring program.
Freierre		Madium		
Ecology	4	Medium	4	Low
Overall ecological indicators have remained stable. Water for the environment has played an important role in reducing the impact of drought.	Ecology indicators, encompassing data and evidence for fish populations and riparian vegetation are mostly stable. There is some evidence of decline in the population structure of golden perch, a key indicator species.	2 of 7 indicators assessed. Murray- Darling Basin Fish Survey was the key data source used to analyse fish populations. Preliminary lines of evidence for non- assessed indicators were considered in determining the ratings.	The evidence suggests that the mechanisms of the Basin Plan are having some positive impact towards ensuring no degradation in ecological indicators. There remain risks in converting asset- based responses to environmental flows into Basin- scale changes in condition.	1 of 7 indicators assessed. Evidence primarily from intervention monitoring programs conducted by water holders. Preliminary lines of evidence for non- assessed indicators were considered in determining the ratings.

Refer to pages 6-9 for more information on Evaluation assessment and confidence ratings scales

Finding

Flow regimes are critical to achieving a healthy, working Basin. Implementation of the Basin Plan, through the delivery of water for the environment (Figure 12), has protected high-value wetlands, maintained base flows and enhanced flow pulses (freshes) through extended dry periods in the southern connected system. These flow regime changes have contributed to the health of wetlands, riparian vegetation and fish communities.

The key factors supporting this key finding are:

- ••• Despite the dry conditions, flow regimes in the southern Basin have improved or been maintained since the implementation of the Basin Plan.
- --- Connectivity of flow along rivers, as indicated by the transmission of flows through the system, has improved across the southern Basin. This is demonstrated through the greater proportion of inflow volumes being discharged at the end of the system.
- Since the implementation of the Basin Plan began, the provision of freshes has improved or been maintained at
 5 of the southern Basin sites analysed (analyses could not be completed with results unclear in the lower Darling River). Figure 13 displays data for the River Murray at Yarrawonga as an example.
 - Freshes are small-to-medium flow events which inundate benches or small anabranches but stay in the river channel. They play an important role in replenishing soil moisture for riparian vegetation, maintaining in-stream habitats and cycling nutrients between parts of the river channel. They also inundate snags and woody debris, which form important habitat for invertebrates. The rise in water level associated with freshes can induce reproductive behaviours in native fish.





Figure 12: Water for the environment delivered in the southern Murray–Darling Basin Source: MDBA



Figure 13: Inflows at southern Basin indicator site, River Murray at downstream Yarrawonga, and days per year above the fresh threshold. Note: Freshes are pulses of water defined by a minimum flow level that is specific to each river and the black line above is the number of days that flow exceeded the threshold to be called a Fresh Source: MDBA

Finding

Native fish in the southern Basin have largely been maintained since the implementation of the Basin Plan. Water for the environment with a primary purpose of achieving fish outcomes has been delivered through more than 130 watering events, with many of these collaborative events involving multiple water holders (Commonwealth and state).

The key factors supporting this key finding are:

- ••• Species richness of the most common and abundant native fish species has been maintained, with 26 of the expected 27 species recorded in the past 7 years.
- There is evidence that the southern purple-spotted gudgeon is still present in the southern Basin, after being considered regionally extinct, with a new small population recorded in the Avoca Basin in 2019. It is likely, however, that another small-bodied rare native species, the Yarra pygmy perch, is no longer present in the Murray-Darling Basin despite reintroduction efforts following the Millennium drought.
- --- The distribution and population structure of Murray cod has been maintained, although there was a decline in abundance of this iconic species in the southern Basin following the 2016 floods and subsequent blackwater events (Figure 14).
- The distribution and abundance of golden perch have also been maintained post-Basin Plan. The population structure of this species is, however, continuing to decline, with little evidence of recruitment into the adult population (Figure 15). This is despite healthy numbers of juveniles being found in a few wetlands, including Tala and Yanga Lakes.

Finding

These results need to be assessed in the context of the underlying health of the system – overall, rivers in the southern Basin remain highly degraded. Full implementation of the Basin Plan is required for restoration of the southern Basin ecosystems.

Further information and detailed evaluative assessment

More detailed discussion of the condition of the southern Basin rivers and the contribution of the Basin Plan to environmental outcomes in the southern Basin, as well as supporting data and evidence, is available in the 2020 Basin Plan Evaluation – Southern Basin evidence report.



Image: the iconic Murray cod



Figure 14: Abundance of Murray cod at Murray–Darling Basin Fish Survey sites throughout the southern Basin. Sites were sampled once over 3-year cycles between 2005 and 2013 as part of Sustainable Rivers Audit sampling. Sites have been sampled annually since 2015. Note: Young-ofthe-year are fish hatched in that year, sub-adult (juvenile) are fish older than a year but not able to breed. Healthy fish populations have a mix of life stages as young fish are continually required to replace fish that die. Source: Murray–Darling Basin Fish Survey (2019)



Figure 15: Abundance of golden perch at Murray–Darling Basin Fish Survey sites throughout the southern Basin. Sites were sampled once over 3-year cycles between 2005 and 2013 as part of Sustainable Rivers Audit sampling. Sites have been sampled annually since 2015: Note: Young-ofthe-year are fish hatched in that year, sub-adult (juvinile) are fish older than a year but not able to breed. Healthy fish populations have a mix of life stages as young fish are continually required to replace fish that die. Source: Murray–Darling Basin Fish Survey (2019)

Case study: Protecting fish in the Murrumbidgee

In January 2019, river levels and flows in the lower Murrumbidgee were low, water temperature was high (26–27 degrees Celsius) and there were several amber-red alerts for blue-green algae. Monitoring showed the dissolved oxygen levels were reducing and the heatwave conditions were expected to continue, consistent with conditions which had seen fish deaths in the lower Darling. As a result, the lower Murrumbidgee was recognised as an area of high risk for fish deaths.

A Murrumbidgee Technical Advisory Group was convened, and a cross-agency response was led by the New South Wales Government to coordinate the delivery of water for the environment. The group, comprised of environmental water holders, site managers, river operators and ecologists, worked together to coordinate, monitor and improve conditions in the region.

Water for the environment was used in several ways to improve the water quality, including:

- Poor quality low oxygen water from Redbank weir pool was diverted onto the floodplain, where it watered floodplain vegetation. This made space for a pulse of fresh water to enter the pool from a small, localised rainfall event, which increased the oxygen levels for fish.
- 2. Water was slowly released from weir pools to allow the low oxygen water to be re-oxygenated through mixing as the water flowed along the river channel.
- Baseflows were increased over several months to maintain river flows in the lower reaches of the Murrumbidgee to prevent the stratification and poor water quality conditions from reoccurring during the protracted hot and dry summer conditions.

The release included water from multiple water holders, including the Commonwealth Environmental Water Holder, The Living Murray initiative, and the New South Wales Office of Environment and Heritage.

Monitoring and analysis of water quality shows that these managed interventions prevented further fish deaths. Lessons learnt from these events and actions will be used to inform future water management decisions, to help improve outcomes for native fish.





Image: the Murrumbidgee River. Credit: John Spencer, New South Wales DPIE

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About the northern Basin The northern Basin

comprises all rivers and catchments of the Darling River upstream of Menindee Lakes on the Darling River, covering an area of approximately 640,000 square kilometres. The northern Basin river system is characterised by a highly variable flow regime, in which prolonged periods of low-flow are periodically interrupted by high-flow events that connect the entire river system. Figure 17 shows that the proportion of flow regulated by dams is much lower than in the southern Basin. The variable climate and limited regulatory capacity mean that flow regimes continue to be characterised by periods of boom and bust (Bureau of Meteorology, 2020).

Overview of river regulation in the Northern Murray–Darling Basin



Figure 17: Overview of river regulation in the northern Murray-Darling Basin Source: MDBA



Restoring northern Basin rivers

Contribution of the Basin Plan to outcomes

Under the Basin Plan, the restoration of environmentally significant flow events is expected to reduce the stress on the system, leading to improvements in the condition of the ecosystems.

The approach includes:

- ••• targeted water recovery combined with protection of low flows and freshes in water resource plans
- --- active management of environmental flows where possible
- planned complementary infrastructure, which will protect or restore key components of the flow regime.

As with the southern Basin, this is intended to avoid further degradation in the short-term and provide a foundation for, and improvements over time to, the condition and abundance of native vegetation, native fish and waterbirds in the system.

Water resource plans in the northern Basin are a key intervention, and implementation remains behind schedule, significantly limiting the contribution of the Basin Plan in the northern rivers. The Queensland plans were accredited and in place on time, but there has not been a sufficient period of operation to judge the contribution of these accredited water resource plans to Basin Plan outcomes. The New South Wales plans are being assessed and remain unaccredited. In the northern Basin, most water for the environment is planned, which means the water remains in the system to achieve environmental outcomes. This is done by placing rules on what can be taken via overland flow diversion or pumping from a watercourse. However, as for the southern Basin, the environmental watering that has been possible during unprecedented dry conditions provides the best foundation for judging the Basin Plan's contribution to outcomes. Far fewer events and significantly lower volumes of held environmental water (water for the environment that is held in storage) are delivered in the northern Basin due to the predominantly unregulated systems (Figure 16).

Overall, the Evaluation reveals limited evidence of positive changes to hydrology outcomes that could be contributed to the Basin Plan since 2012. The decline in transmission of flows through the northern Basin rivers is likely to be attributable to the antecedent conditions during this timescale, including the unprecedented drought and heat conditions in much of the north. More time is required to be able to evaluate the impact that water resource plans and managing water to meet the projects to adjust the limits is having on northern Basin hydrology.



Figure 16: Water for the environment delivered in the northern Murray–Darling Basin system
Table 5: 2020 Evaluation assessment of outcomes in the northern Basin

	Condition		Contribution of the Basin Plan	
Indicator	Performance rating	Confidence	Performance rating	Confidence
Hydrology	• • • • • • • • • • • • • • • • • • •	High	• • • • • • • • • • • • • • • • • • •	Medium
Most hydrology indicators have been maintained at similar levels to pre-Basin Plan baseline, while one has declined.	Hydrology indicators are mostly stable; however there has been a decline in the transmission of flows.	4 of 4 indicators were assessed. These assessments are based on data collected from the gauge network, which produces large amounts of high-quality data. The report by the Interim Inspector- General (2020) highlighted inflow data deficiencies that increase uncertainty about the causes of changes in flow. The MDBA accepts this; however, the Evaluation analysis is not affected by this uncertainty.	The evidence suggests significant limitations to the scale at which outcomes can be achieved in the northern Basin, with positive outcomes limited to regulated catchments. The drying climate and lack of held environmental water are significant limitations to the Basin Plan achieving long-term objectives	4 of 4 indicators assessed. Evidence was primarily from the Commonwealth Environmental Water Holder's long-term intervention monitoring program.
	•••000		••0000	
Ecology	3	Medium	2	Low
Golden perch and Murray cod populations remain stable. River red gum also remain in pre-Basin Plan condition but black box is declining.	Ecology indicators are mostly stable with some decline. Ecology largely remains in poor condition due to the drought.	3 of 6 indicators were assessed for condition. The Murray- Darling Basin Fish Survey and Landsat satellite imagery are key data sources. Preliminary lines of evidence for non- assessed indicators were considered in determining the ratings.	There is limited evidence of positive impacts from water for the environment. The drying climate and lack of held environmental water are significant barriers or limitations to the Basin Plan achieving long-term objectives.	1 of 6 indicators were assessed. Evidence was primarily from the CEWH long- term intervention monitoring program. Preliminary lines of evidence for non- assessed indictors were considered in determining the ratings.

Refer to pages 6-9 for more information on Evaluation assessment and confidence ratings scales

There have been large increases in cease-to-flow periods in many northern Basin rivers coinciding with the unprecedented dry conditions over much of the period since 2012. There have been several large managed flows, which aimed to restore connectivity in the northern Basin in the past 3 years as a result of the Basin Plan (Figure 18). These flows have resulted in temporary improvements in both hydrological indicators as well as biological responses but are insufficient to drive longer term outcomes.

The key factors supporting this key finding are:

- --- Since 2013-14 a total of 1724.7 GL of water for the environment has been delivered across 122 events in the northern Basin, comprising up to 10% of the total annual flow volume
- ••• While some aspects of the flow regime in certain catchments were maintained (e.g. provision of freshes and transmission of flows in the Border Rivers and Gwydir system), there have been declines in most of the hydrological indicators.

Finding

The number of native riverine fish in the northern Basin have been maintained since the implementation of the Basin Plan (Figure 19), although abundance of some species has declined as a result of the continued dry conditions. Native fish passage and refuges have been maintained in several northern Basin rivers through the delivery of water for the environment across thousands of kilometres of river channel.

The key factor supporting this key finding is:

--- Although monitoring in the northern Basin is limited, it is highly likely that water for the environment delivered within channels of the northern Basin during this period has contributed to the growth, reproduction and dispersal of riparian plants and has made important contributions to in-channel productivity.



Source: Stewardson and Guarino 2019, 2020

Figure 18: For much of 2018, flows had ceased in the Barwon River with only a small flow in November to replenish water in pools. The first half of 2019 was also an extended period of cease to flow, which was ended with the delivery of a significant environmental flow that delivered fresh water ahead of the summer



Source: Murray-Darling Annual Fish survey data

Figure 19: Native fish species richness in the valleys of the Northern Basin pre (2005 to 2008) and post (2012 to 2019). The graph shows that across the Northern Basin (columns of the far right) the number of fish species had remained constant since implementation of the Basin Plan, despite the dry conditions. This reflected increases in 6 of the 8 river valleys and declines in the Border Rivers and darling River. Basin Plan Source: Murray-Darling Annual Fish survey data.

The Basin Plan has contributed to some positive environmental outcomes in the northern Basin and the severe impacts of long periods of low-flow or cease-to-flow would undoubtedly have been worse without the Basin Plan and associated delivery of water for the environment. However, with less than intended water for the environment to support outcomes because water recovery is incomplete in key catchments and water resource plans largely not in place, the Basin Plan cannot yet achieve its intended outcomes, and riverine environments are at significant risk of further degradation.

Further information and detailed evaluative assessment

More detailed discussion of the condition of the northern rivers and the contribution of the Basin Plan to environmental outcomes in the northern Basin, as well as supporting data and evidence, is available in the 2020 Basin Plan Evaluation – Northern Basin evidence report



Image: Gwydir River, New South Wales. Credit: Ben Gawne

Case study: Northern Fish Flow protects rivers

A 2019 release of water for the environment in the northern Basin provides a good example of the way in which limited water for the environment has been used to minimise environmental degradation during dry times.

The April-June event saw 36 GL of water for the environment released from reservoirs along the Dumaresq and Gwydir rivers to replenish 1,500 kilometres of habitats extending into the Barwon River. The release was a joint initiative by the Commonwealth Environmental Water Holder and the New South Wales Government, with support from the Queensland Government, local councils and irrigators. The increased flows served to improve water connectivity and quality, and increase food sources, with the aim of enhancing fish movement and migration in the region. Early results from monitoring fish responses following the Northern Fish Flow indicate positive outcomes for fish breeding. Tracking of fish movement shows that the event allowed fish to move past numerous weirs that normally obstruct fish passage. These movements are important to allow fish populations to recolonise in areas where they have been heavily impacted by the drought. Ongoing monitoring is underway to identify longer-term impacts of the flow on the ecosystem.



Figure 20: The Coorong, Lower Lakes and Murray Mouth - Source: MDBA



Improving the Murray-Darling end-ofsystem outcomes

Contribution of the Basin Plan to outcomes

Water regimes and salinity levels are critical factors in maintaining the ecological condition at the end of system and for keeping the Murray Mouth open. There has been significant amounts of water for the environment delivered in the system targeting these factors, although the volume and delivery has been below what will be available once implementation of the Basin Plan is complete. Table 6 summarises the Evaluation findings for the end-of-system.

Overall, the Evaluation shows that end-of-system flows, water levels and connectivity have improved substantially since the implementation of the Basin Plan, with water for the environment contributing significantly to flows during the recent drought. The salinity target for Lake Alexandrina has been met continuously since the end of the Millennium drought, despite continued dry conditions in the past 3 years. The target has not been met in the Coorong, however, salinity has improved since the implementation of Basin Plan, with evidence that water for the environment is contributing to lower salinity levels.

The contribution of the Basin Plan to the ecology of the system can be seen through continued improvement and maintenance of some aspects of the ecology of the system from 2012 to 2019. These outcomes have been achieved despite the ongoing dry conditions in the catchments of the Basin.



Image: Sunrise over Lake Alexandrina, South Australia

Table 6: 2020 Evaluation assessment of outcomes in the Coorong, Lower Lakes and Murray Mouth

	Condition		Contribution of the Basin Plan	
Indicator	Rating	Confidence	Rating	Confidence
Hydrology	• • • • • • • • • • • • • • • • • • •	High	• • • • • • • • • • • • • • • • • • •	High
Salinity and water level targets have been met for the Lower Lakes. Targets in the Coorong have not been met but the indicators have improved.	Hydrology indicators are mostly showing positive trends since implementation of the Basin Plan. Salinity indicators are mostly showing positive trends since implementation of the Basin Plan, despite the salinity target in the Coorong not being achieved.	5 of 5 indicators were assessed. Data has largely come from gauges.	The evidence suggests that mechanisms of the Basin Plan are having a positive impact towards the expected outcomes. However, it appears that under the drying climate the target for the Murray Mouth opening is unachievable.	5 of 5 indicators were assessed. Data has largely come from the CEWH's long- term intervention monitoring program.
	$\bullet \bullet \bullet \bullet \circ \circ$		$\bullet \bullet \bullet \bullet \circ \circ$	
Ecology	4	Medium	4	Medium
There has been some recovery of native fish and vegetation. Waterbirds have been maintained, although their numbers are variable.	There is a mix of positive and negative results. However, in general, the ecological indicators are being maintained or are improving.	7 of 9 indicators were assessed. Key data sources included: southern Coorong ruppia monitoring, University of Adelaide annual Coorong Waterbird census, The Living Murray monitoring.	The evidence suggests that the mechanisms of the Basin Plan are having some positive impact towards the expected outcomes, while in other cases, they are not.	6 of 9 indicators were assessed. Key data includes monitoring from The Living Murray program.

Refer to pages 6-9 for more information on Evaluation assessment and confidence ratings scales

Water for the environment accounted for between 44% and 100% of the total flow through the barrages (Stewardson and Guarino 2020). This means that the **targets related to flows over the barrages have been largely met**, with 2-year average discharges volumes > 600 GL per year each year since 2012. The 3-year target of average annual flows > 2,000 GL per year has been achieved every year except for 2015–16.Water for the environment has contributed to maintaining water levels in the Lower Lakes over the past 5 years (2014–2019).

The modelling suggests that without water for the environment water levels in the Lower Lakes would have been less than 0.4 m AHD for 471 days over the 5-year period, which represents 26% of the time (see Figure 21). Particularly during dry conditions, water for the environment contributes a large proportion of the total river flow into the Lower lakes (Figure 22).

Finding

While the results are strong, not every hydrological outcome has been achieved. Water for the environment has been insufficient in the dry climatic conditions to consistently meet the 3-year average target of 2,000 GL per year. As a result of low flows, the mouth has been functionally open between 40% and 76% of the time since 2014, largely due to dredge operations. This is below the > 90% target and an ongoing reliance on dredging is likely needed to maintain the opening of the Murray Mouth under warmer and drier climatic conditions.



Source: Stewardson & Guarino 18-19

Figure 21: Changes in water levels in the lower lakes with and without (modelled) Commonwealth water for the environment. The greater the gap between the 2 lines, the more impact environmental flows had on water levels.





Source: Stewardson and Guarino, 2020

Figure 22: Contribution of environmental water to Murray River flows at Wellington, in the high flow year (2016–17) and drier years (2018–19, bottom). The top graph shows that environmental water was a smaller proportion of total flows in the wet years, than during subsequent dry years where environmental waterholders collaborated to deliver water to the end of the system

Since the implementation of the Basin Plan, there have been some improvements in fish indicators and recovery of 2 of the 3 Lower Lakes' threatened fish: the Murray hardyhead and the southern pygmy perch. The overall condition of many populations is still, however, considered to be poor and Yarra pygmy perch is considered to be regionally extinct.

There has been an increase in the submerged and emergent vegetation in both Lake Alexandrina and Lake Albert, although these are still recovering to post-drought conditions. There have been improvements in the extent of ruppia in the South Lagoon of the Coorong, but seed banks are not recovering, which poses long-term risks to the population.

The abundance and diversity of waterbirds in the Lower Lakes appear to have recovered, although the numbers are highly variable. In the Coorong resident and migratory shorebirds, however, continue to decline in abundance. The lack of recovery of migratory shorebirds may in part be explained by impacts in the flyway outside the site, but they have also been affected by ongoing impacts in the Coorong.

Further information and detailed evaluative assessment

More detailed discussion of the end-of-system condition and the contribution of the Basin Plan to environmental outcomes in the Coorong, Lower Lakes and Murray Mouth, as well as supporting data and evidence is available in the 2020 Basin Plan Evaluation – End of system evidence report.



Case study: Lamprey numbers bounce back

One significant outcome from the delivery of water for the environment to the end of the system has been a recovery of lamprey fish. Lampreys are primitive fish that were rarely seen in the River Murray in the years following the Millennium drought. Lampreys migrate upstream from the Southern Ocean to spawning grounds in the River Murray catchment and tributaries, making the Coorong and Lower Lakes critical habitats for them.

The Coorong, Lower Lakes and Murray Mouth region is the terminus of the Murray–Darling Basin, where the river discharges to the ocean. The Ramsar-listed area comprises approximately 142,500 hectares of diverse fresh, estuarine, marine and hypersaline wetland. The area supports threatened species, as well as important fish and waterbird communities, including international migratory shorebirds. Since 2015–16, 2,559 GL has been delivered to primarily support end-of-system flows whilst meeting other environmental needs along the way.

During winter 2019, about 130 GL of water for the environment was released from the Goulburn River at the start of July, with flows lasting about a month. These targeted flows reached South Australia's Lower Lakes and Coorong in mid-August, which coincided with the lamprey migration season.

As lampreys passed from salt water to freshwater, nets placed on the barrage fishways by South Australian Research and Development Institute staff caught them so they could be tagged, released and their migration monitored. Between 2012 and 2018 only one shortheaded lamprey was detected in the entire Murray-Darling Basin. This is an example of where water for the environment only achieves objectives with support from additional measures – in this case the fishways. More encouragingly, during winter and spring 2019, 45 pouched lamprey and 13 short-headed lamprey were captured in fishway traps at the barrages. This was the largest number caught since monitoring began after the Millennium drought. One of the shortheaded lamprey was tracked to Lock 8,726 kilometres upstream from the release location. This was the first time a short-headed lamprey was tracked in the Basin.

The increase in lamprey numbers reflects a slow recovery of the River Murray's ecology. The winter flows at the Lower Murray barrages were a collaborative endeavour by the South Australian government, with water provided by the Commonwealth Environmental Water Holder and operational support from SA Water.



Image: Goolwa Barrage between the Coorong and Lower Lakes, South Australia

Watering the floodplains and wetlands

The Importance of lateral connectivity in the Basin

Connectivity is important for many ecosystem processes, including nutrient and carbon cycling, as well as the movement and dispersal of biota. Under natural conditions, floodplains and floodplain wetlands become connected to the river when water flows over banks and out of river channels in floods (Figure 23).



Figure 23: Longitudinal and lateral riverine connectivity Source: MDBA

Table 7: 2020 Evaluation assessment of lateral connectivity

	Condition		Contribution of	f the Basin Plan
Indicator	Rating	Confidence	Rating	Confidence
Hydrology	• • • • • • • • • • • • • • • • • • •	High	• • • • • • • • • • • • • • • • • • •	Medium
Flows to terminal wetlands have been maintained, overbank flows have varied between sites with some decline, particularly downstream.	Indicators have been mixed with some maintenance and some decline.	2 of 2 indicators were assessed. Gauge data is the primary data source.	The evidence shows the Basin Plan has contributed positively to flows to terminal wetland but has made no contribution to overbank flows. Constraints to delivery of overbank flows has limited outcomes.	2 of 2 indicators were assessed. Key evidence was from intervention monitoring.
Ecology	• • • • • • • • • • • • • • • • • • •	Low	• • • • • • • • • • • • • • • • • • •	Low
Vegetation and waterbirds have largely been maintained, but there is variability between locations.	Indicators are largely being maintained with degradation of some indicators at particular catchments.	3 of 8 indicators were assessed. The east Australian waterbird survey and satellite imagery are key data sources.	Evidence suggests that the Basin Plan is resulting in some positive impacts when water can be delivered to floodplains and wetlands. However, constraints to delivering water overbank is limiting outcomes.	2 of 8 indicators were assessed. Information from The Living Murray monitoring program is a key data source.

Refer to pages 6-9 for more information on Evaluation assessment and confidence ratings scales

Floodplain outcomes anticipated in 2012 by Basin Plan hydrological modelling are not yet being achieved. The majority of water for the environment leading to wetland and floodplain inundation is being delivered through regulators and infrastructure rather than through overbank flows, limiting the area of the floodplain that can be watered.

The key factors supporting this key finding are:

- ••• Water for the environment has been used since Basin Plan implementation to inundate many of the wetlands that are known to support waterbirds and the majority of internationally significant Ramsar sites in the Basin.
- ••• Water for the environment has also been delivered to 103,787 hectares of river red gum forest or woodland, 12,283 hectares of black box woodland and 5,470 hectares of coolabah woodland. This represents only 10% of the river red gum forests and woodlands, 1.3% of black box woodlands and 0.4% of coolabah woodlands. There is currently little evidence to show an improvement in these critical communities, and particularly in the iconic river red gum forests of the Basin (Figure 24).

Ongoing implementation activities (such as the relaxation of constraints) are crucial to positioning the Basin Plan to achieve these outcomes. The climate since 2012 has also been a leading factor. The Basin has experienced predominantly dry conditions since 2012, with only a single year of above-average rainfall in 2016–17, when significant floodplain inundation did occur. As a result, there has been insufficient water in the system to provide major floods and to enable water for the environment to support more regular overbank flows.

Further information and detailed evaluative assessment

More detailed discussion of wetland and floodplain condition and the contribution of the Basin Plan to environmental outcomes, as well as supporting data and evidence, is available in the 2020 Basin Plan Evaluation – River connections evidence report.



Image: River red gum on Little Rushy Swamp, Barmah, Victoria



Figure 24: Average (with standard deviation) of the percentage of river red gum communities in moderate or better condition pre-Basin Plan (1987 to 2011) and post-Basin Plan (2014 to 2019) by catchment. The proportion of river red gums in moderate to good condition was similar pre and post Basin Plan for the majority of the catchments, populations in the Barwon-Darling, Gwydir, Loddon, Namoi, Paroo and Warrego catchments showed a decrease in the proportion in moderate to good condition. Source: MDBA



Image: Waterbirds at Narran Lakes, New South Wales

Case study: Narran Lakes

After a 7-year dry spell, the internationally significant Narran Lakes (Dharriwaa to the Yuwaalaraay/Euahlayi First Nations people) wetland received its first flow in early 2020 thanks to a collaboration of environmental water holders.

The Narran Lakes are of immense cultural and environmental significance. When water comes, frogs emerge, birds breed, people arrive and ceremonies begin. Dharriwaa has been important for First Nations groups for thousands of years.

'Our Yuwaalaraay country has been galingin (thirsty) for the longest time. It's always special to be out at Dharriwaa (Narran Lakes) but even more so after these water events.' (*Traditional Owner, Brendan Odee Welsh, Commonwealth Environmental Water Office*).

Water to the internationally significant lakes is vital as endangered and migratory native waterbirds rely on it to breed and survive as it maintains the vegetation that is their home. Without water delivery, the vegetation around the lakes, critical habitat for nesting of some water bird species, will continue to decline and may become unsuitable to support breeding.

A collaborative effort

Under the current water sharing arrangements, in many years, mid-sized flows in the lower Balonne do not reach Narran Lakes. The flow in 2020 was a fantastic example of the power of collaboration. The Australian, Queensland and New South Wales governments, local water licence holders and community representatives, including local First Nations representatives, contributed water, protected flows and conducted monitoring.

The 90 GL delivered into the Narran Lakes was made up of water protected under Queensland water planning arrangements, as well as water purchased by the Australian Government under the Basin Plan and left in the Narran River through water harvesting and overland flow licences. The Australian Government has purchased overland flow licences in the lower Balonne, and on-farm levees and structures associated with these licences have been decommissioned. This means water from these licences now flows freely across the landscape and returns to the river when the flow is large enough for these licences to be triggered, as it was in 2020. Additionally, Cubbie Station a large farming business, voluntarily contributed 10 GL in 2020. The Commonwealth Environmental Water Holder contributed an additional 9 GL through a pilot event-based mechanism.



Figure 25: The Narran Lakes as seen by the Sentinel-2 satellite before the flows at March 1, 2020 (left) and at the peak of inundation on 21 March 2020 (right): Sentinel images sourced by the MDBA, using a water detection algorithm (mNDWI) and colour scheme designed to make water stand out in the landscape. Images: Sentinel images sourced by the MDBA

As a pilot event-based mechanism, the Commonwealth Environmental Water Office offered a grant to irrigators along the Narran River to not pump. If any of these irrigators chose to leave some of the water that they were legally entitled to in the river rather than to pump it, they would be paid for that water at an independently set price. One irrigator chose to forego pumping for an agreed period, which resulted in an additional 9 GL staying in the Narran River. Protecting the mid-sized flows enabled additional water to remain in the river and reach the lakes. The pilot was designed to improve the outcomes of water for the environment while managing the social and economic impacts on local communities. The pilot was supported by local stakeholders. This was the first event-based mechanism implemented as a toolkit measure following the Northern Basin Review.

For transparency, the Commonwealth Environmental Water Office published information including: the independent determination of the price for water left in the river, the grant guidelines, and an independent review of the implementation of the pilot. These documents are available on the Commonwealth Environmental Water Office website. Scientists and First Nations monitored the vegetation around the lakes before the water began to arrive. The MDBA used satellite imagery to analyse the areas that received water. Monitoring suggests that some of the waterbird breeding habitat is regenerating well, whilst other habitat may take further watering events to respond. Next time significant inflows arrive at the right time of year, it is hoped that this will support breeding of many thousands of waterbirds, as witnessed during past floods, such as in 2011 and 2012.

To share information with the community about this important flow event, the Commonwealth Environmental Water Office produced 6 updates, which are available on the Commonwealth Environmental Water Office website.

'Narran Lakes Nature Reserve is a hugely valued reserve for us, and it was great to see the wetlands full. This event also reinforced the importance of connections and collaborations across government agencies, to ensure we documented and therefore improved our understanding of the environmental benefits from these flows. Let's hope they keep coming!' (Rob Smith, Director Northern Inland Branch, New South Wales National Parks and Wildlife Service).

Improving water quality and salinity outcomes

About water quality and salinity in the Basin

Good water quality is vital to ensure water is suitable for drinking, agriculture, recreation and the environment. Water management and land-use practices, as well as natural processes, affect water quality in this large and complex river system.

Salinity refers to the concentration of salts in water or soil and is a major issue for the Murray–Darling Basin. While salt is a natural feature of the Basin's landscapes and rivers, high salinity can reduce the amount of crops that can be grown, affect the health of plants and animals, damage buildings and other infrastructure, and impact the quality of water used by people.

The only natural way that salt can leave the Basin is by flowing down the river and out to sea through the Murray Mouth in South Australia. River salinity can also be managed through salt interception schemes (Figure 26), which are an engineering tool used to divert groundwater and drainage water away from the river system.

Blue-green algae are naturally occurring organisms that live in rivers, lakes and waterways. If conditions are favourable, they can reproduce at very high rates to form 'blooms', which sometimes produce toxic scums and have an impact upon river users and environments.

When droughts are broken by flooding, it can wash organic matter into rivers, triggering a **blackwater** event. Some blackwater merely creates additional food, but hypoxic blackwater is created when the organic matter is decomposed by bacteria and oxygen levels drop significantly. This leads to a sudden and disastrous decrease in the oxygen available to fish and other organisms. Unfortunately, this can cause many fish to die.

Managing flows can help to mitigate water quality and salinity issues in the Basin, in conjunction with land management, infrastructure and other complementary interventions. However, river operators can be limited in their ability to mitigate events. For example, the efficient delivery of entitlements can be in conflict with actions aimed at improving water quality. A lack of options for flow management is particularly evident in the less developed northern Basin, and especially during extended periods of low flow or limited water availability.

Contribution of the Basin Plan to salinity and water quality

The Basin Plan sets objectives and targets for ensuring water quality is good enough to protect and restore ecosystems and is suitable for domestic use, farming and recreation. These targets relate to salinity levels, dissolved oxygen and blue-green algae. The Basin Plan water quality objectives and targets aim to be fit for purpose and to complement state and local management arrangements to manage water quality and salinity in the Basin. Table 8 summarises the evaluation findings for salinity and water quality outcomes.

Water resource plans must also include water quality targets, or alternatives applied by the states. It is noted that as most plans are either accredited only recently, or not yet accredited, it is too early to evaluate implementation against these targets.

As with other environmental outcome themes, water for the environment is the primary driver of contribution by the Basin Plan to date. Water for the environment has now delivered benefits – including for the purpose of water quality management – to the river system for over 10 years. Water for the environment has helped mitigate the effects of elevated salinity.

However, on a number of occasions since the implementation of the Basin Plan, water quality targets have not been met, and there were significant events of poor water quality during periods of low flows with Basin-wide impacts. A number of important opportunities to improve water quality outcomes in the Basin have been identified in various reviews and investigations conducted between 2017 and 2019. Table 8: 2020 Evaluation assessment of water quality

	Condition		Contribution of the Basin Plan	
Indicator	Rating	Confidence	Rating	Confidence
Salinity	• • • • • • • • • • • • • • • • • • •	Medium	• • • • • • • • • • • • • • • • • • •	Low
The Basin Plan sets targets for salinity at 5 sites.	Salinity indicators are mostly showing positive trends since implementation of the Basin Plan, however the target for the lower Darling has not been met in most years.	Salinity was measured at all sites that have targets.	The evidence suggests that mechanisms of the Basin Plan are having a positive impact towards expected outcomes.	There is limited intervention monitoring data relating to water quality indicators.
Dissolved oxygen and algal blooms	•••••• 2	Low	•••••• 2	Low
Under the Basin Plan the Water Quality and Salinity Management Plan aims to reduce the risk of low dissolved oxygen and blue green algae events.	Extreme dry conditions have resulted in challenges in managing dissolved oxygen and algal blooms, and a number of severe events have occurred.	There is limited Basin-scale evidence on long- term trends in dissolved oxygen and algal blooms.	There are some cases where water management has contributed to risk management. However, in many instances risk management requires complementary actions.	There is limited intervention monitoring data relating to water quality indicators.

Refer to pages 6-9 for more information on Evaluation assessment and confidence ratings scales



Figure 26: Salt interception schemes in the southern Basin - Source: MDBA

Salinity targets for 4 of the 5 Basin Plan reporting sites were met for the 2014 to 2019 reporting period. The Basin salinity target at Morgan was met over the period since 2012, and salinity at this site shows an ongoing decreasing trend as a result of salinity management efforts over the last 30 years (Figure 27).

The key factors supporting this finding are:

- Salt interception schemes play an important role during dry periods and since 2012 have diverted on average
 0.43 million tonnes of salt out of the system per year. The target at Burtundy (lower Darling) has not been met, with the exception of 2013-14.
- --- Since Basin Plan inception, the salt export objective of more than 2 million tonnes per year from the River Murray system to the Southern Ocean has only been met once, in 2012-13. However, information on the wider context of overall salinity management in the Basin, including estimates of salt diverted away from the river by salt interception schemes, and salt loads at other key locations in the Basin suggest that, overall, salinity management in the Basin the Basin has been successful.

Since the implementation of the Basin Plan 2012 reporting on dissolved oxygen levels against water quality targets for the period has been inconsistent. State water quality reporting under the Basin Plan, due late 2020, will provide insights moving forward and guide ongoing improvements in monitoring capacity.

The period between 2014 and 2019 was particularly challenging for the management of dissolved oxygen levels in the Murray-Darling Basin. Two events in particular had important consequences for the system:

- In 2016-17, dissolved oxygen concentrations over 2 milligrams per litre were reported in multiple sections of the Murray and tributaries in the southern connected Basin. These conditions were the result of very high rainfall and extensive floodplain inundation in the south-eastern catchment, which was followed by a warmer than usual summer. Hypoxic blackwater was also reported crossing the South Australian border and impacts downstream were mitigated using releases from Lake Victoria to create a dilution flow.
- Extreme drought conditions persisted throughout the northern Basin and caused a cease-to-flow event in the lower Darling in early 2019. Two catastrophic fish death events in December 2018 and January 2019 (see Menindee fish deaths case study) have been attributed to hypoxic conditions due to low or no flow in the lower Darling. Mechanical interventions (aerators) were installed and some fish were relocated in response.

River Murray salinity levels* and the impact of management strategies

*Measured at Morgan, South Australia



Figure 27: Decreasing salinity in the River Murray at Morgan. EC: Electrical conductivity unit commonly used to indicate the salinity of water (1 EC = 1 microsiemens per centimetre, measured at 25 °C) Source: MDBA

Since the implementation of the Basin Plan in 2012, blue-green algae red alerts (exceedance of the recreation water quality target in the Basin Plan) were reported by the MDBA in:

- 2014-15 2 sites on the lower Darling
- 2015-16 widespread at multiple locations on the River Murray and the lower Darling
- 2016-17 continuation of the 2015-16 event
- 2017-18 widespread, especially in the lower Darling
- 2018-19 across many sites.

Water quality reporting by state governments at the end of 2020 will provide further insights into blue-green algae occurrences.

The Basin Plan's contribution to ensuring fit-for-purpose water quality in the Basin relies on full implementation of the Basin Plan. The water quality challenges faced over the 2012 to 2019 period (including a number of significant water quality events) plus the constrained response highlight the need to continue to improve the capacity of Basin governments to manage water quality and salinity – particularly in the context of low or no-flow conditions. Given the severity of events in the past few years, this should also include dedicated strategies for ensuring critical water needs of local communities can continue to be met.

A number of important opportunities to improve water quality outcomes in the Basin have been identified in reviews and investigations undertaken between 2017 and 2019. Action to address many of the recommendations from these reviews is underway, in conjunction with the broader program of Basin Plan implementation. In addition, a review of the water quality targets in the Basin Plan (RM Consulting Group n.d.) in accordance with the Basin Plan is underway. The review includes the appropriateness of the existing flow management target values for salinity at Burtundy and the appropriateness of the salinity targets and the salt export objective as measures of success. The review will also consider whether the salinity targets and salt export objective are in conflict. This review will be finalised in late 2020 and publically released in 2021.

It is important that this work continues given the likelihood of future drier and warmer conditions, which will increase the water quality threats faced by the Basin.

- Good water quality is vital to ensure the Murray-Darling Basin's water is suitable for drinking, agriculture, recreation and a healthy environment. Although water quality in the Basin is generally good, it can be compromised by a number of threats, including high salinity, blue-green algal blooms, low dissolved oxygen levels, nutrients, bushfires and turbidity.
 - In response to community need for Basin-scale water quality information, the MDBA regularly produces a map (figure 28) that provides an overview of threats to water quality across the Basin. The information is based on alerts and advice from Basin state governments.

Further information and detailed evaluative assessment

More detailed discussion of water quality and salinity conditions and the contribution of the Basin Plan to these outcomes, as well as supporting data and evidence, is available in 2020 Basin Plan Evaluation – Plan implementation evidence report.



Figure 28: Threats to water quality in the Murray-Darling Basin. Source: MDBA



Image: A kangaroo drinks from very low water levels in the Darling River, New South Wales

Case study: Menindee fish deaths

The events

Three significant fish death events occurred in the Darling River near Menindee between December 2018 and January 2019. Fisheries staff estimated hundreds of thousands of dead fish, with more dead fish downstream toward Weir 32. Local residents reported much larger numbers of dead fish, with estimates over a million. The species affected included Murray cod, silver perch, golden perch, bony herring and introduced carp. It is likely these events will affect fish populations in the local region, and potentially the Darling and lower Darling rivers, for many years. It is interesting to note that follow-up fisheries surveys identified that many fish survived the event.

Immediate causes

The report by the Independent Panel into fish deaths in the lower Darling (Vertessy et al. 2019) determined the fish deaths were primarily caused by local hydrological and climatic conditions, unparalleled in the observed climate record. Large numbers of fish, which had flourished since favourable spawning conditions in 2016, were isolated in weir pools due to the extreme hot and dry climate during 2018–19.

The weather and a period of low flows combined to create large areas of water with little or no oxygen for the fish to breathe. The process started in mid-2018 when low flows allowed the weir pools to separate into a warm surface layer and cooler deeper layer with lower levels of oxygen. Water quality declined further through October and November 2018 when blue-green algal blooms developed. In early December, a cool change came through with winds that mixed the water, lowering the overall oxygen levels, resulting in the first fish kills above the township of Menindee. This process was repeated through January, leading to further fish deaths.

Implications for water quality

Adverse water quality events are often associated with periods of low flow. The events in the lower Darling highlight the fact there will be situations in which flow management will not be sufficient once the water quality has declined. This points to the need for both proactive risk management and additional emergency measures. The MDBA and Basin state governments have collaborated to improve information on risks and emergency response measures.

Influences on flow

The Vertessy Independent Panel review (2019) found that inflows at the time into the Menindee Lakes were of the order of 2 to 3 times lower than historically (up to 2009). Building on this trend, a number of factors contributed to the flow conditions in January 2019. Firstly, the intense drought affecting the northern Basin saw the lowest flows in the last 20 years in the Darling River at Bourke and Wilcannia during 2017-18. Key elements of the Basin Plan have had slow implementation, including water resource plans and appropriate accounting for floodplain harvesting.

Relaxing constraints on water access and providing more flexible 'carry-forward' arrangements under A Class licences in the 2012 Barwon–Darling Water Sharing Plan led to significant increases in the extraction of water during low-flow periods. Finally, this evaluation found that transmission of flows through the northern Basin rivers has declined due to the unprecedented drought that resulted in dry river channels and high temperatures.



Social, economic and cultural outcomes

The Basin Plan influences the social, economic and cultural conditions across the Basin. This section considers how the Basin Plan has contributed to those outcomes in the Basin.

The Evaluation has used the available evidence to identify, where possible, specific and measurable outcomes that are directly related to the Basin Plan. As described in the context section of this report, there are many factors influencing socio-economic conditions across the Basin other than the Basin Plan.

This Evaluation was undertaken in 4 sub-themes:

- Agriculture and the economy considers the recent trends in agriculture and the Basin economy and evidence on the role of the Basin Plan in recent changes.
- ••• Basin water markets and trade considers evidence about how the Basin Plan water trade rules contributed to social and economic outcomes.
- Basin First Nations reviews how First Nations have been involved in water management and water planning.
- Community adaptation and resilience considers available evidence on the drivers of change for Basin communities and how the Basin Plan has helped or hindered the socio-economic trajectory of Basin communities.

➡ Finding

In an environment where communities are experiencing rapid and challenging changes, the Basin Plan has contributed to some positive social, economic and cultural change in the Basin. However, there has been significant variation in outcomes, ranging from significant negative impacts on some small regional communities to generally positive impacts on most other Basin communities.

Overall, confidently attributing social, economic and cultural outcomes to the Basin Plan remains challenging. This is due to the limited scope of Basin Plan impacts on overall outcomes compared to other factors, data availability and methodological limitations, delays in implementation progress and significant debates within communities and among stakeholders.

Image: Children canoeing at Keepit Dam, New South Wales

Basin Plan activities that aim to influence social, economic and cultural outcomes

The overarching objectives of the Basin Plan are wide ranging and work towards optimising social, economic and environmental outcomes. The Basin Plan implementation actions that most directly influence social, economic and cultural outcomes are:

- ••• setting the sustainable diversion limit and developing water resource plans
- ••• recovering water for the environment (returning overallocated rivers to sustainable levels)
- ··· reviewing Basin Plan water trade rules
- --- managing water for the environment
- --- maintaining water quality
- --- ensuring compliance.

Many of these actions have not yet been completed and the full effects are yet to play out for communities. For example, while water recovery has been occurring since 2008, the new sustainable diversion limits did not take effect until 2019–20 and Basin state governments have until 2024 to implement the Sustainable Diversion Limit Adjustment Mechanism projects.

Implementation actions are focused on water management at the catchment and Basin-scale. The Basin Plan has limited ability to optimise socio-economic outcomes for industries and communities or to assist with mitigating impacts from other external drivers such as drought, commodity markets and other social and economic trends.

Some of these external drivers will, to a much greater extent, dictate the overall outcomes for many communities. It is in this context that the contributions from the Basin Plan identified below should be understood.

Detailed analysis and further information on the socioeconomic components of the Evaluation is available in the 2020 Basin Plan Evaluation – Social, economic and cultural evidence report.

Quality of evidence

The evaluation of the impact of the Basin Plan on social, economic and First Nations cultural outcomes is complex for 2 reasons:

- the Basin Plan lacks an appropriate adaptive management framework that would include quantifiable objectives or targets and an associated monitoring program (for social, economic and cultural outcomes)
- ••• there are a range of drivers that influence conditions across the Basin. These vary in space and time and interact with each other in ways that make it difficult to identify cause and effect.

Within this context, the Evaluation sought multiple lines of evidence to describe conditions and, to the extent possible, identify the impact of the Basin Plan. The lines of evidence used include Australian Bureau of Statistics (ABS) datasets, university research, work of the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) and expert consultants – most notably the work of an independent assessment of social and economic conditions in the Basin led by Ms Robbie Sefton (Sefton Review 2020).

The Sefton Review has provided rich information on social, economic and cultural circumstances in the Basin and has captured an insight into the 'lived experiences' across the Basin. It also provides information on how the implementation of the Basin Plan and other water management arrangements have influenced wellbeing and economic outcomes in the Basin.

Agriculture and the economy

The evaluation of agriculture and the economy examines trends in condition and then outcomes from the Basin Plan implementation since 2012.

At the Basin scale, there is reliable evidence from a range of sources that indicate agriculture and the economy have shown positive trends, however this trend masks significant regional variations with small, remote communities that are heavily dependent on agriculture being particularly vulnerable. In terms of the contribution of the Basin Plan to conditions, it is clear both that the Basin Plan is just one of a suite of drivers influencing conditions and that there is significant regional variation in the contribution of the Basin Plan. Confidence in the contribution analysis is medium due to the complexity of the system and limited data.

Trends in agriculture and the economy

The Basin contributes more than \$200 billion to the national economy each year. Of this, agriculture contributes around \$24 billion, of which around \$9 billion comes from irrigated agriculture (Burgan et al. 2015).

Over the period of the Basin Plan, the total value of agricultural production has increased (Figure 29). A drop in production is expected for 2019–20 due to the drought and potentially COVID-19, which shows that climate and water availability, as well as other non-water related factors significantly influence agricultural output.

Figure 30 shows the Gross Value of Irrigated Agriculture Production (GVIAP) and water use between 2005-06 and 2017-18 across the Murray-Darling Basin, by industry (Australian Bureau of Statistics 2019).

While the ratio of dryland agriculture versus irrigated agriculture has not changed substantially over the period of the Basin Plan, there have been significant changes in the type and location of irrigated agriculture production in the Basin (especially the southern Basin) in recent years. Water markets and trading has facilitated the rapid development and expansion of the horticultural industry (especially almonds) while pastures (dairy), rice and grapevines have declined. In regions where agriculture underpins the local economy, much of the economy outside of the agriculture sector consists of support services directly related to production (for example, input suppliers, mechanics). Fluctuations in conditions that directly affect agricultural production then flow through other support sectors and affect social and economic outcomes for the entire community.

Some areas of the Basin are experiencing particularly challenging economic conditions as a result of changes in irrigated agriculture and wider economic conditions. The Sefton Review identified acute social and economic conditions in areas of northern Victoria and southern New South Wales, as well as in the remote areas across the northern Basin. The Sefton Review noted particular concerns about what was reported by communities in places such as Balranald, Bourke, Cohuna, Barooga (Cobram), Wakool, Finley, Deniliquin, Coonamble, Dirranbandi, Menindee, Walgett and Warren (Sefton Review 2020).

Contribution from Basin Plan activities

Among the Basin Plan implementation activities, the factors that intersect most directly with agriculture and the economy are:

- --- water recovered for the environment
- --- management of water for the environment
- ••• the move to sustainable diversion limits and compliance activities under the Basin Plan.

Table 9 provides a summary of these areas of Basin Plan implementation and the outcomes identified by the Evaluation.

Overall, the results show that factors such as water availability, the recent drought and commodity prices are the dominant drivers on the performance of the agriculture sector. While not a major driver at the Basin scale, evidence shows that the implementation of the Basin Plan has had mixed effects at the local scale. It has enhanced positive outcomes for some, negative outcomes for others, and accelerated changes already in motion across many parts of the irrigation sector.

(i)



Figure 29: Relative significance of dryland and irrigated farming in the Murray–Darling Basin Source: Adapted from Marsden Jacobs and Associates



Figure 30: GVIAP by commodity and total water use Source: Marsden Jacobs and Associates

Implementation action	Description of action	Related social and economic outcomes
Water recovery	The Basin Plan sets out a local water recovery target for each sustainable diversion limit (SDL) resource unit area. The overall Basin target is currently 2075 GL. Projects to adjust limits were agreed in 2018, changing the limits and water recovery target under the Basin Plan. The northern Basin requirement altered from 390 GL to 320 GL following the Northern Basin Review. Water recovery progressed in line with Basin Plan recovery targets. Some local targets in specific water resource areas have not yet been reached.	Water recovery programs (together with water markets) are the main Basin Plan implementation activity that has materially had an impact on farm businesses, supply chains and economies at local scales. These impacts are both positive and negative. They vary spatially and over time depending on the types of farm enterprises in an area and seasonal conditions. Selling water through recovery programs had generally positive effects for participating farmers in the short to medium term. Evidence shows that sellers used proceeds from sales to pay down debt, reinvest in more productive on farm investments, or exit farming (Productivity Commission 2018; Schirmer 2016; Tim Cummins & Associates and Frontier Economics 2017; Wheeler and Cheesman 2013). Infrastructure and water efficiency investments have provided a boost to regional economies.
Managing water for the environment	The Basin Plan establishes a target for hydrology of 'no loss of or degradation in flow regimes' to be achieved by June 2019. Since 2013-14 a total of 13,740 GL of water for the environment has been delivered across 844 events in the southern Basin, comprising on averaging 18% of the total annual flow volume. Environmental water holders and Basin state governments have used water strategically, on the back of recent rainfall to improve river health for everyone.	Water for the environment is expected to deliver recreational, community liveability and tourism benefits. Due to limited research there is insufficient evidence of these benefits in the Basin, particularly the economic impacts of increased tourism. More research and information and improved communications are needed to provide communities with confidence that water for the environment is achieving outcomes.
Maintaining water quality	The objective in relation to water quality and salinity is to maintain appropriate water quality, including salinity levels, for environmental, social, cultural and economic activity in the Murray-Darling Basin.	Significant irrigation development and shifts in water use by industries and regions occurred while still achieving targets. However, there is limited evidence that other aspects of improved water quality outcomes from the Basin Plan are impacting on agriculture and the economy.
Transitioning to sustainable diversion limits	 In 2017, the Basin state governments brought forward 36 SDL Adjustment Mechanism supply and constraint projects designed to improve the use and delivery of water for the environment. As of March 2020, of the 36 supply and constraint projects: 16 projects have made good progress or are on track 14 projects have made some progress but could experience delays 6 projects are at significant risk of not being operational by June 2024 	At this stage, projects are yet to be implemented and therefore outcomes are limited.
Compliance	The MDBA's primary role in compliance is overseeing the state water agencies, with a focus on auditing and reporting on state performance, developing standards and guidelines, and helping to improve capability and a Basin-wide culture of compliance. The MDBA undertakes regular reviews and assurance audits of state compliance activities. Gaps have been observed in compliance that are undermining trust in key components of the Basin Plan.	The economic and agriculture impacts of Basin Plan compliance activities and non-compliance were not assessed.

Table 9: Summary of Basin Plan implementation actions since 2012 and related social and economic outcomes for agriculture and economy

* Water trade is detailed in a following section of this report.

The independent assessment of socioeconomic conditions in the Basin (Sefton Review) concluded that overall, agriculture and the economy across the Basin has benefited from reforms to water entitlements, markets and planning, but the benefits have not been evenly distributed across regions and sectors (Sefton Review 2020).

Water recovered for the environment has had the most significant impact on agriculture and the economy in the Basin. Buybacks and on-farm infrastructure investments have reduced the consumptive pool of water. This has created shifts in farm output and regional economic activity.

Some local economies have also benefited through increased employment in the construction phase of irrigation upgrades occurring through water recovery infrastructure investment activities. Where irrigation use has fallen, small water-dependent communities and economies have been adversely affected. Larger towns and regional centres have been buffered to some extent by their more diverse economies and service economies.

There are lessons to learn around how and where water is recovered. Regardless of the approach – purchasing, on-farm or off-farm infrastructure investment – future water recovery is expected to be more complex. An improved understanding of the implications for local and regional agriculture and economies, along with an appreciation of innovations in agriculture and communities, can help with future targeted water recovery activities.

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Image: Recreational fishers on the Goulburn River, Victoria. Credit: Ben Gawne

Case study: Recreational fishing

For the Basin's regional communities from Queensland to South Australia, fishing is a major social, recreational and economic driver. There is an increasing awareness of the contribution that opportunities to fish provide relaxation, being outdoors, and spending time with friends and family which all contribute to wellbeing. These social benefits are highly valued and are becoming increasingly recognised in how we manage water.

For First Nations people, native fish provide a vital cultural connection. Fishing is a key cultural practice informed by Traditional Ecological Knowledge and passed on through the generations. Community health and wellbeing is tied to the health of Country and therefore the recovery of our native fish is of great significance for First Nations people.

Recreational fishing in the Murray–Darling Basin also contributes an estimated \$403 million to Australia's Gross Domestic Product through direct expenditure of around \$1,352 million and supporting nearly 11,000 jobs. While these numbers appear high, they are less surprising when considered within the context of the half a million recreational anglers who fish in the basin each year. The main species targeted by anglers are native species such as Murray cod, golden perch (also known as yellowbelly and callop) and mulloway. These species are all reliant on the flow regime to provide suitable habitat and food. Flows are particularly important for golden perch whose breeding behaviour is cued by increases in flow and temperature. Water for the environment has been successful in protecting populations through the recent drought, although there is recognition that in some situations (e.g. lower Darling) additional measures will be required to protect fish populations.

The full benefits for recreational fishing from implementing the Basin Plan are not expected to be realised until water recovery is complete, and there has been sufficient time for fish numbers and fishing conditions to respond to the additional water. It is also known that flow is not the only threat to native fish and that many factors (such as carp) can also affect the health of native fish populations. There is some evidence that indicates environmental watering activities since 2012 have contributed materially to increased regional economic outcomes (Productivity Commission 2018; Sefton Review 2020). Improving the riverine ecology support ecosystem services – such as natural pest management systems, reducing heat stress and bolstering plant pollination activities for farms – is expected to yield long-term benefits, but evidence of these impacts remains limited.

There are also direct benefits for tourism and recreational fishing, as well as regional amenity and community liveability from water for the environment At this stage, there is a lack of data to confirm the magnitude of these benefits.

Work under the Basin Plan to improve and maintain water quality across the Basin through a range of mechanisms is also creating benefits for agriculture and the economy.

While much of the improvements in salinity were achieved before the Basin Plan, the ongoing effectiveness of salinity management has kept river salinities and saline groundwater levels low, providing continued benefits for agriculture and the economy.

Other water quality parameters – such as turbidity, dissolved oxygen, and algal growth, flow-on benefits for agriculture and economies including tourism, recreational fishing and local amenity – are expected, but the magnitude of this positive impact is yet to be studied.

Overall, discerning the *relative* influence of external drivers and the Basin Plan on agriculture and the economy in the Basin remains challenging. It is an area for sustained effort through to the next evaluation in 2025.

Basin water markets and trade

The evaluation of Basin water markets and trade examines trends in condition and then outcomes from the Basin Plan implementation since 2012.

The Basin Plan seeks to improve water market confidence, transparency and efficacy. Multiple lines of evidence conform that the water market has facilitated the movement of water to its highest value use and that the market continues to improve. In terms of the contribution of the Basin Plan to water market efficacy, there is low confidence due to limitations in the available evidence and the multiple drivers of market performance.

Trends in Basin water markets and trade

Water markets provide irrigators, environmental, industrial and urban water users with a vital tool to move water to its most productive use and respond to variable water availability. Water markets were established late last century and their underpinning institutions have continued to evolve through National Competition Policy in the 1990s and further legislative reforms by state governments and the Australian Government.

Prices for water have increased significantly for most entitlement types since 2014. Figure 30 shows the price of entitlements across the southern Basin for both high reliability/security and general security entitlements from 2006. Recent work by ABARES summarises the key factors that explain the market price increases observed across the southern Basin in the past 2 decades (Goesch, Legg, and Donoghoe 2020) :

- Reduction in supply due to lower rainfall 5% lower than the long-term average since 2000. This is the main driver of change and is attributed to climate change (Interim Inspector-General of Murray-Darling Basin Water Resources 2020).
- Reductions in supply due to water recovery by the Australian Government, restrictions on interregional trade, changes in state allocation rules and increased access to carryover. The effect on price from water recovery has been relatively small.

 Changes in demand of water away from the more flexible lower value activities (e.g. pastures and rice) to higher value annual (e.g. cotton) and perennial (e.g. horticulture) activities. This has the effect of pushing up demand for water at most water prices.

The Australian Competition and Consumer Commission (ACCC) is investigating the contribution investors are having to water price increase. These investigations will aim to determine if investors are putting upward pressure on price. The ACCC's final report is due in February 2021. The ACCC's interim report has shown how water trading has brought significant benefits to many water users throughout the Basin. The benefits attributed to water trading are:

- --- better balancing of water supply and water
- --- ability for irrigators to earn income though leasing or selling water rights
- --- expansion of production for some commodities
- --- flexibility of how irrigators access and trade water
- ••• release of capital for investment in business (Wheeler et al. 2020).

Together these factors have contributed to the increase in the value of production of irrigated agriculture in the Murray-Darling Basin since 2011.

Distributional changes in water use across regions are having varying impacts on some irrigation-dependent Basin communities. For instance, the water that many dairy farmers in Goulburn Valley sold, is now contributing to greater profits for almond growers around the Sunraysia region of Victoria, nearby regions in New South Wales and into the Riverland region in South Australia.

At the Basin scale, these changes are crucial to sustaining and growing the value of agriculture. However, the shift in water use has negative local implications that have led to tensions in the Basin between communities benefiting from change and those who are seeing water traded to other areas.


Figure 31: Storage volume percentage and volume weighted average prices for high security, general security and low reliability water entitlements Murray–Darling Basin 2004–2020. Source Marsden Jacob Waterflow.[™]

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Contribution from Basin Plan activities

The Basin Plan activities related to the water market are focused on improving market confidence, transparency and efficacy. Table 10 provides a summary of the Basin Plan rules, actions achieved and observed outcomes.

- A number of outcomes have emerged as a result of the water market activity that the implementation of Basin Plan water trading rules support:
 - Water moving to its highest value use has facilitated drought resilience and assisted with the transition to the new sustainable diversion limits.
 - Market transparency and performance has improved. However, a lack of transparency in some areas and timeliness of market information is a barrier to many participants realising the full economic opportunities from trade.
 - Water trade has enabled the growth of different industries, such as almond and cotton, in the southern Basin. However, as water moves to its higher value use, distributional changes are having varying impacts on communities, as well as adding pressure to river operations around deliverability.

Due to the complexities of the water market and importance of external drivers to market behaviour, Basin Plan activities are identified as one of many contributors to these outcomes. Table 10: Summary of water trading implementation and observed social and economic outcomes

Basin Plan water trading rule activity	Actions achieved	Social and economic outcomes observed
Appropriate restriction in trades	Significant improvements in the transparency of reporting and status updates have occurred.	Moving water to its highest value use has facilitated drought resilience and assisted with the transition to the new SDL limits. Market transparency and performance has improved. However, a lack of transparency in some areas and timeliness of market information is a barrier to many participants realising the full economic opportunities from trade.
Information provision and transparency activities undertaken by state governments, Australian Government agencies and IIOs	In general, changes to trade information have improved across the Basin.	
	While trade prices are being reported, there is a lack of separation in market prices across secondary products and there is limited price transparency for trades within irrigation infrastructure operators (IIOs).	
	A lack of transparency and timeliness of market information remains which, if addressed, has to potential to improve market performance.	
Information provision and transparency activities undertaken by IIOs	IIOs have published Network Service Plans, making transparent:trade charges for water delivery and irrigation rights	Water trade has enabled the growth of different industries such as almond and cotton industries in the southern Basin. As water moves to higher value uses, distributional changes are having varying impacts on communities.
	 their trade processes on relevant websites to improve transparency regarding the process. 	
	Delivery rights markets need further development because the liquidity and value of the right can vary both between and within IIOs.	
Market confidence and integrity activities	Water market sensitive protocols are being implemented by Basin state governments.	Although water market literacy across the Basin is improving through work by the MDBA and Basin state governments, First Nations' water literacy is still behind other communities.
	Allocations are announced on an agreed schedule across Basin state governments (fortnightly).	
	Allocation outlooks are published by the Victorian, New South Wales and South Australian governments, both ahead of water year opening and throughout the water year.	



Image: Almond orchard in Nangiloc, Victoria. Photo: Mallee Catchment Management Authority

Case study: Horticulture Below the Barmah Choke

Changes in the irrigation industry in the southern connected Basin have influenced the timing, volume and location of water demand. The rapid development and expansion of new industries such as horticulture have been driven by strong commodity prices, with water trading supporting this rapid development.

The composition of horticultural plantings below the Barmah Choke (a natural narrow channel of the River Murray with limited capacity) have changed significantly over time. Wine grapes and citrus now represent a smaller proportion of total plantings as these industries restructured in response to market pressures. Large greenfield developments of almonds and, to a lesser extent, olives have emerged and grown in scale. The development of these greenfield sites has been associated with a substantial decline in the number of horticulture farms in the older irrigation areas below the Choke. A further change is that the proportion of large farms (over 100 hectares) in part because mid-sized blocks, (10 to 50 hectares), have been consolidated.

Distributional changes are having varying impacts on some irrigation dependent Basin communities (explored

further in the Basin Economy and Agriculture evaluation theme). For instance, the water that many dairy farmers in Goulburn and Murray Valleys sold is now contributing to greater profits for almond growers around Sunraysia (Victoria and New south Wales) and South Australia.

Trading has also contributed to delivery issues for the lower Goulburn River, and potentially influencing conveyance losses (the volume of water which is lost to the system due to evaporation or seepage). There is limited scope for horticulture developments to expand as constraints become binding. For instance, the water thatmany dairy farmers in Goulburn Valley and rice farmers in the mid-Murray sold, is now contributing to greater profits for almond growers around the Sunraysia region of Victoria, nearby regions in New South Wales and into the Riverland region in South Australia.

There are risks demand may not be met in the future under very dry conditions and peak summer crop needs. Demand below the Choke may be met, in part, by available water above the Choke through the temporary water market.



Image: An almond tree in blossom in Nangiloc, Victoria. Photo: Mallee Catchment Management Authority



Figure 32: Estimated national kernel production. Source: Almond Board of Australia

Basin First Nations

The Evaluation examines trends in the socio-economic and cultural wellbeing of First Nations and outcomes from the Basin Plan implementation since 2012.

The assessment of socio-economic or cultural conditions of First Nations is based on indicators of Aboriginal wellbeing, which are documented through a range of data sources, including ABS. The available evidence makes it clear that First Nations' often experience poor social and economic conditions. The Australia-wide Close the Gap initiative 2020 progress report noted most targets to close the gap (including gaps in life expectancy, child mortality rates and school attendance) are not on track or being met.

The contribution of the Basin Plan to conditions is constrained by its limited capacity to influence wellbeing. Within this context, it is also hard to quantify the impact of the Basin Plan due to limited data designed to identify the expected outcomes. The assessment of the contribution of the Basin Plan has low confidence.

Trends in the socio-economic and cultural wellbeing of First Nations

The socio-economic status and demographic make-up of First Nations across the Basin are markedly different to those of non-Indigenous populations. The ABS publishes a range of Australia-wide Aboriginal and Torres Strait Islander population and health statistics that confirms this. However, information stratified to a Basin level or into First Nations is less common.

Of the information available, the picture it paints is often of poor social and economic conditions for many First Nations. Most targets under the Close the Gap Initiative are not on track or being met.. The reasons for these are many and go well beyond the remit of the Basin Plan. However, water management and caring for Country are a vital part of Indigenous cultural, spiritual and economic wellbeing. Water enables First Nations to continue customary and spiritual traditions.

Water enables First Nations to continue customary and spiritual traditions. There is a crucial difference between environmental and cultural flows in terms of Aboriginal values.

Environmental flows are the flows necessary to sustain aquatic ecosystems which, in turn, support human cultures, economies and wellbeing.

Cultural flows are water entitlements that are legally and beneficially owned by the First Nations of a sufficient and adequate quantity and quality to improve the spiritual, cultural, environmental, social and economic conditions of those First Nations³.

Many spiritual and cultural connections depend on water, such as the maintenance of cultural and sacred sites through specific water regimes, facilitating the exchange of generational knowledge and ensuring the ongoing spiritual connection with the flora and fauna.

³

See Murray Lower Darling River Indigenous Nations Echuca declaration



Rivers and water are critical to Indigenous cultural, spiritual and economic wellbeing.

First Nations water holdings across the Basin make up a very small percentage of the total water (0.17%) (Hartwig and Jackson 2020). Generating income from water can also be difficult for First Nations' communities as many water allocations prohibit the use of water for monetary benefit. Although water for economic purposes is available through the conventional licensing frameworks, there are barriers to participation, such as delivery costs, that restrict participation without the necessary support (Productivity Commission 2017a).

The connection to land and water by First Nations is sustained by reconnecting generations to Country through storytelling. The education provided through stories includes land and water creation, animal and place significance, herbal remedies, and how the land and its ecology must be managed for the longterm survival of water-dependent values (Marsden Jacobs Associates 2019a). The Murray-Darling Basin provides wetlands, rivers, billabongs, springs, lakes and aquatic environments that Indigenous people use for educational and ecological activities. Across these landscapes, there are important differences between conventional environmental management and Aboriginal management guided by ecological and cultural values (Marsden Jacobs Associates 2019a)

The network of interconnected rivers and streams are a place for cultural and spiritual gathering for the more than 50 First Nations across the Murray–Darling Basin. The aquatic environments of the Basin provide areas for social and recreational activities, such as swimming and fishing. They provide gathering and storytelling places for reconnecting people to Country and promoting social wellbeing. They are also powerful in providing opportunities to share economic, spiritual, cultural, social and environmental cultural values that further contribute to maintaining a connection to Country.

Contribution from Basin Plan activities

The Basin Plan stipulates that Indigenous values and uses are to be considered at a number of points along the implementation of the Basin Plan. These are:

- Basin state governments are required within water resource plans to identify First Nations' objectives and outcomes related to water management, including giving respect to peoples' cultural flows, and Indigenous communities and organisations.
- The Murray Lower Darling Rivers Indigenous Nations (MLDRIN) and Northern Basin Aboriginal Nations (NBAN) provide advice on the adequacy of water resource plans with respect to this requirement for consideration by the MDBA when undertaking accreditation activities.
- Within the planning for and delivery of water for the environment, the Basin Plan states that environmental water holders must have regard to First Nations people's values. In addition, the MDBA should seek to engage with First Nations to maximise opportunities for delivering not only ecological objectives but also, where practical, environmental, social and economic outcomes that are in line with objectives and outcomes as identified by First Nations.
- Partnerships between the MDBA and Indigenous people aim to improve knowledge of First Nations water requirements and aspirations.

In essence, the implementation of the Basin Plan in collaboration with First Nations is focused on increasing the involvement of First Nations in water planning and management activities, such as using water for the environment and the development and accreditation of water resource plans.

Table 11 provides a summary of the implementation actions and evidence of resulting social and economic outcomes for First Nations.

Table 11: Summary of key Basin Plan implementation actions and outcomes for First Nations

First Nations' implementation actions	First Nations' outputs	Actions
Improve knowledge of water requirements within the Murray-Darling Basin, including the following: requirements relating to the social, spiritual and cultural uses of Basin water resources by Indigenous people.	The MDBA has strengthened its engagement with First Nations to grow First Nations participation and integrate their knowledge into water management practices within the MDBA, including those required by the Basin Plan. This is being achieved through planning and use of water for the environment, water resource plans (WRPs), cultural flows, reviews and evaluations.	 Reconnection with Country Greater understanding from the government agencies Building of mutual respect and the forming of good connections and relationships Greater knowledge of cultural sites and traditions
Development of a water for the environment strategy and undertaking environmental watering that is aligned with Basin Plan Environmental Watering objectives and principles relating to working with Indigenous communities and acknowledging Indigenous uses and values.	Two Basin-wide environmental watering strategies have been developed in 2014 and 2019, including a review in 2019. Water planners are increasingly working with First Nations and organisations including the MLDRIN and NBAN to identify their interests in relation to water management.	 Improved ecological and cultural outcomes covering native fish, frogs, waterbirds, vegetation Documentation of important sites and cultural uses and values Indigenous-led water planning tools, such as the Aboriginal Waterways Assessment.
Development and accreditation of water resource plans.	Under the Basin Plan a total of 33 water resource plans were scheduled to be accredited by 31 December 2019.	 It is too early to determine outcomes directly related to water resource plan implementation and the involvement of First Nations to these plans.

Finding

There have been a range of beneficial outcomes achieved so far through the incorporation of First Nations' views and objectives in the management of Basin resources that align with Basin Plan requirements to have regard for Indigenous uses and values.

The ongoing use of culturally appropriate methods to increase the involvement of Aboriginal peoples in water planning and management activities is one important area of success. Interactions have been ongoing since before the Basin Plan was conceived – notably the Living Murray Indigenous Partnerships Program, where early engagement with First Nations groups, the Murray MLDRIN and NBAN, provided the frameworks required to guide relationships between First Nations and Basin water managers and planners (Jackson et al. 2020). Other programs such as the Aboriginal Waterways Assessment have provided effective and culturally appropriate methods for First Nations to document their values and uses associated with water planning (Mooney and Cullen 2019).

> A key driver for outcomes for First Nations has been the work by the MDBA and Commonwealth Environmental Water Holder to collaborate on projects that provide for First Nations people's input into environmental water planning.

By engaging First Nations in a collaborative design process, the MDBA and Commonwealth Environmental Water Holder foster a partnership with MLDRIN and NBAN and a mechanism to include First Nation objectives into Basin environmental water planning. The Commonwealth Environmental Water Office employs 6 local engagement officers to facilitate building and maintaining relationships with First Nations and working alongside communities throughout the Basin. This complements dedicated state partnerships with First Nations in planning and decisions on use of water for the environment.

Some of the outcomes achieved so far through the

incorporation of First Nations' knowledge, preferences and objectives in environmental watering include:

- ••• enhancing sites as nesting and breeding areas for waterbirds of cultural significance
- restoring and maintaining native vegetation for uses such as bush medicine, craft, ceremony artefacts and food
- achieving vegetation outcomes, which can be linked to re-establishing traditional harvest activity of the site, to enable sharing of cultural knowledge, stories and experiences as a community
- establishing refuge for wildlife in a highly developed and modified landscape (farmland, irrigation, river regulation), including animals of historical and cultural importance
- supporting cultural management, ongoing protection and preservation of significant sites, including artefact, burial sites and occupation sites, connected to the belief in the continuing spiritual presence of ancestors in the landscape.

As the largest holder of water in the Basin, the Commonwealth Environmental Water Holder (CEWH) seeks to provide cultural outcomes through delivering environmental flows with the involvement of Indigenous peoples. The Commonwealth Environmental Water Holder engages with First Nations communities and stakeholders through local engagement officers to incorporate their knowledge, views and solutions into the planning and delivery of water to achieve both cultural and environmental outcomes (Jackson and Nias 2019). The 2020-21 Commonwealth Environmental Water Office Water Management Plan includes formal input from the MLDRIN and NBAN on First Nations environmental objectives and outcomes across the Basin as part of the First Nations Environmental Watering Guidance project. 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. The expected outcomes from this plan will allow for better integration with cultural objectives into the management of water for the environment.

Similar to the findings of the 2017 Basin Plan Evaluation, time is still needed to achieve the sorts of outcomes First Nations are seeking under the Basin Plan, and to further develop First Nations meaningful and beneficial involvement of First Nations in implementing the Basin Plan. For example, it is not yet possible to evaluate the effectiveness of water resource plans in contributing to outcomes for First Nations in the Murray–Darling Basin. Most water resource plans have only been in place for a short period of time and there are a number of plans yet to be accredited.

Cultural flows are also still yet to be fully developed and, while Basin ecosystems are generally improving, long-term environmental benefits are going to take considerable time to materialise and for the related outcomes to be observed.

Effective monitoring and evaluation frameworks that attribute First Nations people's social and economic outcomes to the implementation of the Basin Plan is also an important area for future development. This will ensure the long-term impacts from the Basin Plan are understood.

Case study: **Gayini**

Gayini is a vast 87,816 hectare property owned and managed by the Nari Nari Tribal Council, the site's Traditional Owners. Connection with Country leads to the conservation of precious wildlife, the development of sustainable agriculture and the protection of significant cultural heritage. The area has supported First Nations for 50,000 years and, as a result, has a rich cultural landscape that includes a wealth of Indigenous cultural features from sacred canoe scar trees to ancient burial mounds and campsites. Once more in possession of their land, Nari Nari people are caring for it using a combination of traditional and modern techniques to improve natural and cultural values and its productivity.

Gayini is part of the Lowbidgee floodplain—the largest remaining area of wetlands in the Murrumbidgee Valley, New South Wales and an area of wetland of national and international significance. The site is known for its abundant native birds ranging from spotted pardalotes to large numbers of emus. The wetlands are of particular significance as during floods, they provide feeding and breeding habitat for waterbirds including straw-necked ibis, royal spoonbill, little pied cormorant and Australian pelican. Nationally-listed threatened species are also protected at Gayini, including one of Australia's largest frogs – the Southern Bell Frog – and 2 endangered bird species – the Australasian bittern and Australian painted-snipe.

In 2013, as part of the implementation of the Basin Plan, the New South Wales and Australian Governments purchased 19 separate properties and their water extraction rights in the Lower Murrumbidgee Valley. In May 2018, a consortium led by philanthropic The Nature Conservancy was announced as the successful proponent and took over management of Gayini. The other members of the consortium were the Nari Nari Tribal Council, the Murray-Darling Wetlands Working Group and the University of New South Wales.

> Image: A smoking ceremony to mark the handover of Gayini Nimmie-Caira Credit: Murray Darling Wetlands Working Group

In late 2019, The Nature Conservancy facilitated the legal transfer of ownership of Gayini to the Nari Nari Tribal Council thanks to funding from the Indigenous Land and Sea Corporation and the Wyss Campaign for Nature. Funding has also been provided by the New South Wales Environmental Trust.

The Nari Nari Tribal Council and other consortium members work with the New South Wales Department of Planning, Industry and Environment – Environment, Energy and Science and the Commonwealth Environmental Water Office to manage environmental water allocations across the Gayini Nimmie-Caira area. The environmental watering actions are designed to support the native fauna and flora, including some endangered species that inhabit the network of creeks and wetlands across the floodplain. Coordination with watering into neighbouring Yanga National Park and the North Redbank floodplain is designed to achieve ecological outcomes at a regional landscape scale.

Gayini represents an innovative collaboration between First Nations, non-government organisations and government to empower First Nations while also delivering significant environmental and economic outcomes.



Community adaptation and resilience

This part of the Evaluation focuses on how the Basin Plan has influenced and contributed to the adaptive capacity and resilience of Basin communities. It provides insights into the community experience and, where evidence is available, discusses the extent of socio-economic change that may be attributable to the Basin Plan.

Community adaptation and resilience for the purpose of this evaluation offer a lens through which to evaluate how the Basin Plan and other activities have had a positive or negative effect on communities. **Resilience** refers to the ability of communities to remain viable as they are. **Adaptation** refers to the ability of communities to transform.

The level of community resilience and adaptation is among the most challenging to assess due to uncertainty around appropriate indicators and lack of data. It appears likely that, as with agriculture and the economy, that there is significant regional variation in community resilience and adaptation. There is medium-quality data for community wellbeing. However, quantifying the contribution of the Basin Plan is challenging due to the large number of factors at play and limited data.

Trends in Basin communities

Many smaller communities in outer regional and remote communities are declining, while regional centre areas are growing. A pattern has emerged across most of regional and rural Australia – not just in the Basin – of larger communities growing in population, while many smaller communities' populations are falling (Productivity Commission 2017b). Movement from smaller towns to larger regional centres and cities generally occurs because of greater job opportunities, schooling and education pathways and other reasons.

Smaller and more remote communities across the Basin are less economically diverse and tend to be more reliant on agriculture. These communities do well when key industries are profitable, but they are less able to absorb negative 'shocks' to their economies when those industry conditions change. Regional areas shown to have a heavily reliance on agriculture include Conargo (New South Wales), Karoonda (South Australia), West Wimmera (Victoria), and Carrathool (New South Wales). Smaller communities and outer regional and remote communities typically also have poorer infrastructure and services compared with larger regional centres and cities (Schirmer and Mylek 2020). These communities have less access to high-speed, reliable internet and mobile phone reception relative to communities outside the Basin. The flow-on effect is that these communities are less confident in their community's ability to cope with challenges than the larger regional centres with better services and greater economic diversity.

Work commissioned for the Sefton Review shows that low economic diversity, high dependence on agriculture and remoteness more strongly predicted negative change in social and economic outcomes in the Basin than outside the Basin (Schirmer and Mylek 2020). The Evaluation does not attempt to attribute social and economic condition to one or more drivers because interdependent factors, such as high dependence on agriculture for employment and ongoing drought, cannot be isolated. However, it does highlight the specific challenges that low economic diversity, high dependence on agriculture, and being remote creates for community wellbeing.

Contribution from Basin Plan activities

There are no specific and targeted actions within the Basin Plan to directly support communities aside from communication and information sharing. However, there are many actions within the Plan that will have flow-on effects to communities.

Table 12 provides a summary of relevant areas of implementation and the links to community adaptation and resilience outcomes.

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Basin Plan implementation measures	Description of action and observed outputs	
Water recovery (overall)	The effects of the Basin Plan on agricultural industry output and local economic activity appear to be mixed. Overall results tend to align with and reinforce the underlying shifts in industry and regional economic outcomes driven by wider external factors.	
	Economic impacts of water recovery in water-dependent communities need to be balanced against the socio-economic gains to the community that will occur because of the environmental and cultural outcomes of use.	
Water recovery (approach to water recovery and individuals)	On and off-farm infrastructure and water efficiency investments have created regional economic stimulus.	
	On-farm investment created productivity gains through on-farm efficiencies for many farms (Department of Agriculture and Water Resources 2017; Marsden Jacobs Associates 2017; Productivity Commission 2017a; Schirmer 2016). Increasing technical water use efficiency and supporting farm adaptation and on-farm productivity may increase resiliance and adaptive capacity.	
	Irrigators who have transferred entitlements to access on-farm irrigation grants report overall positive impacts for their farms on a range of measures.	
	On-farm irrigation upgrades create economic and other impacts across the broader agricultural value chain and in regional communities.	
	Selling to water recovery programs had generally positive effects for participating farmers in the short to medium-term.	
Water for the environment	There is mixed evidence to indicate water for the environment over the life of the Basin Plan has contributd materially to increased regional economic outcomes (Productivity Commission 2018; Sefton Review 2020).	
	The continuing lack of monitoring of recreational and other benefits of environmental flow releases reinforces the need to implement the Productivity Commission's recommendation. Others have also pointed to the urgency of better establishing links between water recovery, flow regimes and enhanced ecological outcomes.	
Water quality	The Basin Plan has contributed to the achievement of Basin salinity targets that have been underpinned by a range of salinity management measures, which were implemented before the Basin Plan. However, there is limited evidence that other aspects of improved water quality outcomes from the Basin Plan are having an impact on agriculture and the economy.	

Table 12: Summary of Basin Plan key implementation actions on community resilience and adaptation

Basin Plan implementation measures	Description of action and observed outputs
Water resource plans	There have only been a limited number of plans accredited under the Basin Plan and limited time for them to have an impact on agriculture and economy outcomes over and above those already observable through water recovery.
	Work by the MDBA and partner governments to bring Aboriginal peoples and First Nations into decision-making has led to improvements in Indigenous people's involvement.
Water trade	Basin Plan implementation activities have supported improving the efficiency and effectiveness of markets, building drought resilience.
	Water trading has enabled and supported the development and expansion of new industries, such as the horticulture industry.
	Distributional changes have had positive and negative impacts on communities.
	Higher water prices have been cited as a concern or market failure, particularly during drought. This lack of confidence in markets may reduce self-efficacy and increase stress.
First Nations	There have been a range of outcomes achieved so far through the incorporation of First Nations people's views in the management of Basin resources.
Supporting community adjustment	Programs were established to support structural adjustment during Basin Plan implementation. These programs implemented by the state Governments have had patchy results and the overall approach did not support community adjustment. (Marsden Jacobs, 2019a)
Basin water governance	Recent inquiries into the adequacy and integrity of governance arrangements in the Murray-Darling Basin provide a pathway to responding to a lack of trust, legitimacy and public confidence.

Communities with low economic diversity, high dependence on agriculture, and that are more remote (have lower access to infrastructure and services) are more vulnerable to impacts from low water availability, water trade and commodity prices, and Basin plan activities, such as water recovery.

It is too early to identify the outcomes from this ongoing investment.

Outside the Basin Plan, the Australian Government and Basin state governments support Basin communities through specific community adjustment funding. This funding is in addition to broader government investment and policies targeted to support regional communities in the Basin.

The available evidence shows that Basin Plan impacts on communities have been most significant for those communities most reliant on irrigated agriculture, with negative impacts concentrated in small communities where significant volumes of water recovery has occurred. These communities include areas around the Goulburn Valley (Victoria), Finley, Deniliquin, and Menindee (New South Wales. These impacts have occurred alongside lower water availability and other external social and economic pressures.

These communities expressed concern about the future of irrigation agriculture and the viability of small farmers. They felt the contraction of the consumptive pool of water increased pressure on their economic viability, and hence livelihoods, during droughts. They are concerned that climate change will further exacerbate these pressures (Sefton Review 2020).

For the larger and economically diverse and servicedriven communities in the Basin, Basin Plan reforms are thought to have had very limited implications for community resilience and adaptation.

Regardless of the level of impact, there is currently a high level of distrust in some regions and communities around Basin Plan governance. This lack of trust and confidence in the current institutions may be undermining their resilience and adaptive capacity.

Finding

Effective engagement with the community and having them more involved in the decision-making that can affect their future is vital to support adaptive capacity.

Engagement is the key to success as it provides avenues to support and empower local leadership across these communities and to build knowledge for government and community. It is crucial to have engagement approaches that build capacity, respect diverse stakeholders' views and provide support to work cooperatively and find new ways of seeing and understanding problems and solutions.

Actively investing in bringing communities along the journey of water reform, and making these decisions together, will help build adaptive capacity in Basin communities and assist in securing their futures.

Community wellbeing remains low in many areas of the Basin (Figure 29). Targeted community adaptation and resilience investments will remain an important area of complementary policy in the Basin, particularly given the even greater shifts in patterns of economic activity that are expected to occur in the future as the climate changes.

Governments need to work to continually improve mechanisms for providing targeted and effective adaptation and resilience support to the communities most affected by changes in the Basin economy.

The Murray-Darling Basin Economic Development Program has been put in place to:

- ••• increase the capacity of eligible communities to diversify and strengthen local economies
- enhance the resilience of eligible communities to manage current and future economic challenges and changes
- ••• increase opportunities for employment within eligible communities.

Independent assessment of social and economic conditions in the Basin – what the Panel heard from communities

The Independent assessment of social and economic conditions in the Basin was commissioned in mid-2019 by the Australian Government. The assessment panel was independent, reporting directly to the Minister. The final report was released by the Australian Government on 4 September 2020.

The assessment panel was chaired by Robbie Sefton and commissioned extensive social and economic research.

During the process of developing their final assessment, the Sefton Panel heard from many communities throughout the Basin. The Panel emphasised the need to capture the 'lived experiences' across the Basin, hearing of the social and economic conditions in the Basin through faceto-face and phone meetings with over 750 people, the submission of over 100 written responses and the completion of over 600 online survey responses during their consultation phase throughout 2019.

The positive and negative findings of the Sefton Panel's Basin consultation have proved to be an extremely valuable source of information and have been extensively used throughout this Evaluation. The Panel's Listening to Community Voices report (Sefton Review 2019) outlines what the Panel heard during their assessment.

••• Basin communities are feeling the effects of significant pressure

People living in Basin communities facing reduced water availability and drought are under immense pressure, some describing that their physical and mental health and wellbeing, cultural identity and community prosperity are declining due to the impacts of water reform and drought. ••• There are areas of optimism, growth and positive benefit

Positive stories and examples where water reform has provided net benefits to society overall were heard. Some industries and businesses are expanding, particularly in some of the Basin's larger towns.

•• The benefits and impacts of water reform are uneven

Water reform has benefitted some more than others. This has led to an increase in overall wealth but has also led to a transfer of wealth between regions.

Reduction in the consumptive pool of water is exacerbating the effects of drought and climate change

Water reform is viewed by many people as exacerbating the worst of the impacts of drought, removing a buffer to drought and reducing the scope for post-drought recovery. Many believe these cumulative impacts will be worsened by future climate change.

Trust in governments, agencies and markets is at a low point

Communities are losing confidence in their capacity to influence fair and equitable decision-making.

••• The benefits of environmental flows are not well understood or recognised

Most felt that the environment was benefiting from the return of water to the environment but, many see management decisions, particularly during drought, as lacking focus and out of step with their local communities and/or environmental needs.

--- Lack of connecting infrastructure is further impeding economic development

Physical and digital connectivity through roads, transport and telecommunications were felt by many to be second-class.

--- Communication, transparency and data need to be improved

Understanding of the complexities of water reform, including the roles of different levels of government, is limited. People living in rural and regional communities want real participation in decision-making
 Many expressed a desire for greater involvement and influence in decisions that impact them.





Basin Plan implementation

The National Water Initiative established a blueprint for future water management in Australia in 2004. The Basin Plan applies this national framework to the Murray–Darling Basin and establishes policy and management foundations that aim to work together to enable water in the Basin to be managed sustainably.

Significant progress has been made in implementing the Basin Plan since 2012. The key findings of the Evaluation of implementation progress are presented in 8 sections:

- --- addressing overuse setting sustainable diversion limits and recovering water for the environment
- adaptions to the sustainable diversion limits adjustment mechanisms
- adaptions to the sustainable diversion limits Northern Basin Toolkit Measures
- ••• implementing the Environmental Management Framework
- ... implementing water resource plans
- --- sustainable diversion limit accounting
- --- compliance
- --- implementing water trade rules.

The detailed assessment of implementation progress is included in the 2020 Basin Plan Evaluation – Plan implementation evidence report.

Progress in addressing overuse: setting sustainable diversion limits and recovering water for the environment

The Basin Plan established a new system of water limits focused on sustainable diversion limits. These limits set how much water, on average, can be used in the Basin by towns, communities and industries, while leaving enough water in the river to sustain rivers, lakes and wetlands. There are limits set for 29 surface water and 80 groundwater areas across the Murray-Darling Basin. Initial limits were established under the Basin Plan in 2012. See Figure 34 for a breakdown of the different types of water in the river system and SDLs.

Image: Water regulator on Kangaroo Lake, Victoria







Figure 35: Timeline to deliver projects to adjust sustainable diversion limits Source: MDBA

- Sustainable diversion limits (SDLs) are longterm limits that allow for water use to vary on an annual basis. SDLs are different to the water recover target which is fixed in the Basin Plan
- Limits that determine how much water can be taken out of the natural system are guiding water use and management. The SDLs cover surface water and groundwater use. These limits build on 'the Cap' governments put on surface water diversions in 1995.

Addressing overuse of the Basin's water resources by ensuring limits are not exceeded is the key focus for the Basin Plan. Significant progress has been made through recovering water for the environment.

Water Recovery

Water recovery was undertaken via direct purchase (known as 'buybacks') initially and, more recently, infrastructure investments and efficiency programs. This has been the key mechanism for rebalancing water use in the Basin and establishing the portfolio of water entitlements for the environment. The Basin Plan sets out a local water recovery target for each SDL resource unit area, along with shared water recovery targets for the sustainable diversion limit resource units within a state.

More than 2,100 GL of water for the environment is now held and managed by the Commonwealth Environmental Water Holder, state environmental water holders and through The Living Murray program. This significant volume of water is being used across the Basin to achieve healthy river system outcomes.

The majority of water recovered from the irrigation sector achieved through buybacks and infrastructure upgrades (this excludes reviews and adjustments) was completed prior to 2012 or in the early phases of implementing the Basin Plan. There has been limited water recovery in the last 3 years. The water recovery target has been updated through amendments to the Basin Plan. In January 2018, amendments were made to the Basin Plan as part of the adjustment to SDLs. The amendments reduced the Basin-wide water recovery target by 605 GL per year, dependent on the implementation of supply and efficiency measures (see SDL Adjustment Mechanism section). In July 2018, following the Northern Basin Review, a second set of amendments were made to the Basin Plan, which reduced the water recovery target from 390 GL per year to 320 GL per year in the northern Basin.

As at 30 June 2020, the water recovered for the environment is 2,106 GL per year. Following the amendments to the Basin Plan, the overall target for water recovery is 2,075 GL per year. While the total amount of water recovered across the Basin is higher than the overall target of 2,075 GL per year, there remain some sustainable diversion limit resource units with local and shared water recovery targets that have not yet been met. Water needs to be recovered in particular areas to achieve environmental outcomes. This is why there remains some water to be recovered despite the fact that total recovery across the Basin exceeds 2,075 GL per year. Water recovery still required is currently estimated to include:

- ••• local water recovery of 30.3 GL per year, mostly in the northern Basin
- --- shared water recovery of 14.9 GL per year, mostly in the southern Basin
- efficiency entitlements of 60.1 GL per year to be registered to allow the full effect of the 605 GL per year supply contribution to sustainable diversion limits.

While the remaining water recovery is minor compared to the volumes already attained, **the volumes are crucial to sustainable management in specific catchments.** The recent drought, where limited water was available to maintain environmental assets across the Basin, has shown how important it is that the task be completed. To more accurately assess how much water has been recovered for the environment and to guide future water recovery decisions, long-term diversion limit equivalent factors (known colloquially as the 'Cap factors') have been established. Updated factors have been developed to consider the most recent information used for the accreditation of each water resource plan. The factors will be used to confirm that the water recovery required in each catchment has been completed, as required under the Basin Plan.

However, until all water resource plans are accredited with the updated factors and the SDL Adjustment Mechanism supply, constraints and efficiency projects are completed, the exact level of recovery in a SDL resource unit remains uncertain.

Progress in adapting the sustainable diversion limit: adjustment mechanism

To provide flexibility, the Basin Plan included a mechanism to adjust SDLs.

The SDL Adjustment Mechanism involves 3 elements that work together – supply projects, constraints projects and efficiency projects – to reduce the volume of water needed to be recovered.

- --- Some of the **supply projects** modernise river management, providing the means to more efficiently deliver water to environmental sites.
- ••• The constraints projects help water reach the floodplains and enable greater volumes of water to be delivered down the river.
- ••• Efficiency projects recover water for the environment through modernised infrastructure that enables more efficient water use.

The SDL Adjustment Mechanism requires a suite of 36 projects to be implemented by 2024.

Overall, the Evaluation has confirmed delays and significant risks in delivery of some of the complex supply and constraint projects. Progress in the delivery of efficiency projects also remains slow.

At this stage, a number of the more straightforward supply projects have made good progress, as have a range of river operating practices and rules projects. However, some of the highly complex projects are not on track. As of March 2020, of the 36 supply and constraint projects:

- 16 have made good progress and are under construction, undertaking operational trials or in operation
- 14 projects have made some progress with project design and implementation, however could experience ongoing delays due to stakeholder concerns
- ••• 6 projects are at significant risk of not being operational by June 2024.

Efficiency projects aim to provide up to 450 GL per year more water for the environment. To date, **very few efficiency measures have been locked in**, and the total volume available from these measures is less than 2 GL per year.

In September 2020, the Australian Government announced a new Murray-Darling Communities Investment Package, which included a focus on accelerating planning and delivery of the projects to adjust limits that are at risk of not being delivered by 2024. See Figure 35 for a full timeline to deliver SDL projects.

The Australian Government, also announced in September 2020 that the program would shift focus onto off-farm projects, and that no more water purchases (buybacks) would be considered by the Australian Government.

Ongoing commitment to delivering these projects is needed and is important that Basin communities are involved in their design and delivery. There is currently a high level of community concern regarding these projects and communities are seeking meaningful engagement from all governments.

Progress in adapting the sustainable diversion limits: Northern Basin Toolkit Measures

At the time the Basin Plan came into effect in 2012, it was acknowledged that more work was needed to improve the hydrological, environmental, social and economic knowledge base underpinning the Basin Plan in the northern Basin. The MDBA conducted a 4-year review into the northern Basin as a result.

Following substantial research and collection of new information, the review identified the need to better target water recovery efforts in the north, as well as the need to improve water management arrangements and undertake environmental projects to effectively achieve desired environmental outcomes.

An update of northern Basin SDLs was achieved in 2018 following the 4-year review involving significant new information, data and analysis.

The review resulted in a 70 GL reduction to the 390 GL per year water recovery target in the north. This was possible because the New South Wales and Queensland governments adopted a suite of environmental works and measures (commonly referred to as the 'Northern Basin Toolkit' measures) with assistance from the Australian Government. Implementation of the toolkit measures is in recognition that water alone cannot achieve all intended environmental outcomes in the northern Basin and targeted effort would result in better outcomes.

Full and timely implementation of the toolkit measures will be important to achieving the intended environmental outcomes in the northern Basin.



Image: Kararapko floodplain, South Australia. Credit: South Australia DEW

Case study: **Katarapko**

Katarapko is located near Berri in South Australia and covers more than 9,000 hectares. Most of the area falls within the Murray River National Park. It is a special place because of its cultural, ecological and recreational value. It is home to threatened species (e.g. Murray hardyhead) and includes a range of habitats, with lagoons, swamps, wetlands and creeks. The area also attracts up to 40,000 visitors each year. The ecological health of Katarapko has been declining because of altered flow regimes, obstructions to fish passage, and pest plants and animals.

As part of a \$155 million program, infrastructure has been constructed on the Katarapko and Pike floodplains to enable better use of water for the environment to improve the health and condition of the floodplain. These floodplains were experiencing a decline in ecological health due to altered flow regimes, a build-up of salty soils, and lack of natural flooding. The infrastructure works included removal of barriers to flow and fish passage, as well as the construction of environmental regulators, fishways, blocking banks and culverts. Key infrastructure developed under the program has now been tested for the first time through a managed release of water for the environment. This release commenced in September 2020 and will continue through to December 2020. The floodplains appear to be responding well to the extra water and there's even a very happy and very vocal army of frogs at the Pike floodplain singing the program's praise.

The project is funded by the Australian Government through the MDBA and delivered by the South Australian government in partnership with SA Water. The successful delivery of water for the environment to the Katarapko and Pike floodplains is an example of the progress made in the implementation of SDL Adjustment Mechanism projects and the associated environmental benefits.

Progress in implementing the Environmental Management Framework

To ensure recovered water and other water for the environment is used effectively, the Basin Plan includes an Environmental Management Framework to:

- guide the implementation of improvements to flow regimes and the coordination of water for the environment
- --- enable adaptive management.

The Basin Plan Environmental Management Framework facilitates long-term planning at a system-scale through the Basin-wide environmental watering strategy (Figure 36). The environmental watering strategy provides guidance on implementation of the Environmental Management Framework under the Basin Plan, and asks that state long-term watering plans give regard to this strategy. The Basin-wide environmental watering strategy also provides the context for setting Basin annual environmental watering priorities and state annual environmental watering priorities.

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Overall, the Evaluation has found the Environmental Management Framework and Basin-wide environmental watering strategy to be working well. The Environmental Management Framework is supporting coordinated and collaborative delivery of water for the environment. The strength of the Basin-wide environmental watering strategy is in providing high-level strategic direction at a system scale was acknowledged in the Productivity Commission's 5-year assessment report (Productivity Commission 2018), and the 2017 Basin Plan Evaluation report (MDBA 2017). There are identified areas for improvement in the Environmental Management Framework, including a greater focus on identifying the objectives and outcomes for First Nations and the shared benefits of water for the environment.

There can also be:

- ••• better alignment of the long-term objectives and targets in the various planning instruments
- more guidance for water managers on how to prioritise environmental water delivery in a way that considers local and system-scale outcomes
- --- an increased focus on setting multi-year priorities.

Future iterations of the plans and strategies should seek to make progress on these issues.



Figure 36: Stylised representation of multi-scale adaptive management in the Environmental Watering Framework Source: MDBA



Image: Nyah Vinifera Forest on the River Murray, Victoria. Credit: Mallee CMA

Case study: Nyah floodplain management project

The condition of the Nyah Vinifera Regional Park park was in decline as a result of changed river operations, which had resulted in reduced flood frequency and durations.

The Park, on the western bank of the River Murray, 30 kilometres north of Swan Hill in north-west Victoria, includes 913 hectares of majestic forests, including century-old red gums, billabongs and lagoons, all alongside the banks of the River Murray.

The Nyah Floodplain Management Project is an example of a SDL supply measure project designed to enable the controlled inundation of the Nyah floodplain.

This project will ensure managers can restore a water regime to support the significant vegetation and fauna at Nyah Park through the coordinated operation of pumps and the regulators. This project provides the opportunity to reverse condition decline across the floodplain and deliver significant benefits to improve habitat for the diversity of species.

The park provides camping sites, fishing spots, watering holes, as well as key historical sites from the Wadi Wadi First Nation such as canoe trees, middens and burial grounds. The area is an elongated basin that is drained by Parnee Malloo Creek, a seasonal anabranch of the River Murray.

The Nyah works consist of 4 regulators, 3 on the downstream end of Parnee Malloo Creek and one on the upstream end. Water is contained within the forest through the raising of a track to form a levee at the downstream end of the forest. The project also applies the SDL framework to achieve more targeted and efficient delivery of environmental flows. The works can be operated flexibly to meet the different water regimes of the various vegetation communities found within the park. As an example, the inundation frequency of the red gum swamp forest community will increase from 7 to 9 events in 10 years and the duration of inundation from 93 to 120 days, under the Basin Plan.

The Nyah Floodplain Management Project has been developed by the Mallee Catchment Management Authority on behalf of the Victorian Government and in partnership with the Victorian Department of Environment Land, Water and Planning, Parks Victoria and Goulburn-Murray Water through funding from the Australian Government.

Progress in implementing water resource plans

Under the Basin Plan, water resource plans set out the rules for how water is managed at a local or catchment level, including new limits on how much water can be taken from the system, how much water will be made available to the environment, how water quality standards can be met and how water management arrangements for extreme weather events will work (see figure 37). The plans reflect current arrangements that are working and incorporate new arrangements that strengthen water management at a local level.

> Water resource plans are in place for Queensland, South Australia, Victoria and the Australian Capital Territory.

The plans remaining to be accredited are in New South Wales and are particularly crucial for the future management and outcomes in the northern Basin. These plans will improve the connectivity of northern Basin rivers and environmental outcomes. These plans are also crucial for the effective management and measurement of floodplain harvesting.

With implementation behind schedule, this is an area where governments must continue to work together to complete the implementation task.

In a changing climate, it will also be important that governments identify ways to streamline the adaptation of plans in the future.



Figure 37: Key elements of water resource plans Source: MDBA



Images: A dry Murrumbidgee River at Tharwa Bridge, Australian Capital Territory. Credit: Australian Capital Territory Government

Case study: The Murrumbidgee stops flowing

Tharwa is a village of 13 houses on the banks of the upper Murrumbidgee River about 25 kilometres upstream of Canberra's city centre. The upper Murrumbidgee River flows from the Snowy Mountains through farmland in New South Wales, through the Australian Capital Territory, and back into New South Wales.

Tharwa is not connected to Canberra's water supply. Tharwa residents rely on rain-fed tanks to provide drinking and household water and on a communityrun non-potable water supply pumped from the Murrumbidgee River.

Tharwa almost ran out of water in December 2019. The flow of water in the Murrumbidgee in the village was so light that it stopped, with stagnant pools forming by the Tharwa bridge. It was the driest locals had seen it in 20 years.

Conditions were so dire that the Australian Capital Territory Government trucked in water for the community and residents traveled to Canberra to do their laundry. Australian Capital Territory Government staff cleaned out the community pump uptake as river levels were so low, they had silted up. Meanwhile, bushfires were spreading in New South Wales and there were concerns that there would not be enough water to fight local fires if they broke out.

During periods in November and December 2019, cease-to-pump restrictions triggered by low flows were in place for holders of water access licences for irrigation in the upper Murrumbidgee River catchment, upstream of the Australian Capital Territory. However, river water levels downstream were lower than upstream, suggesting pumping was involved. As this suspected pumping occurred within New South Wales, the Australian Capital Territory Government referred this to the New South Wales Natural Resources Access Regulator. The regulator investigated and issued 2 stop work orders. The investigations are ongoing.

The Australian Capital Territory Government was strongly of the view that the river ran so low, and critical human water needs could not be met, because significant illegal pumping for irrigation upstream of Tharwa made an already bad situation worse. The Australian Capital Territory Government is also of the view that periods of extreme low-flow and no flow have serious negative consequences for ecological values, including native threatened and non-threatened fish, platypus and essential ecological functions, such as riverine connectivity.

Progress in sustainable diversion limit accounting

Water is a limited and valuable resource. Robust and transparent water accounting and compliance are essential to long-term water resource management arrangements that are sustainable, secure and adaptable.

The Basin Plan's SDL water accounting and compliance framework expands on the Cap framework to explicitly include reporting on the water take from watercourses, regulated rivers, groundwater, run-off dams, floodplain harvesting and commercial plantations (net take), and for basic water rights.

Despite the delays in water resource plan development, the move to accounting and compliance against the SDL occurred on 1 July 2019 through bilateral agreements negotiated by the Australian Government with Basin state governments.

SDL accounting and reporting requirements have been implemented, and the compliance framework published along with appropriate risk management strategies in place. The MDBA has subsequently prepared a sustainable diversion limit accounting framework improvement strategy 2020–2025 to continue to build the integrity of the framework (MDBA 2020).

The move to sustainable diversion limit accounting represents a major achievement for governments and for the long-term implementation of the Plan at a Basin scale. The Basin now has an agreed water accounting framework for surface water and groundwater. Basin governments have also demonstrated an ability to adapt the implementation approach to overcome barriers to progress when they emerge.

The MDBA has been working with Basin state governments on transitioning from 'the Cap' on diversions to sustainable diversion limit compliance. The MDBA has also been working with the states to establish groundwater accounting in the Basin, as groundwater sustainable diversion limits are also subject to the new compliance. These accounting arrangements are now in operation.

Full implementation of the SDL Reporting and Compliance Framework is subject to the accreditation of Basin state water resource plans by the Australian Government minister responsible for water.

Progress in compliance

Ensuring compliance with new water management arrangements is crucial to realising the benefits of the Basin Plan. Basin state governments are responsible for regulating water users. The MDBA oversees implementation of the Basin Plan, which includes ensuring that Basin state governments are properly enforcing the water rules through the Basin Plan and water resource plans.

Lack of public confidence in water compliance prompted governments to take collective action to improve water compliance frameworks in each Basin state through the commitment to the Murray-Darling Basin Compliance Compact in 2018.

Since 2018, Basin state governments have made considerable progress against their Compliance Compact commitments.

There is still work ongoing to improve the compliance program in the Basin, to build public confidence in water management including auditing water resource plans to ensure rules are appropriately implemented.

There are a range of opportunities for further improving compliance in the Basin, including leveraging technological advancements. These opportunities should be pursued as a priority.

Progress in implementing water trade rules

Since the water trading rules came into effect in 2014, state governments have made progress in aligning their trading rules with the Basin Plan, including the removal of some major restrictions on inter-regional trade in water entitlements.

Market transparency and performance have improved across the Murray–Darling Basin through actions that have been implemented by many of the state governments and the MDBA. The New South Wales, Victorian and South Australian governments all now have itemised trade data for all groundwater and surface water sources. They also provide a breakdown between environmental and non-environmental allocation trades. Queensland provides aggregated information for most surface water and some groundwater sources. The MDBA publishes a range of trade information on its website.

However, a lack of transparency and timeliness of market information remains and is impacting market performance. During 2018–19, the MDBA conducted a 2-part audit of water trade price reporting. The findings highlighted some significant areas for improvement. It identified that:

- a large number of transactions are recorded as '\$0' value
- information flowing to markets often lacks description
- ••• nearly all transactions recorded in Basin state governments' registers are unverified.

The audit identified challenges for the MDBA on influencing change. Under section 12.48 of the Basin Plan, the obligation to report the trade price is on the seller. There is no requirement for Basin state governments to ensure that they accurately collect and record this information and **there are limited levers for the MDBA to influence fundamental improvements in this area.** The audit also identified that the rapid development of new (or secondary) water market products, such as forward leases, has outpaced the regulatory systems designed to report on trade. The MDBA and Basin state governments are working collaboratively to improve trade pricing information. The MDBA has published a formal management response to the audit, which includes a work program to address the audit's findings. New South Wales and Victoria both implemented improved trade reporting for the start of the 2020-21 water year. New South Wales implemented capturing 'reasons for trade' on 1 July 2020 and Victoria implemented capturing 'reasons for trade' and the agreed date that the price for the trade was reached ('struck date') for all online trades starting on 27 August 2020.

The Murray–Darling Communities Investment Package was announced in September 2020 by the Australian Government. It seeks to improve market information and ensure stronger compliance. The one-stop shop for water storage, in-stream flows and trade information announced with the package will be critical in improving the quality and accessibility of information.

Overall, water markets are maturing and regulation, operational frameworks and governance both supported by and beyond the Basin Plan must also mature to support market efficiency, effectiveness and confidence.



Image: Red gum on Barmah Lake, Victoria

The 6 priority areas for the future

The Basin Plan has a legislative review point in 2026 where it has been anticipated that a revised Basin Plan would be established and agreed to. However, there is a public perception that Basin water reform will be complete in 2026, and the lack of clarity around the Basin Plan update is creating ongoing uncertainty for change-fatigued stakeholders.

Lessons learnt from the Basin Plan initiation and its implementation clearly demonstrate that sustainable water use and management in the Basin is a shared responsibility. Governments, communities, First Nations, industries, and research and interest groups must work together to shape future arrangements so they are practical and effective.

The groundwork must start immediately to enable governments, communities and stakeholders to be well positioned to update the Basin Plan in 2026, drawing on lessons from the past while also focusing on the future drivers of change. During the next phase of water reform, governments need to focus on establishing practical, meaningful and enduring arrangements that are set up and delivered in collaboration with Basin stakeholders. To support progress towards 2026, this section considers how the effectiveness of the Basin Plan could be improved to better support communities, industries, First Nations and the environment.

The Evaluation has identified 6 priority areas where governments must focus effort to improve the effectiveness of the Basin Plan and ensure actions are best suited to meeting objectives. As well as working toward the Basin Plan Review in 2026, action in these areas will also have important short-term benefits for the implementation of the current Basin Plan.

The 6 priority areas for improvement are:

- 1. implementing the Basin Plan
- 2. **adapting** to climate challenges and increasing resilience
- 3. **strengthening** focus and support for social and economic outcomes
- 4. **establishing** a clear and committed pathway for First Nations' social and economic outcomes
- 5. **integrating** water management with other activities to achieve environmental restoration
- 6. advancing science and monitoring.

1. Implementing the Basin Plan

Major finding

Significant progress has been made in implementing the Basin Plan since 2012. Most elements of the Plan are now in place, and are improving sustainable and adaptive water management in the Basin.

More than 2,100 GL of water for the environment is now held and managed by the Commonwealth Environmental Water Holder, state environmental water holders and through The Living Murray program. This water is being used across the Basin to achieve healthy river system outcomes, a momentous achievement in 8 years of implementation.

However, the implementation task remains incomplete with progress lagging in some crucial areas including SDL Adjustment Mechanism projects, northern Basin toolkit projects and the 20 remaining water resource plans. All these projects are critical to modernising the river system and improving river health. For project success, governments need to continue to work in partnership with local communities, and conduct meaningful engagement during project design and delivery.

Most elements of the Plan are now in place and are improving sustainable and adaptive water management in the Basin:

--- Sustainable diversion limits (SDLs)

SDLs on how much water can be taken out of the natural system are guiding water use and management. The limits cover surface water and groundwater use.

These limits build on the Cap1 governments put on diversions in 1995. At the time of the Basin Plan's development, knowledge of the northern Basin and some groundwater areas needed improvement. The review of the northern Basin has helped to overcome significant knowledge gaps and resulted in improved SDLs.

The northern Basin review identified the need to better target effort and to ensure other actions were in place that support the health of the northern Basin river systems and communities. This resulted in commitment to the 'Northern Basin Toolkit' measures.

--- Water for the environment

Addressing overuse of the Basin's water resources has progressed. More than 2,100 gigalitres of water is now held and managed by the Basin's environmental water holders. This significant volume of water is being applied across the Basin to achieve healthy river system outcomes.

The environmental water management frameworks that guide how this water is applied are in place. There is evidence that management arrangements for environmental watering have been improved and have been made more practical since the Basin Plan was made in 2012. Communicating the aims and processes for management of water for the environment remains a challenge and needs improvement.

--- Water resource plans

Water resource plans are in place for Queensland, South Australia, Victoria and the Australian Capital Territory. These plans are important as they establish limits at the catchment or local scale by clearly outlining how much water can be taken from the system, how water will be made available for the environment, how water quality standards will be met and how water management arrangements for extreme weather events will work.

--- Compliance

Compliance arrangements were fast tracked as a result of community concerns and public scrutiny. Basin governments worked together to agree and implement a Compliance Compact. Basin state governments are continuing to make progress against their Compliance Compact commitments.

--- Water monitoring and accounting

There have been significant improvements in water metering, monitoring and accounting. Further improvements are required to build public confidence that all water being traded, used for consumptive or environmental use is accounted for and all players have a fair system.

--- Water trade

The southern Basin water market is well-established and demonstrates the ability of water markets to support the movement of water resources to their highest value use.



Figure 38: Key elements of Basin Plan implementation Source: MDBA

Implementing the Basin Plan

The Evaluation shows the Basin Plan is achieving positive outcomes – measurable environmental outcomes have been observed at the Basin-scale, and some good local projects involving communities and industries. Many of the major elements of the Basin Plan are now in place and are improving sustainable water management. Some critical elements, however, still lag in implementation. Until all components of the Basin Plan are operational, the full benefits for Basin communities and the nation cannot be delivered.

- Recommendation 1 Basin state governments and the Australian Government need to urgently commit to delivering significant Basin Plan projects. These include the SDL Adjustment Mechanism projects, 'Northern Basin Toolkit' measures and the remaining water resource plans, which are yet to be accredited. All are complex initiatives and governments need to continue to work in partnership with local communities to design and implement.
- Recommendation 2 There is still scope for Basin governments to propose new and innovative approaches to achieving the long-term sustainable limits for water use in the Basin.
 As Basin governments and communities engage on completing the remaining elements of Basin Plan implementation it will be vital to show how these new approaches could contribute to delivery of sustainable water use limits.

MDBA commitment:

The groundwork must start soon to devise an approach for the 2026 Basin Plan Review, including meaningful community and other stakeholder involvement in the process. The MDBA will work with Basin governments and stakeholders to take this forward, focusing on the long-term sustainable health of the Basin.
Table 13: Progress and next steps in implementing the Basin Plan

	Progress		Next steps	
_	✓ ✓	Sustainable diversion limits (SDLs) were set in 2012 and are now in place. The transition from the Cap to new limits occurred in mid-	•	The delivery of SDL Adjustment Mechanism projects is needed to modernise the river and change the limits of water use.
	✓	Improved knowledge has allowed for new limits be set for the northern Basin and several groundwater areas.	•	There is a growing risk that the 2024 timeframe for some constraints and
	✓	Water recovery has become more targeted, with a focused effort on other measures to support limits.		sopply projects may not be demoved.
	√	The recovery target has been adjusted to 2,075 GL as a result of 2 amendments to the Basin Plan, including for the SDL Adjustment Mechanism.		
	√	As of July 2020, 13 water resource plans are in place for Queensland, South Australia, Victoria and the Australian Capital Territory.	•	The remaining water resource plans from New South Wales are crucial to future management in the northern Basin.
	✓	As of mid-2020, all 20 New South Wales water resource plans are with the MDBA for assessment.	•	 There are a range of projects in the northern Basin that also need to progress to development and delivery on the ground including the licensing and measurement of floodplain harvesting and overland flows, and the roll-out of remaining 'Northern Basin Toolkit' measures.
	✓	These plans take significant time to develop, assess and accredit.		
	~	Most water resource plans experienced delays in assessment and accreditation.		
	√	Over 2,100 GL of water is now held and managed by the Basin's environmental water holders and is being applied across the Basin to achieve healthy river system outcomes.	•	The National Water Initiative identifies the need for community partnerships. There needs to be more consistent and coordinated effort by the Basin governments and the MDBA in helping water users to work within the new
	✓	Measures, such as the Northern Basin Toolkit have been put in place to enable targeted actions that benefit the environment.		
	✓	The Basin Plan's Environmental Management Framework is in place to guide implementation of improvement to flow regimes, coordination of water for the environment and to enable adaptive management.		framework.
	√	The southern Basin water market is well-established and demonstrates the ability of water markets to support the movement of water resources to their highest value use.	•	Greater and more practical information is needed to support water users' participation in the market.
	√	Improved compliance arrangements were fast-tracked as a result of community concerns and public scrutiny.	•	Trust and community confidence needs to be improved.
	√	Basin governments worked effectively together to agree and implement a Compliance Compact.		
	✓	There have been significant improvements in water metering, monitoring and accounting.		
	✓	Monitoring of Basin Plan outcomes has begun through Basin states and the Commonwealth Environmental Water Holder.	•	 Monitoring programs are being implemented but these vary at temporal and spatial scale. There are significant gaps that need to be addressed to improve analysis of Basin condition.
	~	Accounting methods and processes are in place and are maturing.		
	√	There are a range of implementation reports publicly available that provide transparency on Basin Plan progress.	•	Basin governments have committed to improving transparency on Basin Plan progress and outcomes.

2. Adapting to climate challenges and increasing resilience

Major finding

The Basin's climate is changing. While the climate has natural variability and is prone to extremes, evidence provided identifies the climate of the Basin is changing and the future is likely to be warmer, drier and include more frequent droughts and extreme weather events.

The first 8 years of Basin Plan's implementation have tested the policy in extreme climate conditions. There have been large-scale floods, resulting both in successful fish breeding and in vegetation growth, along with blackwater events and positive and negative community impacts. This has been contrasted with the Basin's driest 3-year period on record, which saw record low inflows, towns running out of water, mass fish deaths, extensive bushfires and significant water quality issues. (The variability of rainfall, water storage and soil moisture levels are highlighted in Figures 39 and 40.)

The shift in climate already observed has reduced water availability, use and management and resulted in flow-on impacts to communities, industries and the environment. Further, climate change represents the greatest risk to achieving Basin Plan's desired social, economic and environmental outcomes.

The Basin Plan was developed to consider and respond to the challenges of climate change in 4 ways (Neave et al 2015),

- ··· refining existing arrangements
- --- buffering the system from stress
- --- enhancing resilience with new arrangements
- --- adapting to future changes.

Many of the Basin Plan's key elements were designed to provide policy responses and tools to help manage climate challenges, such as prolonged and severe drought. Examples of these tools include:

- --- annual water allocations allocating water for both consumptive and environmental use, based on prevailing climatic conditions (i.e. historical water availability in the system)
- SDLs providing the additional water to support healthy water-dependent ecosystems and supporting resilience in the face of a drying climate
- ••• the **Basin-wide environmental watering strategy** and accompanying annual environmental watering priorities guiding where environmental water holders should apply their effort
- --- water resource plans incorporating climate change risks.



Figure 39: Rainfall and storage level data from the Bureau of Meteorology demonstrates how rainfall condition impacts directly on storage levels. Source: Bureau of Meteorology, 2020.



Figure 40: Actual and relative average root soil moisture, particularly in the northern Basin, has experienced significant change in 2020. Source: Bureau of Meteorology, 2020

While there are mechanisms embedded within the Basin Plan and water resource plans to respond to the implications of climate change, these instruments need to be continuously monitored and adapted to keep pace with the challenges of climate change. With a drying trend now clearly reflected in 2 decades of climate data, governments need to fast-track preparedness and adapt water management arrangements.

Climate change is a Basin-scale challenge. It will permanently shift the fundamental characteristics and connectivity of the Basin. Climate change will require difficult decisions to be made at national, Basin and local scales. An almost certain outcome is that there will be insufficient water resources – or unpredictable rainfall/runoff patterns – to continue business as usual.

Adaptation requires collaboration and coordination of Basin state governments' effort. Basin state governments are demonstrating they have progressed their knowledge of the risks and climate adaptation approaches. To achieve outcomes at the Basin scale and help to mitigate risks, jurisdictions will need to work together.

In the short term, the focus for adaptation is on buffering the system from stress by refining existing arrangements and tools. Advancing knowledge, innovation and decision support information will be needed to support adaptation. In the long term, the focus should be on:

- understanding the social, cultural, economic and environmental impacts, risks and trade-offs at the Basin scale under different climate futures
- establishing new objectives and targets for the Basin in collaboration with Basin communities and First Nations
- reviewing water management mechanisms, including the Basin Plan, to be responsive to a range of medium-term future climate scenarios, in addition to using the historical climatic record
- --- establishing processes for how governments will

work with communities to make decisions based on local impacts and trade-offs

••• integrating with other policy and program areas to assist communities and industries to adapt to the anticipated impacts of climate change in the Basin.

There are many parties involved in adapting to climate change. For example, the agricultural sector through rural research and development corporations are developing new knowledge and adaptation tools to support farmers to diversify and plan for the future. Similarly, local governments are active in establishing climate change adaptation tools.

Water managers must not work alone. They must learn from these other parties and develop arrangements that support and accelerate the practical adaptations by industries and communities that are already occurring.

At the Basin scale, there will also be a coordination and information role that will help different stakeholders progress their adaptation and enhance their resilience.

Adapting to climate challenges and increasing resilience

The climate of the Basin is changing and water managers, communities, industries and the environment will need to adapt to a hotter and drier climate future. A key cross-cutting theme from this Evaluation is the need for all water managers and users to plan and adapt to the changing climate for the long-term future of the Basin.

- Recommendation 3 Basin governments should improve sharing of knowledge, tools and innovations that are critical to support climate adaptation and water management. Information and science on future water availability and trends must be shared widely to support businesses, communities and industries plan to be proactive, adapt and diversify.
- Recommendation 4 Basin governments and the MDBA need to prepare to adapt the Basin Plan in 2026 to incorporate future climate scenarios and trends. This means improving existing tools and developing new frameworks for Basin-scale management. An agreed work program should be established and shared publicly.
- Recommendation 5 Basin water users, managers, First Nations and community groups need to plan for the future climate. As well as Basin-wide assessment, local climate opportunities and risks should be given attention along with implications, trade-offs and adaptation priorities.

MDBA commitment:

The MDBA will facilitate the sharing and coordination of information on Basin climate adaptation. The MDBA will bring water managers together with communities, industries, First Nations and governments to explore strategies. The MDBA will focus effort and investment to improve access to science and evidence for all stakeholders to contribute to enhancing climate resilience and adaptation in the Basin.

3. Strengthening focus and support for social and economic outcomes

Major finding

The Basin Plan has high-level social and economic objectives, but has limited levers to achieve these. This contrasts with the detailed environmental outcomes and activities specified by the Basin Plan. There are opportunities to review and strengthen the water management framework in the lead-up to the 2026 Basin Plan review to better promote and focus desired social and economic outcomes.

Other policies and practical actions are needed to work alongside the Basin Plan to help realise the social and economic benefits of effective water management. Policy and management relating to regional development and structural adjustment, agricultural industry innovation and diversification, land use planning and innovation is needed to deliver prosperous and healthy communities, industries and a healthy environment in the Basin. The Basin Plan is not sufficient on its own in achieving a healthy, working and sustainable Murray-Darling Basin.

Strengthening social and economic outcomes within the water management framework

The Basin Plan seeks to optimise social, economic, environmental and cultural outcomes from the use of water resources. Significant long-term social and economic benefits are expected through several pathways:

- water sharing arrangements that ensure water is fit for purpose and will meet critical human needs the evaluation notes that the framework for supporting critical human water needs in the Basin Plan is limited and focused on the southern Basin. A set of objectives supported by investment and innovation may be needed to manage this direct risk to social and economic outcomes under climate change.
- economic and social benefits arising from improved ecosystem health there is insufficient evidence to
 determine the economic and social impacts of water for the environment for amenity, recreation and tourism in
 Basin communities. Improved understanding and monitoring of the economic and social impacts of water for the
 environment is required to determine the value of environmental water to communities and businesses.
- regulating the water market to facilitate a fair and equitable system of water trade across jurisdictions trade supports improved productivity and associated social outcomes. At the Basin scale agricultural productivity has grown and the value of the water market has increased, however, the outcomes of this growth are not evenly distributed among communities with small, remote towns that are heavily dependent on agriculture experiencing declines.
- providing information in a transparent and accessible way to support business decisions water management in the Basin is complex, and the operating environment is difficult for water users, communities and the general public to navigate. To date, investment in information sharing and capability building have not been sufficient to create an operating environment that is fair, transparent and allows people and businesses to adapt in a timely and sustainable manner.

While each of these pathways has been partially effective, the outcomes vary across the Basin and through time. While the levers within the Basin Plan enabling improved social and economic outcomes are limited, there are several areas that could be further explored within the current Basin Plan framework. These include:

- targets There are limited targets built into the Basin Plan against which social and economic outcomes can be managed for and monitored against. Stakeholders involved in the evaluation identified this gap and suggested that the future opportunity for change could improve the adaptive management capacity of the Basin Plan.
- policy, regulation and resources the Basin Plan currently has limited capacity to manage social and economic risks. Water reform is, however, only one influence on social and economic outcomes and across the Basin is less influential than long-term changes in commodity prices, demographic changes, farm rationalisation and access to services. Given this, it will be important to identify what can be achieved through water management and where complementary policy measures may be required. Strengthening the regulatory arrangements for the water market and brokers could also be beneficial.
- social licence given the ongoing challenges in achieving support for the Basin Plan and its implementation, communities will need assurance about their role in managing distributional impacts and risks, particularly where difficult trade-offs between economic, environmental and social objectives due to climate change need to be made.
- information sharing basin governments collect and develop a significant amount of information about the current and future state of the Basin that can help water users to make decisions. There is a need to share information to enable water users, including farmers, water brokers and advisors, natural resource managers and local government, to adapt their businesses and better navigate the system.

- ••• capacity building governments need to complement improvements in information with investment in building capability and leadership at individual and community levels to create an equitable operating environment that supports communities and industries to adapt.
- program implementation delivery of programs (such as the Sustainable Diversion Limit Adjustment Mechanism) in partnership with local stakeholders and businesses would help to ensure that the outcomes of these programs are practical and supported by local communities.

Activating investment and support in the broader policy environment

There is a need for governments to recognise that water management is part of a broader network of policies and external drivers that contribute to the conditions in the Basin, and in regional Australia more broadly.

Many communities in the Basin have developed around irrigated agriculture, and **the changes brought about by the Basin Plan have resulted in a new operating environment.** The recently released Sefton Review: *Independent assessment of the social and economic conditions in the Basin* (Sefton Review 2020) highlighted that some communities and industries are struggling to navigate the extent and pace of changes impacting them.

The fast pace of change and fragmented government investment in building capability and assisting in adaptation has meant that there has been an uneven ability of individuals, businesses and communities to take up opportunities and adapt to the new operating environment. This will be exacerbated in coming years with the effects of the changing climate. The Basin Plan is often considered the root cause of many issues affecting the Basin, however, **there are a range of external drivers affecting Basin communities**, **economies and the natural environment**. These include (but are not limited to):

- --- climate change, drought and extreme events
- --- global and national economic and market policies
- impacts of globalisation, such as the COVID-19 pandemic
- ••• urbanisation, changing populations and workforce structure
- ··· innovation and technological changes
- --- land management and changes in land use
- --- changing social and consumer values.

These drivers are difficult to influence within the water reform framework. The Basin Plan cannot achieve a healthy, working Basin in isolation of related complementary policy and action areas. The Evaluation has found that wider state and Australian Government policies are not working effectively together in the Basin. This has implications for community and industry adaptation and resilience.

To support a healthy and prosperous Basin, there is a need to better coordinate and improve the effectiveness of policies in areas such as regional development and structural adjustment, First Nations, infrastructure and land use planning. Without action in complementary policy areas, the Basin Plan is unlikely to be able to realise its social, economic and cultural outcomes. Governments across the Basin need to recognise this and invest in integrated policy design and implementation.

Strengthening focus on social and economic outcomes

This Evaluation and recent reviews highlight an urgent need for targeted and focused support for communities in the Basin, particularly smaller, irrigation-dependent and remote communities. This requires meaningful engagement to customise support and provide improved information. Basin communities are experiencing rapid change driven by many factors, of which water availability is only one.

Recent commitments by Basin government water ministers to work collectively to share information, the Australian Government's \$35 million Hydrometric Network and Remote Sensing Program in the north and the Australian Government's Murray-Darling Communities Investment Package will improve information access and respond to some of the community concerns about information and engagement.

- Recommendation 6 Basin governments and the MDBA need to work in partnership with industry, First Nations and other water users to ensure water information is more accessible, understandable and timely, in order to create a more transparent, effective, practical operating environment for water users.
- Recommendation 7 Basin governments and the MDBA must commit to working with Basin communities on water management to boost meaningful and coordinated two-way engagement.
- Recommendation 8 Basin governments need to strengthen policies and programs that support communities and industries to adapt and prosper including but going beyond water-focused programs. Investment in collecting social and economic data at Basin and regional scales is required to shape well designed and targeted support for communities and industries. There are opportunities to stimulate regional development and prosperity through facilitating adjustment, and underpinning agricultural development including research and development, First Nations policies, infrastructure investment and land use planning.

MDBA commitment:

In collaboration with the Australian Government, experts and researchers, the MDBA will help improve social, economic and cultural data collection and analysis. Through its regional network, the MDBA will disseminate this information to support community planning processes.

4. Establishing a clear and committed pathway for First Nations' social and economic outcomes

Major finding

First Nations are looking for increased participation and decision-making responsibilities in water management. Continuing and improving this involvement, including cultural water projects and incorporating First Nations knowledge into water management, is crucial.

First Nations are an important and sophisticated contributor to water management in the Basin and have a spiritual connectivity and obligation to care for surface water and groundwater as part of their commitment to caring for Country.

In recognition of both this obligation to care for Country and their contribution to improving water management, the Basin Plan seeks to engage First Nations in water management. The influence of First Nations participation in Basin Plan water management decision-making is increasing, including MDBA advisory groups, and jurisdictional and local site-level activity.

While this has been a positive consequence of the Basin Plan, notably through water resource plan development, there remain limited objectives and actions that provide a pathway for further measurable progress under the Basin Plan for First Nations communities. The social and economic benefits derived from participation are indistinct and not yet fully realised.

First Nations have consistently expressed a desire to take a more leading role in decision-making processes and for their traditional knowledge to be usefully translated into holistic water management practices more widely.

The Australian Government has a broader policy agenda to close the gap in Indigenous disadvantage with the associated framework providing targets to reduce inequality in Aboriginal and Torres Strait Islander wellbeing. The Basin Plan currently contributes to these broader policy objectives in a limited way, although state governments, through a range of policy options, also contribute to improving the circumstances for First Nations. At the national level, complementary, and sometimes overarching, policy initiatives continue to be developed. For instance, work continues on the renewal of the National Water Initiative with specific attention on building First Nations' inclusion in water planning and management. The renewal is being coordinated by the Australian Government Department of Agriculture, Water and the Environment in partnership with state and territory governments, which will be implementing the renewed National Water Initiative. The National Water Initiative underpins the *Water Act 2007* and the Basin Plan.

The Murray-Darling Communities Investment Package, announced on 4 September 2020 by Australian Government Minister responsible for water, the Hon. Keith Pitt MP. contains dedicated Basin First Nations' initiatives. For instance, the First Nations' river rangers program, administered by the National Indigenous Australians Agency will create 4 teams and 20 jobs over 12 months from mid-2021. The program will contribute to social, cultural and economic outcomes for First Nations communities and strengthen Indigenous understanding of and participation in contemporary water governance under the Basin Plan. The investment package also commits to agreeing to the framework for implementing the \$40 million Aboriginal water entitlements program with Aboriginal communities and identifies a timeline for the appointment of an Indigenous board member to the Murray–Darling Basin Authority.

While the delivery of broader complementary Australian Government initiatives continue, the Basin Plan's capacity could be further complemented and enhanced through several pathways. Establishment of culturally appropriate governance structures, genuine co-design of programs and investment in building contemporary water governance literacy of First Nations is critical to ensure successful management of the Murray–Darling Basin. Expanding the education, enterprise and employment benefits from working on Country receiving water through the Basin Plan is also an important goal.

There is also Aboriginal-owned enterprise activity in a wide range of industries across the Basin, which have direct and indirect water dependencies. First Nations' ownership of land in the Basin has significantly increased, but ownership of water entitlements has reduced in recent years. The \$40 million Murray–Darling Basin Aboriginal water entitlements program for the purchase of water entitlements for Indigenous use will be an important step to reversing this recent trend.

Governments should also look for further opportunities in the short term to support greater influence, ownership and autonomy for First Nations in water management and for ways to entrain First Nations' expert knowledge and practices into wider natural resource management. This work should also look to the long-term and identify meaningful and measurable ways in which renewal of the Basin Plan in 2026 can provide a clearer and more certain pathway for expanding First Nations' role in and benefits from water management.

Establishing a clearer and committed pathway for improved First Nations outcomes

There are more than 50 First Nations in the Basin and the MDBA values and respects their significant knowledge of the Basin and its ecosystems. Better involvement and support is needed for First Nations people to benefit from their cultural and economic connections with Basin rivers and floodplains. There is also an opportunity to learn and incorporate First Nations knowledge into Basin water use and management.

 Recommendation 9 - First Nations, Basin governments and the MDBA should develop a practical pathway for the use of water for cultural and economic outcomes. This should build on current knowledge and fast-track initiatives, such as the \$40 million Cultural Flows project for First Nations. Action should be focused on short-term practical activities, as well as build the foundations for enhanced First Nations outcomes in the longer term.

MDBA commitment:

The MDBA commits to working with First Nations to identify practical options that enhance First Nation outcomes as work proceeds on the review of the Basin Plan in 2026.

The appointment of a First Nations Authority member will help the MDBA collaborate with First Nations to enhance our knowledge of the Murray-Darling and apply this to water management.

5. Integrating water management with other activities to achieve environmental restoration

Major finding

The implementation of the Basin Plan has seen significant improvements in the management of water to support ecosystem health. The Basin is now better connected, the levels of water take have been reduced to more sustainable levels and there is a substantial portfolio of water available to be used for the environment.

Use of this water will be guided by a clear strategy to support more resilient Basin ecosystems. Against the backdrop of a changing climate, the Basin Plan provides a crucial mechanism to support the health of natural systems and, subsequently, the health of the Basin as a whole.

However, there remain several barriers to progress. In particular, flow constraints – primarily in the southern Basin – remain a challenge for environmental water holders to deliver water to wetlands and floodplains. Removing these flow constraints is a complex process that involves addressing potential impacts on public and private infrastructure and land along hundreds of kilometres of river channel. Slower than expected implementation of Sustainable Diversion Limit Adjustment Mechanism projects, including constraint and efficiency projects, along with slower than expected implementation of complementary measures such as the 'toolkit' measures in the northern Basin, are delaying the environmental benefits that these programs could achieve.

There are also limited outcomes that the Basin Plan alone can achieve – there is a need to activate investment, support and commitment for areas that complement water management in the Basin such as natural resources, and pest and weed management. While there has been progress in managing natural resources at some sites, Basin-wide progress is needed across complementary policies to deliver long-term outcomes at the Basin scale.

Improving environmental outcomes within water management

Planning for water for the environment and its delivery has matured significantly since the Basin Plan was enacted. Water for the environment is now an established element of water management and is being used by environmental water holders to replenish rivers, wetlands and connected groundwater systems.

There is clear evidence that water for the environment is supporting the health of the Basin, yet there are several barriers that must be overcome before its potential can be fully realised.

To realise the potential, it is vital that:

••• the SDL Adjustment Mechanism projects, including constraint measure projects, are implemented – these projects are intended to achieve environmental outcomes equivalent to the recovery of 605 GL per year of water. Some of the highly complex projects are currently assessed as having a high risk of not being completed by the 2024 target date. These at-risk projects are expected to provide a significant contribution to the overall sustainable diversion limit adjustment volume. Implementation of the constraint measure projects is particularly important for improving floodplain and wetland outcomes.

- the Basin-wide environmental watering strategy is refined and updated (to be updated in 2022) – There is new and better information that should be considered to review the Basin watering strategy targets. In particular the development of long-term watering plans by states and the Commonwealth Environmental Water Office, that have localised flow indicators and the annual watering priorities work. This review work provides an opportunity to engage with communities and jurisdictions on the setting of targets that also consider climate change implications.
- ••• toolkit measures are implemented the toolkit measures include real-time management of flows, mechanisms for protection of water for the environment and environmental works that will enhance environmental outcomes in the northern Basin.
- --- coordination across all levels of government is increased.
- partnerships with communities are built to increase ownership of outcomes – to increase ownership, there must be opportunities to enhance meaningful engagement with communities in processes associated with key reviews and projects that are necessary to ensure that the Basin Plan can be adapted in response to new and better information (e.g. the Basin-wide environmental watering strategy review, the social, economic, and environmental conditions monitoring program announced by the Australian Government Minister responsible for water).
- policy is adaptive to new information and to new circumstances (e.g. emergency responses to environmental events) – Basin monitoring and science programs and plans provide for targeted and prioritised monitoring across the Basin, enabling transparent triple bottom line assessment.
- shortfalls to sustainable diversion limits are addressed – The MDBA must work in partnership with communities and other stakeholders to develop innovative solutions to address the expected shortfall to meeting the sustainable diversion limits.

There is an opportunity to co-design solutions and to have meaningful participation by First Nations and communities in achieving the Basin Plan outcomes associated with Sustainable Diversion Limit Adjustment Mechanism projects.

Integrating water management with natural resource and environmental policy

While there is evidence of the positive contribution of water for the environment to the hydrology and environment of the Basin, there is also evidence that, in many instances, water alone is not sufficient to achieve long-term outcomes.

There are many examples within the Basin that demonstrate how non-water factors such as land management, invasive species and infrastructure undermine the achievement of Basin Plan outcomes. These include:

- Despite meeting flow targets, dredging is still required to keep the Murray Mouth open. Dredging will be required on an ongoing basis to meet the Basin Plan targets in relation to the Murray Mouth.
- Drought conditions led to interventions to rescue and sustain native fish including hardyhead (Victoria) and river blackfish (Queensland) (Murray-Darling Basin Ministerial Council 2004).
- Flows are often insufficient to support fish passage and infrastructure is required to both overcome human barriers and maintain connectivity to support recovery.
- ••• Invasive species in some areas of the Basin have directly undermined environmental outcomes from the Basin Plan. Some examples include:
 - large populations of carp occupying wetlands
 - horses undermining efforts to restore Moira grass wetlands at Barmah–Millewa Forest
 - feral pigs compromising the outcomes of bird breeding events enabled by water for the environment
 - riparian vegetation condition being compromised by overgrazing.

- Water quality management is dependent on more than volumes of water available, with land use and management being a significant factor in salinity, dissolved oxygen and algal blooms. For example, minimising blooms of blue-green algae requires reduction in the nutrients that feed them. Improving farming practices by limiting fertiliser applications, fencing off rivers so livestock can't erode their banks and planting more vegetation to trap nutrients before they reach waterways would benefit water quality outcomes.
- Where extreme dry conditions mean that significant water quality issues cannot be avoided, other interventions that reduce the likelihood or consequences may be required to preserve endangered and threatened species.

There is a need to integrate water management with broader system management at the Basin scale to ensure that Basin Plan outcomes can be realistically achieved. The benefits of an integrated approach have been demonstrated in a number of locations throughout the Basin, where **enhanced environmental outcomes have been achieved through the integration of water for the environment with other natural resources management practices.** For example:

- The Ovens River Demonstration Reach project provides a good example of the benefits of combining water for the environment with a range of actions – including the addition of habitat, removal of carp, clearing of willows, and the addition of a fishway – for recovering native fish species (DEPI 2014)
- Some of the most successful outcomes of environmental flow delivery have been achieved at sites where collaborative relationships between asset and water managers endeavor to achieve common objectives. An example is at Barmah-Millewa forest where fencing, to prevent grazing, combined with water for the environment has supported the growth of Moira Grass, which is a threatened native plant species (SCBEWC 2018).

 Remnant water was pumped from Reedy Lagoon and Black Swamp and 1,170 kg of carp physically removed ahead of a delivery of water for the environment in late spring. The absence of carp meant that aquatic plants flourished and were able to germinate, establish and set seed (SCBEWC 2018).

The importance of coordinating wider natural resource and environmental management interventions with water management will only increase as the Basin and Basin Plan seek to adapt to climate change. Coordinated action at the Basin scale is needed to support progress towards healthier and more resilient ecosystems.

The recent commitments by the Australian Government Minister responsible for water to provide resourcing to support community-led, complementary projects to improve the health of rivers will provide further opportunities to integrate water and environmental management. The implementation of these projects, along with the Northern Basin Toolkit measures, will enhance the environmental outcomes that cannot be achieved through water management alone.

Integrating water management with other activities to achieve environmental restoration

Sustainable water management needs dedicated water for the environment as achieved through the Basin Plan, to work alongside natural resource management. Increased targeted investment and support for actions that complement water management including catchment soils and vegetation health and control of pests and weeds. These activities do not replace the need for environmental flows, but support and complement outcomes, including improved resilience and adaptation to climate change.

Recommendation 10 - Basin governments need to work with communities to develop clear priorities and a framework for broader natural resource measures. Increased investment and support for additional measures can be driven by governments, industries and communities, and it is important that increased effort is targeted and integrated with environmental watering.

MDBA commitment:

The Basin Watering Strategy that guides use of water for the environment will be updated in 2022 and will now also consider inclusion of broader natural resource management, social, cultural outcomes.

The MDBA will update this strategy involving Basin communities, experts and Basin governments.

6. Advancing science and monitoring

Major finding

Better information for water managers and users and enhanced monitoring of Basin conditions is crucial to improving the management of water in the Basin. The current approach is inadequate to transparently support management choices. There is a need to build long-term foundations in supporting science and information systems.

The Murray–Darling Basin Plan was developed based on the best available science and modelling approaches available. There has always been recognition that knowledge and understanding of water management challenges would continue to improve, and ongoing investment in science and monitoring would be needed to support this improvement, **the Basin Plan would need to adapt and improve in response to new information**.

Improving science, monitoring and modelling remains key to adaptive management of the Basin Plan. Examples include:

- ••• the development of the Source modelling platform, in collaboration with eWater Ltd and state governments, ensured that best-practice modelling techniques were used to model the hydrology of the River Murray
- ••• the Recovering the Lower Darling project, funded through the Native Fish Recovery Strategy, has developed a citizen science program to harness local knowledge and involve communities in native fish recovery to better understand and inform water management decisions and to reduce the risk of future mass fish death events
- the 2019 Northern Fish Flow included a release of 36 GL water for the environment to replenish critical waterholes. The water travelled more than 1,200 kilometres along the Macintyre, Gwydir and Barwon rivers. Monitoring and analysis at a number of gauge locations was undertaken along the flow path to determine what proportion of the flow had progressed to where, and when that occurred. Specialist algorithms generated from the Sentinel satellite images, alongside expert advice from river managers and the Commonwealth Environmental Water Office, were used determine the presence of water in the landscape, how the flow was actually behaving and how it moved through waterways and the surrounding landscape.

A number of monitoring programs across the Basin were developed for purposes other than the Basin Plan (e.g. the Sustainable Rivers Audit) and have been modified in an attempt to meet current needs. While there is evidence that pre-existing and new programs broadly align with Basin Plan objectives, a combination of issues – including fragmented results and findings, variability in monitoring methods, and disconnection across state boundaries – have reduced the value of information available to the Evaluation. These knowledge gaps have influenced the ability to fully evaluate against baseline conditions and to understand how conditions have changed over time.

Investment in science and monitoring will be key to ensuring that water managers can implement adaptive management practices, particularly as the Basin adapts to a changing climate. Ongoing and consistent investment in Basin science is needed. Programs such as the Australian Government's Murray–Darling Water and Environment Research Program, and the joint governments' Basin Science Platform provide a good start but consistent and long-term commitment is required. A greater pool of information and knowledge will:

- --- identify opportunities, issues and risks early
- --- support decision-making and inform adaptive management of water policy
- demonstrate the contribution of the Basin Plan to Basin conditions and build public confidence in management of the system.

It is also important to recognise that traditional methods of collecting scientific data alone are no longer viable. Effective **partnerships between governments**, **scientific experts and community groups must be prioritised** to facilitate the participation of communities in the planning and interpretation of scientific data and findings. Community involvement and input is key to validating findings and also ensuring **results are supported and effectively communicated to all stakeholders.** Basin water managers must leverage community and First Nations' knowledge to enable adaptive management in the Basin.

Emphasising the current knowledge gap in the scientific understanding of the Basin is the fact that 18 of 46 environmental outcomes defined during the Evaluation for the Basin Plan could not be fully evaluated due to the limited evidence available for analysis. Key gaps existing in the environmental monitoring include:

- --- condition monitoring of floodplain and wetland assets is limited
- ••• vegetation monitoring, particularly understory and riparian vegetation is limited
- current fish condition monitoring only provides data to support evaluation of a small number of native species

- waterbird monitoring is not adaptive, leading to increased uncertainty in the data due to mismatches in timing of surveys and watering, but also changes in habitat in response to changing climatic conditions
- --- assessment of other threats, including invasive species and land use is incomplete.

The Basin Plan also does not have a formal monitoring program to inform social, cultural and economic outcomes. To date, the approach taken to evaluation has been opportunistic and eclectic, harvesting data from a diverse range of sources and integrating them for assessment. With optimising social, economic and environmental outcomes set to become a central challenge for the Plan as the Basin adapts to climate change, it is important that there is future investment in research and monitoring for these outcomes, alongside investments in environmental sciences.

In the absence of a dedicated and targeted Basinwide monitoring program, fully understanding the effectiveness of the Basin Plan will remain impossible.

Advancing science and monitoring

Greater investment in science and monitoring is badly needed to support the management of a complex river system like the Basin. The Evaluation has identified gaps in monitoring while emerging risks, including climate change, will require improved knowledge to support adaptation. Basin governments need to collaborate and invest more in long-term science and monitoring programs as well as short-to-medium-term intervention monitoring to support understanding and appropriate responses to Basin conditions and changes in them over time.

- Recommendation 11 Basin governments should prioritise higher levels of continuing strategic investment in science and monitoring. The new Australian Government Murray-Darling Water and Environment Research Program and the Basin governments' Science Platform provide a muchneeded foundation an for improved, enduring Basin science program. Any framework and program of investment must be transparent and embed continuous improvement. The investment should also cement enduring collaborative relationships between researchers and managers to improve use of the best available science to water management.
- Recommendation 12 Science and monitoring information must be made more accessible for all Basin stakeholders to improve the communication of Basin outcomes to the broader Basin community.

MDBA commitment:

The MDBA will work with Basin governments and stakeholders to develop an improved Basin-wide monitoring framework which considers social, cultural, economic and environmental themes. The MDBA will work with Basin governments and researchers to clearly identify roles and responsibilities and ensure integration of monitoring programs and improved access to data and information. The MDBA will take an active role in facilitating access and application of information.

References

Australian Bureau of Statistics (2019) <u>Gross Value of Irrigated Agricultural Production</u>, ABS website, accessed 29 October 2020.

Australian Competition and Consumer Commission (2020) <u>Murray–Darling Basin water markets inquiry: interim report</u>, ACCC, Australian Government, accessed 29 October 2020.

Bureau of Meteorology (2020) *Trends and historical conditions in the Murray–Darling Basin,* report to the Murray–Darling Basin Authority, Bureau of Meteorology.

Burgan B, Mahmoudi P and Spoehr J (2015) WISeR Economic Impact Analysis Tool (EIAT), Australian Urban Research Infrastructure Network.

Chiew FHS, Cai W and Smith IN (2009) <u>Advice on defining climate scenarios for use in Murray–Darling Basin Authority</u> <u>Basin Plan modelling</u>, report to the Murray–Darling Basin Authority, CSIRO, accessed 20 October 2020.

Department of Agriculture and Water Resources (2017) <u>Commonwealth water reform investments in the Murray</u>-<u>Darling Basin: analysis of social and economic outcomes</u>, DAWR, Australian Government, accessed 29 October 2020.

Department of Environment and Primary Industries (2014) *Ovens cod love river rehab: river rehabilitation activities benefit native fish,* DEPI, Victorian Government.

Goesch T, Legg P and Donoghoe M (2020) <u>Murray–Darling Basin water markets: trends and drivers 2002–03 to 2018–19.</u> ABARES research report , Australian Government, accessed 29 October 2020.

Gupta M, Hughes N, Whittle L and Westwood T (2020) *Future scenarios for the southern Murray–Darling Basin*, report to the Independent Assessment of Social and Economic Conditions in the Basin, ABARES research report, Australian Government, accessed 29 October 2020.

Hartwig L and Jackson S (2020) The status of Aboriginal water holdings in the Murray–Darling Basin, Australian Rivers Institute, Griffith University.

Interim Inspector-General of Murray-Darling Basin Water Resources (2020) <u>Impact of lower inflows on state shares</u> <u>under the Murray-Darling Basin Agreement</u>, Department of Agriculture, Water and the Environment, Australian Government, accessed 29 October 2020.

Jackson S and Nias D (2019) 'Watering country: Aboriginal partnerships with environmental water managers of the Murray–Darling Basin, Australia', *Australasian Journal of Environmental Management*, 26(3):287–303, doi:10.1080/14 486563.2019.1644544.

Jackson S, Woods R and Hooper F (2020) 'Empowering First Nations in the governance and management of the Murray–Darling Basin', In Hart B, Bond N, Byron N, Pollino C and Stewardson M (Eds.), *Murray–Darling River System, Australia*, Elsevier Press.

Marsden Jacob Associates (2017) <u>Economic effects of the Commonwealth water recovery programs in the Murrumbidgee</u> <u>Irrigation Area</u>, report to the Department of Agriculture and Water Resources, MJA, accessed 29 October 2020.

Marsden Jacob Associates (2019a) <u>Literature review supporting the Independent Assessment of Economic and Social</u> <u>Conditions in the Murray–Darling Basin</u>, report to the Panel for the Independent Assessment of Social and Economic Conditions in the Murray–Darling Basin, MJA, accessed 29 October 2020. Marsden Jacob Associates (2019b) <u>Indigenous water in the Murray–Darling Basin: supporting the Independent</u> <u>Assessment of Economic and Social Conditions in the Murray–Darling Basin</u>, report to the Panel for the Independent Assessment of Social and Economic Conditions in the Murray–Darling Basin, MJA, accessed 29 October 2020.

Matt Coulton, General Manager Water, Bureau of Meteorology, *Murray-Darling Basin Peak Groups Briefing*, 12 November 2020

Mooney W and Cullen A (2019) 'Implementing the Aboriginal Waterways Assessment tool: collaborations to engage and empower First Nations in waterway management', *Australasian Journal of Environmental Management*, 26(3):197–215, doi:10.1080/14486563.2019.1645752.

Murray-Darling Basin Authority (2017) <u>Basin Plan Evaluation 2017</u>, MDBA, Australian Government, accessed 29 October 2020.

Murray-Darling Basin Authority (2018) <u>Basin Plan Evaluation addendum</u>, MDBA, Australian Government, accessed 29 October 2020.

Murray-Darling Basin Authority (2020) <u>Sustainable diversion limit (SDL) accounting framework improvement strategy</u> <u>2020-2025</u>, MDBA, Australian Government, accessed 29 October 2020.

Murray-Darling Basin Ministerial Council (2004) *Native fish strategy for the Murray-Darling Basin 2003–2013*, Murray-Darling Basin Ministerial Council, Australian Government, accessed 29 October 2020.

Neave I, McLeod A, Raisin G, Swirepik J (2015) <u>Managing water in the Murray–Darling Basin under a variable and</u> <u>changing climate</u>, Australian Water Association (AWA). First published AWA Water Journal, April 2015, Vol 42, No 2, pp 102–107.

Productivity Commission (2017a) <u>*Transitioning regional economies*</u>, Productivity Commission, Australian Government, accessed 29 October 2020.

Productivity Commission (2017b) <u>National Water Reform: Productivity Commission inquiry report</u>, Productivity Commission, Australian Government, accessed 29 October 2020.

Productivity Commission (2018) <u>Murray–Darling Basin Plan: Five-year assessment</u>, Productivity Commission, Australian Government, accessed 29 October 2020.

RM Consulting Group Pty Ltd (unpublished) *Review of water quality targets in the Basin Plan*, report to the Murray– Darling Basin Authority, RM Consulting Group Pty Ltd.

Schirmer J (2016) <u>Water reform: Assessing effects of investment in water infrastructure and water entitlement purchase</u>, report to the Australian Government Department of Agriculture and Water Resources, University of Canberra, accessed 29 October 2020.

Schirmer J, Dare L and Mylek M (2019) <u>Wellbeing, resilience and adaptive capacity: a review of current knowledge of</u> <u>social conditions in the Murray–Darling Basin</u>, University of Canberra, accessed 29 October 2020.

Schirmer J and Mylek M (2020) <u>Thriving. surviving. or declining communities: socio-economic change in Murray-Darling</u> <u>Basin communities</u>, report to the Panel for the Independent Assessment of Social and Economic Conditions in the Murray-Darling Basin, University of Canberra, accessed 29 October 2020. Sefton R, Peterson D, Woods R, Kassebaum A, McKenzie D, Simpson B and Ramsay M (2019) <u>Social and Economic</u> <u>Condition in the Murray–Darling Basin Communities Progress Report: Listening to Community Voices</u>, Panel for Independent Assessment of Social and Economic Conditions in the Murray–Darling Basin, accessed 29 October 2020.

Sefton R, Peterson D, Woods R, Kassebaum A, McKenzie D, Simpson B and Ramsay M (2020) <u>Final report: independent</u> <u>assessment of social and economic conditions in the Murray–Darling Basin</u>, report to the Hon Keith Pitt MP, Minister for Resources, Water and Northern Australia, Panel for Independent Assessment of Social and Economic Conditions in the Murray–Darling Basin, accessed 29 October 2020.

Southern Connected Basin Environmental Water Committee (2018) <u>Water for the environment annual report 2017–18</u>, SCBEWC, Australian Government, accessed 29 October 2020.

Stewardson MJ and Guarino F (2020) <u>2018–19 Basin-scale evaluation of Commonwealth environmental water:</u> <u>hydrology</u>, report to the Commonwealth Environmental Water Office, La Trobe University, accessed 29 October 2020.

Tim Cummins & Associates and Frontier Economics (2017) <u>Social and economic impacts of the Basin Plan in Victoria.</u> Melbourne, accessed 5 November 2020.

Vertessy R, Barma D, Baumgartner L, Mitrovic S, Sheldon F and Bond N (2019) <u>Independent assessment of the 2018-19</u> <u>fish deaths in the lower Darling</u>, independent panel report for the Australian Government, accessed 4 November 2020.

Wheeler SA and Cheesman J (2013) 'Key Findings from a Survey of Sellers to the Restoring the Balance Programme', *Economic Papers: A journal of applied economics and policy*, 32(3):340–352, doi: 10.1111/1759-3441.12038.

Wheeler SA, Zuo A, Xu Y, Haensch J and Seidl C (2020) <u>*Water market literature review and empirical analysis*</u>, report to the Australian Competition and Consumer Commission, The University of Adelaide, accessed 29 October 2020.

Zhang L, Zheng HX, Teng J, Chiew FHS and Post D (2020) *Hydroclimate Futures for the Murray–Darling Basin*, report to the Murray–Darling Basin Authority, CSIRO.

Supporting data, reports and documents

A range of data, reports and other documents have been prepared as part of the 2020 Basin Plan Evaluation.

See the MDBA website for more information: mdba.gov.au/2020evaluation

- --- 2020 Basin Plan Evaluation Report
- --- 2020 Basin Plan Evaluation Southern Basin evidence report
- --- 2020 Basin Plan Evaluation Northern Basin evidence report
- --- 2020 Basin Plan Evaluation End of system evidence report
- --- 2020 Basin Plan Evaluation River connections evidence report
- --- 2020 Basin Plan Evaluation Social, economic and cultural evidence report
- --- 2020 Basin Plan Evaluation End of system evidence report
- --- 2020 Basin Plan Evaluation Plan implementation evidence report
- --- Trends and historical conditions in the Murray-Darling Basin
- --- Hydroclimate Futures for the Murray-Darling Basin
- --- Vulnerabilities to climate change in the Murray-Darling Basin



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