Murray valley annual surface water quality report: 2021-2022

Key Points

- Flow during July 2021 to June 2022 was characterised by heavy rain falling across much of the catchment. This rain resulted in several large flow events throughout the catchment.
- The heavy rains led to substantial increases in water storage levels.
- Flooding was the main driver of water quality in the Murray catchment. The water quality index indicated that of the 13 sites in the catchment, 3 were rated as good, 4 as moderate and 6 as poor. As a result of the flooding, 7 sites returned a lower water quality index score in 2021–2022 than compared to 2020–2021.
- All sites were below the Basin Plan agriculture and irrigation salinity target of 833 µS/cm (microSiemens per centimetre) and the End-of-Valley salinity target of 412 µS/cm (for the 80th percentile) during 2021–2022.
- Most red alert warnings for blue-green algae in the Murray catchment occurred in Hume Dam/Lake Hume from late December until mid-February. A red alert was also issued for two sites on the Wakool River in mid-May.

The water quality data used in this report is collected on a monthly frequency at 13 sites in the Murray valley for the State Water Quality Assessment and Monitoring Program and the River Murray water quality monitoring program on behalf of the Murray Darling Basin Authority. These programs are responsible for collecting, analysing and reporting the ambient water quality condition of rivers in NSW. This annual report summarises the surface water quality data collected in the Murray Valley from July 2021 to June 2022. The location of monitoring sites is shown in Figure 1.

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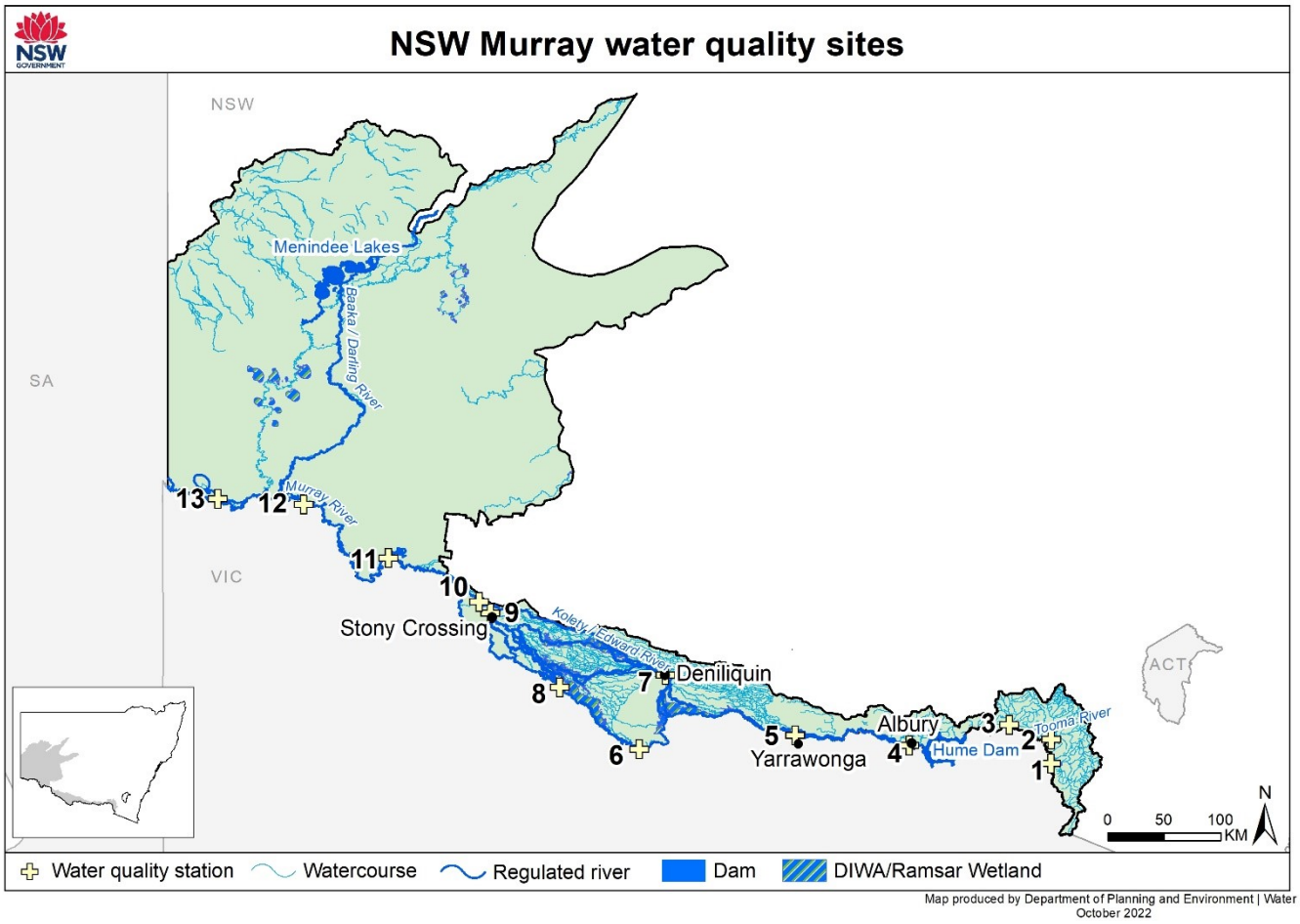


Figure 1: Location of routine water quality monitoring sites in the Murray valley

Table 1: Site information for each monitoring site in the Murray River catchment. Refer to Figure 1 and site numbers for location of each site

Site number	Site name	Water Quality Zone	Station number
1	Murray River at Indi Bridge	Murray unregulated uplands	401556
2	Tooma River at Warbrook	Murray unregulated uplands	401003
3	Murray River at Jingellic	Murray unregulated uplands	401201
4	Murray River at Albury	Murray (upper middle)	409001
5	Murray River downstream Yarrawonga Weir	Murray (upper middle)	409025
6	Murray River at Moama	Murray (upper middle)	40910087
7	Kolety/Edward River at Deniliquin	Kolety/Edward, Wakool	409003
8	Murray River at Barham	Murray (upper middle)	409005
9	Wakool River at Stoney Crossing	Kolety/Edward, Wakool	409013
10	Wakool River at Kyalite	Kolety/Edward, Wakool	409034
11	Murray River at Euston Weir	Murray (lower)	414209
12	Murray River at Merbein	Murray (lower)	414206
13	Murray River at Lock 8	Murray River (lower) lowlands	42610001

Catchment description

The Murray region is bordered by the Great Dividing Range to the east, the Victorian border in the south and the Murrumbidgee region in the north. It covers an area of over 97,800 km^2. The Murray River rises in the Alps at 1,430 m above sea level. The catchment above Hume Dam is the major source of water for the Murray River. The total length of the Murray River is 2,530 km, of which 1,880 km of its length creates the border between NSW and Victoria, before flowing to the river mouth in South Australia.

The natural flow regime is characterised by high winter/spring flows and low summer/autumn flows resulting from run-off derived from its alpine headwaters and associated tributaries. The five longest tributaries are the Mitta Mitta River, Kiewa River, Tooma River, Black Dog Creek and Swampy Plain River. The significant inter-valley diversions of both the Snowy-Tumut and Snowy-Murray Developments of the Snowy Mountains Hydroelectric Scheme impact on the Upper Murray River Water Source. This is a direct result of the operation of Murray 1 and Murray 2 Power Stations and their final storage dam, Khancoban Pondage. Flows in the Murray River system are modified by a highly regulated weir system, water extraction and structures. Yarrawonga Weir is the point of the greatest diversion of water from the Murray River. The two main irrigation channels from Lake Mulwala are the Mulwala Canal, on the NSW side, and the Yarrawonga Main Channel, on the Victorian side. The Mulwala Canal has a discharge capacity of about 10,000 ML/day and provides flows to the Edward and Wakool rivers and numerous distributary streams and canals. Torrumbarry Weir diverts flows into Deniboota Canal in NSW and National Channel in Victoria. Euston Weir regulates water for the Robinvale Irrigation District. The Murrumbidgee River flows into the Murray River upstream of Euston Weir. There are two sites in the Murray Water Resource Plan area listed as wetlands of international importance under the Ramsar Convention. The NSW Central Murray State Forests consist of three discrete but interrelated forest areas the Millewa, Koondrook-Perricoota and Werai forests. Blue Lake in Kosciuszko National Park was listed under the Ramsar Convention in 1996. The Living Murray icon sites within NSW include the Millewa Forest, Koondrook-Perricoota Forest, the eastern section of the Chowilla floodplain and the River Murray Channel. The mountainous areas in the upper Murray catchment are predominantly native vegetation and grazing. Dryland cropping increases downstream of Hume Dam with irrigation areas receiving water through the regulation of flows from the Murray River (DoIW 2018).

Catchment conditions during 2021-2022

Flow during 2021–2022 was characterised by heavy rain falling across much of the catchment (Figure 2A). Discharge in the Murray River downstream of Yarrawonga Weir peaked at almost 46,000 megalitres per day (ML/day) on 11 September 2021 (Figure 2C). These large flows resulted in consistently high discharge (above 10,000 ML/day) downstream at Barham until the end of 2021 when flows reduced to 5,000 to 9,000 ML/day until July 2022 (Figure 2C).

Hume Dam reached 97.1% capacity by the end of November, the highest level since November 2016 (Figure 2B). During the spring, the dam had been operated in controlled release mode to create

airspace and prevent the dam from spilling. In November, the release volume was further increased for safe operations as a consequence of widespread rainfall over the Upper Murray catchment and saturated soils. The releases were reduced during the first week of December in response to reduced inflows, but further releases took place during December and January before a return to normal operations at the end of January (BOM, 2022).

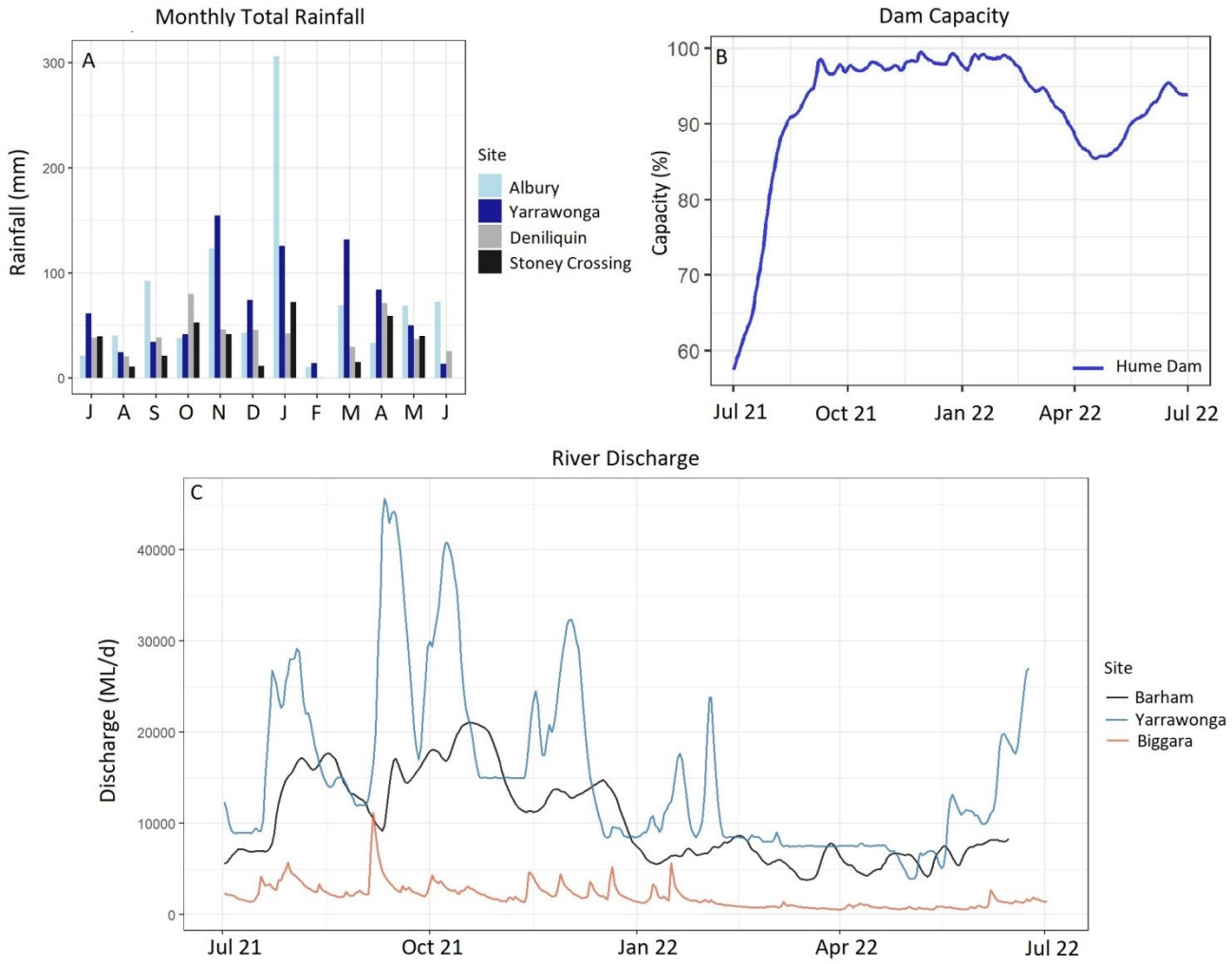


Figure 2: Catchment conditions for selected stations in the Murray catchment from July 2021 to June 2022 for A: Monthly total rainfall (mm) B: Dam capacity (%) and C: River discharge (ML/day)

Water quality for water dependent ecosystems

NSW uses a Water Quality Index (WaQI) as a tool to communicate complex and technical water quality data in a simple and consistent way. The WaQI score was calculated for each monitoring site using total nitrogen, total phosphorus, turbidity, pH, dissolved oxygen and electrical conductivity. The index compares the monthly water quality results against a set of predetermined water quality targets to calculate a score between 1 and 100. A score of 100 represents a site in pristine condition, while a score of one is a very highly degraded site. The results from the WaQI are summarised in Figure 5. Sites where there has been a change of less than 5 points in WaQI score, have been

identified with horizontal arrows. Arrows pointing up or down indicate the score has increased/decreased by more than 5 points.

Three sites in the Murray catchment were rated as good. One is located in the headwaters of the Murray River at Indi Bridge, while the other 2 are in the lower valley at Euston Weir and Merbein. A total of 6 sites rated as poor. The Tooma River at Warbrook has historically had poor water quality with high turbidity, nutrient concentrations and electrical conductivity. Two sites in the mid Murray River at Moama and Barmah had high turbidity, total phosphorus and electrical conductivity. The 2 sites on the Wakool River both had high nutrients and electrical conductivity. The high inflows from the Darling River into the Murray River at Wentworth increased the turbidity and nutrient concentrations at Lock 8 resulting in a poor rating. The remaining 4 monitoring sites rated as moderate.

Compared to the 2020 to 2021 results, the water quality index score for one site in the upper Murray catchment at Indi Bridge improved. Of the 13 monitoring sites, 5 sites showed minimal change while the remaining 7 sites returned a lower index score than in 2020 to 2021.

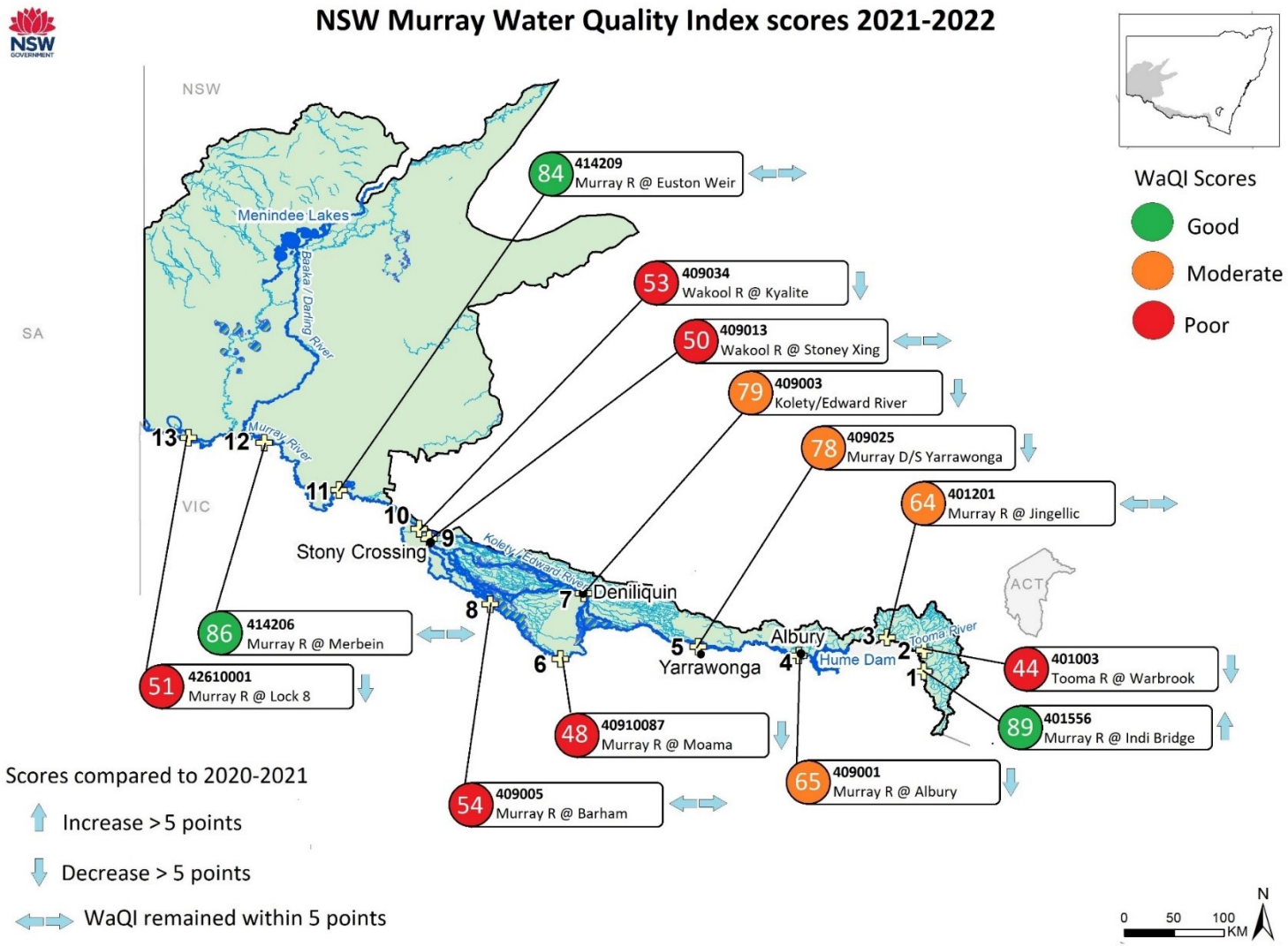


Figure 3: Water quality index scores for the Murray valley

The pH largely ranged between 7 and 8 at all sites in the Murray valley and would not impact on the health of aquatic ecosystems or agricultural enterprises.

There was a slight increase in turbidity with distance down the catchment, reflecting the impact of the cumulative effects of land use, soil disturbance and human activity on water quality. Turbidity decreased in the lower Murray River at Euston Weir and Merbein but increased again at Lock 8 with the inflow of highly turbid floodwaters from the Darling River at Wentworth. Total nitrogen and total phosphorus concentrations followed the same pattern as turbidity, with increasing concentrations with distance downstream until the lower valley, and then increased markedly downstream of the Darling River inflows.

Dissolved oxygen levels fluctuated between sites in response to local drivers. In most cases, the site median was between 80 and 100% saturation. Major flooding resulted in the flushing of organic matter from the lowland floodplain forests and into waterways. The rapid breakdown of this material by bacteria caused dissolved oxygen levels in parts of the Kolety/Edward-Wakool River system to decline to critical levels for fish health.

Electrical conductivity in the Murray River is generally low. The release of water from Hume Dam provides dilution flows. The electrical conductivity of surface water in the Wakool River and Murray River lowlands did increase but still suitable for irrigation purposes. Again, floodwater from the Darling River increased electrical conductivity in the Murray River at Lock 8.

Summary statistics for the key water quality parameters at each monitoring site in the Murray valley have been displayed as box plots (Figure 4). The box plots show the annual 25th, 50th and 75th percentile values, with error bars indicating the 10th and 90th percentile values for each site.

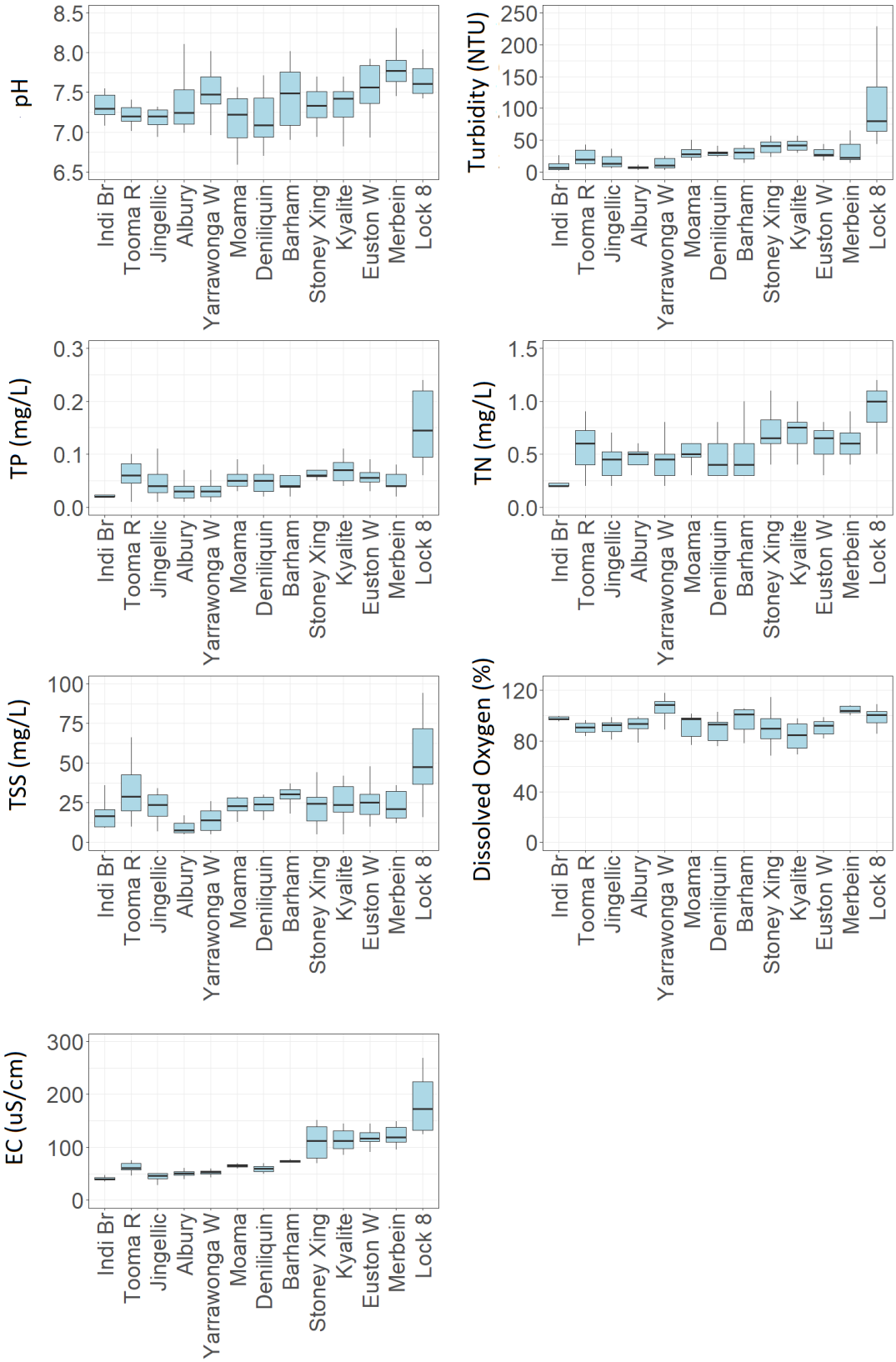


Figure 4: Water quality data for water quality parameters by site

Irrigation and salinity

There are 37 continuous electrical conductivity monitoring sites in the Murray valley managed by NSW agencies with more sites managed by Victoria agencies. Salinity in the lower Murray (Mallee region) can approach critical levels. The numerous monitoring sites assist in the operation of various salt interception schemes in the lower Murray by both NSW and Victorian agencies to reduce salt inputs to the Murray River from saline groundwater.

Electrical conductivity levels are generally low in the upper Murray River with regular inflows diluting salt and keeping electrical conductivity low. The mean daily electrical conductivity in the Murray River fluctuates throughout the year (Figure 5), though results do not exceed the agriculture and irrigation salinity target of 833 µS/cm, keeping the risk of impacts on soil and crop health low.

The Basin Salinity Management Strategy End-of-Valley salinity targets for the Murray River at the NSW/South Australian border is that the 80th percentile electrical conductivity does not exceed 412 µS/cm. The 80th percentile for the Murray River at Lock 6 (downstream of the border) from 2021 to 2022 was 248 µS/cm, which is less than the End-of-Valley target value.

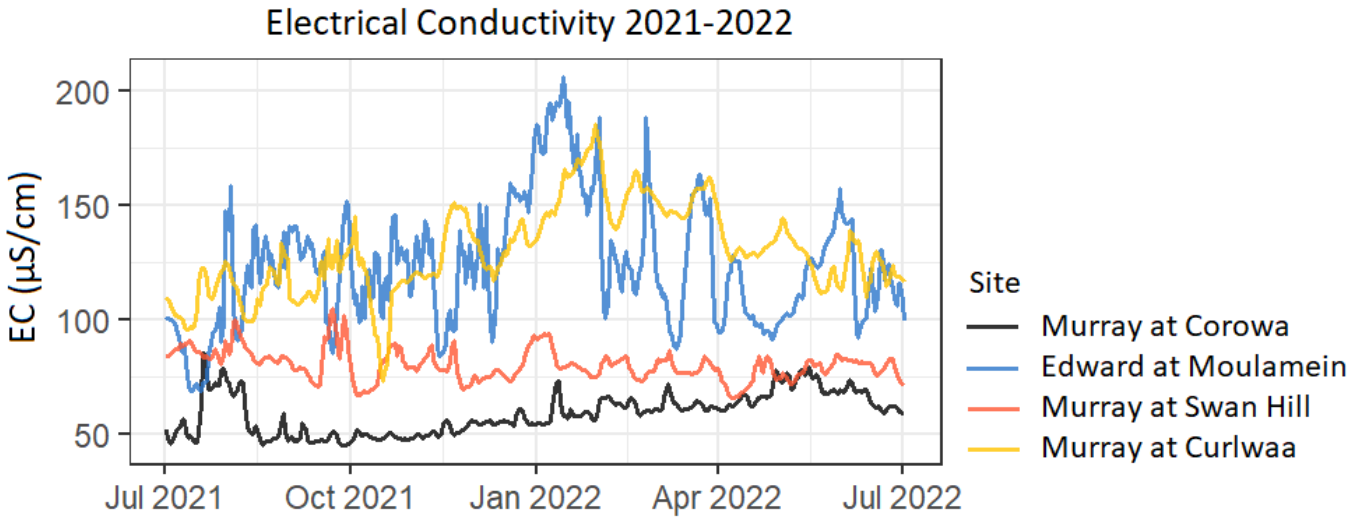


Figure 5: Electrical conductivity (µS/cm) in the Murray valley

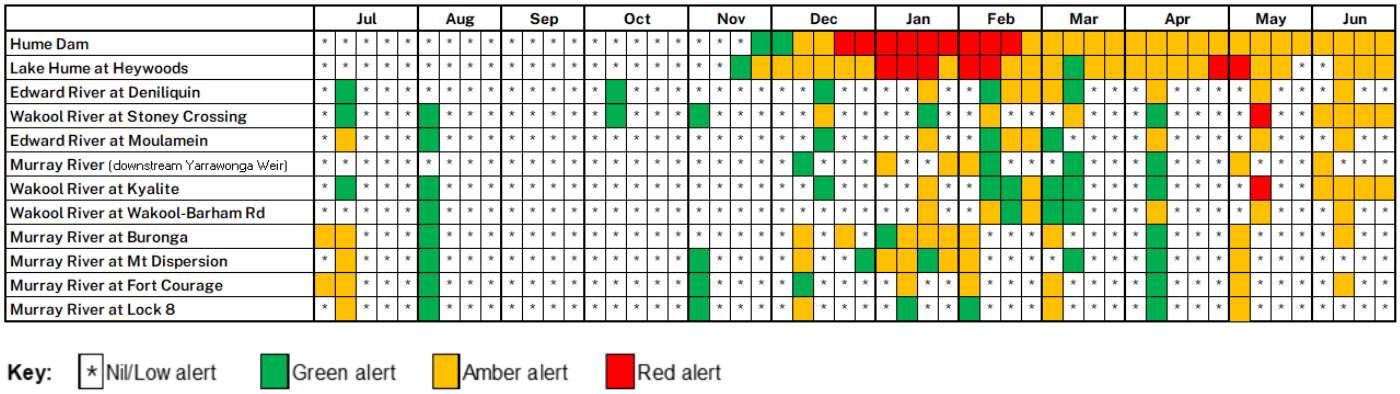
Recreation

Exposure to blue-green algae (cyanobacteria) through ingestion, inhalation or contact during recreational use of water can impact on human health. A colour alert scale is used with a green alert warning indicating low numbers of blue-green algae but requiring monitoring, an amber alert warning being a heightened level of alert with increased sampling and surveillance, and a red alert warning being a state of action where waters are unsuitable for recreational use. For more information about blue-green algae and algal alerts see the WaterNSW algae web page (Algae - WaterNSW).

Hume Dam is known to have regular algal blooms, especially in summer. Inflow from the heavy rainfall events would also have flushed nutrients such as nitrogen and phosphorus into the dam

which has encouraged algal growth. Table 2 indicates the distribution of algal alerts during 2021 to 2022, highlighting that the area around Hume Dam was on red alert for recreational use from December 2021 until February 2022. During January 2022, the Murray–Darling Basin Authority (MDBA) trialled different methods of water release from Hume Dam using spillway gates and valves to improve water quality downstream. Water releases were not drawn from the surface levels where blue-green algae are typically present during the day hence, reducing the transfer of significant amounts of algae downstream (MDBA, 2022).

Table 2: Distribution of algal alert levels along the Murray River Valley July 2021 to June 2022



Extreme water quality events

November 2021 was Australia's wettest November since national records began in 1900 (BoM, 2022). It was also the wettest November on record for New South Wales and for the entire Murray–Darling Basin. The heavy rains led to substantial increases in water storage levels, with many storages spilling. With flooding on this scale came an increased risk of hypoxic blackwater events.

Hypoxic, or low oxygen blackwater occurs when organic material, such as sticks, leaves, bark and grass is broken down in the floodwater or washed off the floodplain into the river. The breakdown of this material by bacteria can rapidly use up all the oxygen in the water. The dark appearance of the water is due to the release of tannins as the organic matter decays. Whilst this breaking down and recycling of organic material is an essential natural process of rivers, a sudden drop or prolonged exposure to low oxygen levels can have adverse impacts. Fish and other aquatic animals have difficulty surviving under low oxygen conditions. As a general guide, native fish and other large aquatic organisms require at least 2 mg/L of dissolved oxygen to survive but may begin to suffer at levels below 4 to 5 mg/L.

In the Upper Murray, dissolved oxygen fell just below 4.0 mg/L at Heywood's Bridge, downstream of the Hume Dam on 4 January 2022. Mitigation activities by MDBA River Operations and WaterNSW involved channelling water releases from Hume Dam through cone valves at Meridian Energy power station to provide greater aeration and injecting compressed air through power station flows. WaterNSW increased monitoring both within Lake Hume and the Murray River downstream. River Operations maintained flows of 3,000 ML/day through the power station until the end of January 2022. Only 2 dead fish were reported and no observations of crayfish leaving the river.

There were concerns the Hume Dam air-space releases might cause dissolved oxygen issues around the Barmah-Millewa Forest. High flows flooding low-lying areas of the forests, combined with increasing water temperatures and high loads of leaf litter on the forest floor saw declining dissolved oxygen in the Kolety/Edward River at Toonalook in November 2021. Agencies and scientific experts worked together to continually monitor the dissolved oxygen levels throughout the river system. Environmental water was delivered through Murray Irrigation escapes providing an oxygenated refuge for fish to move into. Despite conditions being stressful for fish, no fish deaths were reported to NSW Fisheries.

Routine monitoring in the Lower Murray indicated dissolved oxygen was not impacted by the upstream events and dissolved oxygen readings remained above 6.5 mg/L. Large-scale native fish deaths were avoided in the Southern Basin, indicating fish were able to migrate into refuge areas of oxygenated water until better quality water arrived from upstream.

Summary

The quality of the water in a river or stream reflects underlying climate and geology and the multiple activities and land uses occurring in a catchment area. Numerous factors contribute to the observed results.

In 2021 to 2022, flooding was the key driver of water quality. Increased runoff carries high volumes of sediment and attached nutrients into waterways resulting in all 10 of the 13 water quality monitoring sites being rated as moderate or poor. In contrast, the high flows maintained electrical conductivity below the irrigation targets. As a result of the flooding, 7 sites returned a lower water quality index score in 2021-2022 compared to 2020-2021.

The management of inflows into the rivers, and their release, was a careful balancing act, which was continually monitored and adjusted as needed. Agencies and scientific experts worked together to monitor the dissolved oxygen levels throughout the river system and advise the best operational measures to minimise the risk to aquatic life.

Although hypoxic blackwater events may result in the loss of fish and other aquatic life, the impacts of these events on the environment are usually short-term, as the river water re-oxygenates again as the flooding subsides. Naturally occurring events such as these underpin the broad health of rivers. They provide nutrients to drive the overall production of our river and wetland systems. In the longer term, native fish, water birds and other organisms benefit from the increased production in the river, boosting food supplies and supporting breeding cycles.

The flushing of nutrients into Lake Hume by floodwaters may have contributed to the high potentially harmful blue-green algal numbers from December 2021 to June 2022, and occasional alert warnings for recreational use in the Murray, Kolety/Edward and Wakool rivers.

For more detailed information about water quality issues in the Murray catchment see the Murray surface water quality technical report (https://www.industry.nsw.gov.au/__data/assets/pdf_file/0009/305757/Water-quality-technical-report-for-the-Murray-Lower-Darling-surface-water-resource-plan-area-SW8.pdf).

References and further information

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Central Murray: https://www.mdba.gov.au/water-management/catchments/central-murray

Lower Murray: https://www.mdba.gov.au/water-management/catchments/lower-murray