Gwydir valley annual surface water quality report 2022–2023

Key Points

- Flow during July 2022 to June 2023 was characterised by heavy rain in September and October resulting in major flooding in Moree in October.
- Heavy rains led to a substantial increase in the storage level of Copeton Dam. With flooding on this scale came an increased risk of hypoxic blackwater events, resulting in thousands of fish deaths in December 2022.
- Flooding was the main driver of water quality in the Gwydir River. The water quality index indicated that of the 10 sites in the catchment, one was rated as good, 8 rated as moderate and one as poor. Three sites returned a higher water quality index score in 2022–2023 compared to 2021–2022.
- Myall Creek at Molroy exceeded the Basin Plan agriculture and irrigation salinity target of 957 µS/cm (microSiemens per centimetre). All other sites were below this salinity target. The median End-of-Valley salinity target of 412 µS/cm and the 80th percentile target of 545 µS/cm were both exceeded by a small margin.
- Copeton Dam was on red alert for potentially harmful blue-green algae blooms from November 2022 and periodically until April 2023. This did not impact the Gwydir River downstream of the dam.

Water quality data is collected monthly at 10 sites in the Gwydir valley for the State Water Quality Assessment and Monitoring Program. The program is 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 Gwydir Valley from July 2022 to June 2023. The location of monitoring sites is shown in Figure 1.

DOC23/361079

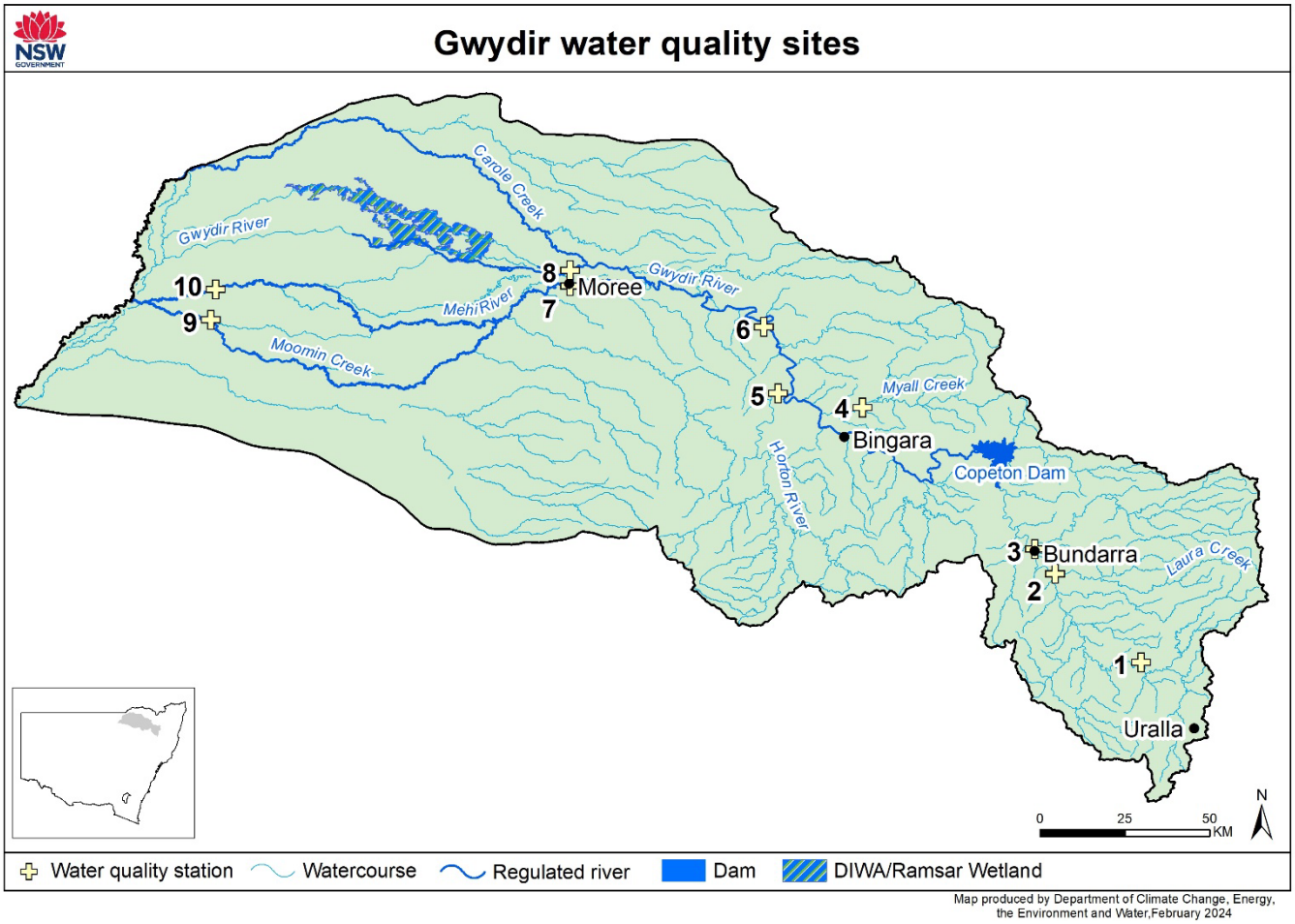

Figure 1: Location of routine water quality monitoring sites in the Gwydir valley

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

Site number	Site name	Water Quality Zone	Station number
1	Gwydir River at Yarrowyck	Gwydir Montane	418014
2	Laura Creek upstream Bundarra	Gwydir Montane	41810006
3	Gwydir River at Bundarra	Gwydir Montane	418008
4	Myall Creek at Sheep Station Creek Road	Gwydir Unregulated Uplands	41810033
5	Horton River at Elcombe Road Bridge	Gwydir Unregulated Uplands	41810058
6	Gwydir River at Gravesend	Gwydir Regulated uplands	418013
7	Gwydir River at Yarraman Bridge	Gwydir Regulated uplands	418004
8	Mehi River at Moree	Gwydir Regulated uplands	418002
9	Moomin Creek at Iffley	Gwydir Lowlands	418054
10	Mehi River at Bronte	Gwydir Lowlands	418058

Catchment description

The Gwydir region is located in northern NSW, bounded by the Border Rivers region to the north, the western slopes of the Great Dividing Range to the east, the Namoi catchment to the south and the Barwon River to the west. It covers an area of more than 26,000 km^2.

The Gwydir River and its tributaries traverse the tablelands of northern NSW, flowing northwest through undulating and rugged country before draining westward out onto a flat riverine plain. Here the river becomes a system of braided streams and floodplain wetlands.

The main tributaries of the Gwydir River are the Copes, Moredun, Georges, Laura, Halls, Myall and Warialda creeks and the Horton River. These tributaries join the Gwydir River upstream of Gravesend. Copeton Dam is the only major storage in the Gwydir catchment. Flows from Copeton Dam are diverted into the various distributary streams in the lower catchment via a series of regulatory weirs.

The Gwydir wetlands are located on the lower Gwydir River and Gingham Watercourse. The wetlands are one of the most extensive and significant semi-permanent terminal wetlands in northwest NSW (Keyte 1994). They are characterised by poorly defined channels and extremely flat grades, which lead to widespread, long-duration flooding. Parts of the Gwydir wetlands have been listed as wetlands of international importance under the Ramsar Convention.

Land use in the Gwydir catchment is largely grazing in the upper catchment with increased dryland farming in the mid and lower catchment. Irrigated agriculture is mostly located close to the main river channels downstream of Pallamallawa. A detailed description of climate, land and water usage and water regulation infrastructures can be found in the Gwydir resource description report (DoIW 2018).

Catchment conditions during 2022-2023

Flow during 2022–2023 was characterised by heavy rain falling across much of the catchment in September and October 2022 and heavy falls in the upper Gwydir catchment in March 2023 (Figure 2A). Regular inflows maintained the storage capacity of Copeton Dam at 100% during 2022 and above 90% at the end of June 2023 (Figure 2B). Figure 2C highlights regular flooding in late 2022 with major flooding occurring in October. Discharge in the Gwydir River at Bundarra peaked at almost 100,000 megalitres per day (ML/day) and over 250,000 ML/day in Gwydir River at Gravesend on 22 October 2022 (Figure 2C). These flows were distributed into the Gwydir and Mehi rivers and Carole/Gil Creek system via a series of regulating weirs.

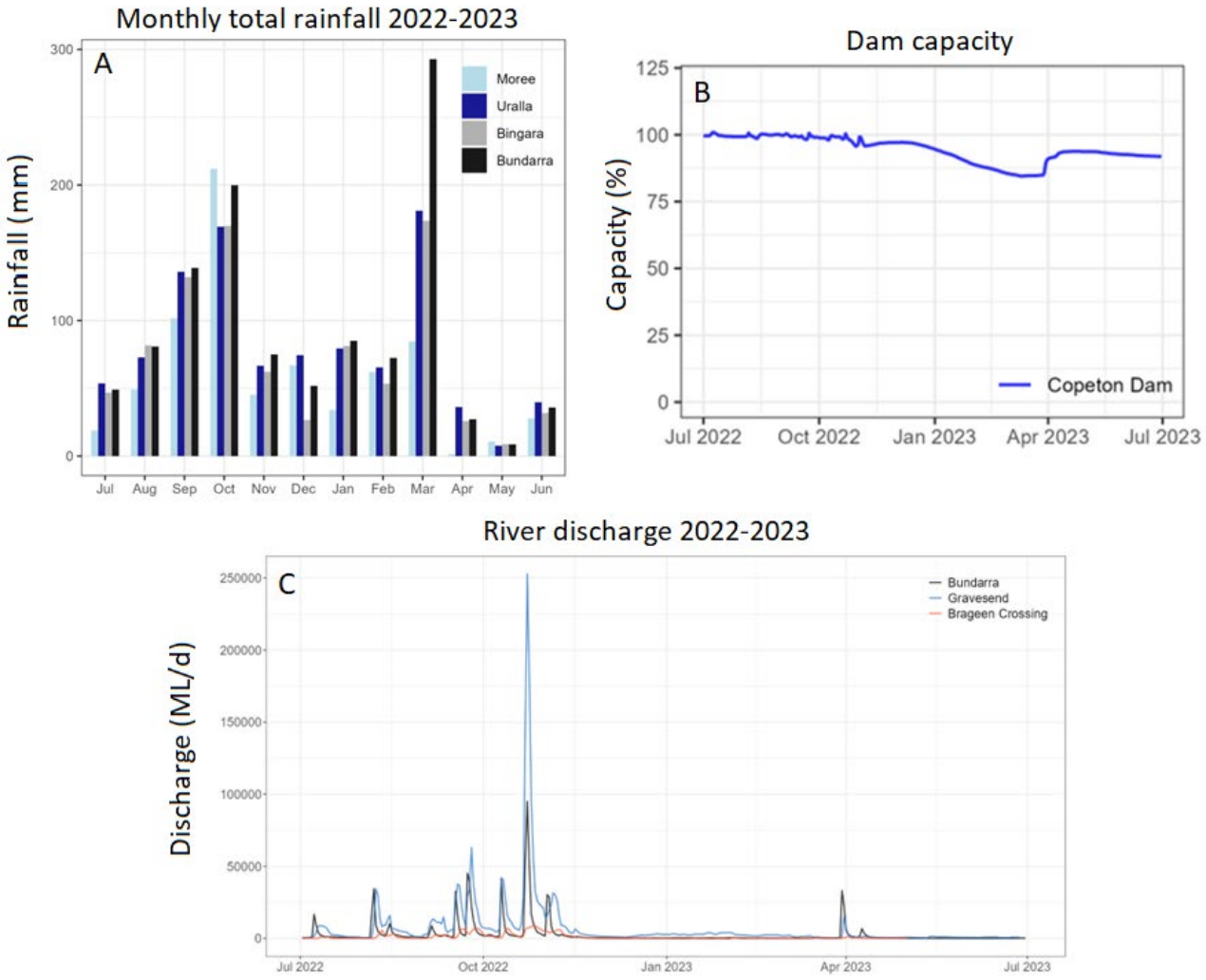

Figure 2: Catchment conditions for selected stations in the Gwydir catchment from July 2022 to June 2023 for A: monthly total rainfall (mm) B: Dam capacity (%) and C: river discharge (ML/day).

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. This value can then be categorised to rate the general water quality at a monitoring site. The results from the WaQI are summarised in Figure 3. 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.

The water quality index category ratings in the Gwydir River improved in 2022–2023 for 3 of the 10 sites compared to 2021–2022. One site decreased from good to moderate.

- Mehi River at Moree remained poor.
- Laura Creek upstream of Bundarra, Moomin Creek at Iffley and the Gwydir River at Gravesend Road Bridge and Yarraman Bridge remained moderate.
- Mehi River at Bronte remained good.
- Horton River at Elcombe Road Bridge decreased from good to moderate.
- Myall Creek and the Gwydir River at Yarrowyck and Bundarra improved from poor to moderate.

The Mehi River at Moree had the lowest water quality index score. The score was impacted by high nutrients, high turbidity and lower dissolved oxygen. The decline in the score for the Horton River at Elcombe Road Bridge was due to lower dissolved oxygen and higher total nitrogen levels in response to the flooding and associated run-off in 2022 to 2023. Electrical conductivity also increased in the Horton River as high rainfall mobilised salts in this naturally saline landscape.

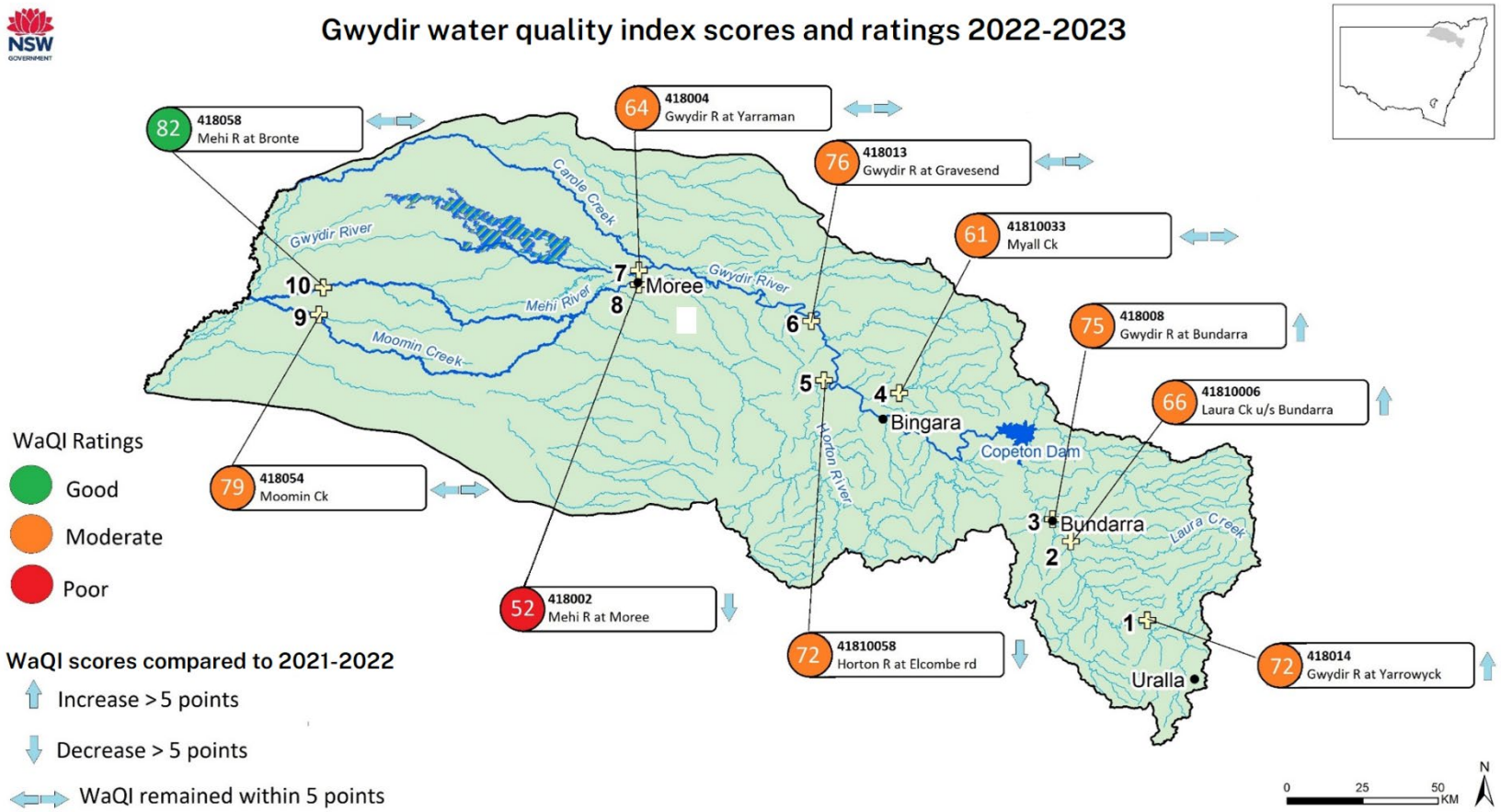

Figure 3: Water quality index scores and ratings for the Gwydir valley

Compared to other water quality parameters, the median pH in the Gwydir valley was relatively consistent down the catchment.

Turbidity increased with distance down the catchment, reflecting the impact of the cumulative effects of land use, soil disturbance and human activity on water quality. The highest results were at the 2 lower catchment sites, Moomin Creek at Iffley and Mehi River at Bronte.

The 3 sites upstream of Copeton Dam (Laura Creek and Gwydir River at Yarrowyck and Bundarra) showed elevated concentrations of total nitrogen and total phosphorus. There are areas in the northeast along the Great Dividing Range with higher soil nitrogen and phosphorus, which combined with the high rainfall and runoff may have contributed to the high nutrient concentrations found at these sites. Downstream of Copeton Dam there is a trend of increasing nutrient concentrations with distance down the catchment, which as for turbidity is a reflection of increased disturbance and human activity on water quality.

Water quality monitoring sites often show a relationship between total nitrogen, total phosphorus and turbidity, indicating similar transport mechanisms for the 3 parameters. Nutrient concentrations in the upland sites were high, but the turbidity was low, suggesting that the nutrients were dissolved in the water, rather than attached to soil particles.

The median dissolved oxygen levels were within the desired range for aquatic ecosystems at most sites. The highest results were in Myall Creek which could be due to the filamentous algae that often grows at this site producing high concentrations of dissolved oxygen. The lowest dissolved oxygen readings were in the lower catchment, where high turbidity reduces light penetration, reducing aquatic plant growth and higher water temperature reduces the solubility of oxygen in the water column. In addition, major flooding resulted in the flushing of organic matter off the lowland floodplains and into waterways. The rapid breakdown of this material by bacteria can cause dissolved oxygen levels to decline as observed in the Mehi River at Bronte.

Natural salt sources in the Myall Creek and Horton River catchments result in these sites having the highest median electrical conductivity. High rainfall and major flooding maintained a low electrical conductivity at all other monitoring sites across the catchment.

Summary statistics for the key water quality parameters at each monitoring site in the Gwydir 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.

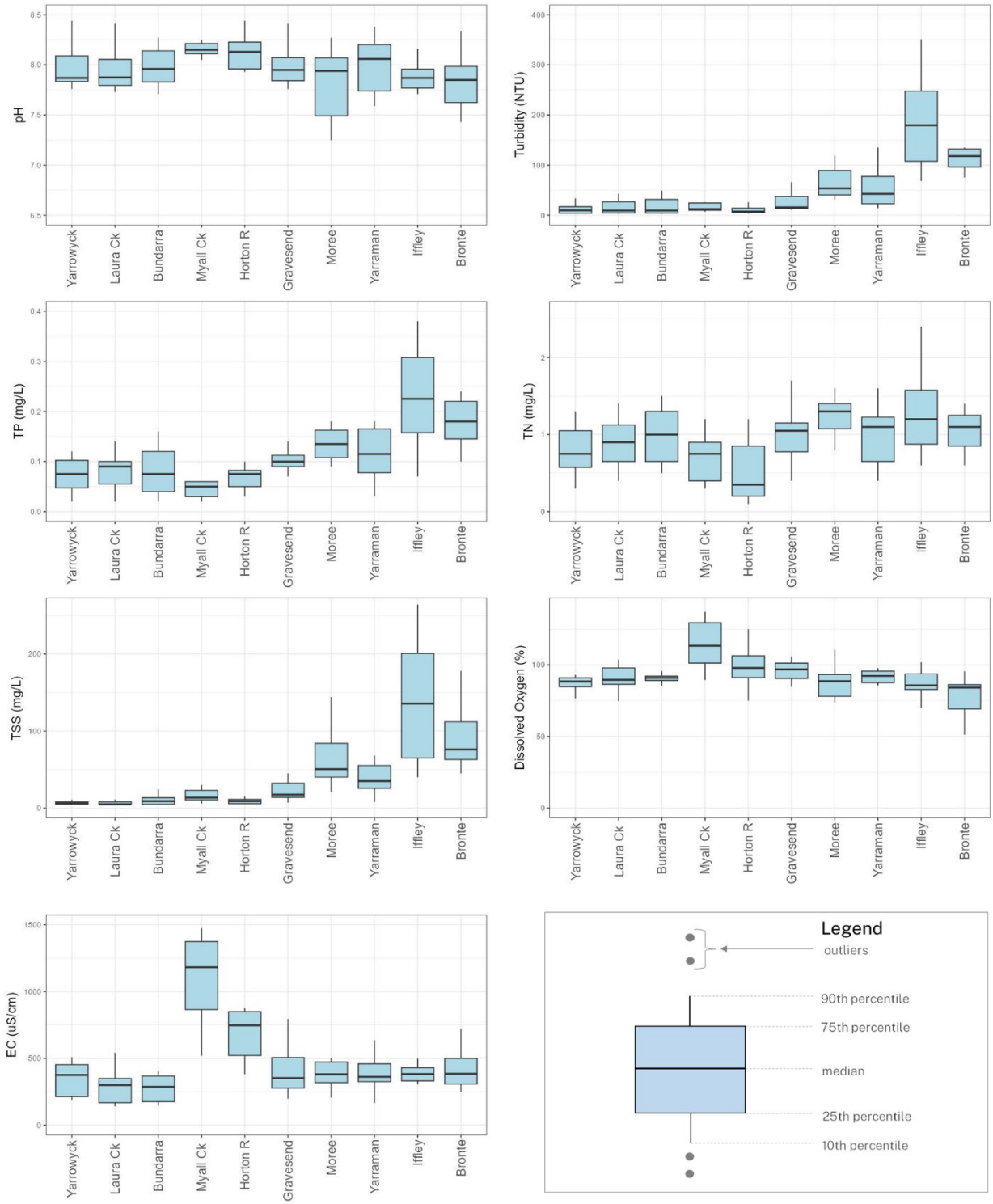
pH
Turbidity (NTU)
TP (mg/L)
TN (mg/L)
TSS (mg/L)
Dissolved Oxygen (%)
EC (uS/cm)
Yarrowyck
Laura Ck
Bundarra
Myall Ck
Horton R
Gravesend
Moree
Yarraman
Iffley
Bronte
Legend
outliers
90th percentile
75th percentile
median
25th percentile
10th percentile

Figure 4: Water quality data by site, moving upstream to downstream from left to right. The water quality parameters shown are pH, Turbidity, Total phosphorus (TP), Total nitrogen (TN), Total suspended solids (TSS), Dissolved oxygen, and electrical conductivity (EC).

Irrigation and salinity

There are 3 continuous electrical conductivity monitoring sites in the Gwydir valley (Myall Creek at Molroy, Gwydir River at Yarraman Bridge, and Mehi River at Bronte). Figure 5 shows electrical conductivity in Myall Creek is much higher than in the other 2 sites. Electrical conductivity in Myall Creek decreases quickly following dilution by heavy rainfall but increases again as flows decrease.

Myall Creek at Molroy had a 95th percentile electrical conductivity of 1,566 µS/cm which is higher than the Basin Plan agriculture and irrigation salinity target of 957 µS/cm. There is limited opportunity for irrigation from Myall Creek, decreasing the risk to agriculture production and soil structure. The 95th percentile in both the Gwydir River at Yarraman Bridge and Mehi River at Bronte was less than the Basin Plan irrigation target.

The Basin Salinity Management Strategy End-of-Valley salinity targets for the Mehi River at Bronte are that:

- the median electrical conductivity does not exceed 412 µS/cm
- the 80th percentile electrical conductivity does not exceed 545 µS/cm and
- the annual salt load does not exceed 7,000 t/year.

The median electrical conductivity of 419 µS/cm only just exceeded the End-of-Valley target. The 80th percentile of 564 µS/cm also only exceeded the target by a small margin. Due to the high flows during 2022 to 2023, the annual salt load of 68,389 t/year greatly exceeded the End-of-Valley target.

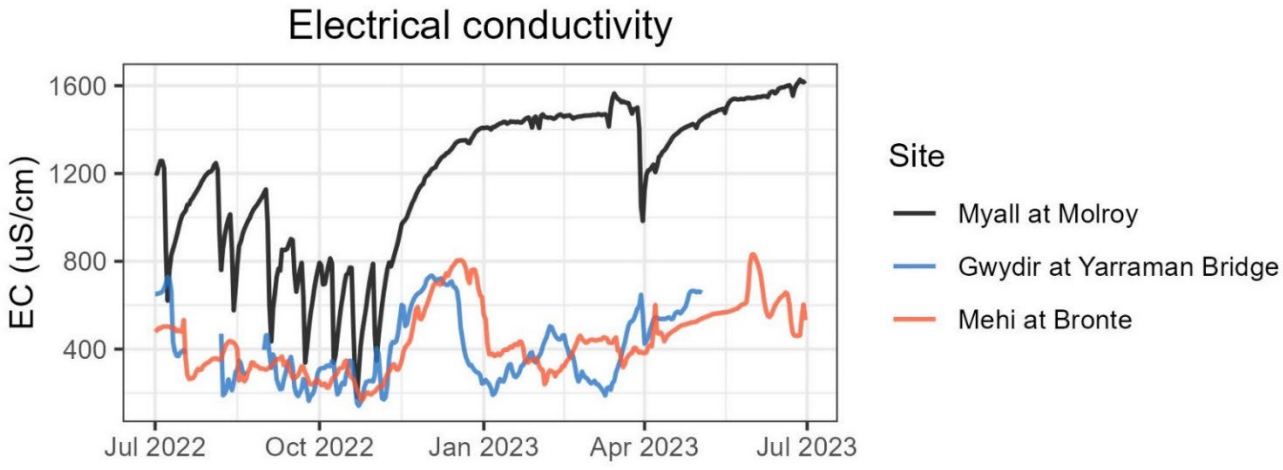

Figure 5: Electrical conductivity (µS/cm) in the Gwydir valley

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).

Blue-green algae have historically not been a major issue in the Gwydir River due to regulated releases maintaining flow during the high-risk summer period. For this reason, monitoring is focused on Copeton Dam. Table 2 indicates the distribution of algal alerts during 2022 to 2023, highlighting that Copeton Dam was on red alert for recreational use from November and for most of the summer period. Inflow from heavy rainfall events likely flushed nutrients such as nitrogen and phosphorus into the dam which encouraged algal growth. As Copeton Dam is a deep, bottom-release storage, algae rarely gets released into the Gwydir River downstream.

Table 2: Distribution of algal alert levels in Copeton Dam July 2022 to June 2023

	Jul					Aug				Sep					Oct				Nov				Dec					Jan				Feb				Mar					Apr				May				Jun				
Copeton Dam	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	1	1	1	1	1	3	3	3	3	3	3	2	2	3	3	3	2	2	2	2	3	3	2	2	3	3	2	2	2	2	2	*	1	1	1	1	1	1
Gwydir River (downstream of Copeton Dam)	*	1	1	1	1	1	*	*	*	*	*	*	*	*	*	1	1	1	1	1	*	*	*	*	*	*	*	*	1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

Key : * = Nil/Low alert | 1 = green alert | 2 = amber alert | 3 = red alert

Extreme water quality events

Spring 2022 was the wettest spring on record (since 1900) for New South Wales. In October, heavy rainfall led to widespread flooding in the Murray–Darling Basin, impacting many towns in inland New South Wales (Figure 6 - BoM, 2023 and Figure 7). Flooding occurred in all catchments across the Northern 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.

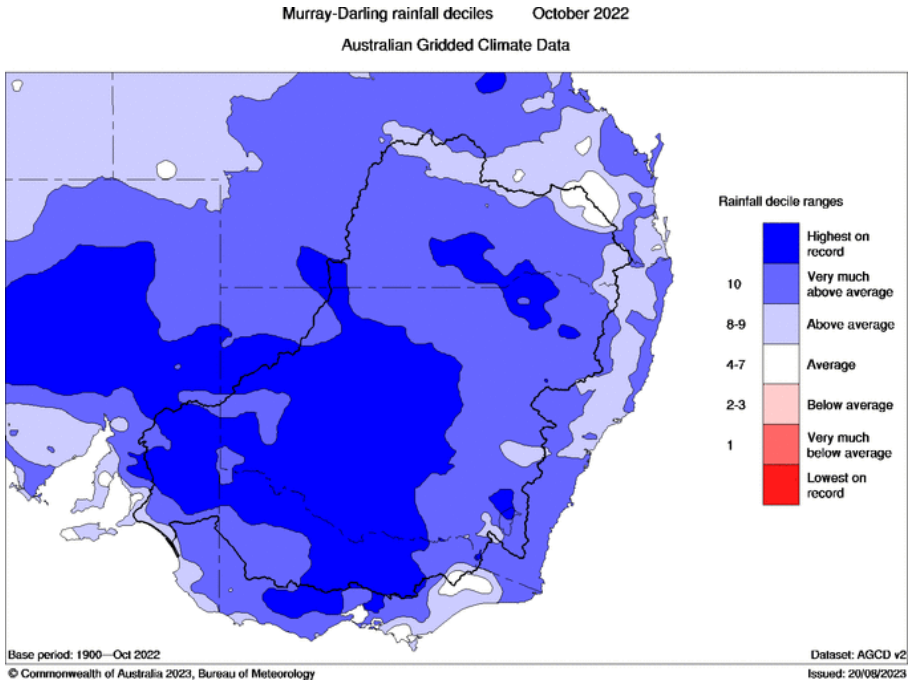

Figure 6: Murray Darling rainfall deciles for October 2022. (Source: BoM)

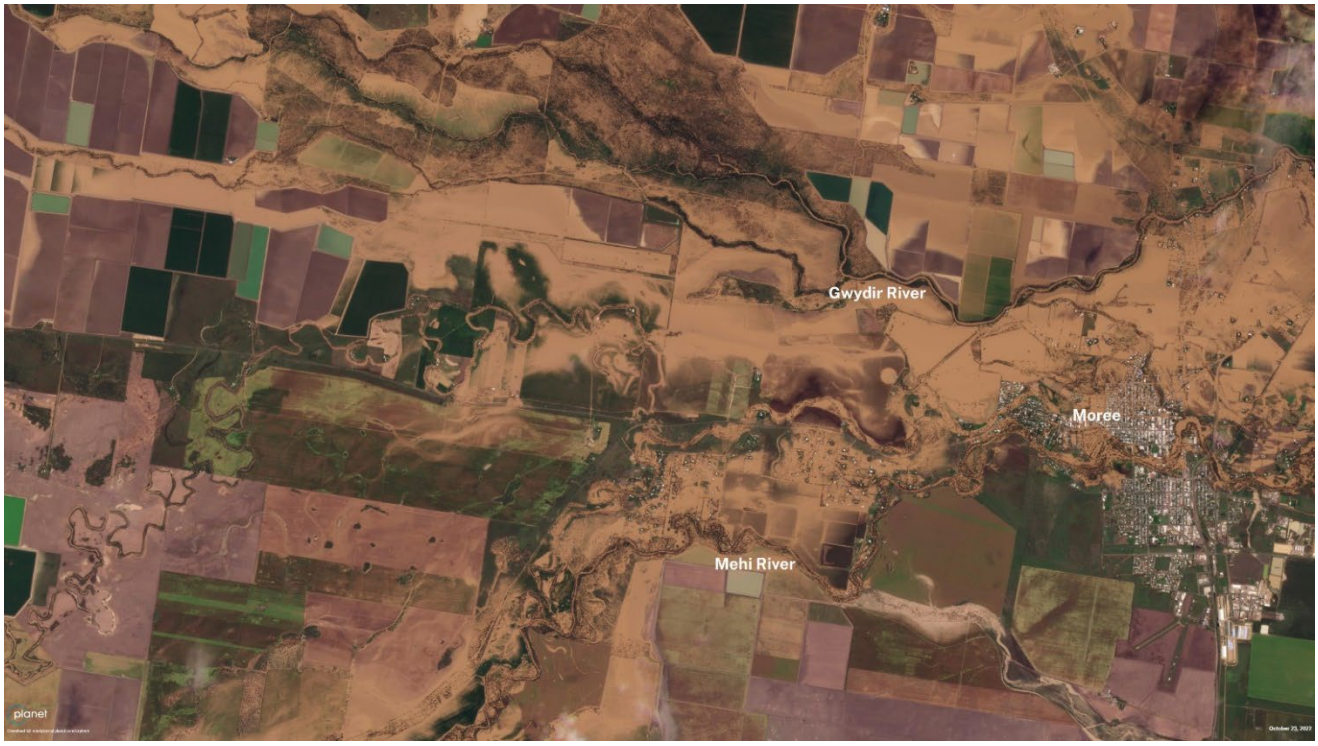

Figure 7: Floodwaters in and around Moree on 23 October 2022. (Source: Planet Explorer)

Widespread flooding in the Gwydir River catchment washed organic material into creeks and waterways, resulting in lower oxygen levels in the lower catchment.

NSW Fisheries investigated one fish death report in the lower Gwydir River, near Moree in December 2022. Thousands of dead fish were reported. Species affected included Bony Herring, Golden Perch, Spangled Perch and Carp. The suspected cause was attributed to critically low dissolved oxygen caused by floodwaters washing organic material into the river. The rapid breakdown of organic material by bacteria in the water causes dissolved oxygen levels to drop below the critical thresholds for fish health. This combined with warm air temperatures and a significant reduction in flow as floodwaters receded also resulted in stranding of some fish in isolated pools. Fish kills in NSW are listed on Department of Primary Industries website.

Summary

The water quality 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 2022 to 2023, major flooding across the catchment was the key driver of water quality. Increased runoff carried high volumes of sediment and attached nutrients into waterways resulting in 9 of 10 water quality monitoring sites being rated as moderate or poor. The high flows in 2022 maintained electrical conductivity below irrigation targets. There is a large salt store in the geology and soils of the Horton River and Myall Creek catchments. Following the heavy rainfall and recharge of shallow groundwater during 2022–2023, these salts could be mobilised over the coming years leading to higher electrical conductivity in the Gwydir and Mehi Rivers downstream.

The widespread flooding in the Gwydir catchment resulted in thousands of fish deaths from hypoxic blackwater, as was experienced in some other catchments across NSW. Hypoxic blackwater is a feature of Australian lowland river systems and 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.

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 from the catchment area into Copeton Dam by floodwaters may have contributed to the high potentially harmful blue-green algal numbers from November 2022 through to April 2023.

For more detailed information about water quality issues in the Gwydir catchment see the Gwydir surface water quality technical report (https://www.industry.nsw.gov.au/__data/assets/pdf_file/0003/305751/Water-quality-technical-report-for-the-Gwydir-surface-water-resource-plan-area-SW15.pdf).

Long-term water quality trends

Analysis of WaQI scores from 2012–2023 to 2022–2023 shows very consistent WaQI ratings at all sites on the Gwydir River (Figure 8). All sites have a long-term median WaQI rating of good or moderate with Gwydir at Bronte, Iffley and Gravesend having the highest long-term scores. The Mehi River at Moree and Laura Creek had the lowest median WaQI scores for the 10-year period. The range of WaQI scores was small across all sites suggesting ratings were consistent throughout the 10-year period despite significant droughts and floods.

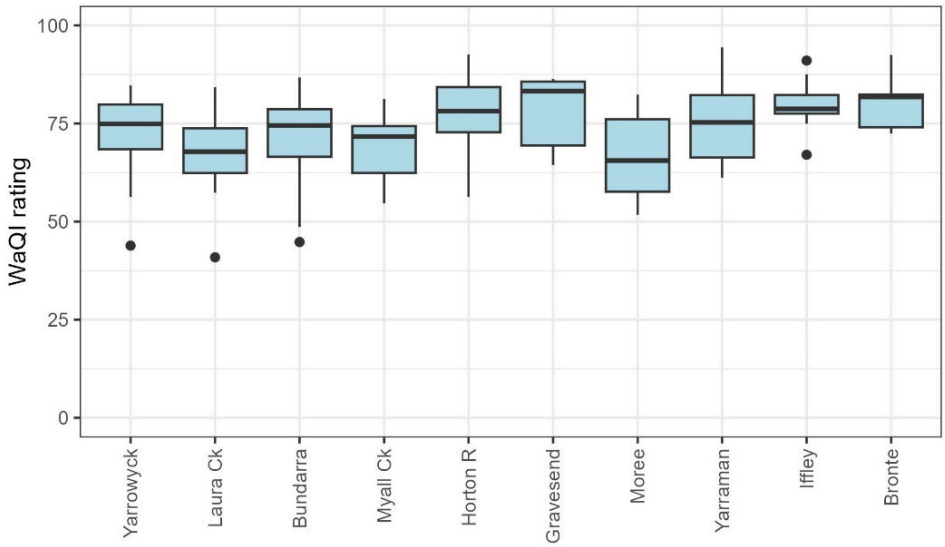

Figure 8: Boxplots showing long-term (2012–2013 to 2022–2023) WaQI ratings for every site in the Gwydir valley

The number of sites with ratings of good, moderate and poor followed a similar trend over time to other inland rivers (Figure 9). The number of sites with a “good” rating has declined, starting at 8

sites in 2012–2013 and declining to one site by 2022–2023. The number of sites with a "poor" rating followed an opposite trend, staying between zero and one until 2019–2020 when it increased to peak levels of 6 sites, with a high number of sites with a poor rating also occurring in 2021–2022. The number of sites with a moderate rating was highly variable peaking at eight sites in 2015–2016, 2020–2021 and 2022–2023. Decreased occurrence of "good" ratings and increases in "moderate" and "poor" ratings coincided with a severe drought then several years of flood.

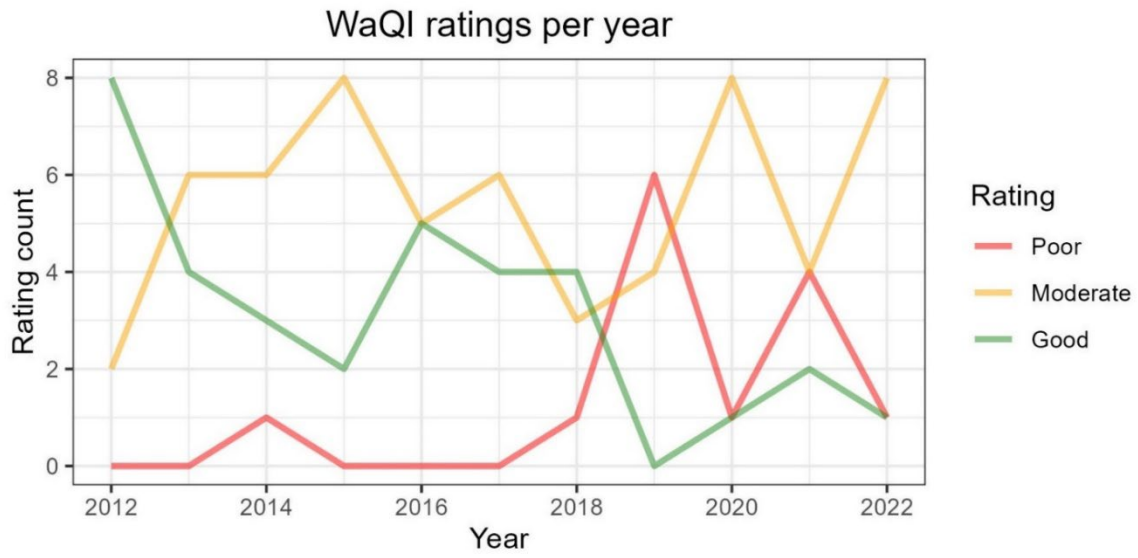

Figure 9: Graph summarising long-term water quality index ratings (2012–2013 to 2022–2023) for every site in the Gwydir Valley by year

References and further information

Bureau of Meteorology, (BoM). 2023. Financial year Australian climate and water statement 2023. Financial year climate and water report 2023. http://www.bom.gov.au/climate/current/financial-year/aus/summary.shtml#tabs=Water

Bureau of Meteorology, (BoM). Recent and historical rainfall maps: http://www.bom.gov.au/climate/maps/rainfall/?variable=rainfall&map=totals&period=daily&region=nat&year=2023&month=10&day=13

DoIW. 2018. Gwydir water resource plan surface water resource description. Department of Primary Industries Water, Parramatta.

Fish kills in NSW: https://www.dpi.nsw.gov.au/fishing/habitat/threats/fish-kills

Keyte, P.A. 1994. Lower Gwydir Wetland plan of management – 1994 to 1997. Report by the Department of Water Resources for the Lower Gwydir Wetland Steering Committee. Sydney, NSW.

NSW DPE water for the environment: https://www.environment.nsw.gov.au/topics/water/water-for-the-environment/gwydir