Regional Water Strategy

Western – Attachment 4: Analysis of restricting upstream licences to meet algal suppression and fish migration targets in the Barwon–Darling River

December 2022

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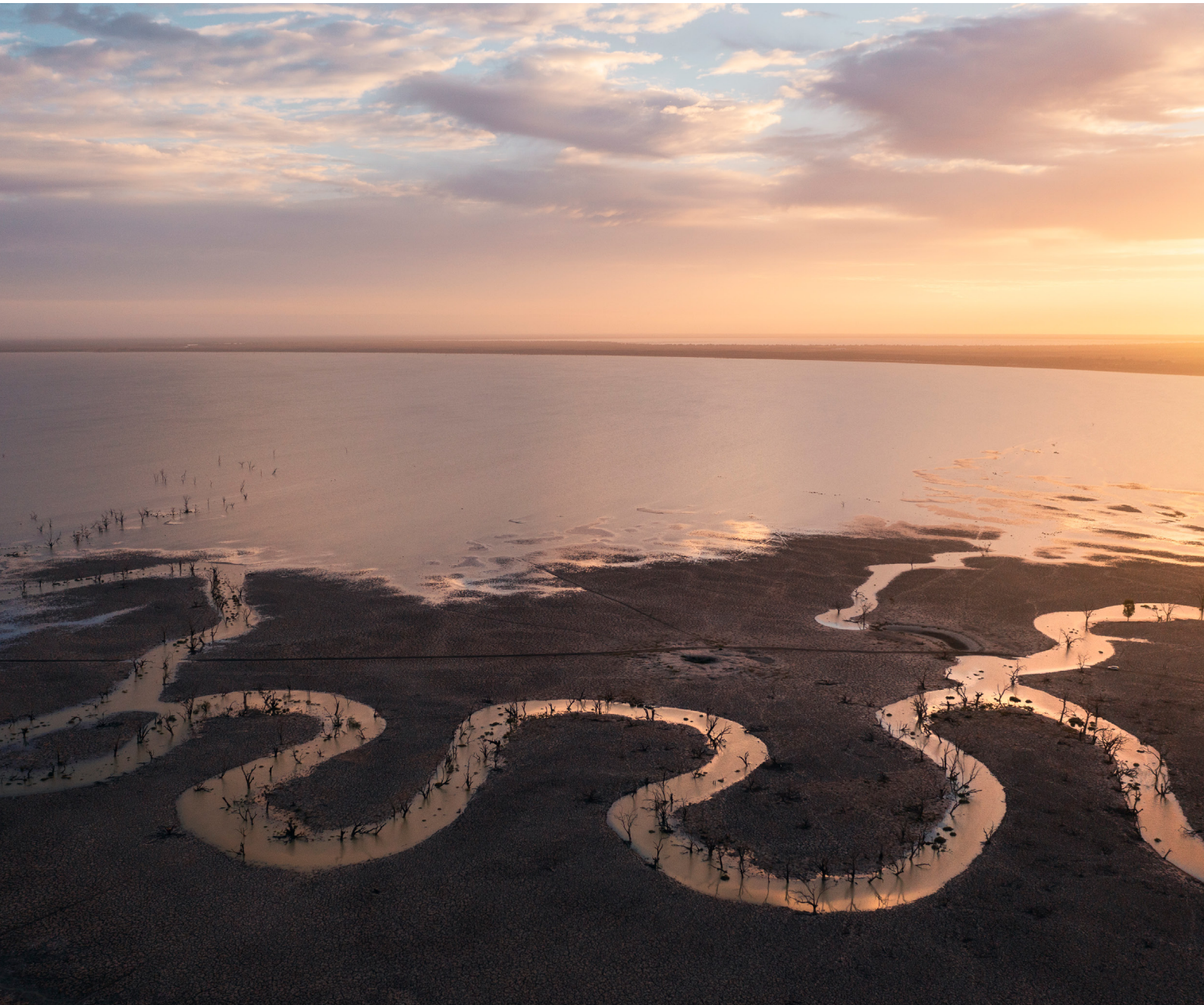

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Cover image Image courtesy of Destination NSW. Menindee Lakes, Menindee.

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This attachment presents the analysis of the benefits and the impacts of restricting supplementary, B Class and C Class licences in order to meet algal suppression and fish migration objectives in the Barwon–Darling River. These were the objectives set out in the Interim Unregulated Flow Management Plan for the North West (the North-West Flow Plan) and was listed as Government Commitment 6 in the draft strategy.

Additional analysis was undertaken of the algal suppression and fish migration targets following public consultation on the draft strategy. This paper reports on the results of this analysis.

The option has been shortlisted in the Final Western Regional Water Strategy as Action 3.2: Finalise the review of the North-West Flow Plan to identify the best way to support algal suppression and fish migration.

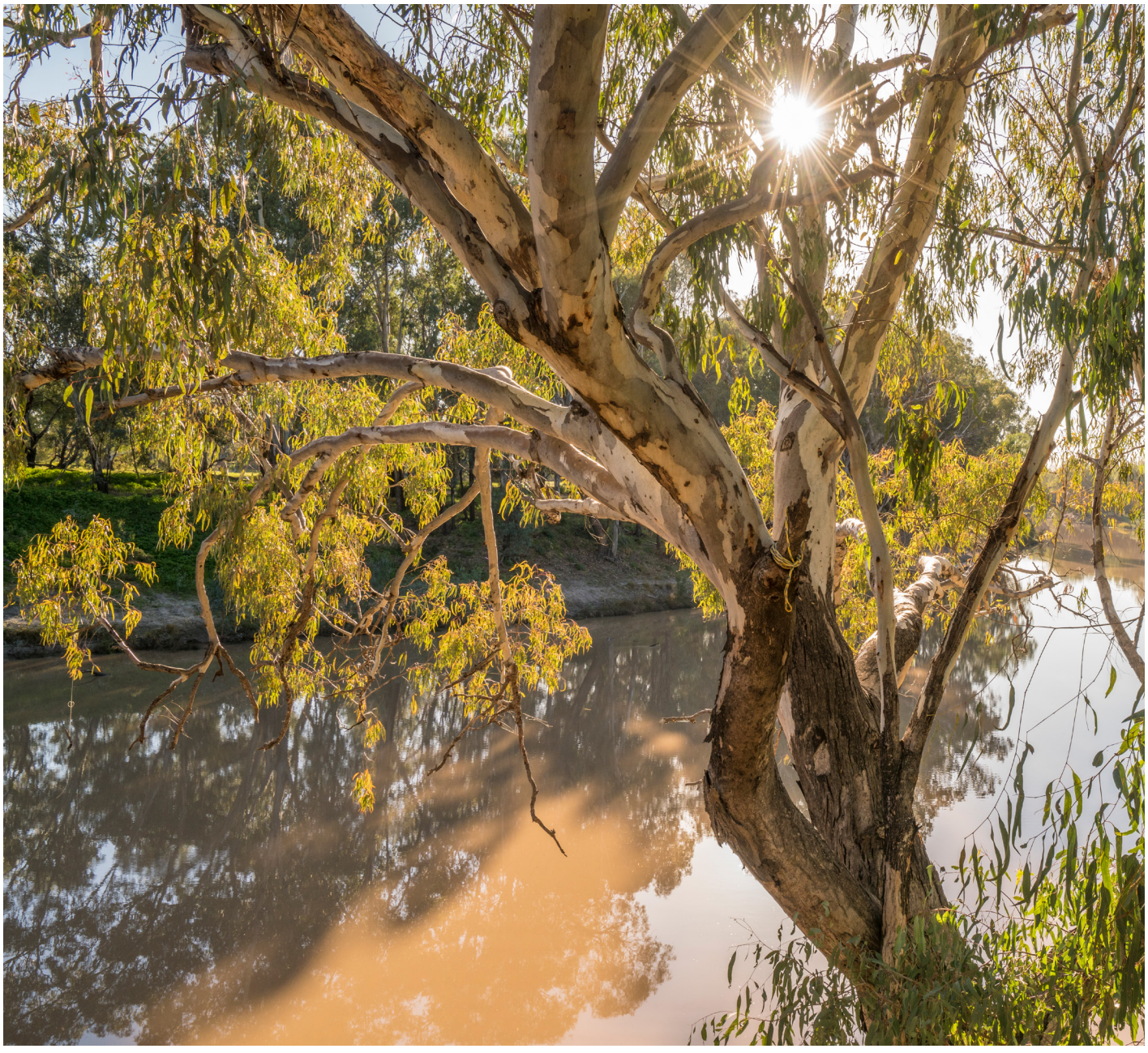

Image courtesy of Destination NSW. Darling River, Bourke.

1. Connectivity objectives addressed by this option

The analysis of this option aimed to understand whether restricting lower priority licences (supplementary licences, B Class and C Class licences) or using held environmental water from northern tributaries could help in meeting the following connectivity objectives:

- Suppress algal blooms: algal blooms in the Barwon–Darling continue to be a persistent and major challenge for towns, the environment and industry.
- Support fish migration: the Barwon–Darling, Lower Darling and Menindee Lakes system is the most ecologically important fish-movement corridor in the basin.

2. Option proposed in the Draft Western Regional Water Strategy

The Draft Western Regional Water Strategy was released for public exhibition on 1 July 2022. The draft strategy outlined the results of the review of the algal suppression and fish migration targets in the North-West Flow Plan and included the proposed flow targets needed to suppress algal blooms in the Barwon–Darling and support fish migration. The proposed targets published in the draft strategy are in Table 1.

Table 1. Proposed North-West Flow Plan Targets in the Draft Western Regional Water Strategy

Target/objective	Trigger for restrictions
Riparian targets Protect flows needed to meet riparian (now called basic landholder) rights requirements.	Objective and targets to be updated to focus on protecting the first flush of water after an extended dry period. This may include extension of the resumption of flow rule triggers from the Barwon–Darling into the northern tributaries.
Algal suppression Preserve a flushing flow event in dry years to break up and disperse algal blooms.	To achieve a flow of 3,000 ML/day for 7 days at Wilcannia if flows are below the following triggers during the spring/summer period: a. Walgett – 250 ML/ day b. Brewarrina – 510 ML/day c. Bourke – 450 ML/day d. Wilcannia – 350 ML/day.
Fish migration Preserve events needed for fish dispersal, spawning and migration at appropriate times of the year.	Achieve the following: • dispersal and condition: 15,000 ML/day for 15 days at Bourke between July and September • spawning: 15,000 ML/day for 15 days at Bourke between October and April • migration: 14,000 ML/day for 15 days at Brewarrina between October and April. These triggers will be revised once fishways are installed.

3. Stakeholder feedback

Some stakeholders did not support the proposed target of 195 GL in Menindee Lakes as a replacement for the riparian targets in the existing North-West Flow Plan. These stakeholders suggested that the flow rates in each reach of the river must be considered for the benefit of both basic rights holders and the environment. There were also several comments indicating that the North-West Flow Plan targets must meet the environmental water requirements under the Long-Term Water Plan.

Other stakeholders indicated a preference for using held environmental water to achieve outcomes, wherever possible. There was support for limiting the times of restrictions to when they can best meet targets, and limited support for restrictions that provide little additional benefit at large cost to water users. These stakeholders also indicated that the proposed regulatory measures must be accompanied by significant further programs such as infrastructure to meaningfully address some of the critical water supply challenges in regional NSW.

4. Outcomes of the analysis

Additional hydrological modelling was undertaken on the algal suppression and fish migration targets, to:

- better understand the potential impacts of the targets on water users
- ensure that the latest versions of the models were being used.

In the draft strategy the impacts on waters users were modelled with the fish migration and algal suppression targets combined. For the final strategy the impacts were modelled separately to understand the individual impacts of each of the proposed targets.

The analysis demonstrated that restrictions on water access for supplementary and Barwon–Darling B Class and C Class licences which are modelled assuming perfect hindsight:[1]

- **are unlikely to reduce extended cease-to-flow periods** because flows sufficient to provide supplementary access do not usually occur during cease-to-flow periods
- **are likely to increase the number of times when there are flows downstream to help suppress algal blooms** at Wilcannia but less likely to help improve the times there are sufficient flows to support fish migration. This is because restrictions on access have less effect on the inflow events that are needed to create the larger flows to support fish migration
- **are unlikely to significantly increase end-of-system flows** in the northern valleys or increase the time Menindee Lakes is above critical levels – resulting in a less than 1% increase in end-of-system flows in the northern tributaries over the long-term
- **produce mixed results when using held environmental water versus restrictions on productive licences**. Held environmental water licences could be better at meeting low-flow targets, but is limited by its volume. For example, while fish migration targets and the higher flow algal suppression target at Wilcannia could be better supported with the use of restrictions, the lower flow algal suppression targets can be better supported by the use of held environmental water licences.

All of the modelling results are based on applying restrictions using the triggers and assuming perfect flow forecasting capacity – this means only restricting upstream access in years when we know the resulting flows will meet the downstream targets.

Limiting upstream restrictions to when the water will meet the downstream targets is the most efficient approach, but our ability to do so depends on how well we can forecast when flows are sufficient to achieve the targeted downstream outcomes. However, good quality forecasting at the level assumed in the design of the original North-West Flow Plan has proved to be an intractable issue and this means we cannot implement these targets by using flow forecasting methods alone. If the targets are to be implemented, we first need to see improvements to the operational flow forecasting capability.

For the fish migration targets, only the existing targets in the North-West Flow Plan were remodelled. This was because the higher targets proposed in the draft strategy were found to be unachievable using restrictions or held environmental water. The current fish migration targets are:

- 10 GL/day at Bourke for 5 days
- 14 GL/day at Brewarrina for 5 days.

The updated hydrological modelling results are presented in Table 2.

1. Perfect hindsight means that only the years where restrictions would meet the targets were chosen. This modelling assumes there is perfect forecasting knowledge which is beyond our current forecasting capability. With imperfect knowledge (or imperfect forecasting ability), a conservative approach to restrictions would be taken, which means restrictions are likely to be imposed more often in these circumstances when downstream flow targets are unlikely to be met. These forecasting challenges are planned to be further investigated.

Table 2. Updated modelling for the fish migration and algal suppression targets by restricting supplementary, B Class and C Class licences*

Need	Benefits	Potential Impacts on diversions	
Algal suppression	Approximately 9 additional years over 125 years with at least one algal suppression event at Wilcannia. Approximately 2% increase in the median storage level of Menindee Lakes over the long term but no change in the time that Menindee Lakes is below 5% full.	Average long-term Impact (diversion).	• Border Rivers: -1.9 GL (-0.9%) • Gwydir: -2.7 GL (-0.6%) • Namoi: -1.2 GL (-0.5%) • Barwon–Darling: -0.3 GL (-0.5%).
		Maximum annual impact (diversion).	• Border Rivers: -11% • Gwydir: -4% • Namoi: -13% • Barwon–Darling: -50%.
		Changes in diversions for Murray licences.	• No change.
Fish migration	Maximum of 5 additional events at Bourke over 125 years. No additional events at Brewarrina.	Average long-term Impact (diversion).	• Border Rivers: -6.5 GL (-3.1%) • Gwydir: -8.0 GL (-1.8%) • Namoi: -4.8 GL (-2.1%) • Barwon–Darling: -1.9 GL (-1.2%).
		Maximum annual impact (diversion).	• Border Rivers: -18% • Gwydir: -26% • Namoi: -31% • Barwon–Darling: -53%.

*Corrections to this table were made in August 2023.
Note: Maximum annual impacts are expressed as a volume, and in parentheses as a percentage of the base case diversions in that year.

4.1: The use of general security held environmental water to help meet riparian and fish migration targets

In the interests of exploring all possible ways to meet the connectivity objectives, in the Draft Western Regional Water Strategy we modelled the maximum possible benefits associated with using 232 GL (or 14%) of general security water to meet downstream outcomes. This amount of general security water is equivalent to the entire general security held environmental water portfolio in the Border Rivers, Gwydir, Namoi and Wambuul–Macquarie valleys. This analysis found that:

- Held environmental water could help meet lower flow (riparian) targets but is limited by volume, so it is not effective at meeting the fish migration targets.
- Restrictions on supplementary licences could help meet higher flow targets but the timing may not align with needs.

The analysis is based on theoretical scenarios that compare using entire held environmental water portfolio with reducing all supplementary licences. Further information can be found at water.dpie.nsw.gov.au/plans-and-programs/regional-water-strategies/public-exhibition/western-regional-water-strategy.

4.2: How the options change end-of-system flows

Restricting supplementary licences to meet the algal suppression targets and fish migration targets have less than a 1% impact on changes to flows at the end of the Border Rivers, Gwydir and Namoi valleys (Table 3 and Table 4). The supplementary water restrictions provide some improvement to the Gwydir Valley end-of-system flows but limited benefits in the other valleys.

Table 3. Changes to end-of-system flows by restricting supplementary licences in order to meet algal suppression targets under a 'perfect forecasting' scenario*

Flow	Base case	Algal suppression targets	Change
Border Rivers at Mungindi			
Very low or no flows (<160 ML/day)	42.3%	42.3%	0.00%
Baseflows (160–550 ML/day)	25.9%	25.8%	-0.1%
Small freshes (550–5,400 ML/day)	28.1%	28.2%	+0.1%
Large freshes/floods (>5,400 ML/day)	3.7%	3.7%	0.00%
Gwydir Valley (Mehi at Collerenabri)			
Very low or no flows (<40 ML/day)	56.6%	56.0%	-0.6%
Baseflows (40–90 ML/day)	15.9%	16.1%	+0.2%
Small freshes (90–900 ML/day)	20.6%	20.9%	+0.3%
Large freshes/floods (>900 ML/day)	6.9%	7.1%	+0.2%
Gwydir Valley (Gil Gil Creek at Galloway)			
Very low or no flows (<25 ML/day)	56.8%	56.7%	-0.1%
Baseflows (24–45 ML/day)	10.1%	10.3%	0.1%
Small freshes (45–750 ML/day)	29.5%	29.4%	-0.1%
Large freshes/floods (>750 ML/day)	3.6%	3.6%	0.0%
Namoi River at Walgett			
Very low or no flows (<30 ML/day)	42.4%	42.4%	-0.1%
Baseflows (30–200 ML/day)	27.4%	27.5%	0.0%
Small freshes (200–2,250 ML/day)	19.0%	19.0%	-0.1%
Large freshes/floods (>2,250 ML/day)	11.1%	11.2%	0.1%

*Corrections to this table were made in August 2023.

Table 4. Changes to end-of-system flows by restricting supplementary licences in order to meet the existing fish migration targets under a 'perfect forecasting' scenario*

Flow	Base case	Fish Migration targets	Change
Border Rivers at Mungindi			
Very low or no flows (<160 ML/day)	42.3%	42.4%	+0.1%
Baseflows (160–550 ML/day)	25.9%	25.8%	0.0%
Small freshes (550–5,400 ML/day)	28.1%	28.0%	-0.2%
Large freshes/floods (>5,400 ML/day)	3.7%	3.8%	+0.1%
Gwydir Valley (Mehi at Collerenabri)			
Very low or no flows (<40 ML/day)	56.6%	56.0%	-0.6%
Baseflows (40–90 ML/day)	15.9%	16.1%	+0.2%
Small freshes (90–900 ML/day)	20.6%	20.5%	-0.1%
Large freshes/floods (>900 ML/day)	6.9%	7.4%	+0.5%
Gwydir Valley (Gil Gil Creek at Galloway)			
Very low or no flows (<25 ML/day)	56.8%	56.8%	+0.1%
Baseflows (24–45 ML/day)	10.1%	10.1%	-0.1%
Small freshes (45–750 ML/day)	29.5%	29.4%	-0.1%
Large freshes/floods (>750 ML/day)	3.6%	3.7%	+0.1%
Namoi River at Walgett			
Very low or no flows (<30 ML/day)	42.4%	42.5%	+0.1%
Baseflows (30–200 ML/day)	27.4%	27.3%	-0.1%
Small freshes (200–2,250 ML/day)	19.0%	18.9%	-0.1%
Large freshes/floods (>2,250 ML/day)	11.1%	11.2%	0.1%

*Corrections to this table were made in August 2023.

For the algal suppression targets, the Department of Planning and Environment analysed how the option would improve or impact different ecological flow targets in the Barwon–Darling (Table 5). The main flow component changes from the algal suppression option in the Barwon–Darling were a minor improvement in the median annual flow rate and the number of freshes/year, and a minor impact on the number of cease-to-flow events/year (Table 5). The extent of change varied between gauges, however, with minor to moderate impacts across the different flow gauges.

The minor increase in freshes is to be expected since the algal suppression flow effectively adds an extra fresh event into drier water years when the target is triggered. The high variation in cease-to-flow metrics between gauges may reflect the fact that inflows are also variable from the Border Rivers, Gwydir and Namoi when supplementary access is suspended. There is also likely to be a rebound effect once the algal suppression flow has passed, with B Class and C Class licence holders trying to 'catch up' on the missed opportunity once access restrictions have ceased.

Table 5. Modelled change in ecological flow metrics in the Barwon–Darling when an updated algal suppression flow is implemented

Metric	Algal suppression average effect across gauges	Algal suppression range of effects across gauges
Years in record	No change	No change
Mean annual flow	Little improvement	No change
Median annual flow	Minor improvement	Little impact to moderate improvement
Number of years with a cease-to-flow event	Little impact	Minor improvement to moderate impact
Number of cease-to-flow events	Minor impact	Minor improvement to moderate impact
Mean duration of cease-to-flow events	Little improvement	Minor improvement to minor impact
Number of freshes	No change	No change
Mean duration of fresh events	Minor improvement	Little improvement to minor improvement
Number of years with ≥ 1 fresh event	Little impact	Minor impact to no change
1.5-year ARI flow rate	Little improvement	No change to minor improvement
2.5-year ARI flow rate	Little improvement	Little impact to minor improvement
5-year ARI flow rate	No change	Little impact to minor improvement
10-year ARI flow rate	No change	No change
95th percentile flow rate	No change	No change
90th percentile flow rate	Little impact	Minor impact to minor improvement
80th percentile flow rate	No change	Little impact to little improvement
20th percentile flow rate	No change	Minor impact to little improvement
10th percentile flow rate	Little improvement	Little improvement minor improvement
Mean days below base case 90th percentile	Little improvement	No change to minor improvement
Mean duration of base case 90th percentile or lower	No change	Little improvement to little impact
Mean duration of base case 20th percentile or lower	No change	Minor improvement to minor impact

Note: ARI is average recurrence interval

Note on the gauges used to analyse the ecohydrology metrics of this option

We analysed the hydrologic time series model outputs for 15 flow gauges along the Barwon–Darling. These gauges provided a good representation of how flow conditions can change along the Barwon–Darling when the inflows from different valleys are also changed. Hydrologic models are imperfect and can occasionally generate results that are unlikely to be accurate. By assessing modelled data from all possible gauges, we were able to more readily identify results that seemed unlikely or anomalous when compared to gauges that were immediately upstream or downstream.

The flow gauges used in our models were:

- Barwon River at Mungindi (416001)
- Barwon River upstream of Presbury (416050)
- Barwon River at Mogil Mogil (422004)
- Barwon River at Collarenebri (422003)
- Barwon River at Tara (422025)
- Barwon River at Dangar Bridge (Walgett) (422001)
- Barwon River at Boorooma (422026)
- Barwon River at Geera (422027)
- Barwon River at Brewarrina (422002)
- Barwon River at Beemery (422028)
- Darling River at Warraweena (425039)
- Darling River at Bourke Town (425003)
- Darling River at Louth (425004)
- Darling River at Tilpa (425900)
- Darling River at Wilcannia Main Channel (425008).

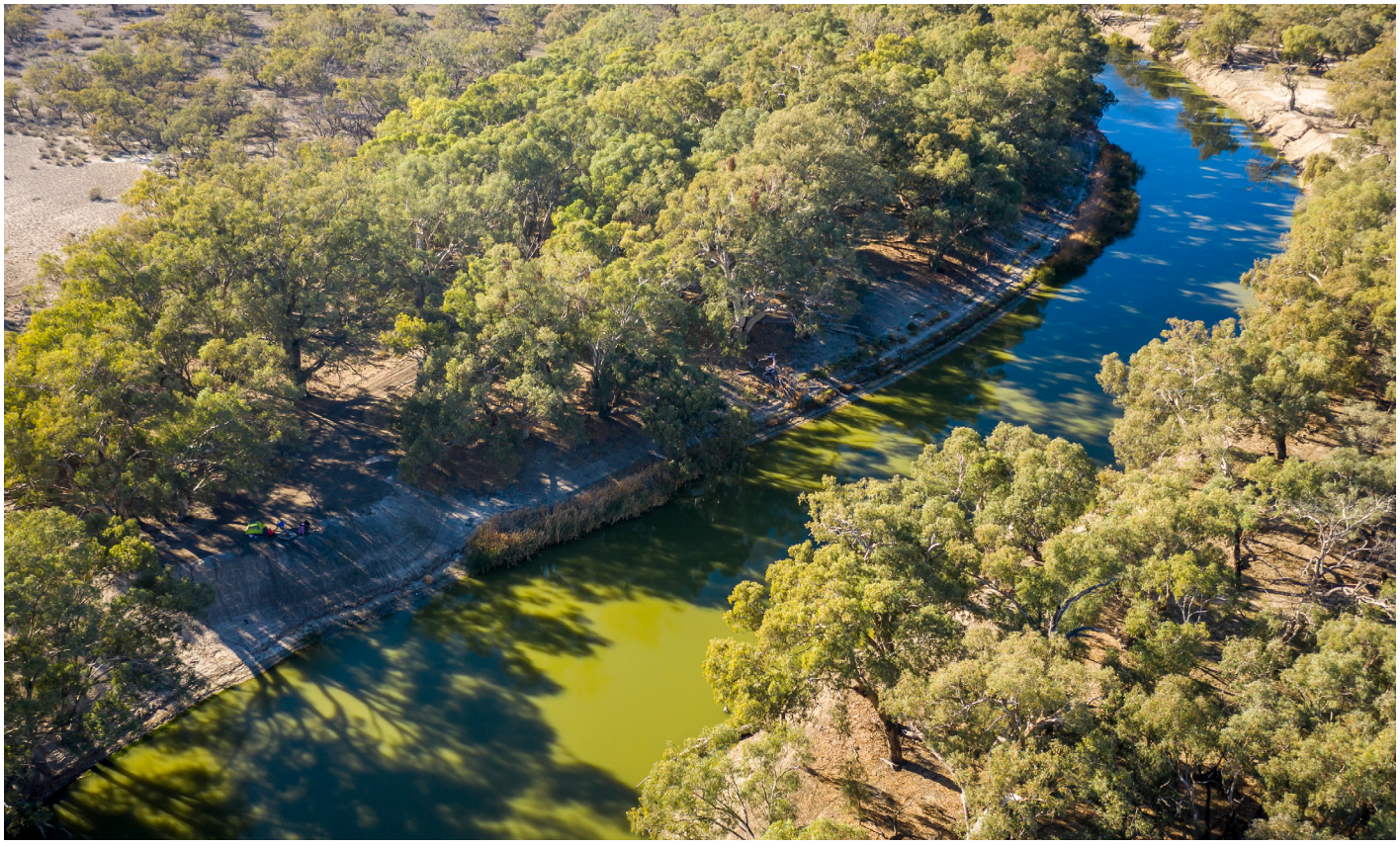

Image courtesy of John Spencer, Department of Planning and Environment. Darling River, Kinchega National Park.

4.3: The economic impacts

The economic analysis considered the impacts on major extractive water users including towns, annual agriculture users and permanent agriculture users within Border Rivers, Gwydir, Namoi and Barwon–Darling valleys. Environmental benefits have not been captured within this analysis due to the high degree of uncertainty of their economic valuation, but an ecohydrology analysis (Table 7) has been completed which provides an understanding of changes in environmental metrics. All economic values presented are averages of present values calculated over 13 overlapping 40-year periods of a historical climate dataset, ranging from 1896 to 2020.

The estimated average present value economic impact over a 40-year period after the implementation of the algal suppression target is $39.2 million, or a decrease in economic activity of 0.8% across all catchments considered. The relative decrease in average economic activity from the base case in each region is between 0.6% to 1.2%, suggesting broad moderate impacts would be expected.

Implementing the existing fish migration targets would likely result in marginally higher average impacts over a 40-year period of $112.7 million, equal to a decrease in economic activity reliant on surface water of 2.2% across the regions considered. This impact is distributed evenly across the regions considered, with most experiencing an approximately 2% impact in comparison to the base case. The only exception is Border Rivers which may experience a slightly higher impact of 3.2%.

Results of the analysis for each catchment considered and in aggregate can be seen in Table 6 for the algal suppression target and in Table 7 for the fish migration target.

Table 6. Algal suppression target average present value (40 years) economic impacts to northern tributaries and Upper Darling

Valley	Average economic impact ($present value, million)	Average economic impact (%)
Border Rivers	-11.9	-1.2
Gwydir	-17.3	-0.7
Namoi	-6.6	-0.6
Barwon–Darling	-3.4	-0.6
Total	**-39.3**	**-0.8**

Table 7. Fish migration target average present value (40 years) economic impacts to northern tributaries and Upper Darling

Valley	Average economic impact ($present value, million)	Average economic impact (%)
Border Rivers	-32.6	-3.2
Gwydir	-46.6	-1.9
Namoi	-21.8	-2.0
Barwon–Darling	-11.8	-2.1
Total	**-112.7**	**-2.2**

5. Proposed approach

The proposed approach on progressing the algal suppression and fish migration targets is outlined in Table 8. The next steps will involve convening an expert panel to provide advice on the analysis to date and make recommendations on a way forward. This will be considered as part of the remake of the Barwon–Darling Water Sharing Plan in 2024.

Stakeholder submissions were generally supportive of implementing algal suppression and fish migration targets as long as they were effectively achieving their stated purpose. Restricting supplementary, floodplain harvesting and B Class and C Class licences under a perfect forecasting scenario did provide some benefit by increasing the number of years there was an algal suppression event. Suppressing algal blooms and improving water quality remains a strategic priority identified in the strategy and is worthwhile considering further.

Given the high flows needed to meet the proposed fish migration triggers, there was minimal to no benefit from restricting lower priority licences to meet the targets.

The modelling shows that meeting the fish migration targets using restrictions or held environmental water is only possible in a small number of times over the historical dataset even under a perfect forecast scenario. This result was similar to the conclusion that Alluvium Consulting reached in their review of the North-West Flow Plan targets.[2] This indicates that using the tool of restricting supplementary access or using held environmental water is not an effective way of achieving the connectivity objectives of supporting fish migration. The flow rates needed for fish migration targets will be different in a river with fishways on weirs and fewer fish barriers, or if the targets are focused on the northern valleys.

Our ability to better forecast flows remains a significant impediment to implementing the algal suppression and fish migration targets. Significant work will be required to develop flow forecasting alternatives for the algal suppression targets. This could, for example, take the form of a rules-based approach with simple, blunt triggers that provide direction on when to restrict water users upstream and allow flows downstream, or a decision-support system to guide operational decision-making on when to restrict water users to meet the proposed targets.

We will also progress collaborative arrangements with environmental water holders to deliver on algal suppression and fish migration actions through watering strategies and work with the Murray–Darling Basin Authority to recognise any connectivity amendments in the Basin Plan review.

2. The Alluvium Consulting review report can be found at, www.industry.nsw.gov.au/water/environmental-water-hub/working-on/north-west-flow-plan

Table 8. Proposed approach to the North-West Flow Plan algal suppression and fish migration targets

Target/objective	Trigger for restrictions	Next steps
Algal suppression **Preserve a flushing flow event in dry years to break up and disperse algal blooms.**	To achieve a flow of 3,000 ML/day for 7 days at Wilcannia if flows are below the following triggers throughout the spring/ summer period: • Walgett – 250 ML/day • Brewarrina – 510 ML/day • Bourke – 450 ML/day • Wilcannia – 350 ML/day.	Aim to progress the targets as part of relevant water sharing plan reviews and consider: • Developing a rules-based approach or a decision support system to guide operational decision-making as an alternative to flow forecasting. • Reviewing the B Class and C Class and supplementary access rules to reduce the impact on water take resulting from the new and updated restrictions by allowing users to recover the water lost during average or high flow seasons -essentially allowing greater water take when there is more water in the system. • Forming an expert panel to review the targets which is a requirement under the Border Rivers Water Sharing Plan.
Fish migration **Preserve events needed for fish dispersal, spawning, and migration at appropriate times of the year.**	The objectives of the fish migration targets cannot be effectively achieved using either restrictions or general security/held environmental water.	• An independent Expert Panel will be asked to review the analysis and make a recommendation about how to proceed with the targets including the full spectrum of options to improve fish migration. This will include considering options from removing the targets and relying on infrastructure changes to fish barriers through to considering fish migration targets in the northern tributaries. • Continue to progress with the development of fishways and to consider the removal of non-town weirs to assist in improving fish migration.

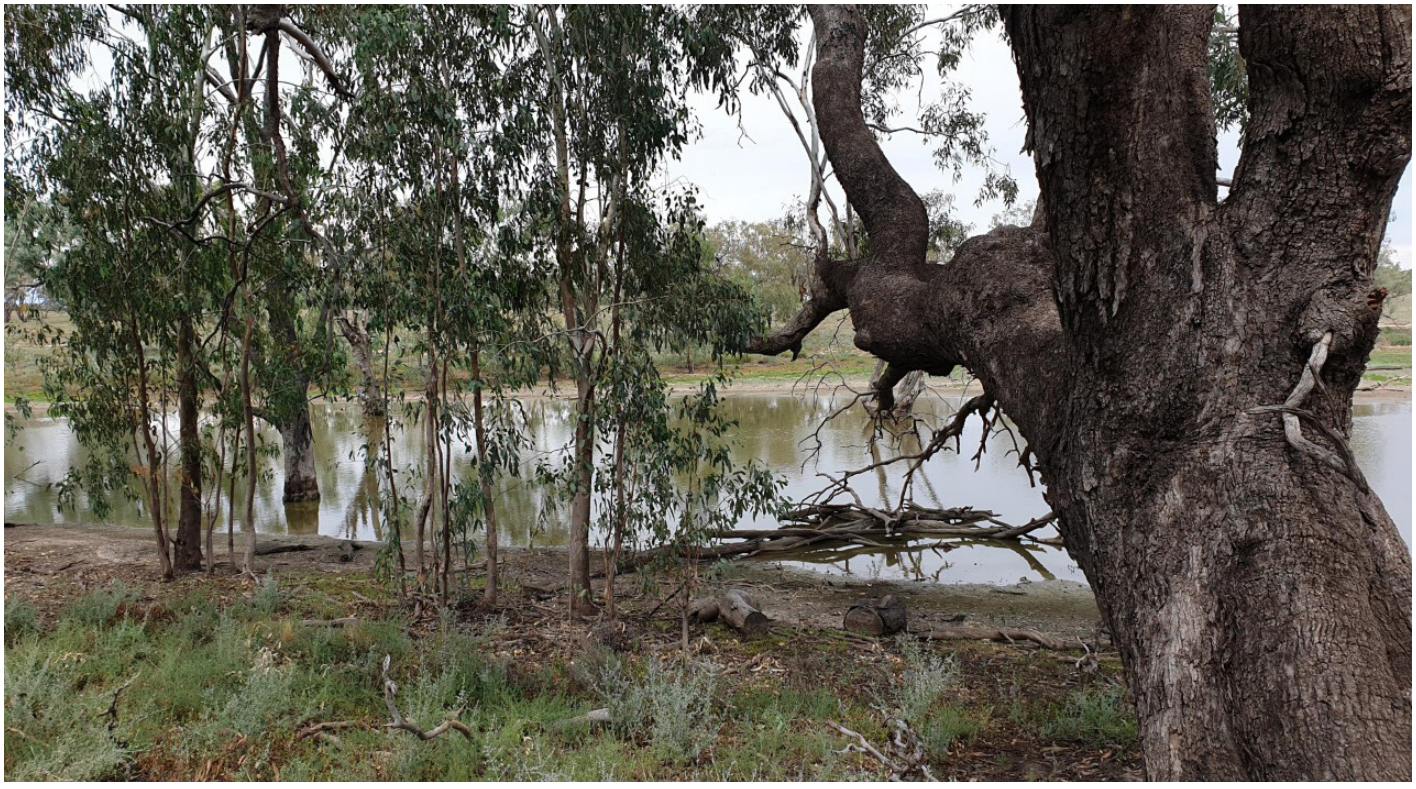

Image courtesy of Sally Anderson-Day. Barwon River, Brewarrina.

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