WATERWATCH
Upper Murrumbidgee

Catchment Health Indicator Program

2020

Supported by:

ACT Government

icon WATER

In Partnership with:

Molonglo Catchment Group

Southern ACT Catchment Group

Ginninderra Catchment Group

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For more information on the Upper Murrumbidgee Waterwatch program go to:
http://www.act.waterwatch.org.au

The Atlas of Living Australia provides database support to the Waterwatch program. Find all the local Waterwatch data at: https://biocollect.ala.org.au/actwaterwatch

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Upper Murrumbidgee Waterwatch (Waterwatch) works with the community to monitor, raise awareness, educate, restore and protect our local waterways. Waterwatch has been running in the ACT region since 1995 and covers the Murrumbidgee catchment upstream of Burrinjuck Dam (with the exception of the Goodradigbee catchment). The total area monitored by Waterwatch is more than 11,400km^2.

Two primary functions of the Waterwatch program are to facilitate community engagement through the monitoring and care of local waterways, and to use the data (water quality, macroinvertebrate [waterbug] and riparian condition) as an early warning system for aquatic ecosystem health issues. A key output of this program is the annual Catchment Health Indicator Program (CHIP) report, which provides a numerical score of catchment health, displayed in individual reach (sections of waterway) report cards, using data collected by Waterwatch volunteers.

The 2020 CHIP report is based upon 1,872 water quality surveys, 184 waterbug surveys and 219 riparian condition surveys conducted by over 200 volunteers. The total number of sites surveyed was 229 with a total of 98 reach report cards produced. Waterwatch now includes the important addition of the number of 'dry' surveys conducted in the overall survey tally (ie. when a volunteer has visited their site but it is completely dry). While these do not contribute to the CHIP score, they are an important factor in the condition of the catchment and highlight survey effort. A total of 50 water quality surveys were 'dry' in 2020 which is only one quarter of total in 2019.

There were three new reaches created this year, all within the Southern ACT catchment. COT1 includes the upper Cotter River capturing the section above Corin Dam (complementing the two downstream reaches on the Cotter River), ORR1 takes in all of the Orroral River, which has been split away from the Gudgenby River reach, and NAA2 on the Naas River which is now split into two sections; one in the Namadgi National Park (NAA1) and a second downstream in the rural valley. Via a continual process of refinement and the addition of further sites as needed, the Waterwatch CHIP program ensures each year's report best represents the condition of our catchment.

Of the 98 reaches presented in this report (Table 1), four were scored as in *excellent* condition, two reaches in the Molonglo catchment plus two in Southern ACT. This was one more than 2019. A further 36 reaches were scored as being in *good* condition, which is one less than last year, and 55 reaches were in *fair* condition, two more than 2019. Four reaches received a *poor* score, one less than last year, and no reaches received a *degraded* score. While the range of scores did not change markedly from 2019, conditions influencing the scores most certainly did. Extended dry conditions could be attributed to many of the results in 2019, but in 2020, either a lack of rain, too much rain or, of course, bushfires, played a role.

Table 1: CHIP results from 2020.

CHIP Result	Cooma	Ginninderra	Molonglo	Southern ACT	Yass	Total
Excellent (A)	0	0	2	2	0	4
Good (B)	11	3	10	12	0	36
Fair (C)	12	11	15	12	5	55
Poor (D)	0	1	0	1	1	3
Degraded (E)	0	0	0	0	0	0

2019 was the driest year on record. This followed on from a dry year in 2018. The adverse impacts this had on the catchment are well documented in previous CHIP reports. It was when the upper Murrumbidgee catchment was at its driest, however, that it was struck by bushfires in late 2019 and early 2020. Nearly the entire Badja River catchment and the headwaters of the Bredbo and Cowra Creek catchments were burnt due to the Badja Forest and Good Good fires which began in December 2019. Bushfires continued throughout January and February 2020 with 80% of Namadgi National Park and over a third of Kosciuszko National Park burned as well as impacting communities surrounding Tharwa, Bredbo and Numeralla.

Then the rain started. The timing had a devastating impact on our waterways in that much of the damage from the fire was already done and the heavy falls maximised the loss of ash, sand and soil from these fresh fire grounds. The first rains of 100mm+ in January sent the usually clear Badja River into a flow of thick, black mud as well as the lower Numeralla and Bredbo Rivers. Then when 60mm+ fell on southern ACT in mid-February, the Gudgenby, Paddy's and Tidbinbilla rivers did the same. The rain washed ash and debris into the rivers and turbidity and phosphorus levels went beyond what most Waterwatch kits were capable of measuring. Thick layers of ash-laden mud lining the riverbanks and smothering the river substrate was, and still is, a feature of many of our major rivers including 120kms of the Murrumbidgee River from reaches CMM4-CMM13. More details on the impacts of the fires is available in a special fire report written by the University of Canberra using Waterwatch data on pages 120-124 of this report.

The onset of heavy rain after the preceding dry years played out differently in non-fire affected parts of the catchment. Organic matter that had been building up in the landscape for years was suddenly flushed into rivers and wetlands. Urban reaches, such as in Cooma, Yass and Tuggeranong, detected high concentrations of phosphorus and/or nitrate washing out of gross pollutant traps and other unknown sources. Waterways adjacent to development sites experienced high turbidity. Waterways with simplified riparian corridors and poor in-stream vegetation are less able to process these influxes of material. This can result in supersaturated dissolved oxygen events when there is too much algae, or very low dissolved oxygen levels when the bacterial degradation of excess organic matter consumes available oxygen. Many waterways improved in condition as the high flows continued throughout the year, but it is the higher-scoring, more intact reaches that responded more positively and more quickly to the favourable conditions.

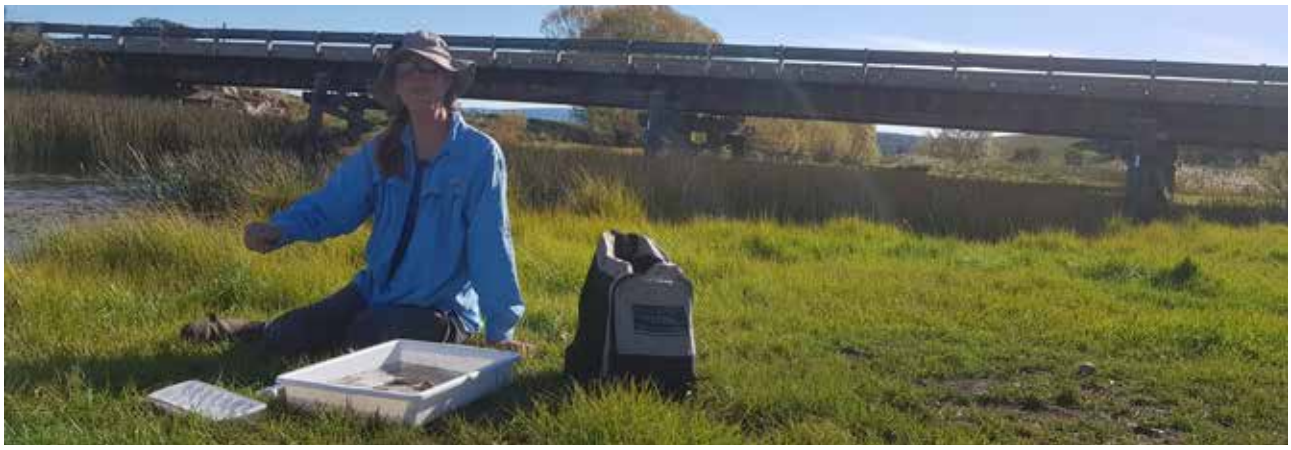
While many in the upper Murrumbidgee catchment would associate 2020 as being a wet year, parts of the Cooma region such as Cooma creeks and Rock Flat Creek received below average rainfall and many these waterways ceased to flow on a number of occasions in 2020.

Over 300 volunteers participated in the Platypus Month surveys in 2020 and noted **31 individual Platypus** over eight 'river reach' sites across the ACT region. The big increase (up from eleven individuals in 2019) was in part due to the additional three sites monitored due to the heightened interest in Platypus Month from the community in 2019. Results appear to suggest that the increased flows through the system due to the wet weather in 2020 positively outweighed any negative effects that the fires may have had on Platypus at the sites surveyed.

And if all this was not enough in 2020, volunteers were then banned from monitoring during COVID-19 lockdown over March and April. Then volunteers who monitor in Namadgi National Park and the Naas areas were unable to access their sites until July due to fire access issues. This might have been enough for any resepectful volunteer to want to hang up their water quality kit and call it a day, but Waterwatch did not lose a single volunteer as a result.

Thank you, as always, to the volunteers. This report would not be possible without their continued efforts to collect this important data on the health of our waterways. 2020 demonstrated that Waterwatch volunteers are a resilient bunch and wont let pandemics and fire-access issues stand in the way of monitoring their part of the upper Murrumbidgee catchment. The continued collection of large amounts of high quality data is a real credit to the dedication of the volunteers who have demonstrated that, with support, they can make a significant contribution to the improvement of our waterways.

The 2020 CHIP report would not have been possible without the generous financial support from ACT Government and from Icon Water. The ACT Government announced in early 2020 that Waterwatch will now receive ongoing funding, meaning the program can continue its important work for many years to come.



Introduction

Upper Murrumbidgee Waterwatch

Upper Murrumbidgee Waterwatch (Waterwatch) engages with the community to monitor, raise awareness, educate, restore and protect our local waterways. Waterwatch has been running in the ACT region since 1995 and covers the Murrumbidgee catchment upstream of Burrinjuck Dam, with the exception of the Goodradigbee catchment. The total area monitored by Waterwatch is more than 11,400km^2.

Four Waterwatch coordinators support volunteers in the major sub-catchments of Cooma, Molonglo, Southern ACT, Ginninderra and Yass (see Figure 1). Each of these sub-catchments make up sections I – V of this report.

As at 31 December 2020, Waterwatch had 229 active sites being monitored by over 200 volunteers. Waterwatch thanks the generous funding from the ACT Government as well as funding for the Cooma Region through Icon Water. Local Land Services also supports the program in the Cooma region. The Atlas of Living Australia also provides support through the maintenance of the database used by the Waterwatch program. At the time of writing this report, the database houses over 25,600 Waterwatch records.

The purpose of the CHIP

The Waterwatch annual report card is called the Catchment Health Indicator Program (CHIP), based upon the data collected by volunteers throughout the preceding year. The purpose of the report is to give the community a better understanding of water quality and riparian health issues in the catchment as well as providing an ongoing baseline assessment of catchment health, to assist natural resource managers and policy-makers in addressing some of these issues. The CHIP is recognised in the ACT Water Strategy 2014-44 as a way to *'enhance knowledge and spatial planning for water and catchment management'* and contributes to multiple monitoring programs and reports within the ACT Government and Icon Water.

How does the CHIP work?

Waterwatch volunteers and coordinators collect data relating to water quality, waterbugs (macroinvertebrates), and riverbank (riparian) vegetation. The frequency of this data collection is outlined in Table 2. These data sources provide the basis for a composite CHIP score that encompasses physico-chemical properties of water, in-stream waterbug diversity and abundance, and riparian vegetation condition. When combined for an individual stretch of waterway (a reach), the data gives us a score that indicates the overall health of that reach. This CHIP score is linked with a colour to produce maps of reaches at both an individual and sub-catchment scale. Importantly, each individual reach map is accompanied by a report card written by the local coordinator. This provides further insight into the state of that reach and possible issues influencing the score. Data from other Waterwatch initiatives such as Platypus Month and Carp Love 20°C, as well as from our colleagues at Frogwatch, are also used in these report cards to provide greater context.

Technical details regarding the computation of CHIP scores is provided in Appendix II.

Table 2. Summary of data collected to produce the CHIP.

	Parameter	Frequency	Number of sites
Water Quality	pH	Monthly	All sites
	Electrical Conductivity	Monthly	All sites
	Turbidity	Monthly	All sites
	Phosphorus	Monthly	All sites
	Nitrate	Monthly	All sites
	Dissolved Oxygen	Monthly	All sites
	Temperature	Monthly	All sites
Macro-invertebrates	SIGNAL 2.0	Biannual (Spring & autumn)	Key sites (min 1/reach)
Riparian Condition	RARC	Biennial	All sites

Figure 1. Overview of the upper Murrumbidgee River catchment, outlining the five major sub-catchment areas represented in this report as well as the border of the ACT. The Goodradigbee catchment is not included in this report.

2020 CHIP

The 2020 CHIP report is based upon 1,872 water quality surveys, 184 waterbug surveys and 219 riparian condition surveys conducted by over 200 volunteers. The total number of sites surveyed was 229 with a total of 98 reach report cards produced. Waterwatch now includes the important addition of the number of 'dry' surveys conducted in the overall survey tally (ie. when a volunteer has visited their site but it is completely dry). While these do not contribute to the CHIP score, they are an important factor in the condition of the catchment and highlight survey effort. A total of 50 water quality surveys were 'dry' in 2020 which is only one quarter of total in 2019.

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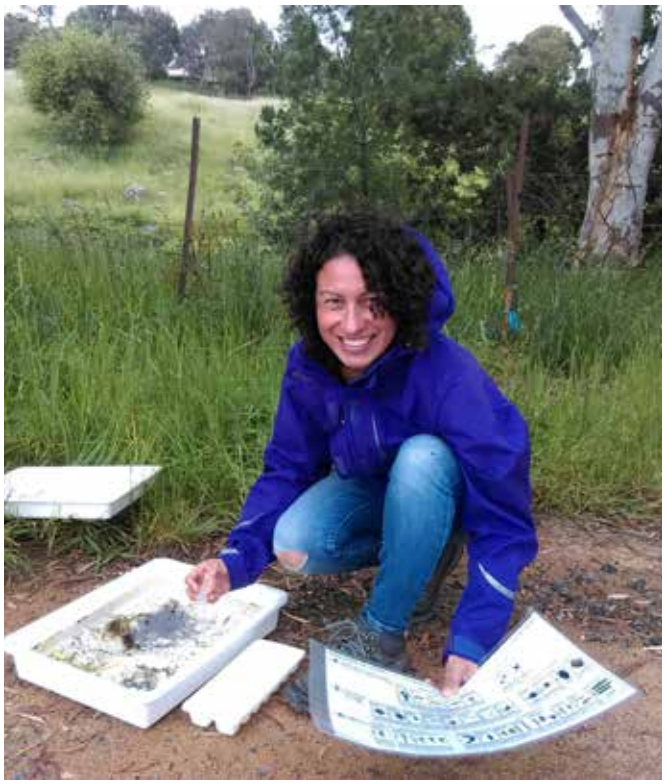
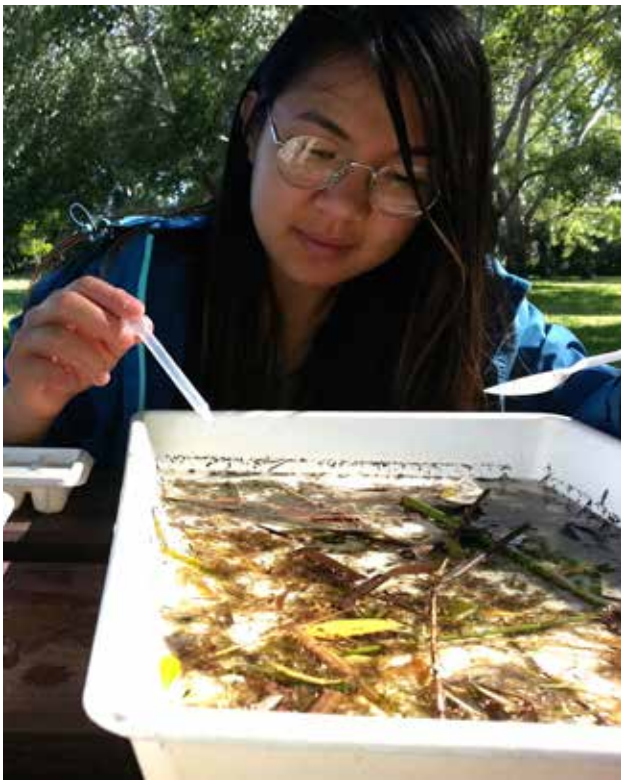




Cooma Region Catchment Facts

The Cooma Region catchment includes the upper Murrumbidgee River south of the ACT, plus the Bredbo, Numeralla, Kybeyan and Badja River sub-catchments. These sub-catchments provide the majority of inflows for the upper Murrumbidgee River upstream of the ACT as 95% of its headwaters are diverted at Tantangara Dam as part of the Snowy Hydro Scheme.

Landuse in the Cooma Region includes urban, rural residential, rural (grazing and cropping) and conservation. The lower lying, more fertile areas of the catchment are generally cleared and modified with more intensive landuse and limited native riparian vegetation. The headwaters of catchments are generally less modified and are in better condition. Protection of in-stream and riparian (riverbank) habitat needs to be prioritised in these areas.

The Actions for Clean Water (ACWA) Plan sets out a strategy for improving water quality (targeting turbidity) in the upper Murrumbidgee catchment. It identifies the Numeralla and Bredbo River catchments as areas where erosion risk is very high. Addressing erosion goes hand in hand with maintaining native vegetation and groundcover while reducing the impact of invasive weeds. These issues are the focus of Landcare groups and regional catchment organisations in the Cooma region.

The upper Murrumbidgee has areas of high-quality aquatic habitat where species such as Murray cod, Trout cod, Macquarie perch, Murray River crayfish, Platypus, Rakali (Water rats) and Eastern long-necked turtles are found. Protecting and improving these habitats and species is the focus of the Upper Murrumbidgee Demonstration Reach (UMDR) initiative. The UMDR works with many partners, including Waterwatch, and focusses on the upper Murrumbidgee River between Tantangara and Burrinjuck Dams.

Waterwatch volunteers have been monitoring river health in the Cooma Region since 2010.

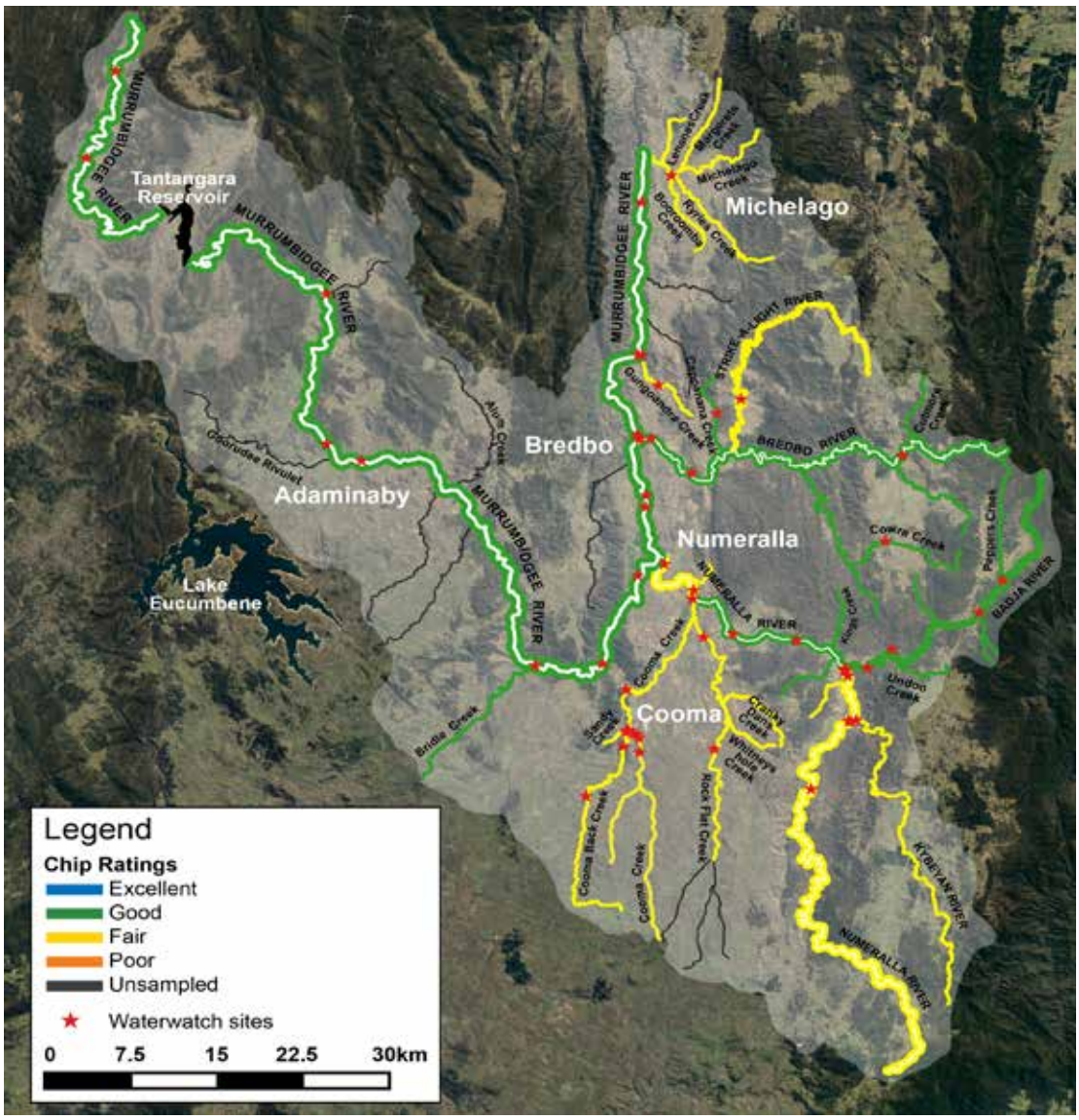
Cooma Catchment Health Summary

2020 saw catchment health in the Cooma Region hold steady or decline slightly from 2019, a year where rivers were stressed due to extremely dry conditions. This seems surprising given the higher rainfall recorded over the wider region, however flows in the Cooma creeks, Rock Flat Creek, Gungoandra Creek, Numeralla River and Bredbo River have been very low for most of the year, and this has affected their health. An exception is the upper Badja catchment which received three times its monthly average rainfall in February, recharging groundwater sources and resulting in sustained high quality flows throughout the year. This benefitted downstream reaches including the lower half of the Numeralla River.

Waterway health in the Cooma Region was heavily impacted by the summer bushfires which affected 10 out of 23 reaches, either directly or as a result of flood waters carrying ash and sediment downstream. Most reaches directly impacted by fires declined in health. When the rains did come, creeks and rivers ran black for many kilometres downstream. Some fish kills were initially seen in the Badja River catchment during January. Waterwatch testing during the main flood event in February, however, showed dissolved oxygen levels were not entirely depleted due to the high rate of flow.

One year after the fires, heavy deposits of ash still remain in rivers and on their banks. This continues to be remobilised after rain, increasing phosphorous levels which in turn leaves our waterways vulnerable to algal blooms should conditions be favourable. Erosion from the firegrounds has also seen thousands of cubic meters of sediment washed in to affected waterways with the Murrumbidgee River downstream of Bredbo especially affected. Much more sediment remains in the tributary gullies, at risk of further erosion. Catchment organisations including Local Land Services and the UMDR are working with funding bodies and landholders to address erosion impacts.

More details on the impacts of the fires is available in a special fire report written by the University of Canberra using Waterwatch data on pages 120-124 of this report.



Badja River BAD1
Headwaters to Undoo Creek

2020 CHIP Result B+ (Good)		
2019 CHIP Result A- (Excellent)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**21**
pH	Fair	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Degraded	
Waterbug	**Good**	**2**
Riparian condition	**Good**	**2**

Reach Facts

Reach network length: approx. 51km
Dominant land uses: Rural and conservation

The Badja River rises in the Badja Swamps Nature Reserve which includes the nationally-listed Big Badja Swamp. From there the reach flows through open, historically cleared country and then on through steeper, uncleared country with good native vegetation cover. Up until December 2019, this reach was one of the healthiest streams in the Cooma Region, with consistently *excellent* water quality, abundant and diverse waterbugs and *good* riparian condition.

The 2019-2020 bushfires, however, greatly impacted this reach with fire burning out most of the catchment. After the fire, the Waterwatch volunteer noted that the banks and "*most of (the) surrounding catchment has been predominately burnt at all levels...canopy/shrub/ground*". It took many months for groundcover to re-establish and the November waterbug survey found that most riparian vegetation had not yet recovered. The riparian condition score noted in this report, however, is pre-fire as sites are surveyed every two years.

Once the rains did come the river turned into a flow of thick black mud and isolated fish kills (trout) were seen as dissolved oxygen levels plummeted. Luckily, during February the reach received three times its average monthly rainfall, restoring flows and water quality as the ash was flushed downstream. Good follow up rains in winter positively influenced waterbug scores but our surveys did show a decline in diversity and abundance compared to previous years.

A year has past since the fires at BAD600 and recovery remains slow.

Badja River BAD2

Undoo Creek to Numeralla River

2020 CHIP Result B (Good)		
2019 CHIP Result B+ (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**31**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Degraded	
Waterbug	**Good**	**2**
Riparian condition	**Fair**	**3**

Reach Facts

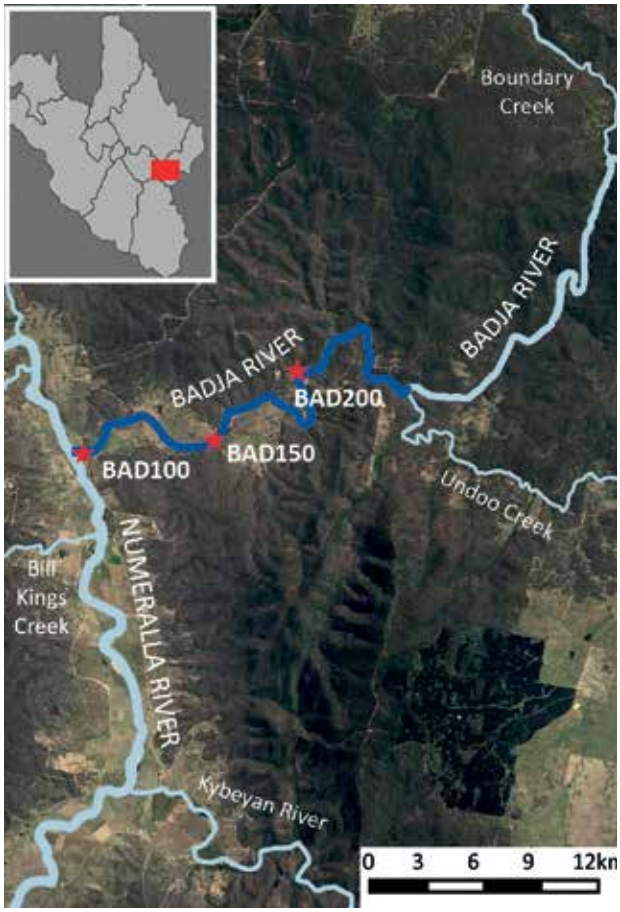
Reach network length: approx. 8.6km
Dominant land uses: Rural and rural residential

The lower section of the Badja River runs through open, cleared country used predominantly for grazing and some dryland cropping. In contrast to the upstream section (BAD1), the cumulative impact of increased rural residential activities and historic landuse change are evident in this reach. This section of the Badja is known to become very turbid during high run-off events and there is an increase in Carp and woody weeds such as willows and blackberries. Recreational gold fossicking activities are also having an increasing impact on the riparian zone near BAD200.

Numeralla Landcare Group and local landholders have worked for many years to fence the river off from stock, control blackberries and willows, increase native plantings and control erosion on tributary gullies.

The 2019-2020 summer bushfires heavily impacted the catchment in the upper section of this reach. Heavy rains directly following the fires turned the river into a flowing stream of thick, black ash with large dead Carp seen floating in the backwaters. High phosphorous readings resulted with readings of 0.15mg/L recorded in the months directly following the fires. Our volunteer noted "*river banks [were] covered in deposited black sediment from fires and floods*". This ash will continue to compromise in-stream habitat and adversely affect water quality for the foreseeable future.

Interestingly BAD2 received only half the rainfall received in BAD1 in 2020, highlighting the variability of rainfall across the region.

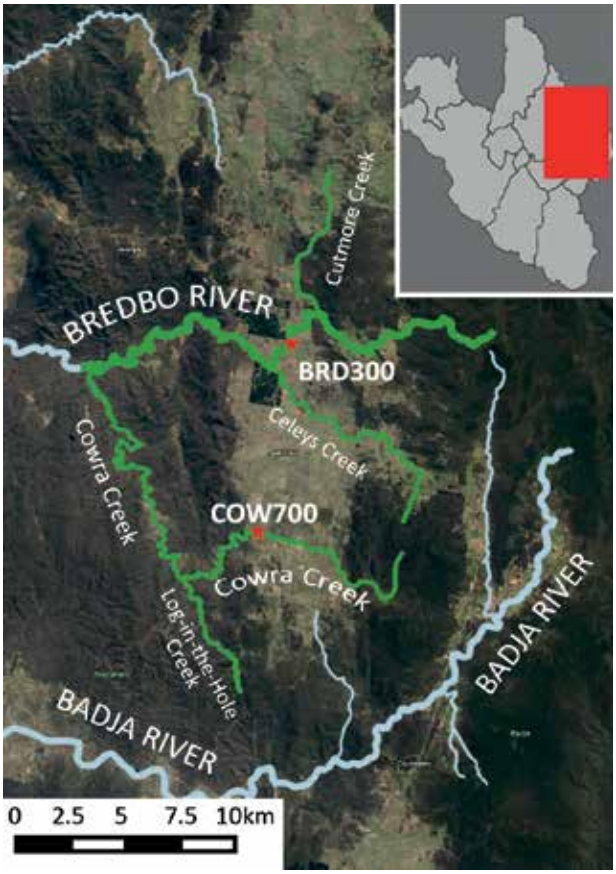


Heavy ash deposited in February 2020 in the lower Badja River after the fires in the catchment upstream.

Bredbo River BRD1

Headwaters to Cowra Creek confluence

2020 CHIP Result B (Good)		
2019 CHIP Result B (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**18**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Poor	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Degraded	
Waterbug	**Good**	**2**
Riparian condition	**Fair**	**2**



Reach Facts

Reach network length: approx. 33km
Dominant land uses: Rural

This reach runs through a mix of unmodified and cleared grazing country. Generally good groundcover levels are retained throughout the catchment which in turn protects water quality, however some gully erosion is found in the middle of the Cowra Creek catchment. This is related to historical gold mining and landuse activities such as clearing and grazing. Our Waterwatch sites are upstream of this area.

In past years sampling has shown consistently *excellent* water quality and waterbug surveys in the Bredbo River which has always included high numbers of stoneflies nymphs - one of the most pollution-sensitive waterbug types. This demonstrated the positive effects of a well vegetated catchment and the presence of good instream habitat.

The extremely dry conditions saw much of this reach reduced to isolated pools towards the end of 2019, followed by bushfire impacting a large part of the upper Bredbo and part of the Cowra Creek catchments in early 2020. When rains came after the fire, a thick layer of ash was deposited on banks and this can still be seen a year later. Water quality also declined with high turbidity seen during run-off events and high phosphorous levels persisting throughout the year. Despite some rain in the catchment, water levels at both sites have remained low for the majority of the year. This suggests this catchment has received less rain than others in the region.

Thick deposits of ash formed on the banks of the Bredbo River (BRD300) following the fires.

Bredbo River BRD2

Cowra Creek to Murrumbidgee River

2020 CHIP Result B- (Good)		
2019 CHIP Result B- (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**21**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	**Good**	**1**
Riparian condition	**Poor**	**3**

Reach Facts

Reach network length: approx. 25km
Dominant land uses: Rural including dryland cropping and grazing

The lower end of this reach has wide alluvial floodplains which are used for dryland cropping and grazing. In some areas, stock are allowed to graze the river corridor.

This reach is in a high priority ACWA catchment with five key erosion sites identified. Historic and current landuse activities have resulted in large amounts of sand and sediment washing down from upstream catchments and is now smothering available aquatic habitat. During high flow events, turbidity can become very high. Electrical conductivity (salt and mineral levels) is also often elevated but this is more attributed to natural groundwater sources.

Exotic species including African lovegrass, blackberry, willow and poplars dominate the riparian (riverside) vegetation. In the downstream section of this reach however, native reed beds are stabilising sand bars. This is allowing the re-establishment of a defined river channel, increasing the diversity of in-stream habitat and in turn improving the diversity and abundance of waterbugs. The Bredbo Landcare Group is working in this area to control riparian weeds and improve native vegetation.

Although the area surrounding this reach was not burnt in the 2019-2020 bushfires, thick deposits of ash were washed down from the fireground upstream and these remain on the riverbanks and at the bottom of pools. This ash is a source of phosphorous which resulted in this reach being affected by algal growth when water levels were low and warm conditions experienced.

Algal growth was evident on the lower Bredbo River after the fires due to increased nutrient loads.

Cooma Creek COO1

Headwaters to Banksia Lane

2020 CHIP Result C (Fair)		
2019 CHIP Result C (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Fair**	**17 (3 dry)**
pH	Good	
Turbidity	Good	
Phosphorus	Degraded	
Nitrate	Good	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**2 (1 dry)**
Riparian condition	**Poor**	**2**

Reach Facts

Reach network length: approx. 22km
Dominant land uses: Rural and urban

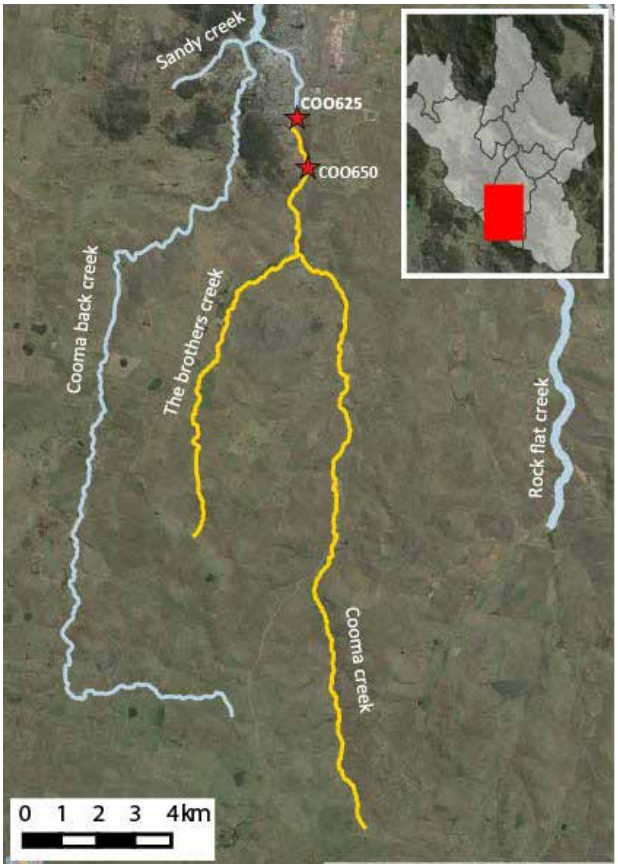
The headwaters of Cooma Creek rise south of Cooma and flow through open, basalt country. The fertile floodplains in this reach are used for dryland cropping and grazing agriculture. Native vegetation has been historically modified and in-stream vegetation such as reeds/sedges which are beneficial for stability and nutrient retention, are largely absent in the creek.

Much of the upper section of Cooma Creek is unfenced and stock access can reduce ground cover and increase erosion. Cropping activities can also mean that floodplain groundcover is laid bare and vulnerable to wash off during high intensity storm events. The geology of the catchment also influences electrical conductivity, nutrient and pH levels.

Despite good rainfall in other parts of the upper Murrumbidgee catchment, below average rainfall was experienced in this reach and flows were low for the first half of the year. This contributed to the elevated phosphorous, electrical conductivity (as high as 1230µS/cm in June), pH and turbidity, and low dissolved oxygen levels seen in 2020. Azolla, a red or green native floating water fern that favours low flow, also increased at the downstream site (COO625).

Water quality, lack of in-stream habitat and flows at our waterbug site contributed to the *fair* waterbug score for this reach. The site was dry in autumn and no survey could be conducted.

Improving the habitat and health of Cooma's creeks is a focus of the Cooma Landcare Group in partnership with Snowy Monaro Regional Council and Cooma Waterwatch. This work has been assisted by a NSW Environmental Trust grant in the last few years.



Cooma Creek downstream of Titree Lane (COO625) was reduced to pools for much of 2020.

Cooma Creek COO2

Banksia Lane to Cooma Back Creek confluence

2020 CHIP Result C (Fair)		
2019 CHIP Result C (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Fair**	**18 (1 dry)**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Degraded	
Nitrate	Good	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**2**

Reach Facts

Reach network length: approx. 3km
Dominant land uses: Urban

This section of Cooma Creek flows through the township of Cooma. Flood mitigation levees have been constructed and there is a popular walking path along the length of this reach. Stormwater from the town is discharged into the creek untreated and litter from stormwater drains is an ongoing problem.

The Cooma Creek environment is greatly modified and little native vegetation remains along its corridor. This means the small amount of in-stream habitat which remains such as reeds and long grass, is highly important to support biodiversity inhabiting the creek including ducks, swamp hens, frogs, Galaxias, Rakali (native Water rat) and Platypus.

There was below average rainfall in the catchment during 2020 and low/no flows were recorded at our sites for two-thirds of the year. The lack of flows from the upstream catchment has meant water flows and quality in the creek has been largely influenced by stormwater inputs for much of the year. This included *degraded* concentrations of phosphorus being regularly detected at 0.25mg/L which is the upper limit of measurement for the phosphorus kits.

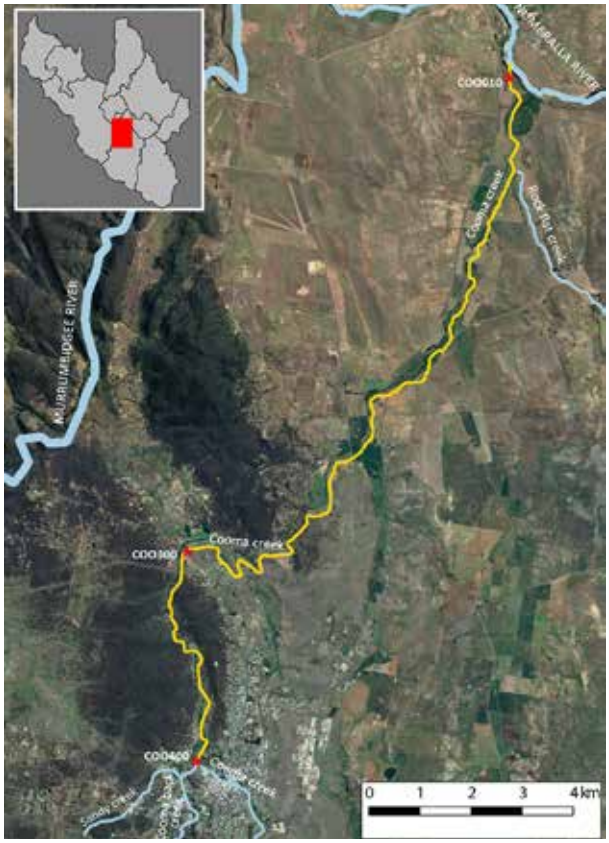
Improving the habitat and health of Cooma's creeks is a focus of the Cooma Landcare Group in partnership with Snowy Monaro Regional Council and Cooma Waterwatch. This includes regular litter clean-ups along this reach. It's pleasing to report that the number of plastic bags, bottles and drink cans found are much reduced now that the single use plastic bag ban and the NSW container deposit scheme have been put in place.

Urban stormwater in this section of Cooma Creek has had a significant impact on the water quality in 2020.

Cooma Creek COO3

Cooma Back Creek confluence to Numeralla River

2020 CHIP Result C (Fair)		
2019 CHIP Result C- (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Fair**	**24 (7 dry)**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Degraded	
Nitrate	Degraded	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**2 (1 dry)**
Riparian condition	**Poor**	**3**



Reach Facts

Reach network length: approx. 18km
Dominant land uses: Conservation, rural residential and rural

This reach includes the Cooma Creek downstream of Cooma to its confluence with the Numeralla River. This reach is flanked by the North Ridge Nature Reserve at its upper end, then flows through more open, rural residential holdings in the Mittagang Road area and finally through Bunyan/Chakola where river flats are used for irrigated cropping. The lower part of this reach flows through highly modified farming country and riparian vegetation is very reduced.

Flows have been very low in 2020 and so Cooma's sewage treatment plant (located near the top of this reach) and urban inflows from upstream have provided the main flows throughout the year. This has influenced water quality in the reach including high nitrate levels, which have been recorded as high as 20mg/L at COO300. The bottom end of the reach was dry for more than half of the year and could not be surveyed for waterbugs in autumn and spring. Hence, waterbug surveys were carried out COO300 (the next site upstream) in spring and this likely resulted in the improvement in the overall reach score.

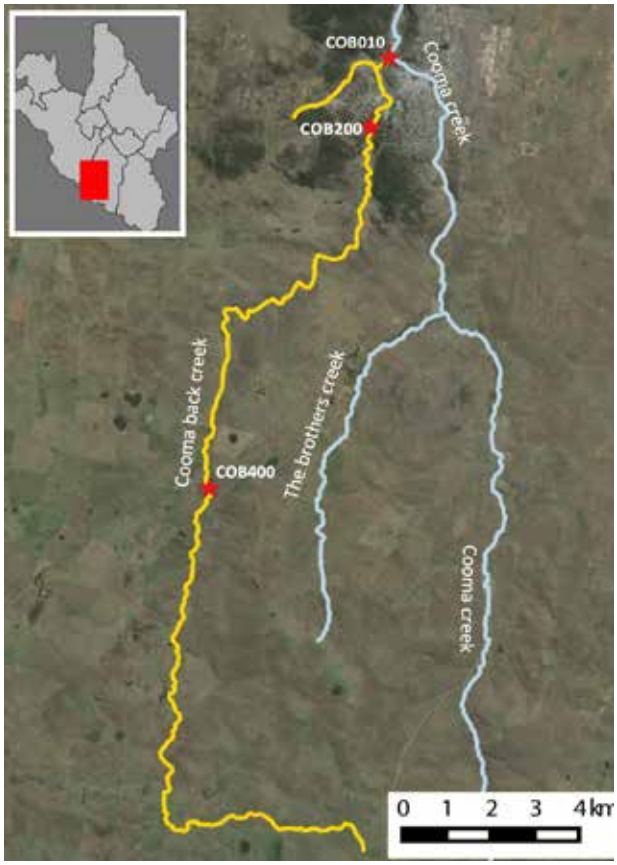
Riparian vegetation is being improved along the creek to help protect Platypus habitat as part of the NSW Environmental Trust funded 'Improving Cooma's creeks' project. This project is a partnership between Cooma Landcare, Cooma Waterwatch and the Snowy Monaro Regional Council. Our Platypus surveys on the Cooma Creek downstream of Cooma have recorded at least one Platypus each year, with a juvenile seen in 2019.

This section of Cooma Creek has been dry for most of 2020.

Cooma Back Creek COB1

Headwaters to Cooma Creek

2020 CHIP Result C+ (Fair)		
2019 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Fair**	**28 (2 dry)**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Degraded	
Nitrate	Excellent	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**3**
Riparian condition	**Poor**	**3**



Reach Facts

Reach network length: approx. 30km
Dominant land uses: Conservation, urban, rural residential and rural

This reach includes the entire Cooma Back Creek and tributaries. The upper section of the reach flows through open, cleared country used for grazing and dryland cropping. The lower section of the reach includes Coolamatong (Lambie Gorge), a registered Aboriginal cultural site.

Frogwatch surveys conducted on the creek at the downstream end of Coolamatong show the highest frog diversity in the Cooma township area, with five species being recorded.

Water quality in this reach is mainly influenced by catchment geology and urban in-flows. Our monitoring shows that electrical conductivity goes up in dry periods as salts and minerals become more concentrated. Despite the wetter conditions experienced regionally in 2020, rainfall in the catchment was below average and water levels were low or had no flow for two-thirds of the year. Electrical conductivity got as high as 1790µS/cm at COB200 in January but got down below 1000µS/cm with increased flows post June.

Low flows has seen our waterbug survey site becoming colonised by in-stream vegetation which is beneficial for the creek, providing filtering and stabilising effects as well as improving habitat. Waterbugs found there include mostly tolerant bug types benefitting from the still waters and rich organic matter accumulating as a result.

Riparian plantings are being carried out on the creek below the Coolamatong to help enhance habitat for frogs and bank stability.

Low flows has resulted in filtering beds of reeds establishing at COB010.

Gungoandra Creek GUD1

Headwaters to Murrumbidgee River

2020 CHIP Result C+ (Fair)		
2019 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**23 (2 dry)**
pH	Good	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Fair	
Waterbug	**Fair**	**2 (1 dry)**
Riparian condition	**Poor**	**2**

Reach Facts

Reach network length: approx. 9km
Dominant land uses: Rural and conservation

This reach includes the entire Gungoandra Creek and flows into the Murrumbidgee River downstream of Bredbo Gorge. The upper section of the creek has been cleared and is used for grazing. The lower section, where the two Waterwatch sites are placed, is managed for conservation by Bush Heritage Australia (BHA) as part of their Scottsdale Reserve. This includes work to improve the health of the creek by planting native vegetation in the riparian corridor and throughout the catchment, in-stream erosion works as well as feral animal control targeting pigs which dig up the creek.

Removal of stock grazing has seen stands of native reeds establishing along the length of creek at Scottsdale which provide positive benefits such as filtering the water, settling sediment, in-stream habitat and stabilising the stream channel. Galaxias (a small native fish), Rakali (native Water rats), Platypus and Lathams Snipe have all been sighted along the creek. Recovery works have been supported by funding from Local Land Services and the Rivers of Carbon program as part of the Upper Murrumbidgee Demonstration Reach partnership.

The entire creek catchment was impacted by bushfires in February, 2020 with riparian vegetation and instream reed beds being burnt along the creek. While many old, hollow-bearing trees were lost as a result, signs of recovery throughout the year were promising. Although more rainfall was received in 2020 than in 2019, the creek was mostly low or formed isolated pools and completely dried up twice during the year.

Extensive plantings have occurred on the Gungoandra Creek thanks to BHA volunteers (Photo: G. McDowell).

Kybeyan River KYB1

Headwaters to Numeralla River

2020 CHIP Result C+ (Fair)

2019 CHIP Result C+ (Fair)

Parameter	Rating	No. Survey
Water quality	**Good**	**10**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**1**

Reach Facts

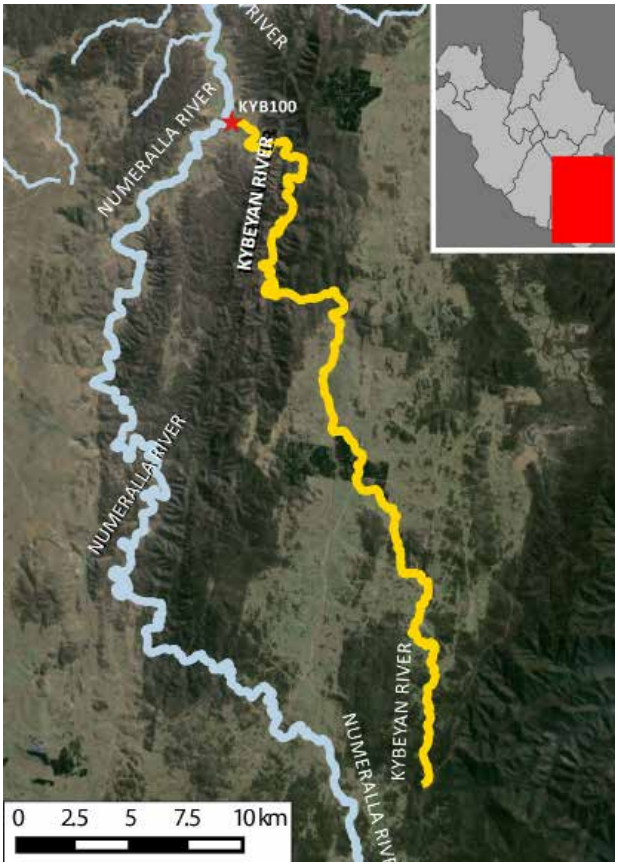
Reach network length: approx. 49km
Dominant land uses: Rural and conservation

This reach includes the entire Kybeyan River catchment. The river has cleared grazing country around its headwaters, from where it flows through steep, unmodified country and then on to join the Numeralla River. There is an ACWA site on a tributary gully at the bottom end of this reach.

After good rains in the river's headwaters early in 2020, the river has had steady flows throughout the year. Nutrient levels are always very low in this reach and the water appears clear most of the time. This is a reflection of the intact habitat and vegetation in the catchment. That said, turbidity can become elevated after high runoff events. Riparian condition at the bottom of the reach is a result of historic clearing and current grazing practices, leaving only a narrow strip of vegetation adjacent to the river.

The adjoining landholder notes that 20 years ago Trout were plentiful and Platypus sightings common. In contrast, Carp are now more often sighted, Eastern gambusia (a small pest fish) are present in large numbers and Platypus are sighted only very occasionally. A highlight was two Rakali (native Water rats) seen swimming around and cavorting at the Waterwatch site in spring, 2020.

This reach has only one site and another volunteer to monitor an additional site further upstream would greatly enhance our knowledge of this catchment.

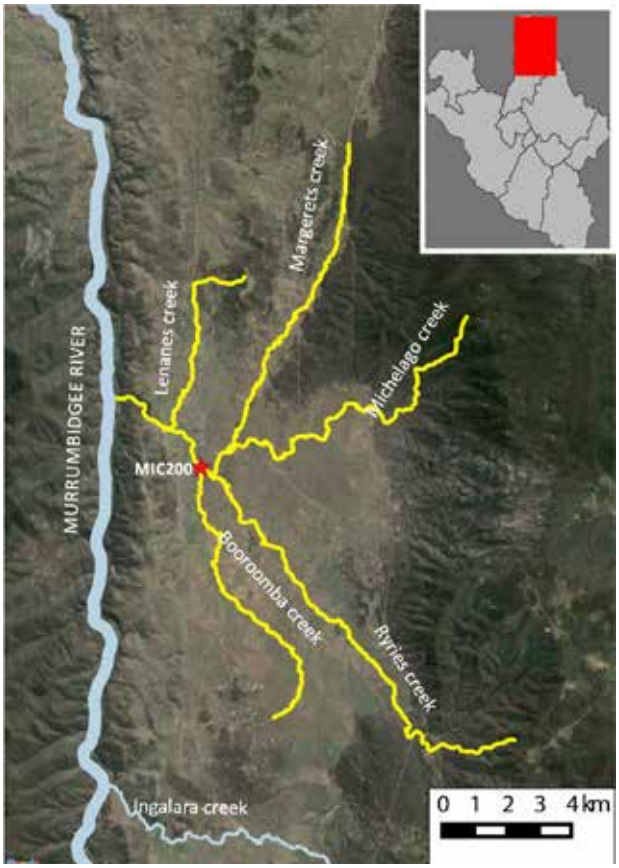


Turbidity can become an issue on the Kybeyan River after high rain events.

Michelago Creek MIC1

Headwaters to Murrumbidgee River

2020 CHIP Result C+ (Fair)		
2019 CHIP Result C+(Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**10**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**1**



Reach Facts

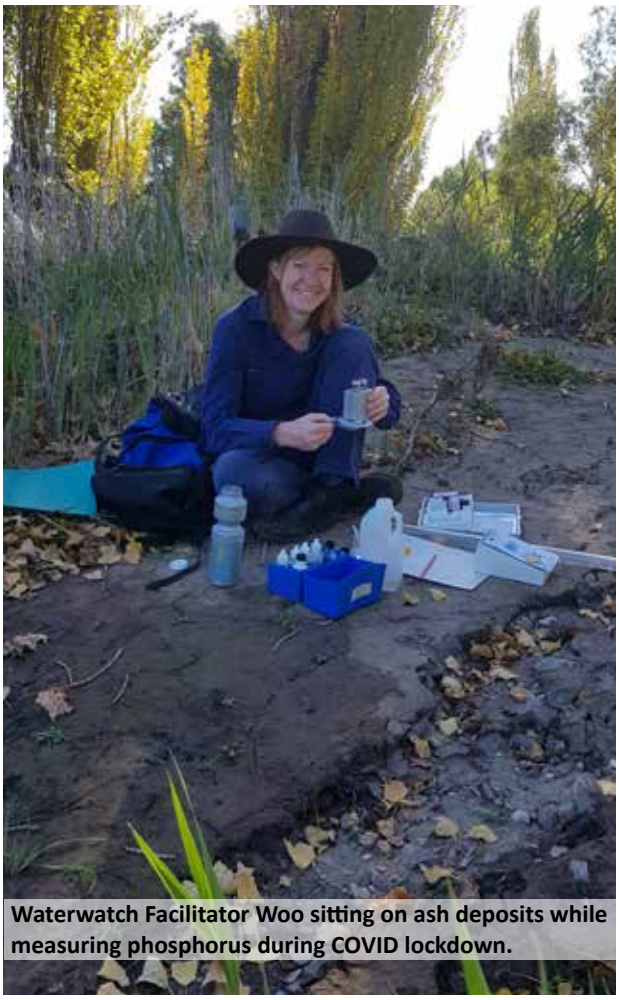
Reach network length: approx. 55km
Dominant land uses: Rural, rural residential and conservation

This reach includes the entire Michelago Creek catchment including the Margerets and Ryries Creeks. The upper sections of these creeks retain native, unmodified vegetation where they rise in the Tinderry Range. The lower sections flow through open, historically cleared country used for grazing and rural residential purposes (in and around the village of Michelago). Current and historical landuse has resulted in *poor* riparian condition with very limited native vegetation remaining, having been replaced by exotic species such as Poplars and Willows.

Thick deposits of ash ten metres up the bank were seen at the Waterwatch site after the summer bushfires burnt out the top of the Ryries Creek catchment. This resulted in elevated phosphorous concentrations which is unusual for this reach. Electrical conductivity is naturally high in this reach due to the geology of the catchment. This year, levels were further elevated because of the fire impact, with condictivity regularly reaching over 700µS/cm in the months following the fires. Despite this, waterbug scores were better than in previous years which may be associated with increased flows in 2020.

Michelago Landcare have been working along the creek replanting native riparian vegetation and installing rock gabions to stabilise streambanks. Large stands of native reeds are establishing in the lower part of the reach which is having a stabilising effect and improves in-stream habitat.

This reach is monitored at only one site and another volunteer to monitor an additional site upstream would greatly enhance our knowledge of this reach.



Waterwatch Facilitator Woo sitting on ash deposits while measuring phosphorus during COVID lockdown.

Murrumbidgee River CMM1

Headwaters to Tantangara Dam

2020 CHIP Result B+ (Good)		
2019 CHIP Result B+ (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**12**
pH	Excelent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Excellent	
Waterbug	**Good**	**2**
Riparian condition	**Fair**	**2**

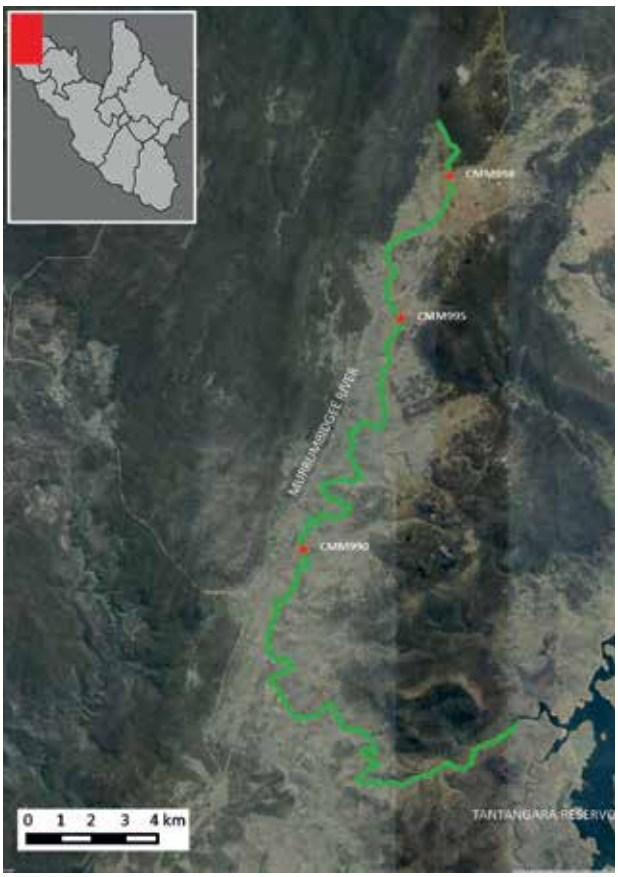
Reach Facts

Reach network length: approx. 53km
Dominant land uses: Conservation

This reach is the Murrumbidgee River from its headwaters to Tantangara Dam and is entirely within Kosciuszko National Park. The vegetation in the catchment includes heaths, grasslands, bogs and subalpine woodlands typical of the Australian Alps bioregion. The area is used for camping, fishing and touring. It is closed between the June and October long weekends and is not monitored during this time.

When monitoring began in this reach, water quality and waterbug surveys showed consistently high scores. The river had crystal clear water, low nutrient concentrations, neutral pH and very low electrical conductivity. Waterbug surveys had very high species diversity including many of the most sensitive bug types. Riparian vegetation however only scores *fair* as the lack of canopy layer in natural tussock grasslands is not accounted for by the riparian survey method used by the CHIP.

Over the last years, however, the banks are increasingly pugged (destabilised by hard hooves of feral horses), the riversides heavily grazed, algal growth is increasing, the water has become regularly turbid and nutrients have increased. There is an increase in fine sediment on the river bed and waterbug surveys show the most sensitive bug types declining and sediment tolerant types increasing. The wetter conditions and higher flows in 2020 improved water quality including turbidity and dissolved oxygen. Despite the better conditions significant grazing impact, pugging and horse dung were still observed in riparian zones. Thankfully, this catchment was not impacted by the summer bushfires which affected other parts of northern Kosciuszko.

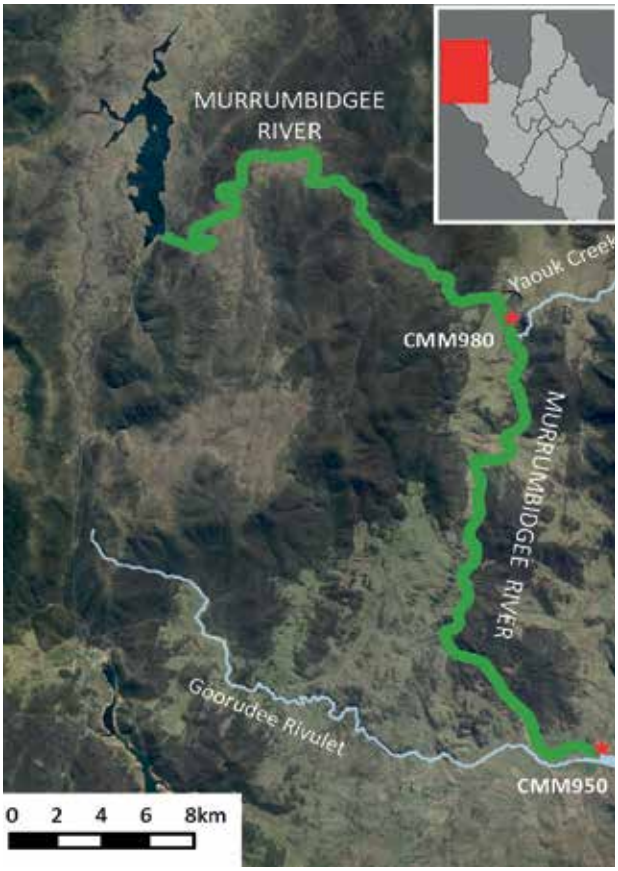


Pugging from feral horses was evident along the banks of the Murrumbidgee River at CMM995.

Murrumbidgee River CMM2

Tantangara Dam to Goorudee Rivulet confluence

2020 CHIP Result B (Good)		
2019 CHIP Result B (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**22**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Excellent	
Waterbug	**Good**	**2**
Riparian condition	**Poor**	**2**



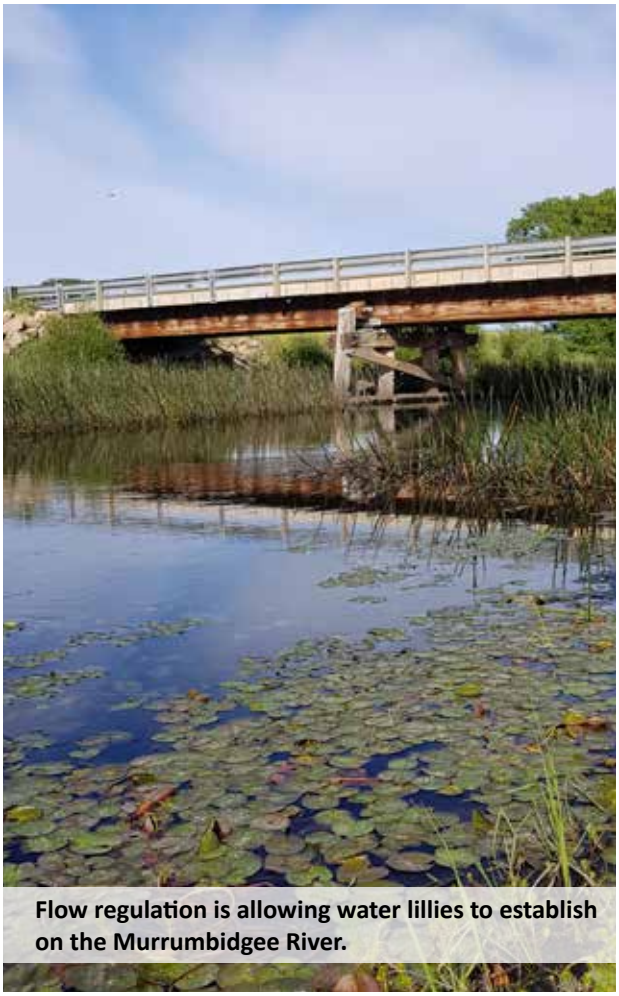
Reach Facts

Reach network length: approx. 55km
Dominant land uses: Rural

This reach includes the Murrumbidgee River and its tributaries immediately downstream of Tantangara Dam. The catchment comprises of open valley floors which once would have contained tracts of swampy meadows/tussock grasslands (now used for grazing) with a backdrop of steep unmodified country. Riparian vegetation only scores as *poor* as the lack of the canopy layer in natural tussock grasslands is not accounted for by the riparian survey method used for the CHIP.

Tantangara Dam diverts 95% of river flows to Eucumbene Dam as part of the Snowy Mountains scheme. The river also receives a small environmental flow allocation each year, dependent on inflows received the year before. The impact of flow regulation is very evident with instream habitat and aquatic species present exhibiting the characteristics of slower flowing ecosystems rather than a fast flowing upland stream. For example, water-lillies are growing at the edges and there is fine sediment build-up in-stream. Waterbug surveys consistently show high numbers of tolerant bug types which thrive in silt/organic matter such as segmented worms and freshwater snails.

Water quality scores reflect the high quality of water released from the dam, which maintains a base flow in the reach throughout the year. Native Macquarie perch occur in this reach and are part of a nationally significant population which occurs in the upper Murrumbidgee River. Carp and Redfin are not recorded in this reach and any sightings should be reported to NSW Fisheries.



Flow regulation is allowing water lillies to establish on the Murrumbidgee River.

Murrumbidgee River CMM3

Goorudee Rivulet to Bridle Creek confluence

2020 CHIP Result B+ (Good)		
2019 CHIP Result B+ (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**18**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Excellent	
Waterbug	**Good**	**2**
Riparian condition	**Fair**	**2**

Reach Facts

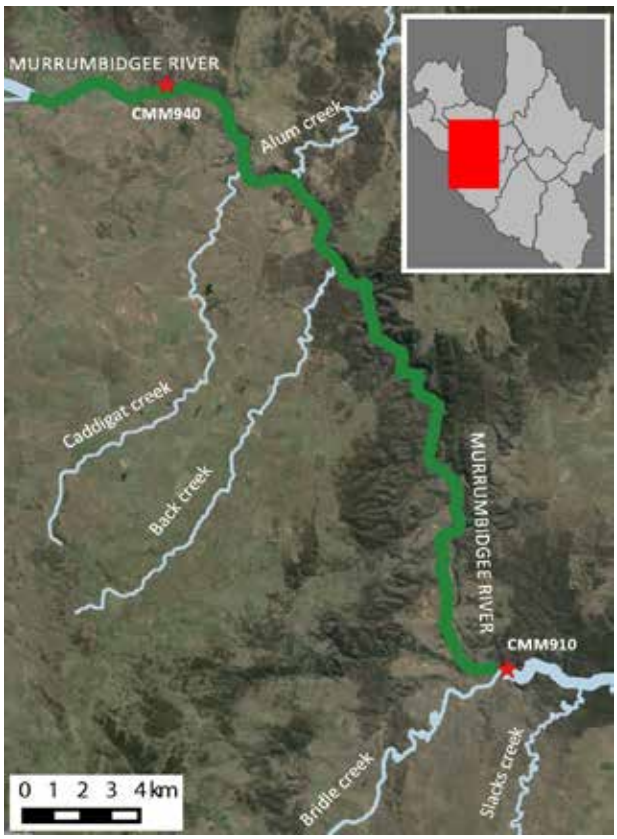
Reach network length: approx. 43km
Dominant land uses: Rural and conservation

This reach includes the Murrumbidgee River from Goorudee Rivulet down to the area known as Dry Plains. The river in this reach firstly flows through more open, undulating country (used predominantly for grazing purposes) and then through steeper gorge country dominated by woodland vegetation cover which remains largely unmodified. These factors contribute to the good scores observed in this reach.

Of concern is the build up of fine and sandy sediments which are progressively accumulating on the bottom of the river, caused by streambank erosion and catchment erosion more broadly. High numbers of feral goats and increasing number of deer in the catchment are contributing to the problem. This sediment has the ability to affect the breeding habitat of the nationally significant Macquarie perch population present in the reach.

The uppermost areas of some of this reach's tributary catchments were impacted by the summer bushfires and there was a flush of ashen silt seen after heavy rains in the catchment during February, 2020. Phosphorous, nitrate, electrical conductivity and turbidity were elevated as a result. Heavy algae growth was seen during bug surveys in autumn, likely resulting from the influx of nutrients from the ash. Numbers of the most sensitive water bugs observed during the autumn bug surveys were also less than usually detected.

The most upstream distribution of Carp in the upper Murrumbidgee River occurs in this reach. Redfin are absent and sightings need to be reported to NSW Fisheries.

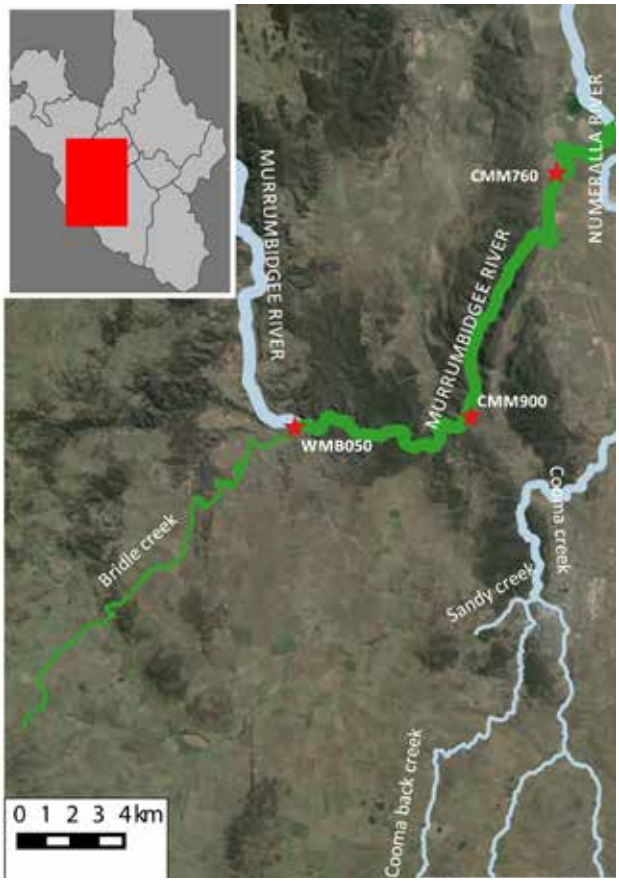


Riffle habitat in this reach is an important spawning area for Macquarie perch.

Murrumbidgee River CMM4

Bridle Creek to Numeralla River confluence

2020 CHIP Result B (Good)		
2019 CHIP Result B- (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**29**
pH	Excellent	
Turbidity	Fair	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Excellent	
Waterbug	**Good**	**2**
Riparian condition	**Poor**	**3**



Reach Facts

Reach network length: approx. 31km
Dominant land uses: Rural and conservation

This reach includes the Murrumbidgee River from Bridle Creek to the Numeralla River confluence. The upper section of this reach adjoins the Binjura Nature Reserve, including the Cooma Gorge which contains high quality riparian and aquatic habitat. This area is the known breeding habitat of a nationally significant Macquarie perch population (a threatened fish species). Downstream of the gorge the river adjoins wide alluvial floodplains which are used for grazing and cropping agriculture.

There is a Platypus Month survey site at the top of this reach, where Platypus and Rakali (Water rats) have both been observed. Carp and Eastern gambusia (both feral fish) are also present. Redfin (a feral fish species which are known to carry a virus deadly to Macquarie perch and trout) are absent and sightings need to be reported to NSW Fisheries.

Water quality in the early part of the year was influenced by high levels of phosphorous and turbidity due to ash and silt washed in from upstream tributary catchments which were fire affected. This shows the downstream effects of bushfires impacting areas many kilometres away. Luckily this impact was short lived and water quality readings returned to usual levels by mid-year.

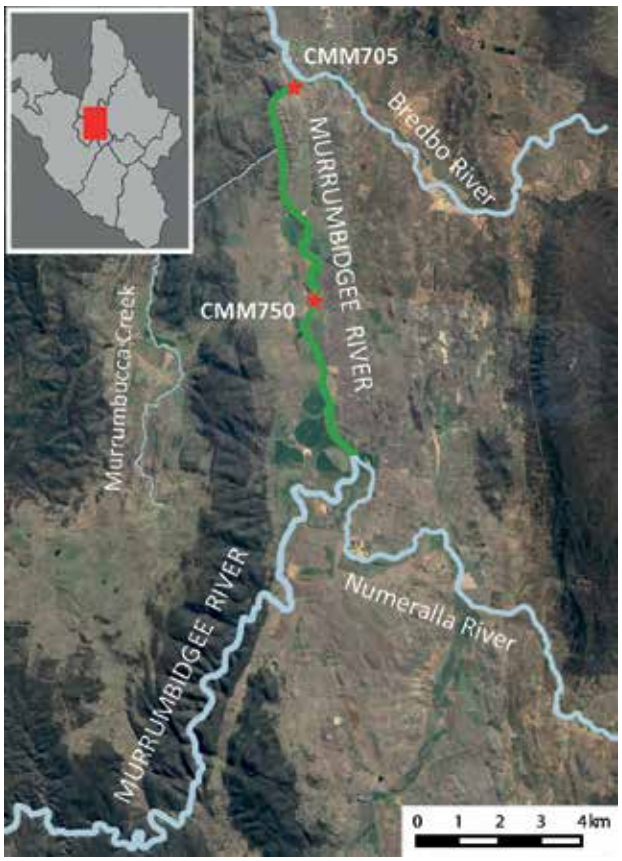
The UMDR and Local Land Services are working with landholders to reduce woody weeds and enhance riparian vegetation in and below the Cooma Gorge to benefit river health, improve aquatic habitat connectivity and protect Macquarie perch habitat.

This section of the Murrumbidgee River was luckily not directly affected by the bushfires in early 2020.

Murrumbidgee River CMM5

Numeralla River to Bredbo River confluence

2020 CHIP Result B- (Good)		
2019 CHIP Result B (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**19**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Excellent	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**2**



Reach Facts

Reach network length: approx. 12km
Dominant land uses: Rural

This reach includes the Murrumbidgee River from the Numeralla River to the Bredbo River confluence. Wide alluvial floodplains flank the river in this reach and are used for dryland and irrigated cropping as well as grazing. Very limited native riparian vegetation remains due to historic clearing and this is reflected in the *poor* riparian condition score.

This reach is in a priority ACWA catchment and there are two ACWA erosion sites present. The Numeralla River is also a source of sand and sediment due to historic erosion which is now moving downstream through this reach. These 'sand slugs' have clogged up the river channel, smothered in-stream habitat and provided an ideal seed bed for willows to take hold and spread.

Water quality in this reach is influenced by inflow from upstream catchments including the Numeralla River. The summer bushfires impacted a significant part of the Numeralla catchment and large amounts of ash and sediment were washed down into this reach in February, 2020. This in turn raised phosphorous, nitrate and turbidity levels. Ashen deposits and fine sediments could be seen on the river bed throughout the year.

The spring waterbug survey also noted fine silt on the bottom and edges of the river and long, green filamentous algae present – possibly a result of the additional nutrients in the system. Pollution tolerant bug types such as fly larvae and 'true bugs' (Hemiptera) dominated both bug surveys.

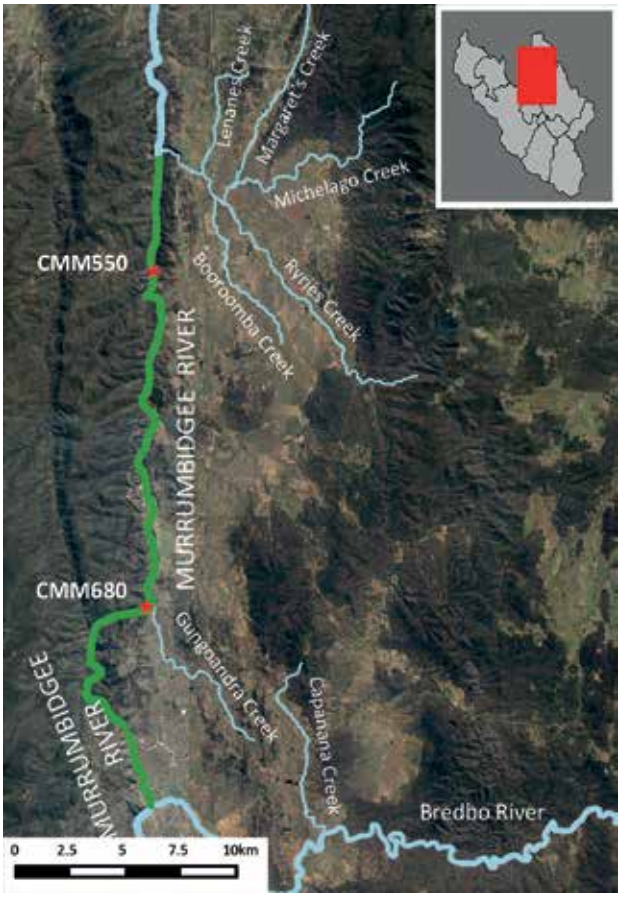
Extraction for irrigation has put additional pressure on water resources in this reach and significantly reduced water levels downstream during dry times.

Bredbo Landcare have been working hard to restore vegetation on the Murrumbidgee River at CMM705.

Murrumbidgee River CMM6

Bredbo River to Michelago Creek confluence

2020 CHIP Result B (Good)		
2019 CHIP Result B+ (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**23**
pH	Excellent	
Turbidity	Good	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Fair	
Waterbug	**Fair**	**3**
Riparian condition	**Fair**	**2**



Reach Facts

Reach network length: approx. 35km
Dominant land uses: Rural and conservation

This reach includes the Murrumbidgee River from the Bredbo River to the Michelago Creek confluence. It flows through the Bredbo and Colinton Gorges which form the upper and lower sections of the reach. These gorge areas contain good quality riparian and aquatic habitat. The middle section flows through the Bumbalong Valley which has more open, cleared country.

This section of the Murrumbidgee River demonstrates the importance of high quality riverine habitats on overall river health. For example, intact riparian and in-stream habitats capture sediments entering the water and absorb nutrients out of the system, resulting in more stable oxygen levels and clearer water. Macquarie perch, Murray cod, Trout cod and Murray River crayfish, all of which are protected species, are present and further highlight the importance of this reach.

Bush Heritage Australia (BHA)'s Scottsdale Reserve flanks the lower Bredbo Gorge. BHA carries out Platypus Month surveys and are working to improve the river corridor through riparian restoration, erosion control and installing fish habitat. This is part of the Upper Murrumbidgee Demonstration Reach partnership, which is working with landholders to reconnect the Bredbo and Colinton gorges.

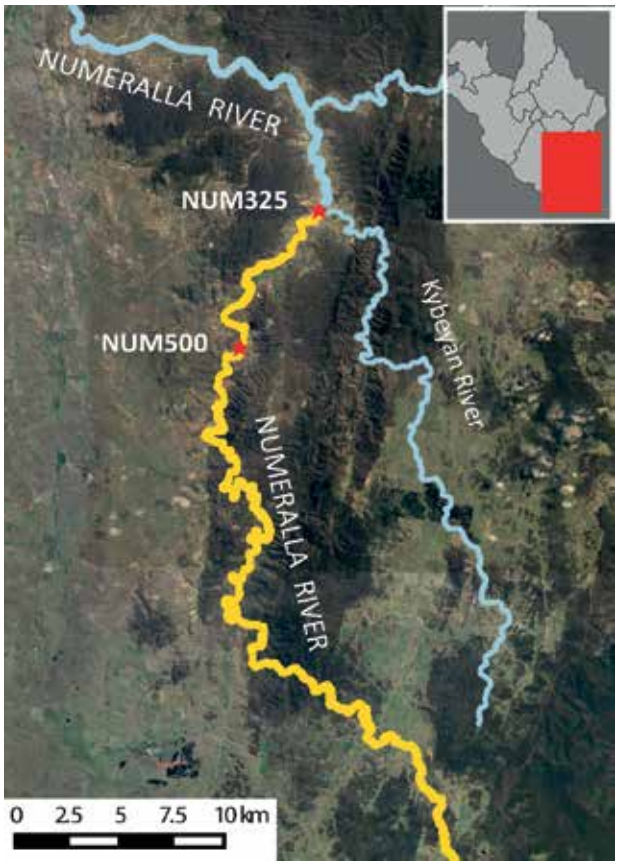
This reach was heavily impacted by bushfire in February, 2020. Subsequent rains resulted in the mass movement of ash and sediment into the river corridor, smothering habitat and elevating phosphorous, nitrate and turbidity levels. Heavy deposits of ash and sediment remain on the banks and instream, and there is more sediment in tributary gullies at risk of further erosion.

Large sediment deposits in the Murrumbidgee River at Bumbalong following the bushfires.

Numeralla River NUM1

Headwaters to Kybeyan River confluence

2020 CHIP Result C+ (Fair)		
2019 CHIP Result C (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**15**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**2**



Reach Facts

Reach network length: approx. 38km
Dominant land uses: Rural and conservation

This reach includes the Numeralla River upstream of the Kybeyan River confluence. Land use includes dryland cropping and grazing, especially in the mid to lower sections. In these areas native vegetation has been cleared and historic erosion has contributed large amounts of sand and fine sediment to the river. Sections of the upper reaches retain native vegetation including in the Dangelong Nature Reserve.

Cultivation and grazing affects water quality through elevated electrical conductivity levels. Loss of native vegetation on banks reduces riparian condition scores as well as streambank stability. This reach is a high priority ACWA catchment where erosion risk was assessed as very high.

The Numeralla Landcare Group, Numeralla Fishing Club, landholders and catchment organisations have worked since the 1990s to stabilise streambank erosion, fence the river from stock, replant native vegetation and reintroduce woody habitat in the lower end of this reach. This has stabilised the river channel and improved riparian and instream habitat there.

The extremely dry conditions in 2019 saw the river reduced to isolated pools and river ti-trees started to dieback. Despite wetter conditions in the wider region in 2020, this catchment has missed out on much of this rainfall. Thus, the river levels have remained low for most of the year and drying to isolated pools over winter. What water this reach did receive, has contributed to a slight improvement in the overall score.

Mike waterwatching at Mt Forest Road causeway (NUM500).

Numeralla River NUM2

Kybeyan River to Badja River confluence

2020 CHIP Result C+ (Fair)		
2019 CHIP Result B- (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**12**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Poor	
Nitrate	Excellent	
Electrical Conductivity	Fair	
Dissolved Oxygen	Degraded	
Waterbug	**Poor**	**2**
Riparian condition	**Fair**	**2**

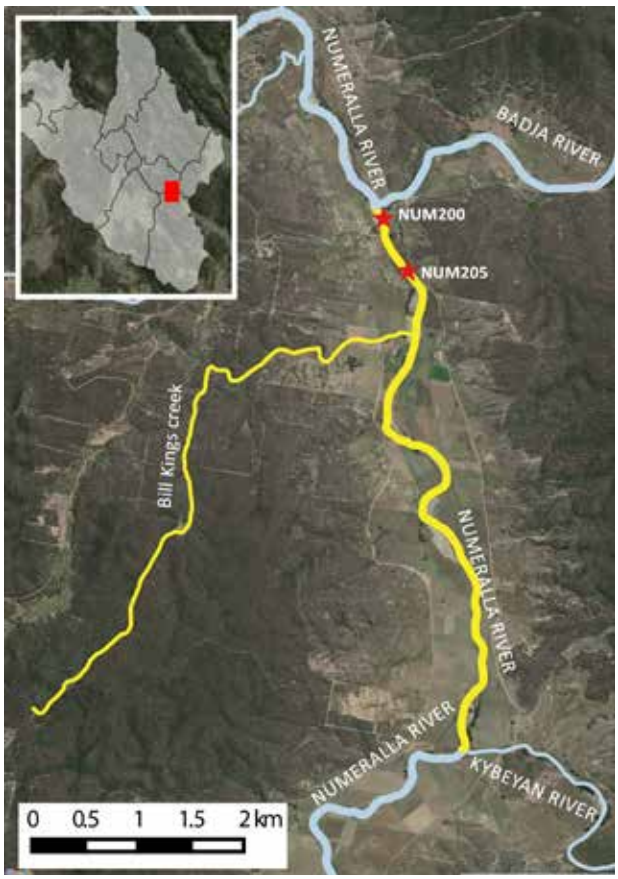
Reach Facts

Reach network length: approx. 40km
Dominant land uses: Rural and conservation

This reach includes the Numeralla River from the Kybeyan River to the Badja River confluence. It is flanked by wide alluvial floodplains used for dryland cropping and grazing. The Numeralla village is at the bottom end of the reach. Past landuse has resulted in loss of native vegetation and erosion has contributed large amounts of sand to the river channel that continues to move downstream. This reach is a high priority ACWA catchment where erosion risk was assessed as very high.

Numeralla Landcare, the Numeralla Fishing Club, landholders and catchment organisations have been working since the 1990s to fence the river from stock, stabilise streambanks, replant native vegetation and reintroduce woody instream habitat (re-snagging). This in turn has improved instream vegetation stabilising instream sand bars. These factors all contribute to this reach usually having a better CHIP score than in the reach upstream (NUM1).

There were large amounts of ash washed into the downstream section of this reach near the confluence of the Badja River – a catchment which was almost entirely burnt during the summer bushfires. The ashen deposits at NUM200 were up to 30cm deep and remain exposed on the riverbed and banks a year after the fires. This had an adverse affect on water quality, leading to increased phosphorous levels as well as and a reduction of waterbug diversity. Despite wetter conditions in the wider region, river levels in this reach have remained low for the first half of the year, drying to pools over winter.

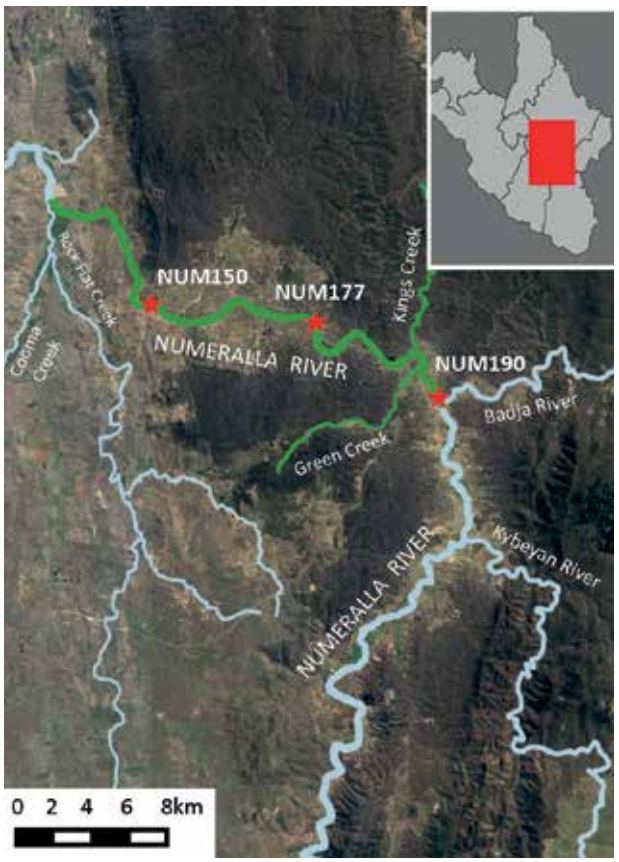


Large amounts of ash were deposited on the Numeralla River at NUM200 from the Badja fires.

Numeralla River NUM3

Badja River to Cooma Creek confluence

2020 CHIP Result B+ (Good)		
2019 CHIP Result B (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**29**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Fair	
Waterbug	**Good**	**2**
Riparian condition	**Fair**	**3**



Reach Facts

Reach network length: approx. 14km
Dominant land uses: Rural and rural residential

This reach includes the Numeralla River from the Badja River to the Cooma Creek confluence. The top half of this reach is flanked with good native vegetation including tall stands of Ribbon gums, fringing ti-trees and bottlebrushes, beds of in-stream reeds and swathes of water milfoil submerged in the river.

The downstream section of the reach has wide floodplains used for dryland cropping and grazing. Here native vegetation has been cleared and historic erosion has contributed large amounts of sand and fine sediment into the river. This reach is in a high priority ACWA catchment where erosion risk was assessed to be very high.

Platypus were once common but are now only occasionally sighted. Carp are common and upstream of NUM150 there is a known Carp spawning hot spot. Eastern gambusia are also found in high numbers.

Water quality and river levels are influenced by the inflows of the Badja River at the top of this reach. Hence, this section of the Numeralla River was inundated with heavy ash and sand deposits from the fire grounds in the Badja catchment at the start of 2020. This resulted in *degraded* levels of phosphorus, electrical conductivity, nitrate and turbidity directly following the fires in January. The poor water quality was short lived, however as higher than average rainfall in the headwaters of the Badja River resulted in high flows and improved water quality after the initial ash plume was washed through.

Sand washed down from the fire grounds in the Badja catchment will affect this reach for years to come.

Numeralla River NUM4

Cooma Creek confluence to Murrumbidgee River

2020 CHIP Result C (Fair)		
2019 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**22**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Good	
Dissolved Oxygen	Degraded	
Waterbug	**Poor**	**2**
Riparian condition	**Poor**	**2**

Reach Facts

Reach network length: approx. 17km
Dominant land uses: Rural

This reach includes the Numeralla River from the Cooma Creek to its confluence with the Murrumbidgee River. It runs through wide floodplains which are used for grazing and dryland and irrigated cropping. Stock are allowed to access the river in some areas.

Overall, there is very little native vegetation remaining along this section of the Numeralla River and invasive plant species such as Willows, Box elder (an emerging, but rapidly spreading weed species), Poplars and Blackberry are abundant. In-stream sand deposits are widespread in the river and continue to be mobilised downstream. Lower water levels over the last years have seen reeds and native ti-tree colonising in-stream sand bars which is having a stabilising effect.

Ash and sediment washed down from fire affected Badja River catchment upstream was observed with thick deposits seen on the banks, especially at the bottom end of this reach. This ash continued to influence water quality in the reach throughout the year as it was remobilised every time water levels rose, with increased levels phosphorous and nitrate detected and decreasing dissolved oxygen levels. This reach lies in a priority ACWA catchment where erosion risk was assessed to be very high. Increased turbidity has been observed after high run-off events.

Platypus are reported to have been very common in the lower Numeralla River in the past, but now only occasional sightings are noted. Carp are seen in large numbers, including spawning runs up the river past Chakola.

The woody weed, Box elder, is starting to take hold in the lower Numeralla catchment.

Rock Flat Creek ROC1

Headwaters to Cooma Creek

2020 CHIP Result C- (Fair)

2019 CHIP Result C+ (Fair)

Parameter	Rating	No. Survey
Water quality	**Good**	**21**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Poor	
Nitrate	Excellent	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Degraded	
Waterbug	**Poor**	**2**
Riparian condition	**Degraded**	**2**

Reach Facts

Reach network length: approx. 42km
Dominant land uses: Rural

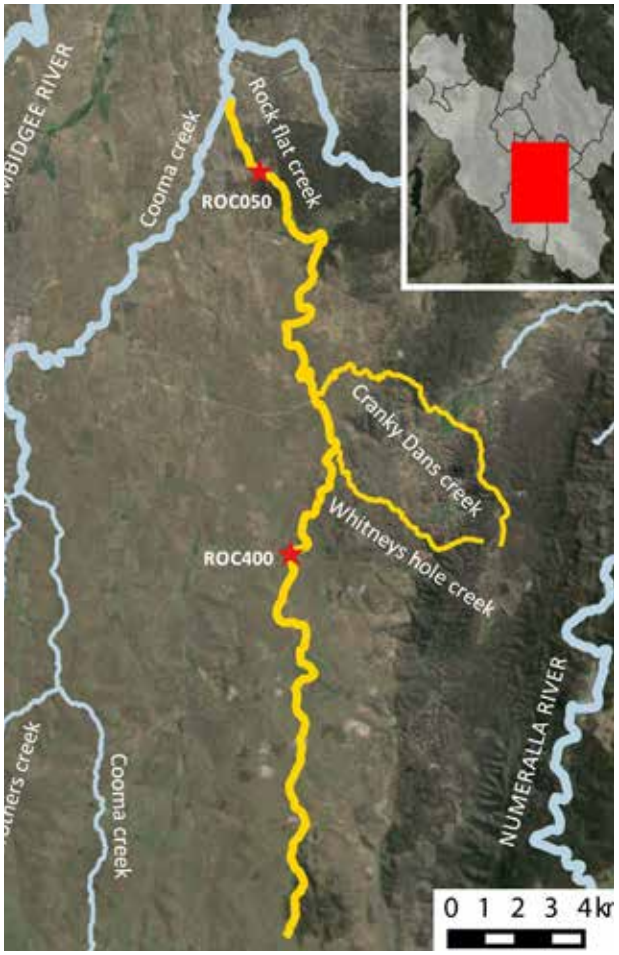
This reach flows through open basalt country, which is used for grazing and cropping agriculture. It includes a high priority ACWA site just downstream of the Cottage Hill Road crossing due to the risk of erosion.

Riparian vegetation along the creek is highly modified with the canopy and shrub layers largely absent, except for some scattered willows. Similarly, there is a lack of in-stream vegetation along this reach, especially where the creek is accessed by stock. In areas where stock impact is highest, increased streambank pugging (trampling) and grazing of in-stream vegetation is observed.

Sections of the creek have unstable streambanks causing increased turbidity and sediment inputs during high runoff events which in turn reduces water quality and smothers available habitat. These factors influence the waterbug community found in this reach which usually consists of very tolerant species such as segmented worms, flatworms, fly larvae and beetle larvae.

Water levels have been very low during the last few years and the creek has been reduced to a series of pools. This situation has continued throughout 2020 because this catchment has missed out on much of the higher rainfall experienced in other parts of our region. Phosphorus levels around 0.07mg/L were regularly detected as was dissolved oxygen at super saturated levels. Waterwatcher Micheal noted that this was most likely a byproduct of the large amounts of algae present at the site over much of the year.

This reach was at one time a renowned trout stream but now Carp are more commonly seen.

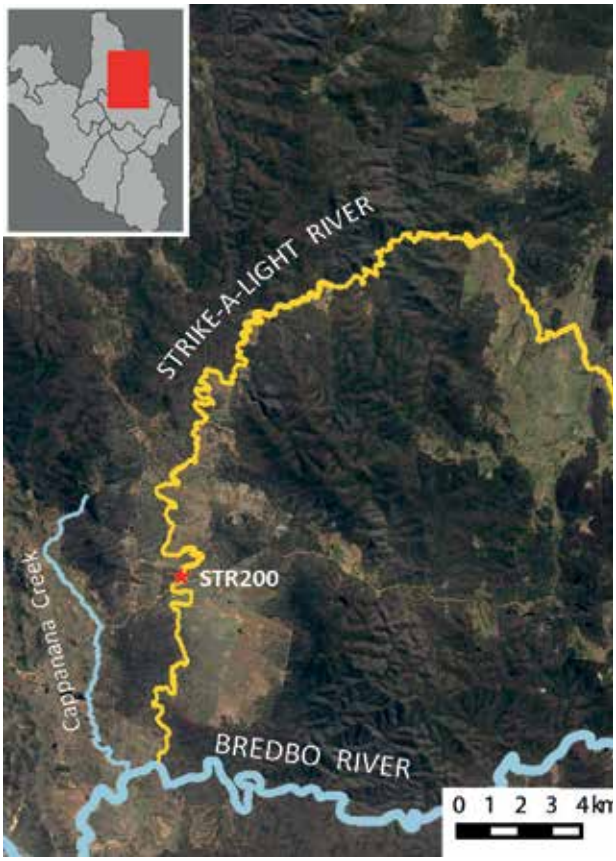


Rock Flat Creek suffered from low flows for most of 2020.

Strike-A-Light River STR1

Headwaters to Bredbo River

2020 CHIP Result C (Fair)		
2019 CHIP Result B- (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**11**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**1**



Reach Facts

Reach network length: approx. 38km
Dominant land uses: Rural

This reach includes the entire Strike-A-Light River catchment. The catchment includes cleared open country, utilised predominantly for grazing agriculture at the top and bottom ends of the reach. In these areas riparian vegetation has been cleared. The middle of the reach is largely native vegetation with intact riparian areas and good in-stream habitat.

The middle section influences the water quality observations at Waterwatch site STR200, which runs clear and free of algae, even during periods of low flow. Electrical conductivity is often high at this site, which in part can be attributed to geology. Despite having peaks in 2020 of 700µS/cm there was a slight overall improvement on last year due to increased flows in the catchment.

The top of the Strike-A-Light River catchment was impacted by the Calabash fire in February 2020 followed by heavy rains which flushed large amounts of ash off the fireground. Thick deposits of ash remain on the banks all along the river, resuspending nutrients during periods of high flows.

Waterbug scores were poor in autumn which can also be attributed to fire effects. There was an improvement in spring with two types of pollution-sensitive stonefly detected - Notonemouridae and Gripopterygidae (the latter commonly known as 'fluffy bums').

Rakali (Water rats) and Eastern water dragons have been seen in the river near the Waterwatch site. This reach is monitored at only this one site and another volunteer to monitor upstream would greatly enhance our knowledge of this catchment.

Ash and sediment washed down from the fireground, affecting the Strike-A-Light River at STR200.

Ginninderra Catchment Facts

Over 42% of ACT residents live in Ginninderra Creek catchment making it the most urbanised in the ACT. It carries substantial urban water runoff, from both established and newly developing suburbs, directly into the Murrumbidgee River.

Ginninderra Creek itself begins in the north-western edge of Canberra, in the upper reaches of the Mulligans Flat Nature Reserve, and flows west though the suburbs within Gungahlin and Belconnen. It enters the Murrumbidgee after passing through the catchment's most significant and best-preserved remnant ecosystem: the Ginninderra Gorge, including the spectacular upper and lower falls. Gooromon Ponds Creek joins Ginninderra Creek near Dunlop and captures run off from much of the NSW land around Wallaroo, including Halls Creek.

Steady development in Canberra's north has impacted significantly over the past 30 years, with sediment from development sites and weeds the two most significant issues. The riparian zone for most of the creek is dominated by exotic grasses with a mix of native and exotic mid-storey and canopy. Some notable exceptions are areas where Landcare groups have been working for many years. This includes Evatt, Umbagong District Park, Macgregor and Dunlop.

Ginninderra Waterwatch Volunteers have been monitoring this catchment since 1997.

Ginninderra Catchment Health Summary

In 2020, the Ginninderra Creek catchment experienced a range of conditions. This began with the prolonged dry conditions in January, where dissolved oxygen levels were very low and parts of the creek and some urban wetlands completely dried up. By mid-February the rains began, influenced by a La Niña system, and conditions improved with water levels returning to more normal levels.

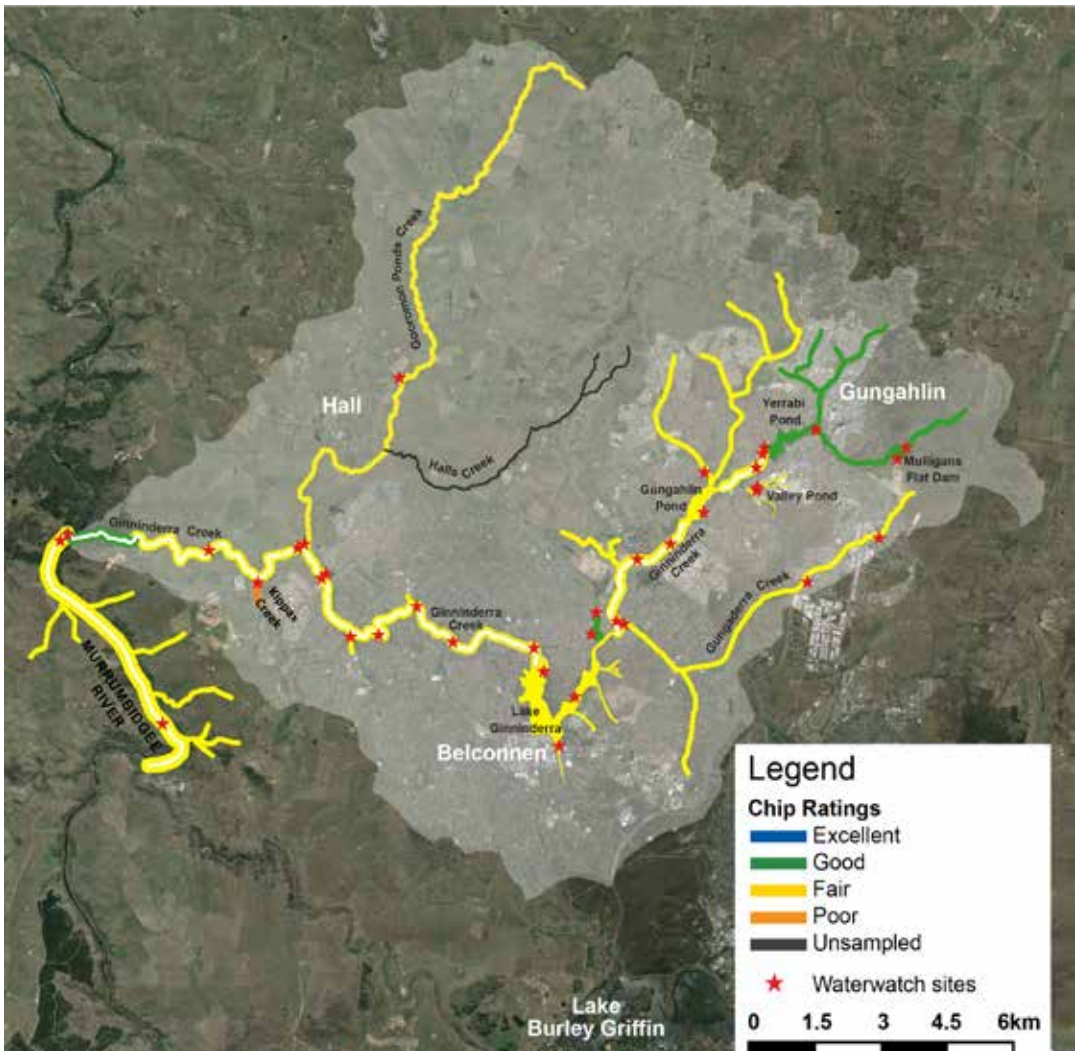
Although most of the urbanised sections of Ginninderra Creek benefited from the rains, the Murrumbidgee River received a considerable amount of ash from the fire affected areas upstream after flooding events, which turned into thick deposits accumulating on the banks with high readings of phosphorus and turbidity recorded.

Overall, three reaches had a *good* score, eleven had *fair* scores and one reach scored *poor*. Compared to last year's CHIP results, there was a significant improvement in the condition of some reaches and that is probably influenced by the better flows in the catchment.

Not all reaches, however, responded to the increased flows in the same way. Once the rainfall increased, large amounts of organic material was washed down from the urban landscapes. Despite the increased flow, dissolved oxygen levels were still low in places such as in Umbagong District Park (GIN024). This is most likely due to the bacterial degradation of the increased loads of organic matter consuming available oxygen.

In 2020, flooding events led to an influx of nutrients such as phosphorus and nitrate. Constructed wetlands serve as filters to prevent those nutrients running straight into the creeks. The Valley Ponds wetlands and Lexcen Avenue Pond, while absorbing some of the nutrients, still saw an increase in algae resulting from increased internal nutrient loads. This then produced an excess of dissolved oxygen as a by-product of photosynthesis, this is known as super saturation.

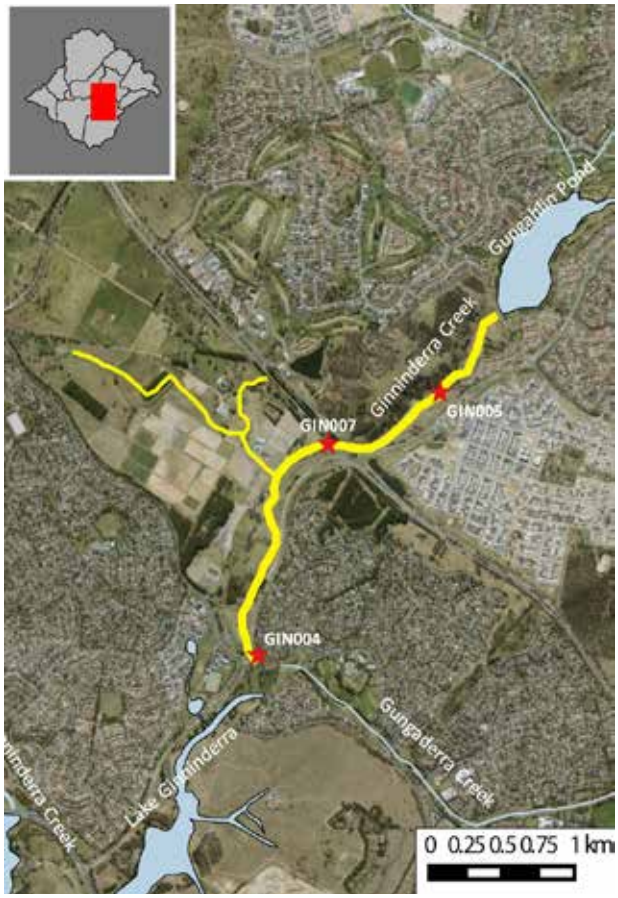
So while the increased flows benefitted scores overall, it will take time to flush the build-up of pollution and nutrients through the system. By improving the complexity of groundcover and other riparian vegetation in the urban landscape, stormwater quality will be better treated before it enters the creek.



Ginninderra Creek GIN1

Crace to Giralang Pond

2020 CHIP Result C (Fair)		
2019 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Fair**	**20**
pH	Excellent	
Turbidity	Fair	
Phosphorus	Excellent	
Nitrate	Degraded	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**3**



Reach Facts

Reach network length: approx. 5km
Dominant land uses: Urban

Starting at the outflow of Gungahlin Pond this reach includes the stormwater inflow from Nicholls and Crace. The middle of the reach receives runoff from the CSIRO field test facility while the downstream section flows through the Old Palmerville township historic site 12 and Landcare Forest. The end point for this reach is Giralang Pond which is the only small stream pond present on Ginninderra Creek.

This section of the catchment is highly urbanised. Urbanised areas have a high proportion of impervious surfaces which increases runoff, warms the water and add lots of urban pollutants to the waterways.

The areas adjacent to Ginninderra Creek in this reach have good ground cover and little signs of erosion, as well as plenty of in-stream reeds. The absence of large trees and shrubs means the creek can be quite exposed and tends to receive a poor score for riparian condition.

Feral fish (Carp, Redfin perch and Eastern gambusia) are frequently sighted throughout this reach.

Dredging to improve stormwater flow in this section of Ginninderra Creek was conducted in autumn 2020. Unfortunately it resulted in adverse water quality impacts as well as fish mortalities. The Environment Protection Authority was notified and used the Waterwatch data collected by our volunteers in their report to support their findings.

Looking upstream on Ginninderra Creek at Giralang Pond (GIN004).

Ginninderra Creek GIN2

Lake Ginninderra

2020 CHIP Result C+ (Fair)		
2019 CHIP Result C (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**24**
pH	Excellent	
Turbidity	Fair	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**3**

Reach Facts

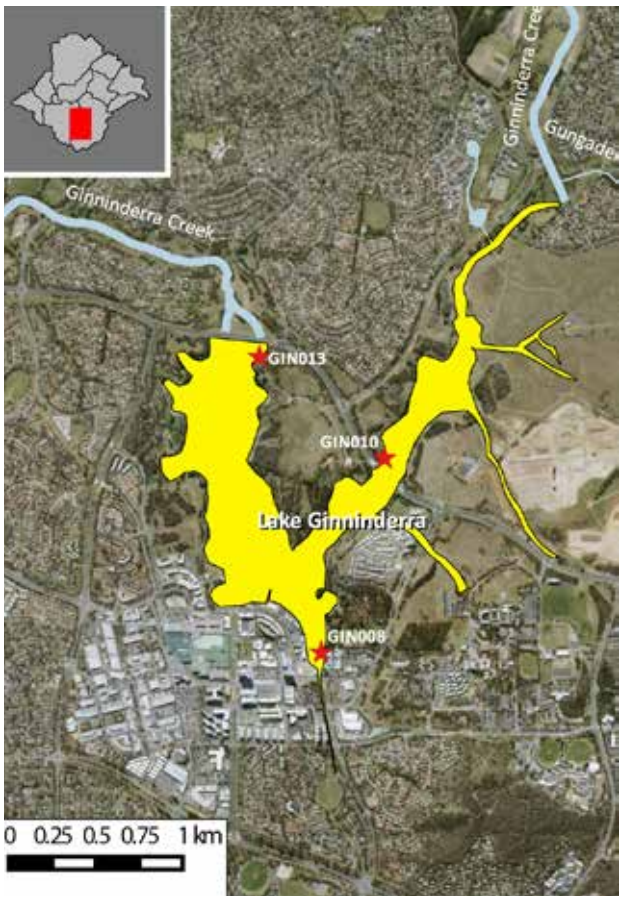
Reach network length: approx. 9km
Dominant land uses: Urban

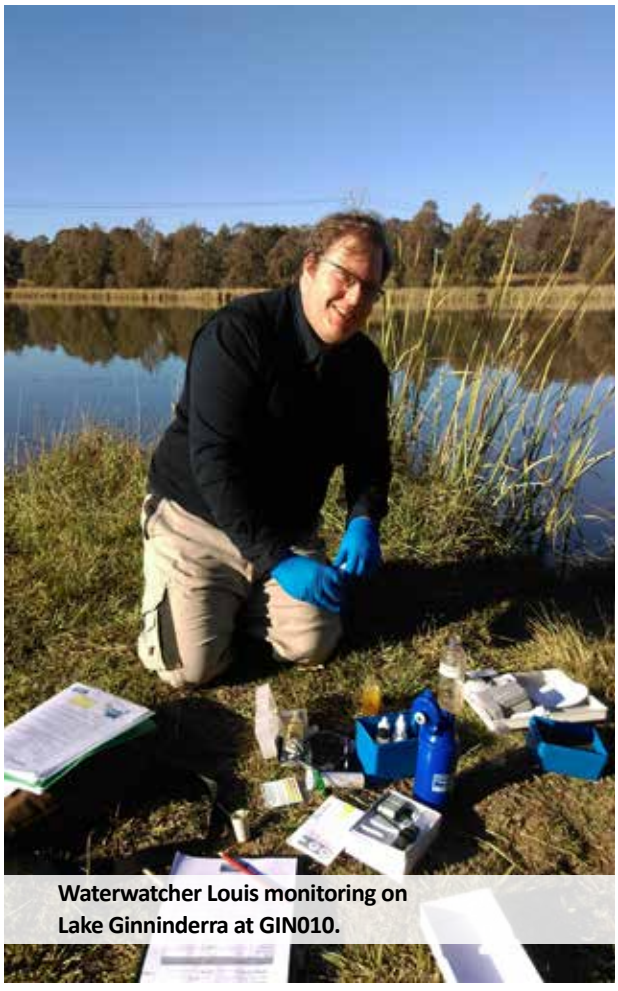
Starting below Giralang Pond and finishing at the Lake Ginninderra dam wall, this reach covers the main town centre of Belconnen. The main inflow is from Ginninderra Creek from the north-east, which includes the new development suburb of Lawson. The other inflow is at the southern end of the Lake and is mostly urban stormwater that flows into the recently redeveloped Eastern Valley Way wetland.

Fishermen and an array of bird species such as Dusky moorhens, Purple swamphens and White-faced herons, are frequently sighted in this reach within Lake Ginninderra. Rubbish was also noted as it continues to be a problem throughout the reach.

The riparian zone in this area of Lake Ginninderra is mainly composed of grasses and shrubs, with many being introduced species. There is little available habitat for wildlife along the edges of the Lake. There is scope for improvement in areas that are not required for visitor access and do not need to be maintained in a "neat and tidy" manner.

This year there was a slight improvement in the waterbug score, mainly due to a higher diversity and more pollution-sensitive species being recorded in the autumn waterbug survey. This included three types of caddisflies, two types of mayflies as well as freshwater mites (Acarina), with a total of eight bug Orders found altogether.





Waterwatcher Louis monitoring on Lake Ginninderra at GIN010.

Ginninderra Creek GIN3

Dam wall to Ginninderra Drive

2020 CHIP Result C- (Fair)

2019 CHIP Result C+ (Fair)

Parameter	Rating	No. Survey
Water quality	**Good**	**25**
pH	Excellent	
Turbidity	Excellent	
Total Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	**Degraded**	**2**
Riparian condition	**Poor**	**3**

Reach Facts

Reach network length: approx. 4km
Dominant land uses: Urban

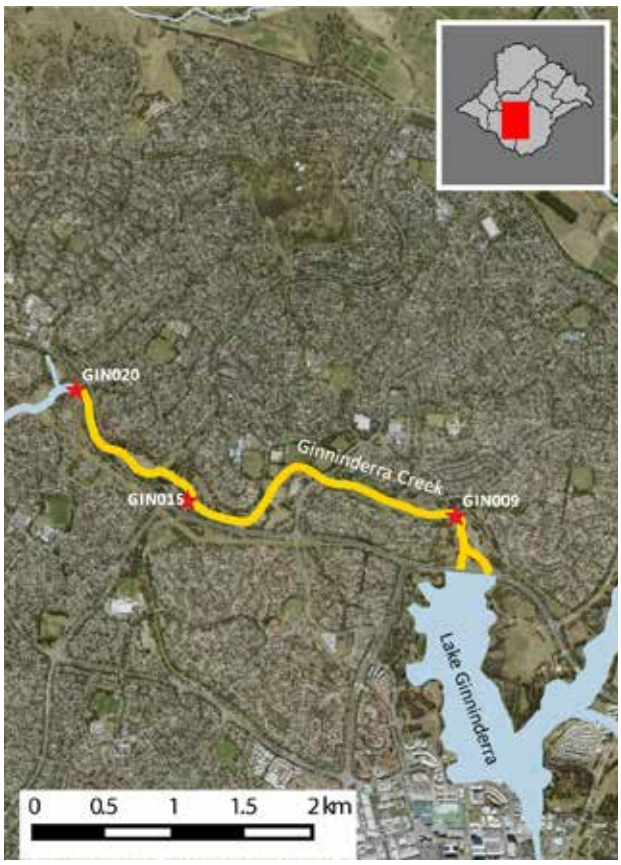
This reach begins below the Lake Ginninderra spillway and sits entirely within established suburbs with high urban stormwater inflow. The reach has good reed cover and wide, well-grassed buffer zones in most areas. During rain events the water in this section runs very clear and turbidity is only observed when overflow from Lake Ginninderra occurs.

Even though there is a moderate presence of trees along the edge of Ginninderra Creek in this section, the majority are introduced species like Poplars and Willows. These trees drop large amounts of leaf litter into the waterways in autumn causing spikes in nutrients. Some areas of the creek (around GIN009) are choked up with these leaves.

The Ginninderra Catchment Group and ACT Government's tree unit have applied significant effort over several years to replace Poplars with native species in this reach. It will take a few years for the benefit of this management strategy to be reflected in the riparian condition scores.

In 2020, Waterwatch recorded only pollution-tolerant waterbug species, with a total of six types in both the autumn and spring sampling, yielding a *degraded* score overall. Consistant higher flows may have influenced this result, as less habitat was available at the time of sampling and bugs can be flushed from the site during such events. It would be ideal to give the bugs a chance to re-establish after high rainfall, but conditions and sampling schedules do not always allow this to occur.

Two new wetlands that will help improve the water quality of the stormwater were recently built in this reach through the ACT Healthy Waterways program.

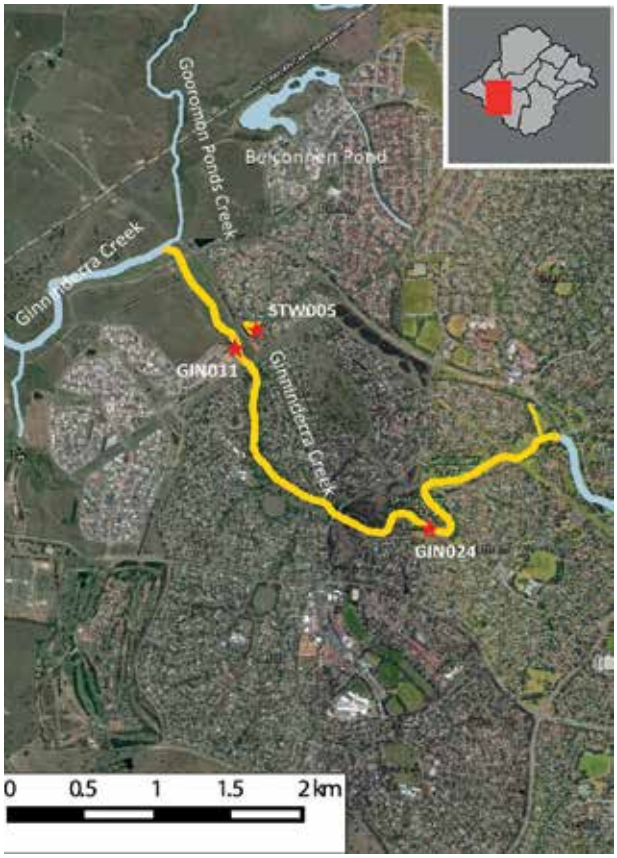


Waterwatchers Trevor and Ann near their Waterwatch site (GIN020).

Ginninderra Creek GIN4

Ginninderra Creek at Umbagong District Park

2020 CHIP Result C+ (Fair)		
2019 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**32**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**4**
Riparian condition	**Poor**	**3**



Reach Facts

Reach network length: approx. 6km
Dominant land uses: Urban

This reach starts downstream of Ginninderra Drive and flows through the Umbagong District Park, ending at the confluence with Gooromon Pond Creek. The reach is well vegetated with a good native riparian zone and wide grassland buffers in many sections. Previous creek restoration projects by the Ginninderra Catchment Group and Umbagong and Macgregor Landcare Groups have improved riparian condition and water quality.

Native species commonly recorded is this reach include Reed Warblers, Buff-Rumped Thornbills and Pobblebonk tadpoles. Rubbish is also often found and our volunteers have helped relentlessly to clean this section of Ginninderra Creek.

In 2020, this reach showed some extreme records owing to the variable weather pattern. In January for example, during the continued dry spell, Waterwatcher Lesley observed four feral Carp *"gasping"* in the shallows at GIN024, the water described as shallow and dark in colour and the dissolved oxygen was only measured at 1%. The landscape too was showing signs of stress as three very large Casuarina trees adjacent to the site, appeared to be dying. After more than 50ml of rain in February, however, one of the three "*dead-looking*" casuarinas had had some green growth on lower branches. Dissolved oxygen rose to 58%. After returning to her water quality monitoring after a hiatus during lockdown, Lesley was interviewed by the Canberra Times and was able to share the improvements of Ginninderra Creek at Umbagong with the broader Canberra community.

Waterwatcher Lesley saw Ginninderra Creek at GIN024 return to good health after the rains (Photo: Canberra Times).

Ginninderra Creek GIN5

Gooromon Ponds Creek confluence to Ginninderra Falls Gorge

2020 CHIP Result C (Fair)		
2019 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**14**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Poor	
Dissolved Oxygen	Excellent	
Waterbug	**Poor**	**2**
Riparian condition	**Poor**	**2**

Reach Facts

Reach network length: approx. 7km
Dominant land uses: Urban/Rural Fringe

This reach runs from the confluence with Gooromon Ponds Creek to the rural properties around Kilby Homestead. The upper section has significant bank erosion and the lower section runs through sheep and cattle farms.

Ginninderra Catchment Group, Greening Australia and the Riverview group have undertaken Willow removal and native regeneration work in the mid-section.

The regeneration of native shrubs and increased habitat availability including fallen logs on the edge of the creek at Kilby Homestead are positive outcomes from this work. This provides essential refuge for small vertebrates such as frogs and lizards. On the negative side, feral deer are present in this area. Yass Local Land Services are conducting monitoring on their impacts.

In 2020, much of the in-stream vegetation around GIN040 was removed due to flash floods. The water level was so high in August, after 106mm of rain in the previous week, that it covered the bridge at Kilby Homestead, leaving debris over the bridge and throughout the riparian zone. As a consequence of less aquatic vegetation in the creek, we also observed less waterbug types in the spring survey. Only six types of waterbug were recorded and the bulk of them were pollution-tolerant water boatman and backswimmers.

On a good note, Eastern water dragons were still observed during water sampling at GIN040 in September and November.

Volunteer Antonia helping out at the spring waterbug survey at GIN040.

Ginninderra Creek GIN6

Ginninderra Falls Gorge to Murrumbidgee River confluence

2020 CHIP Result B (Good)

2019 CHIP Result C+ (Fair)

Parameter	Rating	No. Survey
Water quality	**Excellent**	**4**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Poor	
Dissolved Oxygen	Excellent	
Waterbug	**Fair**	**2**
Riparian condition	**Fair**	**1**

Reach Facts

Reach network length: approx. 3km
Dominant land uses: Conservation

This reach comprises the high conservation value area of the Ginninderra Falls and Gorge. It is composed of large areas of native woodlands and shrubs. The rough terrain and inaccessible nature of the downstream section contributes to its complex structure. This section has the best riparian habitat in the catchment. Ginninderra Falls also represents an important Ngunnawal cultural and heritage site, known to host significant indigenous ceremonies and male initiations.

Although the riparian vegetation there is well represented by mature casuarinas and gum trees, not much regeneration is observed along the creek. Despite the good vegetation cover, the upstream stressors such as urbanisation and farming can still be seen downstream, with elevated electrical conductivity readings. The creek bed in this section is mainly rocky with very little aquatic vegetation.

In 2020, there was an improvement in the overall score for this reach. This was attributed mainly to the waterbug scores, where an increase in diversity was detected at both the autumn and spring surveys. The increased rainfall and flows most likely increases in waterbug diversity. It was interesting to note the presence of pollution-sensitive micro-caddis fly larvae. At only 2-6mm in length, this small larvae constructs a transparent, purse-like case with a glue-like secretion from its mouth.

Eastern water dragons are commonly seen in this reach and a bold juvenile swam up very close to the Waterwatch team in spring as they conducted their water testing.

Waterwatcher Ange testing for nitrate at GIN050 on Ginninderra Creek.

Gooromon Ponds Creek GOO1

Headwaters to confluence with Ginninderra Creek

2020 CHIP Result C (Fair)

2019 CHIP Result C (Fair)

Parameter	Rating	No. Survey
Water quality	**Good**	**19**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**2**
Riparian condition	**Degraded**	**2**

Reach Facts

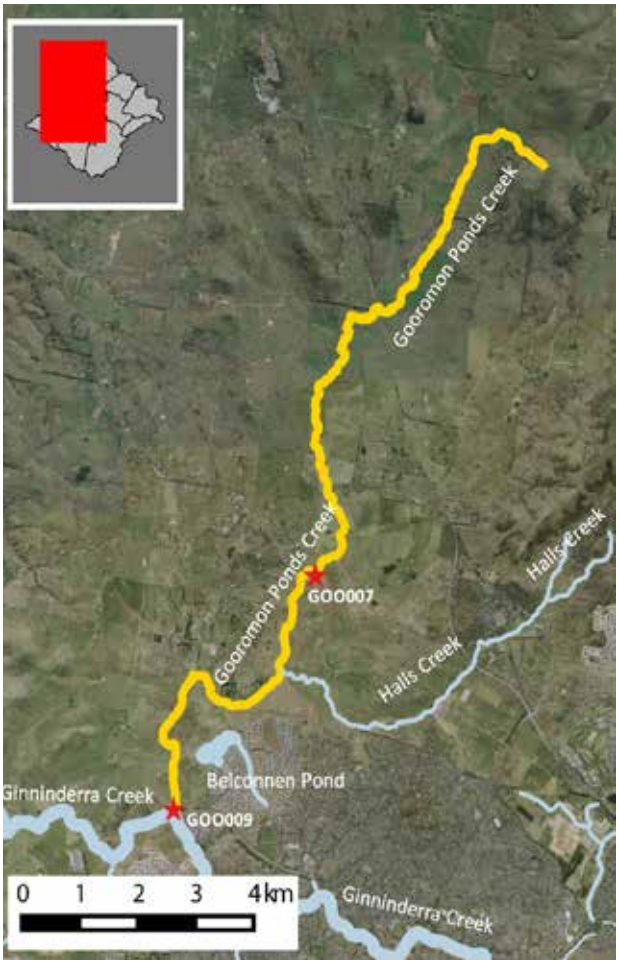
Reach network length: approx. 17km
Dominant land uses: Rural

Flowing through the rural land surrounding Hall and Wallaroo, the Gooromon Ponds Creek is a mostly ephemeral creek with intermittent pools. This creek contains sections of moderate erosion and extensive areas with low habitat quality

This reach represents a typically impacted farmland region with low riparian condition scores. Ground cover is relatively intact however exotic pasture grasses dominate, mid-storey and canopy species are scarce and mostly exotic and there is a complete lack of on ground habitat features such as fallen logs and tussock grasses. The lack of native canopy cover and consequently no leaf litter and native canopy regeneration all contribute to reduced soil stability and can result in erosion.

Historically, electrical conductivity has been elevated in this reach and is most likely influenced by both the geology of the region and historical land use. Readings as high as 1240µS/cm were recorded by Waterwatcher Charlie at GOO007 in July 2020 when water levels were low. Charlie has also frequently observed illegal dumping at his monitoring site.

Waterbug surveys in this reach showed high diversity, with ten types in both autumn and spring surveys, although the majority were pollution-tolerant species, such as water boatman and bloodworms. On a good note, Leptophlebiidae mayflies, a pollution-sensitive type of waterbug, were detected in the spring sample at GOO009.



Gooroomon Creek at Jaramlee Crossing (GOO009) just above the confluence with Ginninderra Creek.

Gungaderra Creek GDC1

Gungahlin to Giralang Pond

2020 CHIP Result C+ (Fair)		
2019 CHIP Result C+ (Fair)		
Parameter	**Rating**	**Survey**
Water quality	**Good**	**21**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**4**
Riparian condition	**Poor**	**3**

Reach Facts

Reach network length: approx. 10km
Dominant land uses: Urban

This reach starts in the southern suburbs of Gungahlin, flows through the Gungaderra Grassland Reserve and into Ginninderra Creek at Giralang Pond just upstream of Lake Ginninderra. It also includes a stormwater channel from the University of Canberra and Canberra Stadium and has moderate urban stormwater inflow.

This reach displays a marked decrease in water quality parameters from the upstream (GDC010) to the downstream site (STW001), showing the cumulative effects of the water running through the urban landscape, travelling over lots of impermeable surfaces including concrete drains.

The lack of native canopy and understorey and dominant exotic vegetation, such as poplar trees, in addition to sections of concrete stormwater drains, account for the poor riparian vegetation assessment. A plan to improve the width of riparian habitat is being worked on with the ACT Government wetland staff.

In 2020, water quality parameters fluctuated in line with the weather patterns. Lower water levels and dissolved oxygen were observed during the dry conditions earlier in the year, and higher flows and increased turbidity after floods influenced by the La Niña event. It was great to see a good variety of waterbugs during spring sampling in STW001 with eight different types, including sensitive caddisflies and mites. This was a contrast to the autumn sampling earlier in the year, with only five types detected.

Waterwatcher Grant checking the water turbidity at Gungaderra Creek Pond (GDC005).

Gungahlin Pond GUN2

Headwaters of Ginninderra Creek north arm to Gungahlin Ponds

2020 CHIP Result C+ (Fair)		
2019 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**29**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**3**

Reach Facts

Reach network length: approx. 6km
Dominant land uses: Urban/Rural Fringe

The north arm of Ginninderra Creek originates in the rural lands surrounding the northern suburbs of Gungahlin and joins the east arm in Gungahlin Pond. The upper section is mostly ephemeral drainage lines disconnected by stock dams before flowing into the sediment control pond of Gungahlin. This reach receives a high inflow of urban stormwater from surrounding suburbs and new developing suburbs.

Limited sections of the riparian zone score well for their habitat values, with some significant native canopy evident. Exotic species, however, with limited habitat values, dominate the edge of Gungahlin Pond. These highly urbanised areas are regularly mowed to the edgeof the water, making the regeneration of native plants difficult. On the other hand, in-stream vegetation in the form of reeds are present throughout the reach, and abundant in some areas, providing good habitat for frogs, turtles and waterbugs. It is also positive to note the regular recording of several bird species from the volunteers, such as ducks, coots, swans, ibis and swamp hens.

In 2020, this reach showed a great diversity of waterbugs with nine types in both autumn and spring surveys, although the majority fell in the pollution-tolerant range such as bloodworms (a type of fly larvae) and water boatman. On a good note, it was great to observe 100 water mites, a pollution-sensitive type, in the autumn sampling. Mites can be blue, red or yellow although this colour variation is not necessarily species specific.

Waterwatcher Chris sampling at Gungahlin Ponds (GUN001).

Kippax Creek KIP1

Headwaters to Ginninderra Creek confluence

2020 CHIP Result D+ (Poor)		
2019 CHIP Result D+ (Poor)		
Parameter	**Rating**	**No. Survey**
Water quality	**Fair**	**10**
pH	Excellent	
Turbidity	Good	
Phosphorus	Degraded	
Nitrate	Degraded	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Degraded	
Waterbug	**Degraded**	**2**
Riparian condition	**Poor**	**1**

Reach Facts

Reach network length: approx. 2km
Dominant land uses: Urban

Kippax Creek is now mostly a system of stormwater drains and drainage lines. The remaining "natural" creek section is only a 400m stretch from the last gross pollutant trap to the confluence with Ginninderra Creek. This reach does offer a great opportunity to study the impacts of a catchment that is heavily urbanised with limited water quality improvement infrastructure. The lower section sits within an important native grassland at the Umbagong District Park.

Although the weed, African lovegrass, is still very common in the area, it is interesting to note the increased presence of the native Kangaroo grass. Overall, the reach lacks native ground cover, complexity in structure of layers and habitat features. It is important, however, to mention the regeneration of some native trees and the presence of reeds along this reach.

Our volunteer has been carefully monitoring the erosion in this reach which has increased in recent years following a number of flash floods.

In 2020, phosphorus and nitrate levels have increased which may have been a consequence of the upstream gross pollutant trap (GPT) overflowing after heavy rains, as noted by Waterwatcher Lesley. In August phosphorus and nitrate readings were as high as 0.125mg/L and 30mg/L, respectively, (for perspective, an *excellent* range would be <0.02mg/L and <1mg/L respectively). GPT's aid in water quality control by removing solids and pollutants from the stormwater which otherwise would flow straight into the creek. Frequent cleaning, however, is imperative for them to work efficiently.

The small section of Kippax Creek that is not a concrete stormwater drain (KIP001).

McKellar Wetlands MCW1

Designed habitat wetland system, McKellar

2020 CHIP Result B- (Good)		
2019 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**19 (1 dry)**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**2**

Reach Facts

Reach network length: approx. 500m
Dominant land uses: Urban

The two McKellar wetlands are designed primarily for frog habitat, and secondly for recreation. This is evident in the significant reed growth in both wetlands, and the connecting channel linking them, which is heavily vegetated to facilitate animals such as frogs and turtles to move through. It is situated in an established suburb, with nutrient inputs derived from sources such as gardening and cleaning as well as leaves from deciduous trees.

The poor riparian condition score is influenced by the low levels of canopy and understorey, although ground cover results are considered good, with a high number of native tussock grasses. The wetlands in this reach are typical of many urbanised areas in Canberra, with manicured grasses and low numbers of trees. The riparian assessment does not account for the aforementioned good in-stream habitat.

This reach has seen extremes in 2020, by being bone dry in January to full after the rains in February and March. With such a wet year, it was also the first time that the volunteer observed the connecting channel in action, where the overflow from MCW002 was seeping towards MCW001, increasing the connectivity between these two wetlands.

With above average rainfall for much of the year, water quality parameters have improved and yielded an *excellent* score, and waterbugs were diverse with a total of nine and ten types in the autumn and spring surveys, respectively.

A family was observed by the Waterwatch volunteer fishing and catching a large Carp in MCW1.

Waterwatcher Luke captured the extremes of McKellar Wetlands in January (top) and February (below).

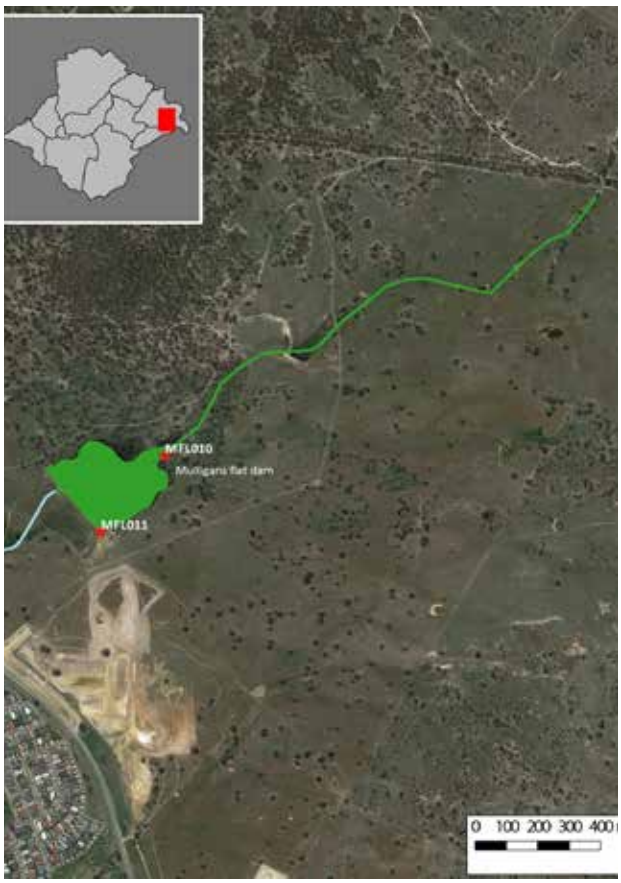
Mulligan's Flat Dam MFL1

Headwaters of Ginninderra Creek to Mulligan's Flat Dam

2020 CHIP Result B- (Good)

2019 CHIP Result D+ (Poor)

Parameter	Rating	No. Survey
Water quality	**Good**	**22 (2 dry)**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	poor	
Nitrate	Good	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**2**
Riparian condition	**Fair**	**2**



Reach Facts

Reach network length: approx. 2km
Dominant land uses: Conservation

Mulligan's Flat Dam was originally an old farm dam, now repurposed as an ecological habitat for aquatic life, and native fauna and flora in general. The Mulligan's Flat Woodland Sanctuary was established in 1995 to protect the Box-gum grassy woodlands and associated fauna in the Gungahlin area. The Dam is normally filled with rainwater that is grass-filtered, and is a popular spot for bird watchers. The site plays host to a number of conservation projects and the sanctuary is protected by a predator-proof fence.

Mulligan's Flat's main habitat is grasslands and there are high levels of native ground cover vegetation which promote soil stability and provide habitat for small vertebrates, such as frogs, lizards and the New Holland mouse. Most of the secondary grassland communities in Mulligans Flat were created by the early farmers who cleared woodland areas in the region.

Mulligan's Flat bounced back in 2020 as one of the top sites in the Ginninderra catchment following the above average rainfall after both sites completely drying up by the end of in 2019.

Water literally brings life! As the waters receded in the large dam in 2019, only three and four waterbug Orders were present in the autumn and spring surveys. This year up to ten Orders were detected. Not only was waterbug diversity higher, but also the pollution-sensitive bugs such as caddisflies and mayflies were found after being absent in 2019.

Mulligan's Flat Dam at MFL001 has returned to its former splendor.

Murrumbidgee River CMM11

Molonglo River confluence to Ginninderra Creek confluence

2020 CHIP Result C- (Fair)		
2019 CHIP Result C (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**8**
pH	Excellent	
Turbidity	Fair	
Phosphorus	Poor	
Nitrate	Degraded	
Electrical Conductivity	Fair	
Dissolved Oxygen	Excellent	
Waterbug	**Degraded**	**2**
Riparian condition	**Poor**	**2**

Reach Facts

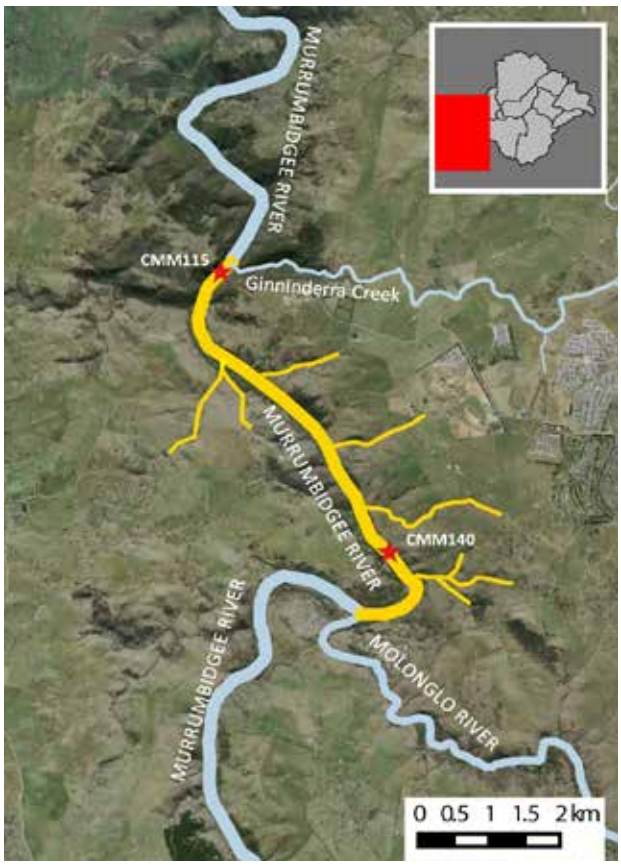
Reach network length: approx. 7.1km
Dominant land uses: Conservation, rural

Starting below the confluence of the Molonglo River and finishing at the confluence with Ginninderra Creek, this reach includes mostly rural land and part of the Murrumbidgee River Reserve. Some sections of gorge country are also included and the upper section of the reach receives the outflow from the Lower Molonglo Water Quality Control Centre (LMWQCC).

A number of high nitrate readings have been recorded in this reach over the past couple of years, particularly during the low flows of 2018 and 2019. This can most likely be attributed to discharges from the LMWQCC as Waterwatch sites on the Murrumbidgee River above the Molonglo River confluence have indicated little to no nitrate present.

When the rains began in February 2020, high amounts of ash from multiple fire-affected areas in the upper catchment were washed downstream, with up to four metres of ash accumulating along the banks of Murrumbidgee River in this reach. This not only affected water quality, with increased turbidity and phosphorus levels, but it also completely changed the habitat for waterbugs. The sludge and ash smothered many of the aquatic plants present along the edge of the river and resulted in only three types of tolerant waterbugs being detected in spring 2020 versus nine Orders in spring 2019.

Pest species have been observed in this reach such as fox, deer and carp.



Waterwatcher Tyson measuring the dissolved oxygen at CMM115. Note dark ash from the fires on the riverbanks.

The Valley Ponds GUN1

Wetland to Gungahlin Town Centre

2020 CHIP Result C (Fair)		
2019 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Fair**	**8**
pH	Poor	
Turbidity	Excellent	
Phosphorus	Poor	
Nitrate	Excellent	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**2**

Reach Facts

Reach network length: approx. 2km
Dominant land uses: Urban

Originally an old farm dam and artificial seepage grassland, this site was a unique habitat for this catchment. The site has since been redeveloped into an urban wetland for the Gungahlin town centre and parts of Palmerston. It is now a high-quality education and recreation wetland.

There are low levels of native canopy cover and regeneration in this urban reach and reeds are a common feature in the ponds. The riparian assessment score should improve over time as the plantings in this wetland become more established.

Birralee Scout Group is heavily involved in the sampling in this reach, with Venturers helping in the water testing and Bunyip Cubs and Yowie Pack involved in the autumn and spring waterbug surveys. The local Waterwatch volunteers regularly observe Swamp Hens, Black swans and cygnets in the wetland.

In late 2020, the two wetlands in this reach displayed a range in water quality values that indicated the top wetland (GUN010) was acting as a filter for the system downstream (GUN008). This was particularly evident for phosphorus and nitrate with results in the downstream wetland notably lower than that detected upstream. Additionally, both wetlands had more alkaline pH readings (8.5-9) and dissolved oxygen supersaturation (146-187%), well outside the normal range of 88-100% saturation. This is likely related to the elevated levels of algae present in the system which produce large amounts of oxygen as a byproduct of photosynthesis.

Aquatic vegetation at Valley Ponds (GUN010).

Yerrabi Pond YER1

Headwaters of Ginninderra Creek to Yerrabi Dam Wall

2020 CHIP Result C+ (Fair)		
2019 CHIP Result B- (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**16**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**2**

Reach Facts

Reach network length: approx. 10km
Dominant land uses: Urban/Rural Fringe

The east arm of Ginninderra Creek originates in the rural landscape surrounding the northern suburbs of Gungahlin. It includes the former rural property, now significant woodland reserve, of Mulligans Flat Woodland Sanctuary. The upper section is mostly ephemeral creeks, disconnected by stock dams. The reach receives a moderate inflow of urban stormwater from surrounding suburbs.

The Riparian vegetation score is largely influenced by the outflow of Yerrabi Pond, which backs onto a concrete channel connected to a main road. The other areas that do contain riparian vegetation are mainly comprised of exotic species, especially in regards to the ground cover. A few scattered trees do occur, with Casuarinas being the most representative native tree. That said, Ribbon weed, a native in-stream plant, is found here and acts to improve water quality and provides important habitat for aquatic life.

Feral fish such as Eastern gambusia and Carp are regularly sighted throughout Yerrabi Pond although it is also stocked with Murray cod and Golden perch fingerlings by the ACT Government's Conservation and Research Unit.

In 2020, a decrease in dissolved oxygen levels as well as an increase in nitrate and electrical conductivity levels saw a decline in the overall score. It is possible that, after the drier conditions in 2019 and early 2020, the rain and flood events washed organic materials and pollutants off the fast-growing suburban areas in the upper catchment, and down to Yerrabi Pond through the stormwater system.

Ribbon Weed, an important native aquatic plant, is found at Yerabi Pond (YER001) (Photo: C. Skeels).

Molonglo Catchment Facts

The Molonglo catchment extends from the Murrumbidgee River, just downstream of Uriarra Crossing, to the headwaters of Molonglo and Queanbeyan Rivers and Jerrabomberra Creek, an area of about 2,000 km^2

This diverse catchment includes the urban areas of Queanbeyan and inner Canberra, villages such as Captains Flat and rural residential areas and farmland including Burra, Royalla and Carwoola. There is new residential development occurring at Googong, south-east of Queanbeyan, and around the lower Molonglo River in the Molonglo Valley. Non-residential areas include native and pine forests, wetlands, national parks and the foreshores of Googong Dam, which supplies some of Canberra's and Queanbeyan's water.

Lake Burley Griffin is on the Molonglo River and collects stormwater and runoff from Queanbeyan, much of north Canberra and Fyshwick industrial area, as well as treated output from the Queanbeyan sewerage treatment plant. Lake Burley Griffin water quality is monitored by the National Capital Authority and information can be found at http://www.nationalcapital.gov.au/WaterQuality/index.php/en/.

The Molonglo catchment has a large population with urban waterways flowing in concrete channels. This is a key issue for urban catchments where there is little riparian vegetation and habitat to slow down flows and capture and absorb nutrients and sediments.

Of the six priority sub-catchments in the ACT Healthy Waterways project, four are in the Molonglo catchment. These sub-catchments are currently the focus of water quality improvement strategies such as wetlands and water-sensitive urban design.

Ten projects that formed part of the ACT Government's Healthy Waterways program have been completed in four sub-catchments of the Molonglo catchment. Water quality improvements are anticipated from these raingardens, wetlands, ponds and waterway restoration projects.

Though water quality across the Molonglo catchment is generally good, when taking account of all our catchment health indicators (water quality, waterbugs and riparian condition), it is the highly urbanised reaches and rural creeks with largely cleared vegetation, that are in the poorest condition.

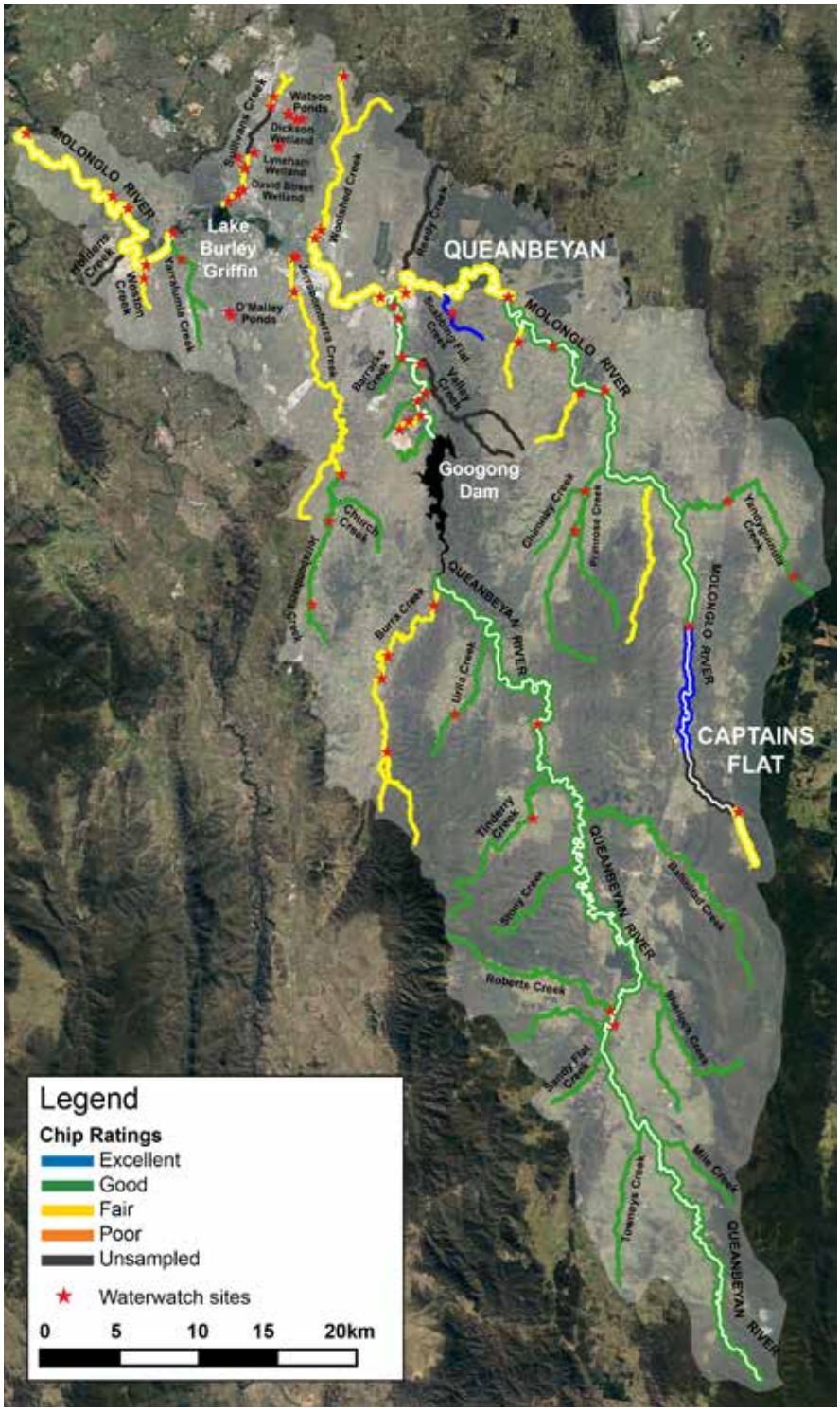
Molonglo Catchment Health Summary

After three exceptionally dry years, culminating in the driest year on record for our region, extensive rainfall in February 2020 saw most ephemeral creeks flowing again in the catchment, and good flows restored to our rivers.

The increase in rainfall in the Molonglo catchment in 2020 did not translate into improved water quality in most reaches. Compared to 2019, overall CHIP scores were worse in 13 reaches, the same in four, and better in ten reaches. Almost all of this change was attributable to a decline in water quality.

Direct impacts from the widespread fires which affected other sub-catchments in the upper Murrumbidgee in 2019-20 were limited in the Molonglo catchment, with only an area near the Molonglo River between Pialligo and Oaks Estate burnt in January. Thus, the decline in water quality cannot be attributed to fire-impacts.

The most likely reason as to why there is a slight downward trend is that increased runoff from rain results in increased pollutants entering waterways, reducing water quality. This is particularly the case for nutrient parameters (phosphorus and nitrate) and sediment in the water column measured as turbidity. These results are often at high levels, directly following rainfall, but can subside in a day or two and not be detected by a Waterwatch volunteer. When rainfall has occurred as frequently as it did in 2020, however, the chances of Waterwatch sampling coinciding with a rain event are greatly increased.



Water quality, of course, should not automatically deteriorate when runoff occurs. Intact groundcover and complex, native riparian zones all treat water and help it soak into the landscape. This has the double benefit of recharging groundwater, helping streams to flow for longer, as well as ensuring there are less pollutants in the water before it enters the waterway. The Molonglo catchment only has three reaches with *good* or *excellent* riparian condition. The fact that all three showed improvements in water quality in 2020, would not be a coincidence.

Interruptions to water quality testing as a result of site access issues due to fire risk and COVID-19, resulted in 16% fewer water quality records in the Molonglo catchment than the previous year. Despite the challenges, almost 500 records were collected by our wonderful, dedicated volunteers during 2020.

Banksia Street Wetland SUW2

Sullivans Creek in O'Connor

2020 CHIP Result B- (Good)		
2019 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**10**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Fair	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**2**
Riparian condition	**Fair**	**1**

Reach Facts

Reach network length: approx. 0.2Ha
Dominant land uses: Urban, recreation

Banksia Street is an artificial off-line wetland, constructed in 2010. Low flows are diverted from the westerly arm of Sullivans Creek concrete channel to pass through the wetland, then overflow back into the westerly channel when water levels are sufficiently high.

Despite only a *fair* vegetation condition rating, this attractive Wetland has a great selection of riparian, edge and submergent plant species, as well as other habitat features such as logs, rating it the best of the urban Wetlands. The narrow width of vegetation prevented a higher riparian condition score. Only the upstream sections of some creeks and rivers, with wide, multiple layers of native vegetation, have attracted a better score.

Banksia St Wetland went from a puddle of greenish water with a dry ephemeral section (an area that dries out from time to time) in January, to high water levels in the space of a month. *"New waterplant growth" was noted by our volunteers in May. They also noted ducks, lots of insects and "lots of new riparian weeds"* in November which luckily were removed the following day by the Banksia St Wetland community group. The group organise weeding parties, as well as mulching, planting and rubbish removal activities to keep the Wetland in beautiful condition.

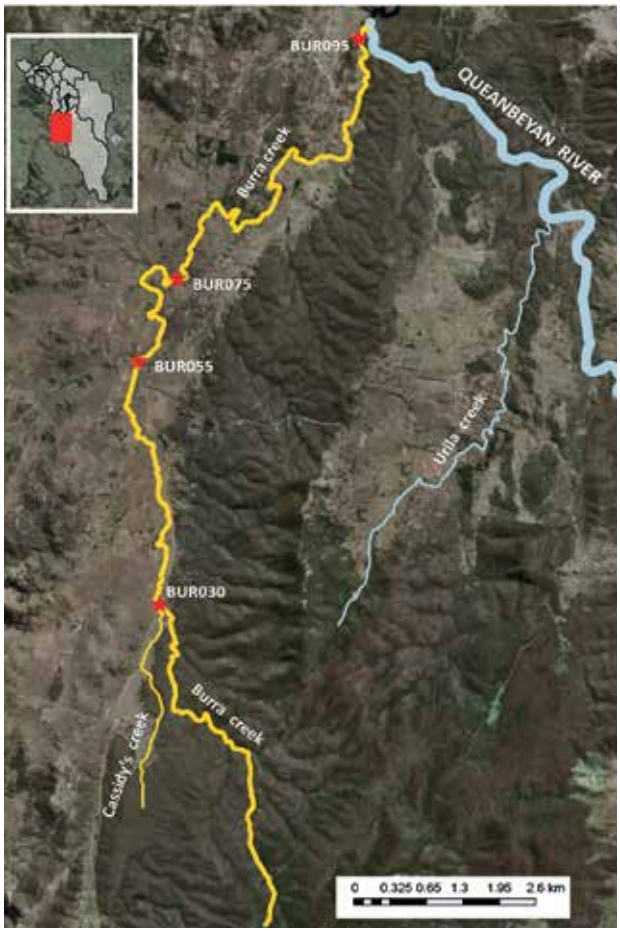
Several colourful, large yabbies were found during turtle research at the wetland in late 2020. One turtle was observed walking away from the wetland but unfortunately none were caught in nets set for the turtle surveys.

Waterwatch Coordinator Bruno Ferronato and his trusty assistant, Sophia, conducting turtle trapping at Banksia St.

Burra Creek BUR1

Headwaters to Googong Foreshores NR

2020 CHIP Result C+ (Fair)		
2019 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**38 (1 dry)**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**4**



Reach Facts

Reach network length: approx. 40km
Dominant land uses: Native bush, grazing, rural, conservation

Burra Creek arises in the north-western edge of the Tinderry Mountains and flows into the Queanbeyan River just upstream of Googong Dam. It flows through rural subdivisions and includes the outlet of the pipeline from the Murrumbidgee to Googong water transfer scheme before passing through the southern end of Googong Foreshores nature reserve.

Riparian vegetation is largely absent or dominated by introduced Willows and Poplars. This large reach is impacted by historic land clearing, and stock continue to have access to the creek in many places, causing erosion and damage to the minimal riparian vegetation. This has resulted in three out of the four sites being rated as *poor* for riparian condition. Sodic soils (those high in sodium) in the reach increase the risk of erosion, and the potential for water logging and salt outbreaks which can in turn reduce and alter vegetation.

After being dry in the upper site (BUR030) in January, flooding occurred in Burra Creek in February and again in August. In addition, the Murrumbidgee to Googong pipeline began operating regularly between March and July, pumping water from the Murrumbidgee River into Burra Creek. This pumping is for the purpose of ensuring water security in the upper Murrumbidgee catchment. Unfortunately, this water was very turbid with high levels of phosphorus recorded resulting from fire impacts in the upper catchments of the Murrumbidgee River. Many of the phosphorus results were many times higher than at BUR030 above the pipeline entry, where low nutrient levels and clear water were experienced over the same time period.

Burra Creek at BUR055 receiving flows from the Murrumbidgee to Googong pipeline, March 2020.

David Street Wetland SUW1

Sullivans Creek catchment in O'Connor

2020 CHIP Result C+ (Fair)		
2019 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**13**
pH	Excellent	
Turbidity	Good	
Phosphorus	Excellent	
Nitrate	Poor	
Electrical Conductivity	Good	
Dissolved Oxygen	Degraded	
Waterbug	**Poor**	**2**
Riparian condition	**Fair**	**1**

Reach Facts

Reach network length: approx. 0.21Ha
Dominant land uses: Urban, recreation

David Street Wetland is the second offline wetland along the westerly branch of Sullivans Creek. It was constructed in 2001 and takes a portion of any higher flows from the concrete stormwater channel. These pass through the wetland then overflow back into the westerly concrete channel, just before it joins the main northern branch.

As the oldest and smallest wetland in the inner North, David St Wetland has captured a deep layer of sediment over time, and this year reeds have grown across the middle of the pond.

The recent University of Canberra/ACT Government report on urban wetlands concluded that this wetland is still functioning to remove sediment and some nutrients, reducing downstream impacts.

Despite some water quality parameters varying compared to the previous year, the final rating was the same. This reflects the complex and variable influences of an urban water catchment, where fertiliser on gardens can have an impact on downstream water quality, as well as local stormwater runoff from roads and shops.

On New Year's Eve 2019, an Eastern long-necked turtle dug her nest and laid eggs whilst neighbours sharing a drink next to the wetland looked on in amazement. The observers even redirected dog walkers, and contacted Bruno (Ginninderra Waterwatch Coordinator and turtle expert) about protecting the nest. It's wonderful to see such stewardship of a local wetland and the care taken to protect its wildlife.

A native Indigofera shrub flowering at David St Wetland.

Dickson Wetland DIC1

Sullivans Creek catchment

2020 CHIP Result B (Good)		
2019 CHIP Result B+ (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**13**
pH	Excellent	
Turbidity	Fair	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Excellent	
Waterbug	**Fair**	**2**
Riparian condition	**Fair**	**1**

Reach Facts

Reach area: approx. 1Ha
Dominant land uses: Urban

Dickson Wetland was constructed in 2011 and is on the lower western slopes near Mt Majura. A large concrete stormwater channel is fed into the constructed wetland, but during high rainfall events the wetland is bypassed. Water from the wetland flows back into the concrete channel and through to Lyneham Wetland, just upstream of the confluence with Sullivans Creek.

Once again Dickson Wetland had the highest water quality rating of any reach in the Molonglo catchment, and was one of only a few reaches to receive an *excellent* dissolved oxygen result. This was also reflected in the diverse waterbug result with eleven different Orders detected in both the spring and autumn surveys.

The wetland has a vibrant urban ecology provided by reasonably diverse water plants and landscape plantings. Habitat features like logs, rocks and different water depths help attract diverse waterbirds, and support a variety of fish, both native and feral. A pair of Wood ducks with 16 ducklings were also observed in autumn.

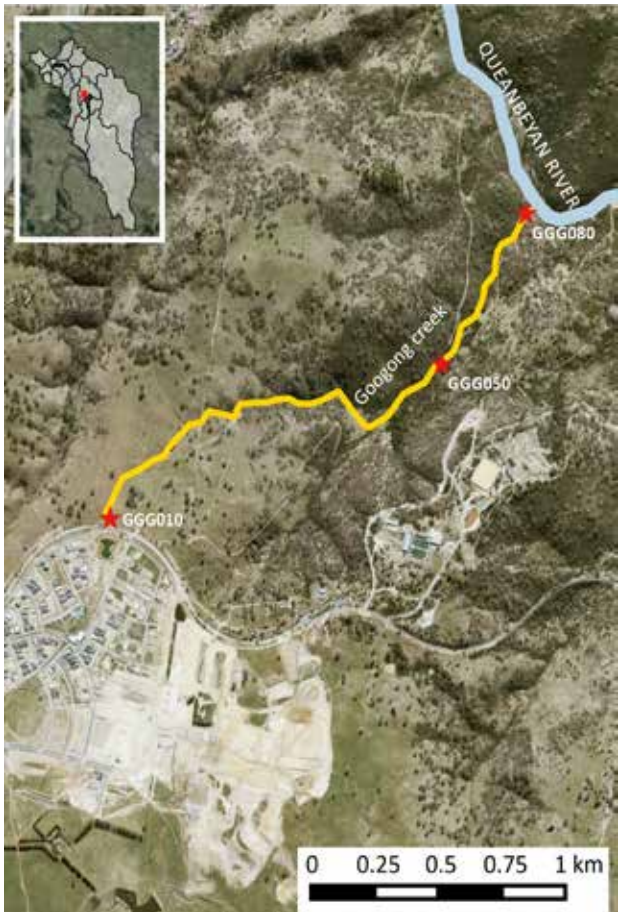
It was wonderful to hear the frogs come back this year, with up to five species recorded in the Frogwatch surveys in October. Local residents keep an eye on the gross pollution trap at the inflow entrance to the wetland and request it be cleaned out when needed. They also continue to clean up rubbish, weed regularly, and supplement the native plants, making this well-designed wetland and surrounding landscape highly valued by locals and visitors alike.

The good diversity of edge vegetation is starting to mature at Dickson Wetland.

Googong Creek GGG1

Headwaters to Queanbeyan River confluence

2020 CHIP Result C+ (Fair)		
2019 CHIP Result B (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Fair**	**10**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Degraded	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Degraded	
Waterbug	**No Data**	**0**
Riparian condition	**Fair**	**3**



Reach Facts

Reach network length: approx. 2.5km
Dominant land uses: Native bush, grazing, urban, infrastructure, rural residential

Googong Creek rises in the developing township of Googong and runs into the Queanbeyan River downstream from Googong Dam. It passes through a stormwater holding dam (Beltana Pond GGG010) on the edge of Googong township and crosses a pipeline access track, creating a second dam on the creek.

There is a weir on the downstream section before the creek reaches the Queanbeyan River upstream of Wickerslack Lane. Googong Creek flows intermittently but now takes discharge from the Googong water recycling plant. High nitrate (2-10mg/L) concentrations are regularly detected here and are likely attributed to the water treatment discharge.

Development in the reach is increasing with a new suburb development on the south-eastern side of the upper creek beginning in 2020. High sediment loads associated with the existing developments was detected during April and again in November with turbidity reading between 90-200NTU.

Such a small creek is too small to sample waterbugs, so only water quality and riparian condition surveys contributed to the overall CHIP score.

Platypus may regularly be seen feeding in the Queanbeyan River close to the downstream site near the confluence.

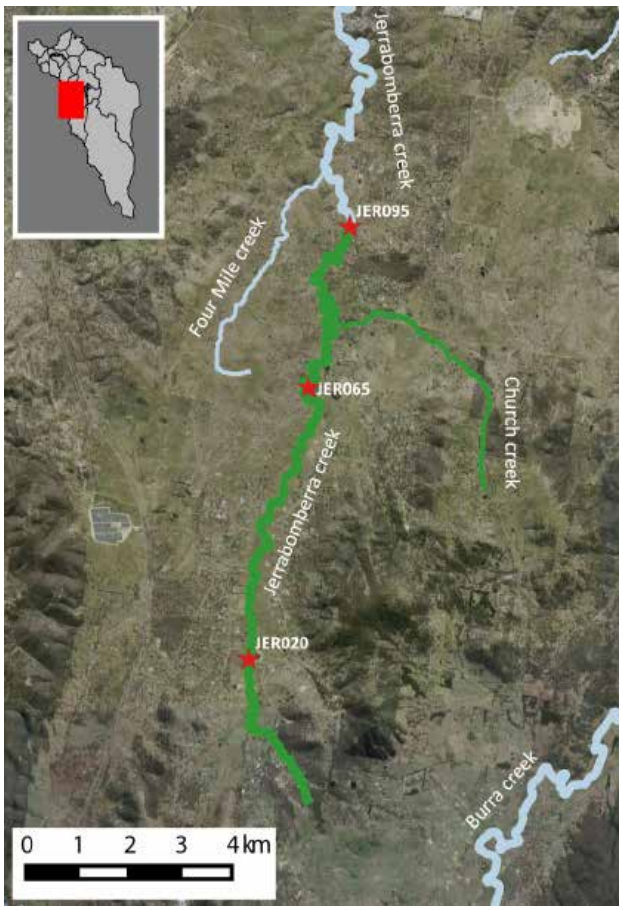
Access to the downstream sites on this reach is difficult so it may not continue as a standalone reach unless we can find a fit, keen volunteer to take these sites on this year. Please contact Waterwatch if you're interested.

Beltana Pond (GGG010) captures stormwater off the Googong township.

Jerrabomberra Creek JER1

Headwaters to Fernleigh Drive

2020 CHIP Result B (Good)		
2019 CHIP Result B- (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**25 (1 dry)**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	**Good**	**2**
Riparian condition	**Fair**	**3**



Reach Facts

Reach network length: approx. 15km
Dominant land uses: Native bush, Rural residential,

Jerrabomberra Creek arises in the hills surrounding the rural residential area of Royalla along the south-east side of the ACT border. This reach, including a number of small tributaries, has varying degrees of riparian condition ranging from healthy sections, areas through rural subdivisions with very little riparian vegetation and sections with deep gully erosion.

There are new areas of development on the Church Creek tributary with potential to impact this reach, with these developments being largely dependent on groundwater as are many properties in the sub-catchment. As rainfall shifts from winter to summer dominated, this increasing use of groundwater has greater potential to impact stream flows, which are partially dependent on groundwater for their base flow.

Electrical conductivity is likely to remain *poor* in this catchment in the near future because of long term land clearing.

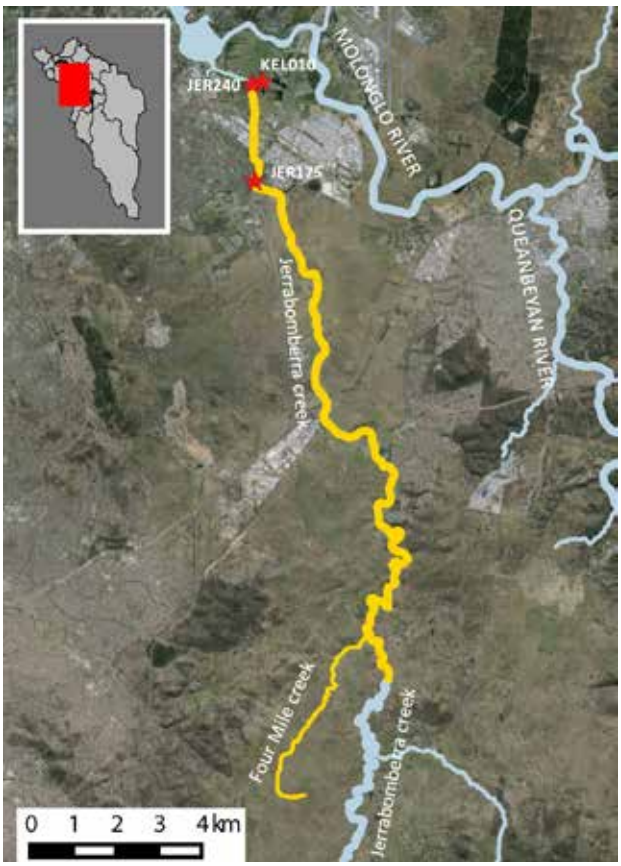
The autumn waterbug survey noted that flows had not been sufficient to flush out the buildup of diatom algae. Both waterbug surveys saw high diversity with good availability of rock pools and stands of Typha (also called Cumbungi) along the edges. That said, the overall number of waterbugs detected suggests high nutrient/salinity levels according to the SIGNAL2 method used by Waterwatch. Ten main Orders were detected in autumn and thirteen in spring but there were only just enough bugs in both samples to meet the minimum number required for a survey. A beautiful, green, 40mm Aeshnidae dragonfly nymph was the highlight of the spring survey.

A large (40mm) Aeshnidae dragonfly nymph caught at JER095 during the spring bug survey.

Jerrabomberra Creek JER2

Fernleigh Park to Molonglo River confluence

2020 CHIP Result C+ (Fair)		
2019 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**28 (3 dry)**
pH	Excellent	
Turbidity	Fair	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**3**



Reach Facts

Reach network length: approx. 19km
Dominant land uses: Rural residential, light industrial, urban, conservation, recreation

This section of Jerrabomberra Creek flows from Fernleigh Park, past residential, rural and industrial areas and a grassland reserve, before ending at the Jerrabomberra Wetlands Nature Reserve. The water in the downstream section is backed up and slowed down by Scrivener Dam, which contains the waters of Lake Burley Griffin.

This reach also takes stormwater runoff from major roads and parts of Fyshwick light industrial area.

The Jerrabomberra Wetlands Nature Reserve includes an ephemeral wetland, Kelly's Swamp. It naturally has higher nutrients (like phosphorus), electrical conductivity and turbidity, than the main creek and the cycle of wetting and drying in the swamp provides rich habitat for an array of birds and other aquatic fauna.

One of the new wetlands constructed in this reach, under the ACT Healthy Waterways Program, was established in Narrabundah and is expected to improve the water quality entering Jerrabomberra Wetlands. It will be interesting to see what changes occur at the Waterwatch site in Narrabundah (JER175), which is below the outfall from the new wetland.

A Narrabundah community planting event at the new wetland in October was very well attended, and several hundreds of diverse species of native plants were added to the wetland plantings. The hope is they will be cared for by the local community, to make the wetland a beautiful and functional part of the landscape beside Jerrabomberra Creek which is a concrete channel in this section of the reach.

Jerrabomberra Creek near Canberra Ave in Narrabundah (JER175).

Lyneham Wetland LYN1

Sullivans Creek catchment off Wattle Street Lyneham

2020 CHIP Result C+ (Fair)

2019 CHIP Result D+ (Poor)

Parameter	Rating	No. Survey
Water quality	**Good**	**11 (1 dry)**
pH	Excellent	
Turbidity	Fair	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Good	
Dissolved Oxygen	Degraded	
Waterbug	**Poor**	**2**
Riparian condition	**Poor**	**1**

Reach Facts

Reach area: approx. 1Ha
Dominant land uses: Urban

Lyneham Wetland is a large artificial wetland constructed in 2011–12. Urban stormwater from Dickson, Downer, Hackett and Watson flows to Lyneham Wetland through the stormwater network of concrete pipes and channels. Unlike Dickson Wetland, an offline wetland, Lyneham is an online wetland which takes all runoff, including high flows following storms. Lyneham Wetland overflows into Sullivans Creek when water levels are sufficiently high.

Waterbugs consistently score poorly at this wetland, with limited habitat being one of the main factors. This is partly because this wetland has water pumped from it as part of the Inner North Reticulation Network and provides temporary storage in order to irrigate sports ovals. In June the local Waterwatchers noted the wetland was drawn down to muddy pools. Thus, if the water level drops, leaving plants at the water's edge high and dry, available habitat for waterbugs is limited. Getting the balance between water recycling, water quality treatment and biodiversity can be a challenging in urban wetlands with multiple uses, such as this one.

During a turtle survey in December, Waterwatchers were lucky to witness nesting Australasian grebes in the reeds below the bridge across the wetland. A frequent visitor pointed them out along with nesting Choughs in the trees and the "*nuptual flights*" of ants. No wonder nearby residents and passersby enjoy visiting this peaceful wetland.

Lyneham Wetland was reduced to pools in June due to the Inner North Reticulation Network (Photo: L. Amos).

Molonglo River MOL1

Headwaters to Captains Flat

2020 CHIP Result C+ (Fair)		
2019 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**No Data**	**0**
pH	NA	
Turbidity	NA	
Phosphorus	NA	
Nitrate	NA	
Electrical Conductivity	NA	
Dissolved Oxygen	NA	
Waterbug	**Good**	**2**
Riparian condition	**Poor**	**1**

Reach Facts

Reach network length: approx. 3.5km
Dominant land uses: Conservation, grazing, rural residential

From its origins in the north-western section of Tallaganda National Park in the Great Dividing Range, the Molonglo River flows north through grazing properties to Captains Flat. Apart from the uppermost section of the reach, which is wet sclerophyll forest, it is largely cleared rural land with limited riparian vegetation. The lack of vegetation and habitat features such as logs along the river have contributed to the poor riparian condition score.

This is a valuable reference reach for the Molonglo River, being upstream of the old Captains Flat mine, but it continues to lack water quality data due to the absence of a volunteer. Thus, only waterbugs and riparian condition surveys are contributing to the overall CHIP score again this year.

Stonefly larvae (Plecoptera) are something of a rarity in the Molonglo catchment, and they are highly sensitive to many types of pollution. Of the ten waterbug surveys across the Molonglo catchment which found stonefly larvae, only five or less stoneflies were detected. This reach, however, had large numbers of them, with 40 found in the autumn survey and 350 in spring.

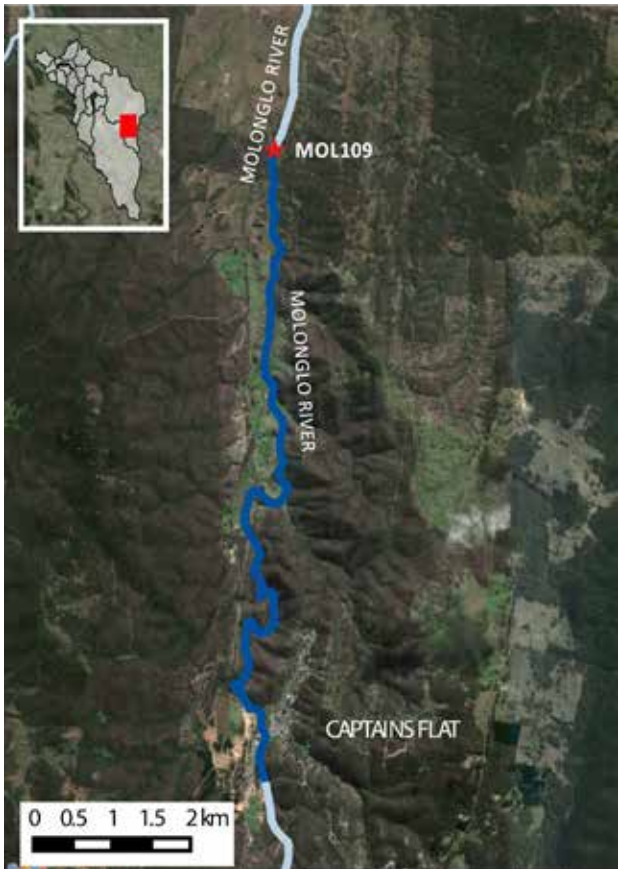
The reach also had a rich diversity of other waterbugs, with large numbers of other sensitive types and a variety of tadpoles caught in the waterbug surveys. This reflects the good waterbug habitat provided by dense in-stream vegetation, diverse water-edge plants and a large old Eucalyptus tree giving shade and shelter to the site.

A diversity of in-stream habitat contibutes to the variety and abundance of waterbugs detected at MOL030.

Molonglo River MOL2

Captains Flat to Travelling Stock Reserve

2020 CHIP Result A- (Excellent)		
2019 CHIP Result B (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**11 (1 dry)**
pH	Good	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	**Good**	**2**
Riparian condition	**Excellent**	**1**



Reach Facts

Reach network length: approx. 10km
Dominant land uses: Grazing, rural residential, mining (historical)

The upstream section of this reach of the Molonglo River begins below the Captains Flat Dam. Leachate from a mine closed in the 1960s continues to contaminate the river with acid minewater and potentially with heavy metals. The Molonglo flows mostly through modified rural land and finishes at the Travelling Stock Reserve (TSR) at Foxlow.

This reach had the only *excellent* riparian condition score in the Molonglo catchment but, with only one site, this score is not representative of the majority of the reach. It does, however, indicate the importance of this TSR in providing essential habitat and refuge for birds and other animals. It is also a vital connection to Yanununbeyan National Park which extends into higher altitudes. Waterwatchers Wendy and Steve often comment on the rich variety of woodland birds in this important TSR haven.

The reach received one of the best waterbug scores in the Molonglo catchment this year, after being one of the worst last year. After record low flows in 2019, the rainfall helped bring back the waterbugs in abundance, with pollution-sensitive stoneflies found in both autumn and spring surveys.

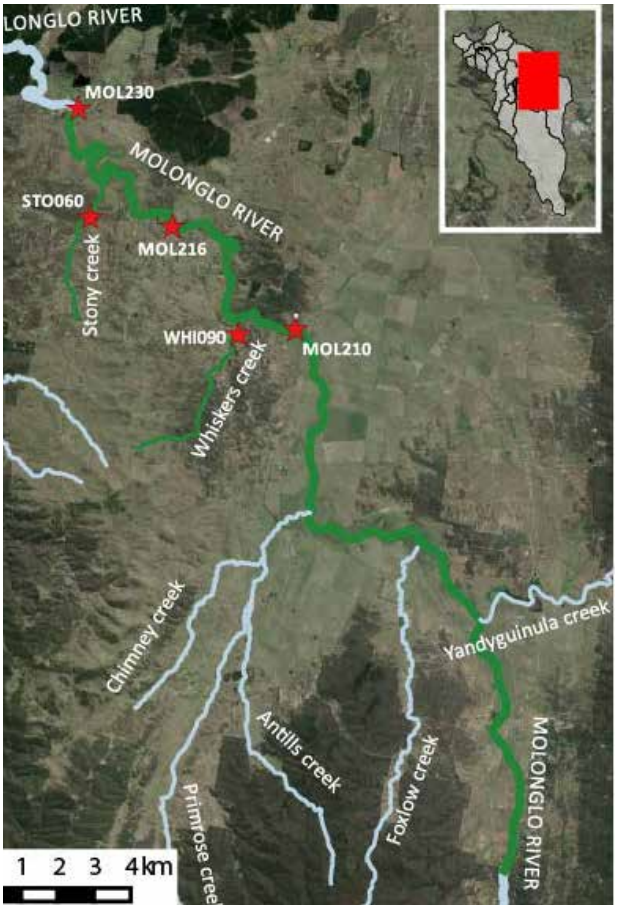
Interestingly, *"Certain ... stonefly families such as the Gripopterygidae and Notonemouridae,... are tolerant of metals even though they are sensitive to many other forms of pollution"* according to the waterbug (SIGNAL2) user manual. This may explain the presence of both aforementioned types of stonefly in a reach immediately downstream of the old Captain's Flat mine.

Waterwatcher Wendy sampling at MOL109 after floods in August 2020 (Photo: S. Hodgman).

Molonglo River MOL3

Downstream of Travelling Stock Reserve near Foxlow

2020 CHIP Result B (Good)		
2019 CHIP Result B- (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**27 (1 dry)**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	**Good**	**2**
Riparian condition	**Fair**	**5**



Reach Facts

Reach network length: approx. 54km
Dominant land uses: Grazing, rural residential

This reach extends from below the Travelling Stock Reserve south of Foxlow to Burbong Bridge on the Kings Highway and flows through modified rural land and rural subdivisions. The reach includes Plains Creek, Whiskers Creek and Stony Creek, with runoff from the Hoskinstown Plain, which is a frost hollow and largely treeless.

Willows continue to re-establish along this reach, and riverside vegetation is often dominated by exotic species or absent for large stretches. Large rural properties with highly cleared landscapes dominate the main river channel, but some of the smaller creeks have better vegetation condition. Weeds at Burbong bridge, in the rail corridor, are varied and extensive.

Rabbits were also present in large numbers at Burbong Bridge, and extensive rabbit warrens combined with high flows resulted in new areas of erosion beside the river.

The smaller tributaries of Stony and Whiskers Creek often have some of the highest electrical conductivity (EC) results in the upper Murrumbidgee catchment (in excess of 1000µS/cm). After the rains came in February 2020, however, EC was roughly halved as the salts and minerals became more diluted.

All sites on the reach had slightly elevated phosphorus for much of the year, generally associated with higher turbidity. This may reflect the fact that stock have access to the waterways in this reach. Stock will trample and eat riparian vegetation, increasing muddy runoff and erosion as there is less vegetation to filter water running into the river.

Waterwatcher John at Burbong Bridge (MOL230), one of his seven (!) sites.

Molonglo River MOL4

Downstream of Burbong Bridge to Queanbeyan River confluence

2020 CHIP Result C+ (Fair)

2019 CHIP Result B- (Good)

Parameter	Rating	No. Survey
Water quality	**Good**	**8**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	**Good**	**2**
Riparian condition	**Poor**	**1**

Reach Facts

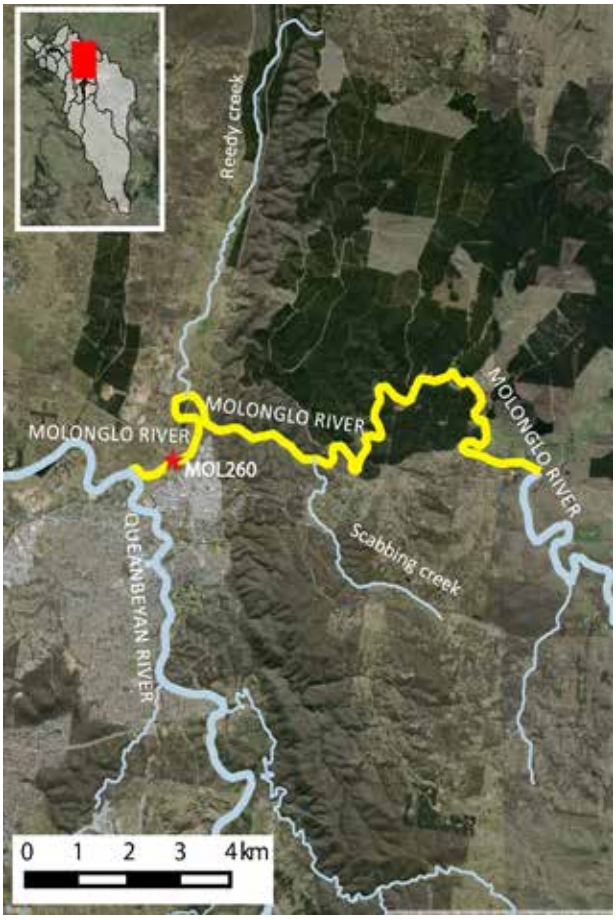
Reach network length: approx. 16km
Dominant land uses: Grazing, rural residential, forestry, conservation, urban

This reach begins downstream of the Kings Highway at Burbong Bridge on the NSW/ACT border, passes through the southern section of Kowen Forest pine plantation, and through Molonglo Gorge with its faster flows and intact native vegetation, and ends above the confluence with the Queanbeyan River at Oaks Estate.

Waterway restoration upstream of Yass Rd to Molonglo Gorge Reserve was undertaken as one of the ACT Healthy Waterways projects in 2019-20. The work included stock exclusion fencing, revegetation and weed control. Very dry conditions posed challenges for the revegetation works but plants were replaced and watered, and it is hoped that many will survive. If successful, these works will reduce erosion risk, filter runoff to improve water quality and improve habitat and connectivity with the Molonglo Gorge section of this reach.

In May 2020, a solvent spill from the East Queanbeyan Industrial Estate flowed via stormwater drains into the Molonglo River over two consecutive days. The spill extended at least 1.5km downstream to Oaks Estate bridge. Locals walking along the river below Oaks Estate reporting a strong smell and their eyes stinging from the pollution. The extensive cleanup involved NSW and ACT Environment Protection Authorities.

This reach is monitored at only one site and another volunteer to monitor an additional site upstream would greatly enhance our knowledge of this section of river.



Waterwatcher Jen helping out with the waterbug survey at Yass Road Bridge, MOL260.

Molonglo River MOL5

Upstream of Lake Burley Griffin

2020 CHIP Result C+ (Fair)		
2019 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**13**
pH	Excellent	
Turbidity	Fair	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**2**

Reach Facts

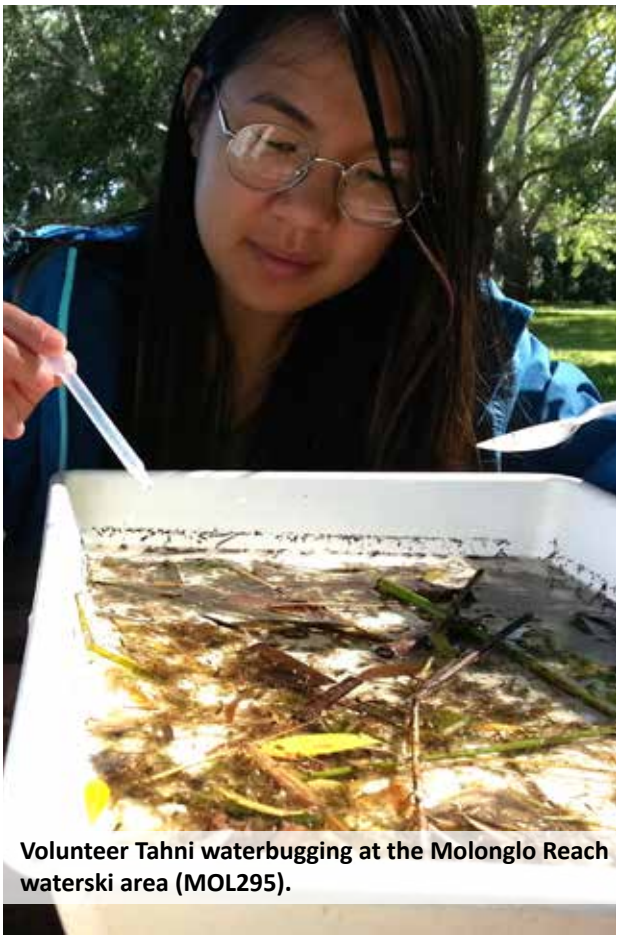
Reach network length: approx. 10km
Dominant land uses: Urban, industrial, horticulture, grazing

This section of the Molonglo River begins at the confluence with the Queanbeyan River at Oaks Estate. It borders on land dealing with a range of industry such as the Queanbeyan Sewage Treatment Plant, Fyshwick industrial estate, Pialligo nurseries and an extensive turf growing business. The river forms the northern boundary of Jerrabomberra Wetlands Nature Reserve before entering Lake Burley Griffin. Much of the water in this part of the Molonglo River is backed up and slowed down by the presence of Scrivener Dam on Lake Burley Griffin, an area commonly known as the Molonglo Reach.

Waterway restoration work in 2019 in the upstream section of this reach included revegetation and weed control as part of an ACT Healthy Waterways project. Downstream, there is a good, if somewhat limited, diversity of aquatic plants on the river banks at the lower Waterwatch site (MOL295), as well as the presence of ribbon weed.

Two fires in January 2020 burned an area of grassy woodland between Pialligo and Oaks Estate. Dark water noted during both waterbug surveys may have been related to ash from the fires, as well as increased organic matter such as leaves washed into the river from higher rainfall. This breaks down to produce natural dissolved organic acids, resulting in darker water, often described as tea coloured.

There were many of the feral fish Eastern gambusia found in the autumn waterbug survey, and small Carp fingerlings were noted in November and December.



Volunteer Tahni waterbugging at the Molonglo Reach waterski area (MOL295).

Molonglo River MOL6

Scrivener Dam to below Deep Creek confluence

2020 CHIP Result C+ (Fair)		
2019 CHIP Result B- (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**20**
pH	Excellent	
Turbidity	Fair	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Fair	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**3**

Reach Facts

Reach network length: approx. 10km
Dominant land uses: Urban, grazing, conservation

This section of the Molonglo River extends from downstream of Lake Burley Griffin to below the Deep Creek confluence, due south of Kama Nature Reserve. This reach encompasses extensive and ongoing Molonglo Valley urban developments and the Molonglo River Reserve runs its entire length.

As the development of the suburb of Whitlam continues, high turbidity was observed on several occasions by the Waterwatch volunteers flowing down Deep Creek and into the Molonglo River at MOL375. Extreme turbidity of 100-400+ NTU was recorded on three separate occasions at this site in 2020 and were reported to the Environmental Protection Agency. Such inputs of sediment have many adverse effects on rivers including smothering the rocky river substrate where many waterbugs live. Waterbugs are the main food source of Platypus and native fish such as Murray cod - both are which are found in this reach.

Littering and dumping of building waste is reported by volunteers as a growing problem at Coppins Crossing.

Huge amounts of large woody debris was wahed down the river during 2020 and built up against rocks and trees at MOL375. Flooding pushed this log jam over small to medium Casuarina trees growing in the channel and flattened many in the process. The channel is now wider in places, with banks and bars washed away by high flows.

This reach contains one of the sites where annual Platypus Month surveys are conducted by Waterwatch. Two Platypus and two Rakali were recorded here during August 2020.

High turbidity flowing from Deep Creek into the Molonglo River at MOL375, October 2020.

Molonglo River MOL7

Deep Creek confluence to Murrumbidgee River confluence

2020 CHIP Result C (Fair)		
2019 CHIP Result C (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Fair**	**10**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Poor	
Nitrate	Degraded	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Fair	
Waterbug	**Poor**	**2**
Riparian condition	**Fair**	**1**

Reach Facts

Reach network length: approx. 16km
Dominant land uses: Urban, infrastructure, grazing, conservation

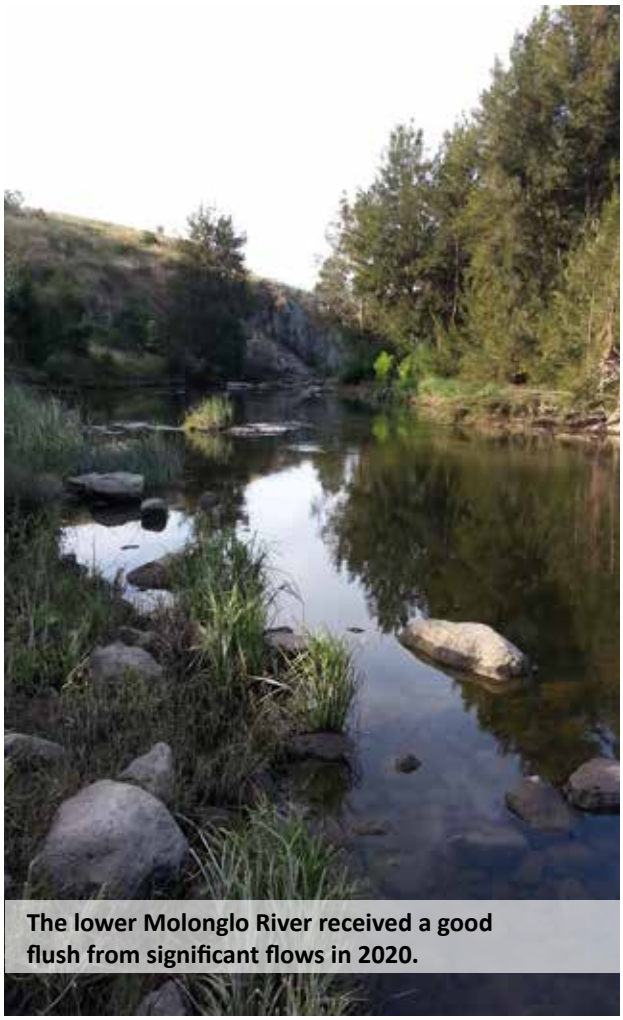
This reach on the Molonglo River extends from below Deep Creek confluence to the Murrumbidgee River confluence. This reach includes the Molonglo River Reserve and the Lower Molonglo Water Quality Control Centre (LMWQCC) just above the confluence.

The reach is strongly impacted by outflows from the LMWQCC, with nitrate levels much higher than upstream and most other sites in the catchment (3-55 mg/L). Nitrate receive a rating of *degraded* at this reach as do the next two reaches downstream on the Murrumbidgee River CMM11 and 12).

Electrical conductivity was also much higher than the next site upstream (range 210-690µS/cm), and phosphorus levels were frequently high with five *poor* or *degraded* readings over the year (0.01-0.12mg/L).

Water temperatures usually remain high here over the cooler months due to the warm treatment water being released. That said, it had a lower minimum temperature than previous years (min 12.5°C in August) most likely due to the significant increase in rainfall in 2020. The consistently higher water temperature and nutrients are the likely cause of a buildup of various types of algae, which is only occasionally flushed out by higher flows.

The waterbug surveys were *poor* overall with a low diversity of main types. That said, there is often a high diversity within Orders with at least five different types of caddisfly detected. This favouring of particular types over others can at times indicate a water quality issue. Other unusual waterbugs were also detected such as very large black riffle beetle larvae as well as Macrobrachium freshwater prawns.



The lower Molonglo River received a good flush from significant flows in 2020.

Primrose Creek PRI1

Headwaters to Molonglo River confluence

2020 CHIP Result B- (Good)		
2019 CHIP Result B- (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**19**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Degraded	
Waterbug	**Good**	**2**
Riparian condition	**Poor**	**2**

Reach Facts

Reach network length: approx. 34km
Dominant land uses: Conservation, grazing, rural

Primrose Creek is a chain of ponds flowing mostly through rural land. Its headwaters are in Yanununbeyan State Conservation Area and Mount Foxlow. It includes Chimney Creek and Antills Creek, and flows into the Molonglo River near Carwoola. The lower section of Primrose Creek is actively eroding. With the exception of the headwaters of Primrose Creek and Antills Creek, there is little or no native riparian vegetation, and just a scattering of exotic trees.

High electrical conductivity is associated with low flows in these ephemeral streams, resulting from the geology and hydrology of the local area as well as extensive historical land clearing.

There are frequently horses, cows and sheep in or near the creeks, potentially causing erosion, damaging in-stream vegetation and reducing water quality.

Despite all this, Primrose Creek itself has diverse aquatic vegetation and is often teeming with life. The Spring waterbug survey, for example, saw three types of mayfly nymphs, five types of caddisfly larvae and six types of water beetles. It is one of few sites in the Molonglo catchment with scuds (Amphipoda), sometimes present in large numbers.

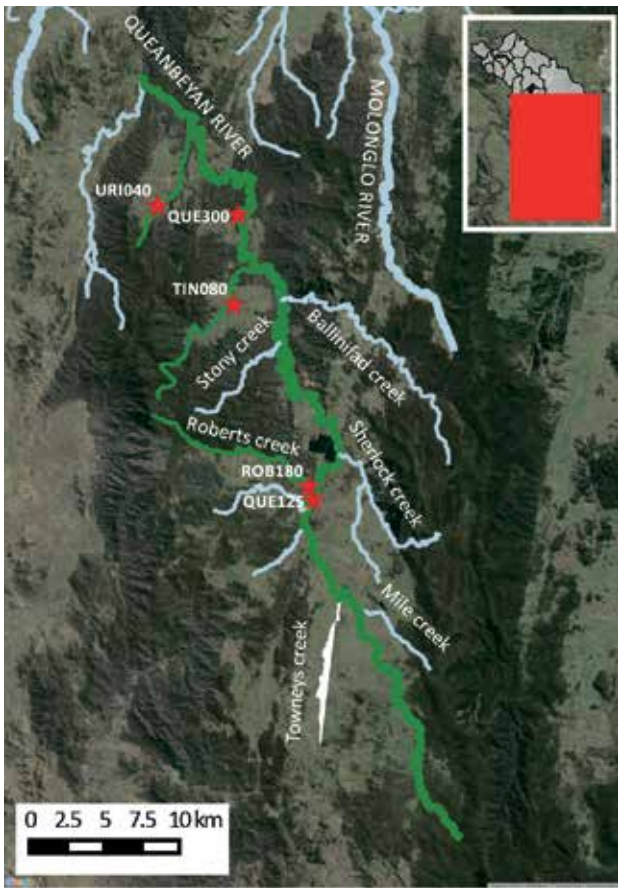
An Eastern long-necked turtle and Mountain galaxias (small native fish) have been observed here in previous years. Volunteer Nick also photographed a pale tiger snake (from a safe distance) as it entered the water at Chimney Creek in November. Nick also noted hearing multiple frog species calling – possibly explaining the presence of said snake.

Tiger snake observed at Chimney Creek in November 2020 (photo: N. Loades).

Queanbeyan River QUE1

Upstream of Googong Dam

2020 CHIP Result B (Good)		
2019 CHIP Result B+ (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**51 (0 dry)**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Degraded	
Waterbug	**Good**	**2**
Riparian condition	**Fair**	**5**



Reach Facts

Reach network length: approx. 143km
Dominant land uses: Conservation, grazing, rural residential

This reach is the largest in the catchment. The upper section of the Queanbeyan River runs from its origins on the southern slopes of the western Tinderry Ranges to Googong Dam in the north. The reach includes Sherlock, Urialla, Tinderry, Lyons, Roberts and Bradleys creeks.

Despite widespread heavy rainfall in February, the creeks in this reach almost ceased to flow again in April, after being dry for most of the previous two years. Only the Queanbeyan River flowed well from February onwards.

There were several floods over the year, but happily Sandy at the downstream site (QUE300) noted in Novmber that they still had their "*resident Platypus which made my day - pristine scene!*"

A concern in this upper reach of the Queanbeyan River is the increasing number of higher phosphorus (P) readings, despite an overall rating of *excellent*. One potential source of high P is runoff from rural enterprises. High P was detected, in both clear and muddy conditions, at the upstream river site (QUE125), on Tinderry Creek (TIN080) as well as further downstream.

The dissolved oxygen has dropped from *excellent* to *degraded* this year. This may be due to an increased build-up in organic matter over the dry period being flushed into system, which in turn produces bacteria that consumes oxygen.

This reach is exceptional in having no Carp, but there were continuing signs of feral deer during 2020.

Waterwatch Coordinator Martin shows his mussels during the spring waterbug survey at QUE300.

Queanbeyan River QUE2

Downstream of Googong Dam to city of Queanbeyan

2020 CHIP Result B (Good)		
2019 CHIP Result B+ (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**38 (3 dry)**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Excellent	
Waterbug	**Fair**	**2**
Riparian condition	**Fair**	**4**

Reach Facts

Reach network length: approx. 6.7km
Dominant land uses: Urban, rural residential

This section of the Queanbeyan River extends downstream from Googong Dam to the edge of Queanbeyan city. Googong, Montgomery and Gorge Creeks near the Googong township, feed into this reach and have their own Waterwatch sites. Googong Creek (GGG1) is treated as a separate reach in this report. The Valley Creek flowing out of Cuumbuen Nature Reserve also feeds into this reach.

The Queanbeyan River here receives water from Googong Reservoir. It had good flows in 2020 with the dam overflowing for some of the year and all the tributaries running from February onwards. This reach received a near perfect score for water quality, with one exception, electrical conductivity. This is in part owed to both Montgomery and Gorge Creeks which regularly have high conductivity, suspected to be associated with the underlying geology.

There was sediment pollution events in October and November, with turbid plumes coming down Googong Creek into the Queanbeyan River, measuring 90 and 100NTU respectively . Googong Creek has extensive development occurring at the top of the sub-catchment and when not properly contained, continues to put pressure on our waterways.

Platypus are regularly sighted in this reach and such high levels of turbidity reduce available habitat for their prime food source – waterbugs. Many waterbugs live in the small rock crevices along these cobbly-bottomed rivers and cannot persist there when sediment clogs up these crevices.

A plume of turbid water flowing into the Queanbeyan River from Googong Creek, November 2020.

Queanbeyan River QUE3

Queanbeyan city to Molonglo River confluence

2020 CHIP Result B- (Good)		
2019 CHIP Result B- (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**27**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Good	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**3**

Reach Facts

Reach network length: approx. 9.4km
Dominant land uses: Urban

This section of the Queanbeyan River extends through the city of Queanbeyan to its confluence with the Molonglo River. It takes runoff from township of Queanbeyan, the Cuumbeun Nature Reserve and the eastern slopes of Mt Jerrabomberra. The reach includes Barracks Creek and the Queanbeyan Weir.

A large new bridge over the Queanbeyan River in the upstream section of this reach, a long-planned bypass of Queanbeyan city, was opened during the year. The new road bisects relatively undisturbed bushland, and disconnects some riparian habitat.

Frog species have declined considerably over successive years, with several species not being detected in this reach in recent times. It will be important to monitor this section of the Queanbeyan River for potential impacts as it holds some important ecological values such as some Frogwatch sites with relatively high abundance and diversity.

River vegetation condition along the reach is variable. There are, however, native plantings continuing in the lower part of the reach which may improve the riparian condition score over time. These include planting and weeding done near Oaks Estate as part of an ACT Healthy Waterways project in 2019.

Platypus and Rakali (native Water rats) are seen regularly in this reach. Waterwatch runs Platypus walks for the public here every year, and the reach now contains one of eight sites where annual Platypus Month surveys are run by Waterwatch. Five Platypus and three Rakali were recorded at surveys during August (see summary of Platypus Month 2020 at the end of this report).

Perfect conditions on the Queanbeyan River for Platypus spotting, August 2020.

Scabbing Flat Creek SCA1

Headwaters to Kings Highway

2020 CHIP Result A- (Excellent)		
2019 CHIP Result DD (Data Deficient)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**8 (2 dry)**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Good	
Waterbug	**No Data**	**0**
Riparian condition	**Good**	**1**

Reach Facts

Reach network length: approx. 5.1km
Dominant land uses: Conservation

Scabbing Flat Creek is an ephemeral creek (intermittently flowing) which arises in Cuumbeun Nature Reserve. The name Queanbeyan is thought to be derived from Cuumbeun, an Indigenous name for the area. Most of the catchment is in the Nature Reserve, which is high value Grassy Box Woodland, an endangered ecological community. The Reserve is located on the escarpment to the east of the Queanbeyan valley and bisected by Captains Flat Road. The Kings Highway marks the northern edge of the Reserve and the creek flows in a concrete culvert under the Kings Highway, where it eventually flows into the Molonglo River beyond this reach.

With access to the downstream end of the site largely restricted, the dumping problems of previous years are much reduced, and only the rubbish from earlier years and the council roadwork piles remain.

It was wonderful to see this lovely creek flowing for much of 2020, after being dry for almost all of the previous two years. Flows returned in February and Waterwatcher John noted three different species of frog calling including the Spotted grass frog *Limnodynastes tasmaniensis*. When this creek does flow, water quality is very *excellent*. This reach has a good, intact riparian corridor and these layers of vegetation help filter the water, keep the water temperature stable, the dissolved oxygen on average over 80% saturation and the nutrient levels low.

Such a small ephemeral creek is too small and fragile to sample waterbugs.

Scabbing Flat Creek in Cuumbeun Nature Reserve, December 2020.

Sullivans Creek SUL1

Headwaters to Randwick and Flemington Road Pond, Mitchell

2020 CHIP Result C+ (Fair)		
2019 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**19**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Fair	
Nitrate	Good	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**2**

Reach Facts

Reach network length: approx. 6km
Dominant land uses: Conservation, grazing (historical), industrial

Sullivans Creek originates in Goorooyarroo Nature Reserve, flowing through historical grazing land then into a concrete stormwater channel. It then flows through the new suburb of Kenny, west of Watson, and adjoins the industrial area of Mitchell where it includes the stormwater channel from Exhibition Park (EPIC) and flows through two constructed wetlands. The two Waterwatch sites are located at the inflow and outflow of the most downstream of these wetlands (Flemington Pond).

Rubbish continues to be a significant issue in Flemington Pond with one volunteer this year noting "So much litter, hundreds of plastic bottles." Despite this, there is generally a good diversity of water birds using the wetland, however the potential impact of rubbish on wildlife is concerning, with wildlife entanglements an ongoing danger.

Flemington Pond continued to have issues with phosphorus and nitrate, with high levels detected flowing into the pond from upstream. There is some reduction in both nutrient parameters at the downstream site (SUL018) but levels are still at times falling only into the *fair* to *poor* categories. These high concentrations most likely contributed to the large amounts of filamentous algae observed at the pond during the spring waterbug survey.

High numbers of mites and flatworms were a feature of both spring and autumn waterbug surveys, with mites being the most sensitive type found. There were also leeches, which are very tolerant of pollution.

Rubbish washing off the industrial area of Mitchell is an ongoing issue at Flemington Pond.

Sullivans Creek ANU SUL3

Lyneham Wetland to Lake Burley Griffin confluence

2020 CHIP Result C (Fair)		
2019 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Fair**	**13**
pH	Excellent	
Turbidity	Fair	
Phosphorus	Degraded	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**3**

Reach Facts

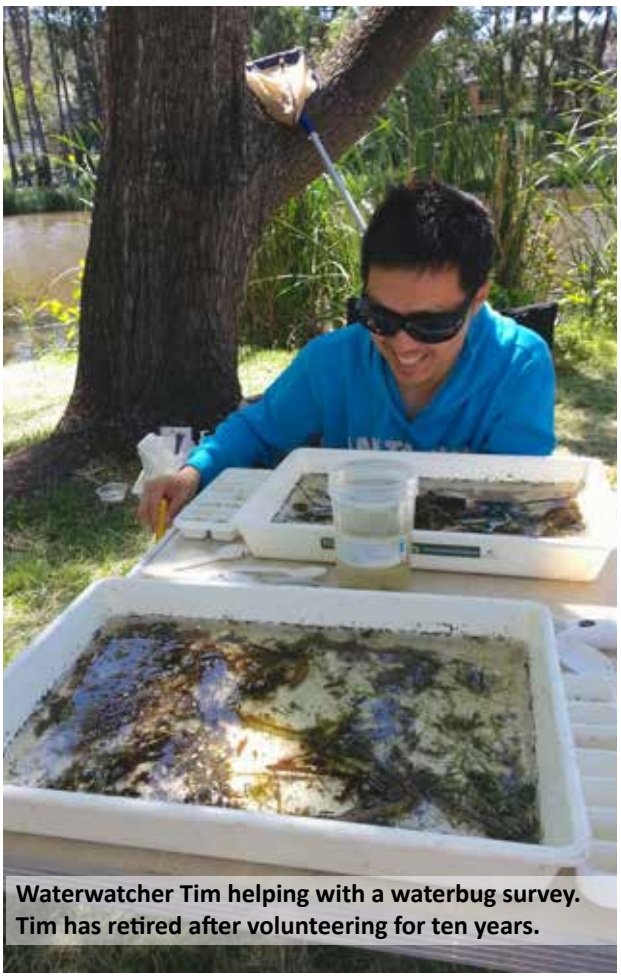
Reach network length: approx. 3.7km
Dominant land uses: Urban, recreation

Once known as Ngambri Creek, this section of Sullivans Creek flows into a concrete channel through playing fields and parklands in O'Connor and Turner. It crosses under a number of minor roads and through the Barry Drive gross pollution trap, before entering the ANU campus. It passes Toad Hall Pond before continuing through the campus, flowing through some short reed-filled sections and on into Lake Burley Griffin. Large new developments have begun along the creek through the ANU, though much of it was on hold over 2020.

Feral fish are regularly recorded in the lower section of Sullivans Creek, with Carp observed spawning and Eastern gambusia seen in large numbers. On a better note, a native fish, Western carp gudgeon, are also common and there are regular sightings of Rakali (native Water rats).

High phosphorus is a continuing problem in this reach, increasing the potential for algal blooms in Lake Burley Griffin. Extreme phosphorus in excess of 0.35mg/L was regularly recorded (*degraded* levels of phosphorus are measurements >0.08mg/L). Water quality in this large urban catchment could be improved if more sections of the creek supported vegetation or were filtered through functioning wetlands.

Long time Waterwatcher Tim has retired after monitoring all three sites in this reach for ten years. We thank him for making such a contribution to the Waterwatch dataset and for improving our understanding of the lower Sullivans creek catchment. If you would be interested in monitoring in this reach, please get in touch with Waterwatch.



Waterwatcher Tim helping with a waterbug survey. Tim has retired after volunteering for ten years.

Watson Wetlands and Ponds WAT1

Justice Robert Hope Park to Aspinall Street

2020 CHIP Result B- (Good)		
2019 CHIP Result B (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**12**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Poor	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**2**

Reach Facts

Reach network length: approx. 1.4km
Dominant land uses: Conservation, urban

Watson Wetlands and ponds are on the lower western slopes of Mt Majura nature reserve They comprise a drainage line, with two dams, in remnant yellow box/red gum grassy woodland at Justice Robert Hope Park, which overflow during high rainfall. Further down, a small constructed wetland receives runoff from the adjacent suburb, and a small wetland soak takes overflows at the bottom of the reach. It is at these two most downstream wetlands where the water sampling is conducted. The water then flows via pipes into Sullivans Creek.

The lower site (WAT040) was dry in January for the first time since our records started in 2010, towards the end of the milennium drought. The upstream site, the adjacent North Watson Wetlands (WAT010), does not support the diversity of water plants or waterbugs that the more natural ephemeral pond does.

Four types of frogs were heard calling at WAT040 in September, where wide swathes of diverse aquatic and edge vegetation providing good frog habitat. Aquatic submerged plants at this site include curly pondweed (Potamogeton sp.) and water milfoil (Myriophyllum sp.), which were flowering profusely in November.

Unfortunately, large numbers of the feral fish, Eastern gambusia, were observed in both ponds during the warmer months. These fish are known to predate on frog eggs and tadpoles and can limit frog breeding success, particularly in areas with poor refuge habitat for tadpoles. Given the diversity of habitat mentioned in WAT040, it is hoped the frogs bred successfully.

A good range of native vegetation is a feature of the lower Watson wetland (WAT040).

Weston Creek WES1

Headwaters to Molonglo River confluence

2020 CHIP Result C+ (Fair)

2019 CHIP Result C+ (Fair)

Parameter	Rating	No. Survey
Water quality	**Good**	**19**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Poor	
Nitrate	Good	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**2**

Reach Facts

Reach network length: approx. 6.7km
Dominant land uses: Urban

This reach includes drainage from the western side of Mt Taylor, and Stirling Ridge. It flows in a concrete stormwater channel through the Canberra suburban area of Weston Creek before entering ponds on the south-east edge of the new Molonglo Valley suburban area. It then passes close to the eastern side of Coombs, where development is nearing completion, and on to the confluence with the Molonglo River.

Varying amounts of water at the downstream site (WES450) come from underground storage south-east of the creek. This flows out into a small pool and on through a dense reed bed before flowing down a more natural, narrow channel to the Molonglo River. Upstream of the pool, a concrete channel carries any overflow water from the large connected ponds beside Cotter Road.

As with similar urban catchments, flows can vary considerably, with evidence of short term, high flows after heavy rain. Another problem of urban catchments, litter is now regularly reported around both sites by Waterwatcher Gail. Gail also makes notes on birds observed each month such as the "*Coots have cootlings*", as well mentioning the frogs and other aquatic life.

Phosphorus is an ongoing concern in this reach as well as spikes in nitrate, increasing the chances of algal blooms.

An illegal yabby trap was pulled from the upstream pond in December. These traps frequently drown Platypus, Rakali and turtles.

Site WES450 with the suburb of Coombs in the background. Note blue-green algae on the waters edge.

Woolshed Creek WOO1

Headwaters to Molonglo River confluence

2020 CHIP Result C+ (Fair)		
2019 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**14**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**2**

Reach Facts

Reach network length: approx. 19km
Dominant land uses: Rural, urban, site of Majura Parkway

Woolshed Creek originates at a farm dam situated over a spring. It flows through highly modified rural land with some native riparian vegetation in the upper sections and some significant waterholes. Two short sections of the creek were moved to make way for Majura Parkway. The creek joins the Molonglo River near Fairbairn Avenue, just upstream of Lake Burley Griffin. Lower Woolshed Creek has an important fossil site with rare Silurian Period fossil beds.

Given its hydrogeology and extensive historical land clearing, the Majura Valley has salt outbreaks in the landscape which can strongly affect electrical conductivity in the creek. There are signs of yabbies at the downstream site and Eastern water dragons are sometimes seen.

This reach has the poorest vegetation condition score in the Molonglo catchment. In addition, a very busy road system adjacent to the downstream site presents challenges for this small but ecologically important creek. Rubbish washes in from road drains and there is considerable dust and fumes with the high volume of traffic.

Native plantings conducted in recent years upstream may help to reduce salt loads over time, but plantings along much more of the creek and its tributaries would greatly improve habitat, flow regimes and water quality. Having said that, there are many sections of the reach with dense in-channel vegetation, though the plant diversity is limited.

Woolshed Creek (WOO090) and the fossil site below Fairbairn Ave and Majura Parkway.

Yandyguinula Creek YAN1

Headwaters to Molonglo River confluence

2020 CHIP Result B+ (Good)		
2019 CHIP Result B (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**17 (1 dry)**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Degraded	
Waterbug	**Good**	**2**
Riparian condition	**Good**	**2**

Reach Facts

Reach network length: approx. 18km
Dominant land uses: Conservation, grazing, wetlands

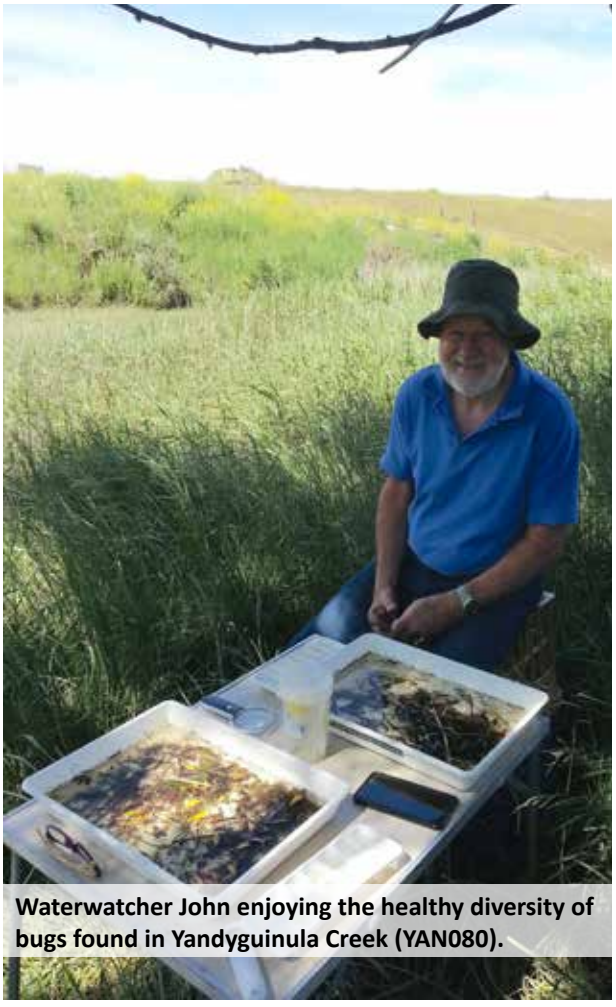
Yandyguinula Creek is an ephemeral tributary of the Molonglo River, with the confluence on Foxlow near Hoskinstown. It arises in Tallaganda National Park on the western side of the Great Dividing Range and flows into modified rural land with little or no riparian vegetation other than Willows. Near its confluence with the Molonglo River, it passes through an extensive wetland area which supports a significant bird population.

In October, volunteer John was sampling water at the upstream site (YAN020) when he was "*stunned and enchanted*" when a lyrebird started calling from about 15 metres away. He also heard a cicada-bird, which he said were migrating through the area at that time of year.

This upstream site, is situated in Tallaganda State Forest and enjoys a beautiful, intact riparian zone and near pristine water quality. The downstream site, however, shows more of the effects of human impacts with less complexity along the creek's edge, dissolved oxygen levels being lower and electrical conductivity readings creeping upwards.

Whether wet or dry, frogs were heard calling throughout much of the year at the lower site, with up to four species heard in spring. Frogs were also heard over several months at YAN020, where they have not been recorded for the past two years due to the dry conditions.

An Eastern long-necked turtle was also observed sliding into the water across the creek in April.



Waterwatcher John enjoying the healthy diversity of bugs found in Yandyguinula Creek (YAN080).

Yarralumla Creek YAR1

Headwaters to Molonglo River confluence

2020 CHIP Result C+ (Fair)		
2019 CHIP Result B- (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**19**
pH	Excellent	
Turbidity	Excellent	
Total Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	**Poor**	**2**
Riparian condition	**Fair**	**3**

Reach Facts

Reach network length: approx. 9km
Dominant land uses: Conservation, urban

Yarralumla Creek includes three drainage lines which run largely in concrete channels, one along the west side of Mt Mugga Mugga, one from Farrer to Phillip, and one from Long Gully to Garran. The reach also includes East O'Malley Pond. Yarralumla Creek then runs parallel with Curtin in a concrete stormwater channel and down to the Molonglo River, immediately below Scrivener Dam.

Various ACT Healthy Waterways projects were undertaken upstream on the network of concrete channels, aiming to reduce high flows and provide better filtration of sediment and nutrients. These projects were completed in 2019 but will take several years to be fully functional, as plants grow and establish

A highly altered section of the creek around Cotter Road (at downstream site, YAR400), is one of the above-mentioned project sites. This area had suffered serious erosion over many years and has been gabion-lined with a staggered series of rock groynes to slow the water and reduce the scouring of the channel.

It was good to welcome back volunteer Mike, who returned to O'Malley Pond (OMA075, OMA090) testing in August.

Water quality parameters at the downstream site varied wildly, depending on flows coming off this highly urbanised area with electrical conductivity up to 830µS/cm, nitrate as high as 7mg/L and phosphorus up to 0.1mg/L. The spring waterbug survey detected ten main Orders but most of these were pollution-tolerant with large numbers of snails and leeches in the sample.

ACT Healthy Waterways infrastructure on Yarralumla Creek, looking upstream at YAR400.

Southern ACT Catchment Facts

For the purposes of this report, the Southern ACT area is divided into eight main sub-catchments which are the Murrumbidgee River, Naas River, Gudgenby River, Cotter River, Paddy's River, Lake Tuggeranong, Point Hut Ponds and Guises Creek.

The Naas and the Gudgenby River systems are at the highest elevation in the ACT and originate in the mountains of the Namadji National Park. The Cotter River provides our main drinking water supply and flows north, adjacent to the Brindabella Ranges. Paddy's River is a smaller rural waterway flowing to the west of the Bullen Range, past forestry land and grazing properties to the immediate west of Canberra.

The Lake Tuggeranong and Point Hut Ponds systems receive water from urban waterways flowing west into the two lakes. The Lake Tuggeranong infrastructure consists of pipes and concrete channels. The Point Hut Ponds were designed more recently and feature upstream wetlands and terraced, vegetated stormwater channels.

Guises Creek is a small, rural creek on the eastern edge of the ACT adjacent to the Monaro Highway.

Three new reaches are included from Southern ACT this year. These are the Upper Cotter River capturing the river above Corin Dam, the Orroral River, which has been split away from the Gudgenby River reach and the Naas River which is now split into two sections, one in the rural valley and one in the Namadgi National Park.

All of these waterways join the Murrumbidgee River in the ACT, which flows north from Angle Crossing, near Tharwa, to Uriarra Crossing, just before the Molonglo River confluence in the north west corner of the ACT.

Protecting and improving the aquatic habitats and species on the upper Murrumbidgee River is the focus of the Upper Murrumbidgee Demonstration Reach (UMDR) initiative. The UMDR works with many partners, including Waterwatch, and focusses in part on the Murrumbidgee main stem in Southern ACT (CMM7-10).

Southern ACT Catchment Health Summary

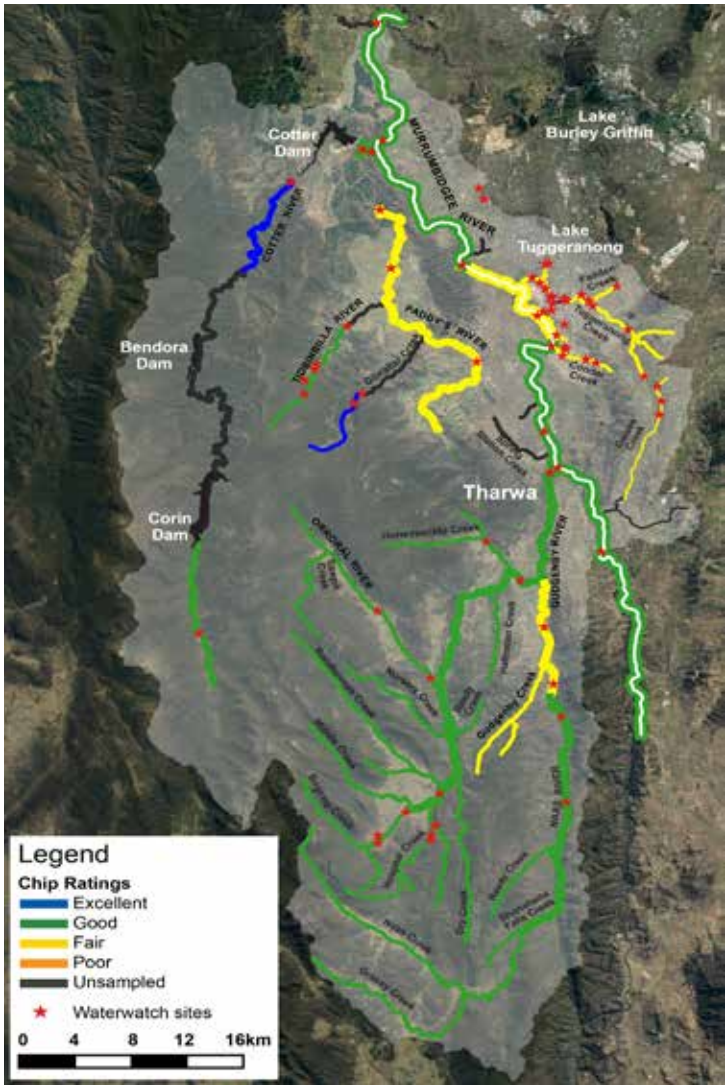
The Southern ACT catchments experienced a very mixed year with the end of an extended dry period in February, a bushfire, followed by significant rainfall. Seven months in 2020 received above average falls, the wettest being October (158mm).

Waterway health was heavily impacted by the summer bushfires which affected 15 out of 27 reaches in Southern ACT. The Orroral Valley bushfire started in late January 2020 in this catchment and burnt 80% of Namadgi National Park before it was extinguished. The higher than average rainfall mentioned above started in mid-February and had a devasting effect as heavy rains hit both fresh firegrounds and drought-stricken areas denuded of vegetation, washing ash, sediment and sand into the waterways.

Thus, the fires either impacted waterways directly, such as Gibralter, Bogong and Hospital creeks, or as a result of flood waters carrying ash and sediment downstream, such as on the Murrumbidgee, Tidbinbilla, Paddy's and the lower Gudgenby rivers. Thick deposits of fine, black ash covered the banks of many rivers and was remobilised every time flows increased, resulting in higher phosphorus concentrations and turbidity throughout the year. More details on the impacts of the fires is available in a special fire report written by the University of Canberra using Waterwatch data on pages 120-124 of this report.

Not all the phosphorus affecting water quality in 2020 was due to bushfires however. High concentrations were detected in urban waterways such as Isabella Pond, the middle of Tuggeranong Creek and Stranger Pond. Some could be attributed to heavy rains washing nutrients into the system in February after the extended dry and others are coming from unknown sources in the urban landscape. Identifying these sources and stopping them are critical if we are to tackle the blue green algae issue in Lake Tuggeranong.

While there were varied influences on the waterways of Southern ACT in 2020, the overall CHIP scores remained similar to last year. That said, many waterways had been filled and/or flushed by the end of the year and it is hoped that recovery will become more evident in 2021.



Barney's Gully MMB1

Woodcock Drive, Gordon to confluence with Murrumbidgee River

2020 CHIP Result C+ (Fair)		
2019 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**10 (1 dry)**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	**Poor**	**2**
Riparian condition	**Fair**	**1**

Reach Facts

Reach network length: approx. 1km
Dominant land uses: Peri urban, conservation and recreation

Barney's Gully is an ephemeral creek near Woodcock Drive, Gordon. This natural creek is connected to this suburb and flows into the Murrumbidgee just over a kilometre downstream of Point Hut Crossing. It is one of the last original clay bed creeks that form a chain of pools full of rushes, only flowing after periods of rain. Most others in the Tuggeranong valley were converted to concrete stormwater channels and/or dammed to form urban lakes.

This small creek is showing the positive effects of years of hard work by the Park carers of Southern Murrumbidgee (POSM). Leaky weirs and erosion control works have promoted abundant reeds and ground cover to support multiple species of frogs that are regularly reported calling in the reach.

That said, the native woody vegetation planted here, barely made it through the last drought with *"stressed and dying"* mature wattles, tea-trees and eucalypts noted throughout the gully in January.

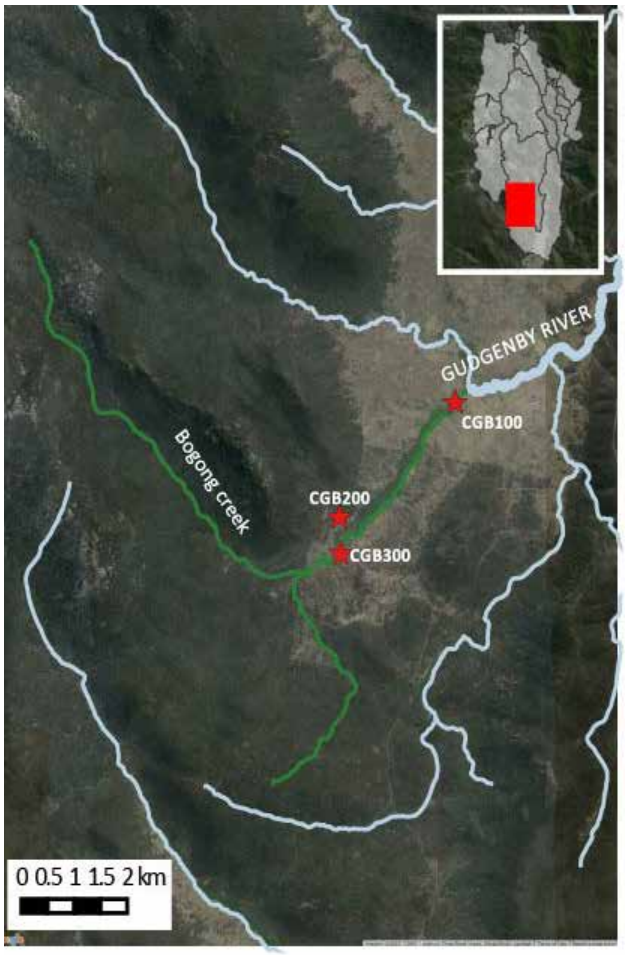
Clouds of *"fine, fluffy, slimy green algae"* were observed by Waterwatcher Deb in May and increased through the winter. By September this made the waterbug survey challenging and only seven Orders were found. Unfortunately there was no sign of the yabbies that have been seen in abundance in the past, although a crayfish symbiot, a type of flatworm that lives on yabbies, was detected in April.

Barney's Gully looking replenished by late 2020.

Bogong Creek Catchment BOG1

Headwaters to Yankee Hat trail bridge

2020 CHIP Result B (Good)		
2019 CHIP Result B+ (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**19**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Good	
Dissolved Oxygen	Degraded	
Waterbug	**Good**	**2**
Riparian condition	**Fair**	**1**



Reach Facts

Reach network length: approx 13km
Dominant land uses: Conservation

This reach is in the Namadgi National Park and is part of the Gudgenby River catchment. At its downstream end, the creek is a wide and mostly treeless upland creek/bog.

The overall water quality in this reach is *good* and the two bog sites often have clear, slow flowing water even in very dry conditions. Like other upland bogs, however, oxygen levels become depleted over the long, hot summer period. If no relief is provided by rain this will ultimately affect the abundance of many of the waterbugs found here, such as water snails and Calocidae caddisfly larvae ('shingle' caddis) which feed on rotting vegetation

Major sections of this creek's catchment were burnt by bushfires in February 2020. Volunteer Vance, leader of the Brindabella Venturers, described being "shocked" after seeing the fires and in particular *"the silting up of the southern Bogong site, where before there had always been that deep pool .. now barely a handspan deep."*

Riparian condition scored *fair* due to the complete loss of shrubs and forest debris at fire-affected sites. These are vital components of healthy waterway ecosystems. Herbaceous weeds were noted in high numbers by the end of the year.

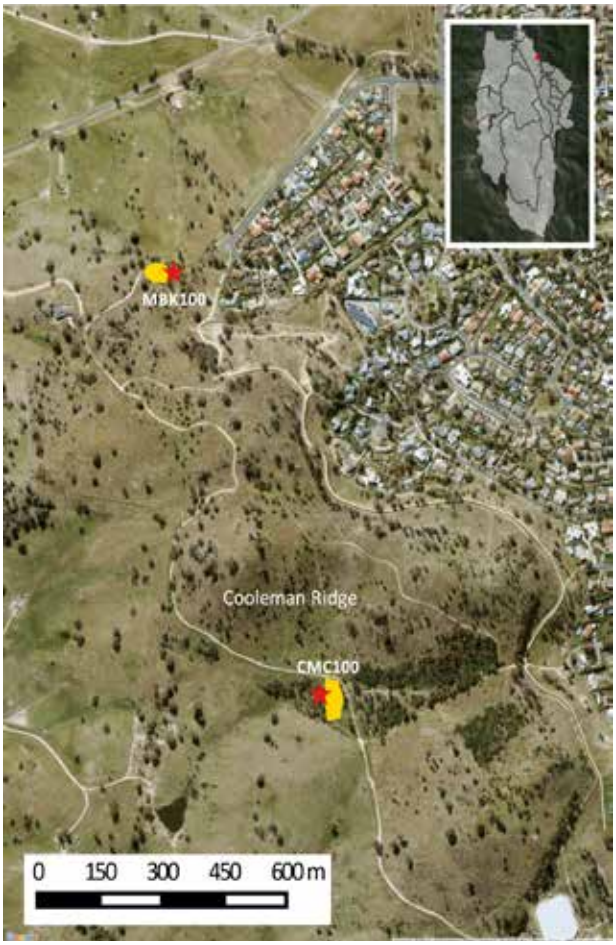
Dissolved oxygen levels remained low after the fires (as low as 2mg/L) and soluble nutrient levels rose. There was also a threefold increase in electrical conductivity between the upstream (50µS/cm) and downstream sites (150µS/cm).

Aerial photo of Bogong Creek with fire-affected terrain in the background (Photo: J. Lehane).

Cooleman Ridge Dams RAN1

Two dams on Cooleman Ridge

2020 CHIP Result C- (Fair)		
2019 CHIP Result D+ (Poor)		
Parameter	**Rating**	**No. Survey**
Water quality	**Fair**	**18 (2 dry)**
pH	Fair	
Turbidity	Fair	
Phosphorus	Degraded	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Degraded	
Waterbug	**Poor**	**2**
Riparian condition	**Poor**	**2**



Reach Facts

Reach network area: approx. Kathner Street Dam 0.05Ha, Old Dam 0.15Ha
Dominant land uses: Suburban reserve

Kathner Street Dam (MBK100) is a small dam in Cooleman Ridge Nature Park. It was made to provide water for horses as part of the bicentennial trail. The 'Old dam'(CMC100) is on the eastern slopes of Cooleman Ridge. In April 2019 stock exclusion fencing was installed around the Old dam. This year an off-watering site for stock was established.

Both dams were dry at the start of the year. When water returned, significant amounts of nutrient and organic matter was washed into these small water bodies. Phosphorus (P) concentrations were measured at >1.0mg/L - beyond the range of even the high range P kits. Turbidity was 80NTU in the Kathner dam and 150NTU in the Old dam and electrical conductivity (EC) was as high as 1180µS/cm. Dissolved oxygen could not be detected at either of the dams that month.

Water quality improved after the dams filled and regular rain runoff continued to flush the dams. That said, the dissolved oxygen levels remained low and P continued to be well above *degraded* concentrations. EC reduced because of dilution from regular rainfall and improved from *degraded* last year to *good* in 2020.

Given the dams had been dry for so long, it was a surprise to find any life for the autumn waterbug survey, where seven Orders were found. The spring survey showed continued improvement with nine Orders detected including caddisfly larvae and several needle bugs.

Kathner Street Dam (MBK100), Cooleman Ridge starting to refill in March 2020.

Cotter River COT1

Headwaters to Corin Dam

2020 CHIP Result B (Good)		
NEW REACH		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**3**
pH	Good	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Good	
Waterbug	**Fair**	**1**
Riparian condition	**Fair**	**1**

Reach Facts

Reach network length: approx. 12km
Dominant land uses: Drinking water catchment and conservation

This reach covers the headwaters of the Cotter River above Corin Dam in the Bimberi wilderness area. Much of this catchment is dominated by a low eucalyptus canopy (under seven metres). Access to the public is restricted as this reach forms part of the ACT's main drinking water supply. Monitoring began in September 2020 and is conducted by ACT Parks and Conservation staff. Feral deer are a significant issue.

The surrounding catchment was affected by fire in February 2020. All layers of vegetation were burnt with the understorey (shrubs), logs, and most of the leaf litter debris significantly reduced as a result. Epicormic regrowth from surviving trees was only beginning to emerge in September. Pleasingly, many native shrub seeds survived the fires and signs of regeneration were also observed.

The water quality was surprisingly good given the fires but 2021 will give a better indication when all the seasons are monitored. The waterbug survey was less promising with low diversity (only six Orders found) and low numbers overall. More than half the sample consisted of the pollution-tolerant blackfly larvae.

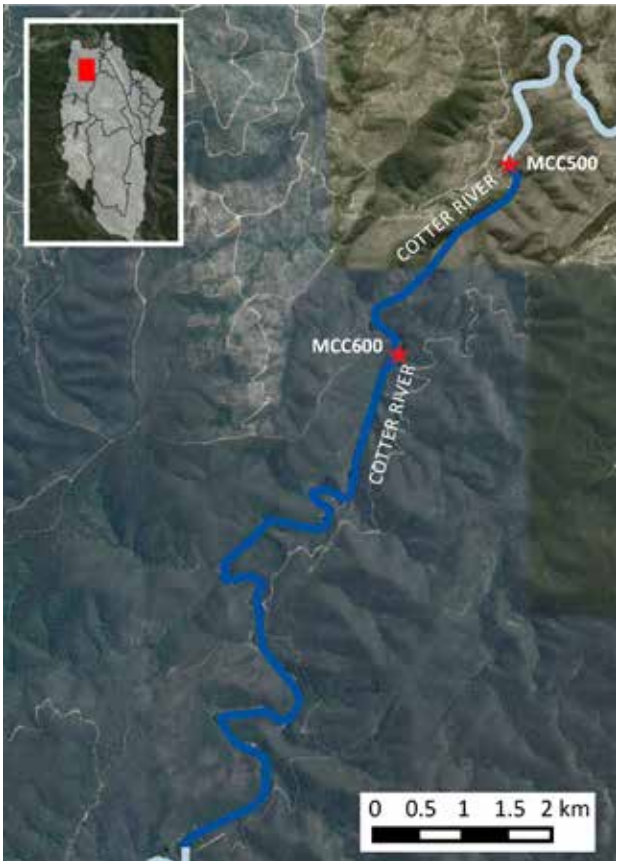
A survey of the vulnerable Two-spined blackfish was conducted in this reach after the fires by ACT Government's Conservation Research team. They found a significant reduction in overall numbers and noted sediment smothering the riverbed habitat as a contributing factor. The Waterwatch monitoring site lacked these sediment loads.

Evidence of fire in the upper Cotter River catchment, September 2020.

Cotter River COT2

Pipeline Road Crossing to Vanity's Crossing

2020 CHIP Result A- (Excellent)		
2019 CHIP Result A- (Excellent)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**15**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Excellent	
Waterbug	**Good**	**2**
Riparian condition	**Good**	**2**



Reach Facts

Reach network length: approx. 11km
Dominant land uses: Drinking water catchment and conservation

This reach runs along the stretch of the Cotter River between the Bendora and Cotter dams. This section of the Cotter has restricted access for vehicles and is heavily monitored and managed by Icon Water and the ACT government. This is in part due to the area being a significant part of the ACT's drinking water catchment as well as having a remnant population of the endangered Macquarie perch. Waterwatch monitoring is exclusively conducted by Waterwatch and ACT Parks and Conservation staff.

Water quality in this reach received a near perfect score. Nitrate was the only issue and was found in most samples (1mg/L), possibly coming from the fire affected areas above Corin dam. As a result of the wet winter and spring conditions, Bendora dam began to overflow in mid October and Corin dam was also overflowing by late November.

The waterbug survey at Vanity's Crossing in autumn scored only *fair*. There were plenty of pollution sensitive mayfly and caddisfly larvae, along with two big 'toe biters' (Order: Megaloptera), also sensitive to pollution. Missing, however, were stonefly nymphs, the other key sensitive insect, normally founds in high numbers in this reach. High river flows resulted in stoneflies being detected again in the spring.

In June 2020, Waterwatch monitoring was resumed at Spur Hole Creek (MCC600) by ACT Parks and Conservation Rangers. This allows for better coverage of this important reach.

The clear Cotter River water at Vanity's Crossing.

Cotter River COT3

Cotter Dam to Murrumbidgee River confluence

2020 CHIP Result B+ (Good)		
2019 CHIP Result B+ (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**15**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Excellent	
Waterbug	**Good**	**2**
Riparian condition	**Fair**	**2**

Reach Facts

Reach network length: approx. 2.5km
Dominant land uses: Recreation

Water flowing through this reach is heavily influenced by water from the Murrumbidgee River that is regularly pumped from the Cotter Pumphouse to the base of the dam wall to augment environmental releases from the dam (known as the Murrumbidgee to Cotter or 'M2C' flows). Additional inflows from the Paddy's River, further downstream of the dam wall, can also significantly affect the water quality flowing past the Cotter Campground.

These three rivers had very different influences over the water quality results for this reach in 2020. M2C pumping began in April with base flow releases from the Cotter Dam providing input up until then. Phosphorus levels at the Cotter bridge recorded 0.15 and 0.03mg/L in July and August respectively along with turbidity levels over 35NTU. These measurements coincide with M2C pumping and with rain events and are most likely a result of resuspended ash and sediment washed down from the fire grounds into the Murrumbidgee River.

Water quality started to improve again as the Cotter River releases increases as the dam filled and spilled over in October. This peaked at 1300 ML/day in early November. This reach owes its *excellent* water quality to the Cotter supply.

The most dramatic measurement, however, was from the Paddy's river after the heavy rain in February. It brought with it a slurry of ash laden sediment that turned the water black (500NTU) and coated the banks near the campground (SCR100). Luckily this turbid water was diluted by the Cotter flush in time to support a *good* spring waterbug survey result.

The Cotter River at the campground (SCR100) September 2020 (Photo: M. Blume).

Gibraltar Creek GIB1

Headwaters to Woods Reserve

2020 CHIP Result A (Excellent)		
2019 CHIP Result A- (Excellent)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**22**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Good	
Waterbug	**Good**	**2**
Riparian condition	**Excellent**	**2**

Reach Facts

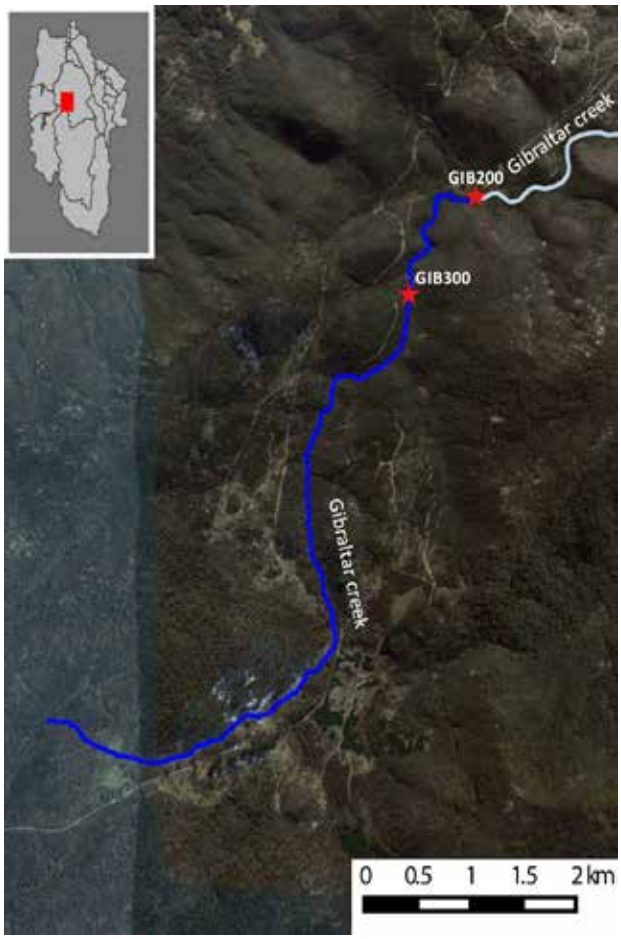
Reach network length: approx. 8.5km
Dominant land uses: Recreation and forestry.

Gibraltar Creek is a small stream running from near Corin Dam and flowing east to Paddy's River. The upper sections form upland bogs. Most of the surrounding land was used for softwood plantations up until the 2003 bushfires. The catchment also has a high recreational use with a large campsite, public walking tracks and a popular commercial facility at Corin Forest. This reach regularly receives one of the highest CHIP scores in the entire upper Murrumbidgee catchment.

Increased use of barriers to limit public entry to old forestry roads has had a positive impact reducing activities such as dumping and irresponsible off-road driving. In 2020 the reserves and camping facilities were completely closed to vehicles until June due to the fires in February 2020. The latest riparian vegetation survey for this reach was taken in August 2019, and therefore did not capture the damage of these bushfires.

The water quality in this creek is rarely other than *excellent*. Dissolved oxygen levels, however, tend to drop when flows are reduced. The increased rainfall in 2020 meant that dissolved oxygen levels improved on 2019, even with the catchment being heavily impacted by fire.

Large amounts of sandy sediment were deposited in the creek after the fires. This had a major impact on waterbug populations in autumn with only seven Orders found. The spring survey was back to revealing *excellent* levels of diversity with lots of naked caddisfly larvae, three different types of mayfly nymphs and reasonable numbers of stonefly. All of these are very sensitive to pollution.

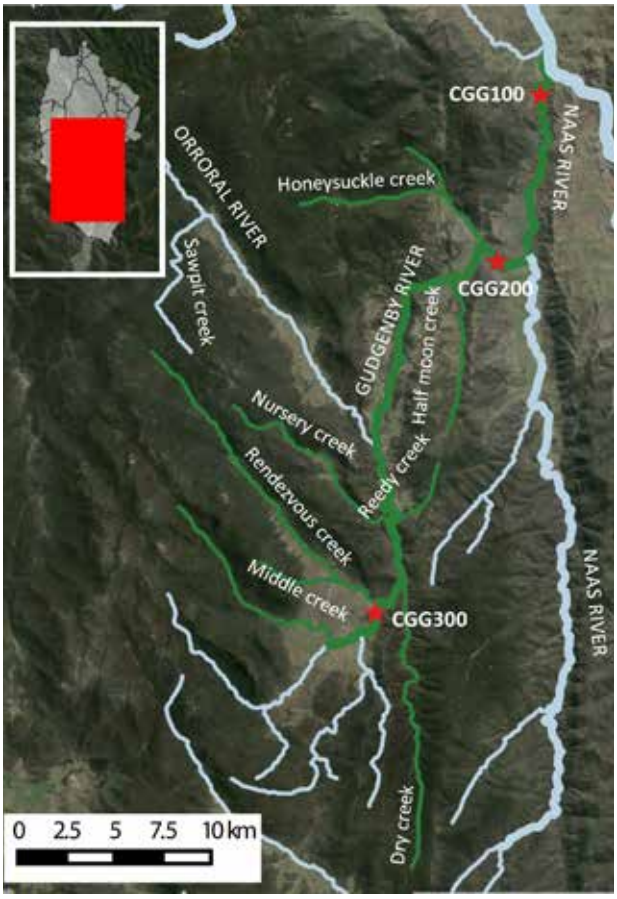


Regrowth after the fires at Gibralter Falls, GIB300. May 2020 (Photo: D. Brown).

Gudgenby River Catchment CGG1

Headwaters to the Murrumbidgee River confluence

2020 CHIP Result B (Good)		
2019 CHIP Result B- (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**22**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Excellent	
Waterbug	**Good**	**2**
Riparian condition	**Poor**	**3**



Reach Facts

Reach network length: approx 35km
Dominant land uses: Conservation and rural grazing

This reach includes the length of the Gudgenby River from the headwaters in Namadji National Park to the confluence with the Murrumbidgee River near Tharwa. The first seven kilometres flow through the northern end of the Park with the remainder running through mixed grazing properties. The riparian vegetation in the latter section lacks significant native tree cover and understorey, possibly due to clearing. A new site was created this year in the upstream conservation, section in order to create a more well-balanced picture of this reach.

At the start of 2020, the Gudgenby River had ceased to flow due to the prolonged dry conditions. Then, in late January, the upper section of this catchment was severely burnt by bushfires. This resulted in large amounts of ash and charcoal being washed down to the confluence with the Murrumbidgee River at Tharwa when heavy rains followed in February. While testing at CGG100 that month, Waterwatcher Deb noted that it was "*..shocking to visit this site. Water darker than melted dark chocolate. Small pieces of charcoal and black fine sediment thickly coating banks..*"

The ash and charcoal remained in the lower sections of the river for the remainder of the year. While the water quality did improve with the increased rainfall, the phosphorus concentrations was above 0.02mg/L and electrical conductivity stayed over 120µS/cm all year.

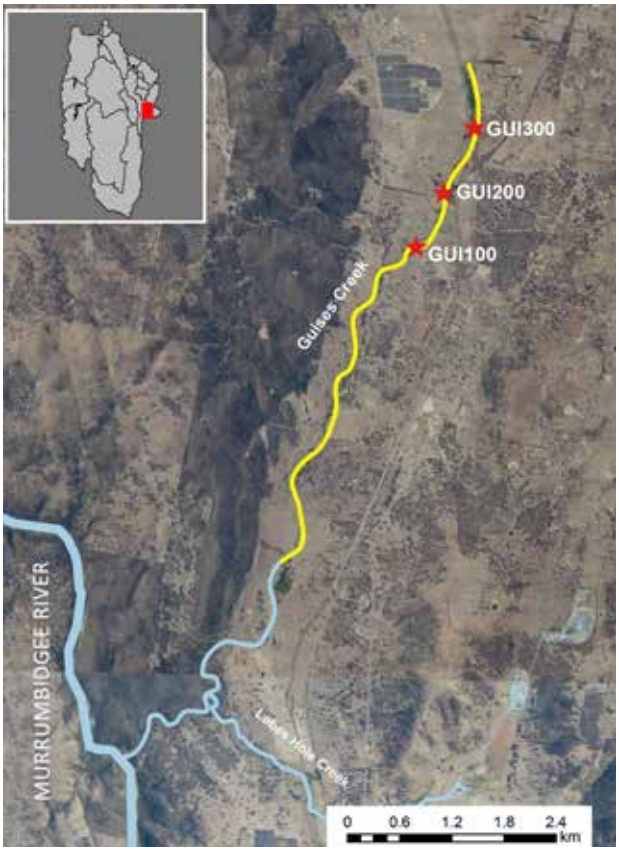
The waterbug surveys revealed mostly pollution tolerant species in autumn. There was a shift to more sensitive species, namely stonefly, mayfly and caddisfly larvae by spring.

The Brindabella Venturers sampling the new upstream site, CGG300, on the Gudgenby River (Photo: J. Lehane).

Guises Creek Catchment GUI1

Headwaters to confluence with Murrumbidgee River

2020 CHIP Result C- (Fair)		
2019 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Fair**	**28**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Degraded	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Degraded	
Waterbug	**Poor**	**2**
Riparian condition	**Poor**	**3**



Reach Facts

Reach network length: approx 120km
Dominant land uses: Conservation and rural grazing

This reach is a permanent spring sitting on igneous bedrock adjacent to the Monaro Highway on the eastern border of the ACT. The reach extends from its head, due west of Royalla, to a large dam on a property 4km south of Rosevue Homestead property. The three sites were chosen to capture changes to water quality as it passes the homestead.

This is the first CHIP report with a water quality assessment for this creek. The electrical conductivity was frequently higher than 400µS/cm. It is difficult to say whether this is due to the underlying geology or surrounding land use. The ignimbrite rock is associated with clay rich sediments which may leach minerals into the creek.

The very high nitrate levels almost all appeared in the homestead (GUI200) section where they were as high as 7mg/L in May. Nitrate was lower at the site above and below the homestead. It was interesting to note the system reduced nitrate concentrations between the homestead and the site below. The dissolved oxygen was around 70% saturation at the top and bottom sites but was lower at the homestead. Along with direct nitrate inputs, the lowering oxygen levels may also indicate high levels of bacteria. The nearby septic system, chook yards and frequent visits by several horses to the creek, support this theory.

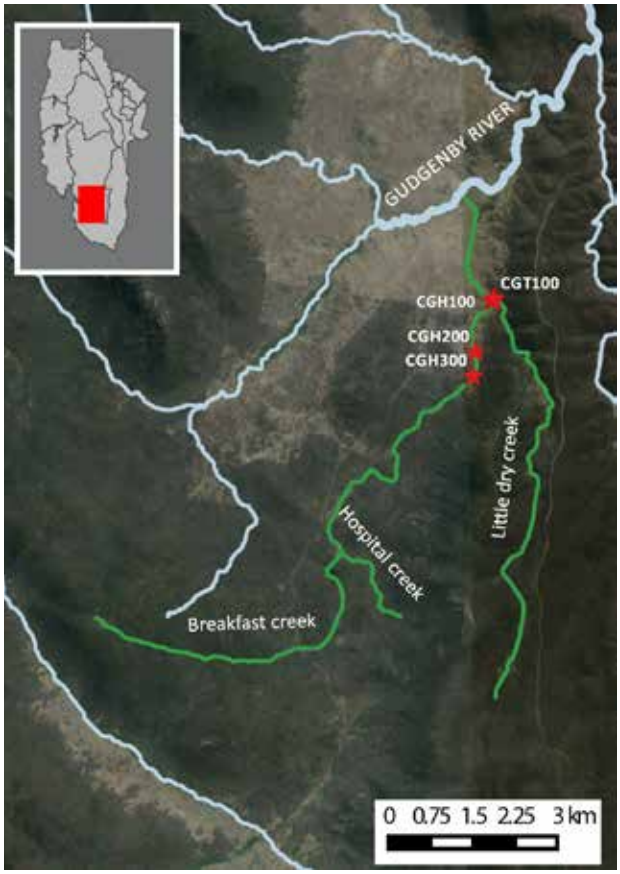
Despite the poorer water quality, the homestead site revealed eleven types of waterbugs in the October survey. Among them two types of mayfly, micro-caddisfly, diving beetles and a large yabby. That said, the majority of waterbugs found were very tolerant to pollution.

Waterwatcher Angus monitoring at Rosevue Homestead (GUI200), July 2020.

Hospital Creek Catchment HOS1

Headwaters to the confluence with the Gudgenby River

2020 CHIP Result B+ (Good)		
2019 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**26 (1 dry)**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Fair	
Dissolved Oxygen	Good	
Waterbug	**Good**	**2**
Riparian condition	**Fair**	**2**



Reach Facts

Reach network length: Hospital Creek arm (on the left) 12km, Little Dry Creek arm (on right) 7km
Dominant land uses: Conservation

Hospital Creek is mostly a forested gully situated south east of Bogong Creek, in Namadgi National Park. It runs north, forming as upland bog before joining the Gudgenby River near its headwaters. Access to this area was restricted in 2020 until May, due to the summer bushfires.

There was evidence of many spot fires around the bog areas as well as a "*drastic reduction in vegetation*" at the southern site (CGH300) according to the volunteers. The riparian surveys in July found near total loss of shrubs, no regrowth apart from weeds and epicormic buds on surviving trees. Leaf litter was mostly absent, standing trees were burnt and many were dead. By the end of the year invasive weeds, such as nodding thistle, had become "*chest deep*" near the forested sites.

The return of animal life was welcomed by the Waterwatch teams. At least two species of frogs (Common Eastern froglets and Pobblebonks) were found in good numbers from May onwards. By September seven different bird species, including wedged-tailed eagles with a new nest, were spotted as well as notes on fresh wombat scats and burrows and snake tracks.

Both waterbug surveys found *good* results even three months after the fires. Water quality was an improvement in most parameters compared to the very dry 2019. That said, some spikes were recorded in electrical conductivity, phosphorus and nitrate as the effects of burnt catchment were felt through the system.

The bog section of the creek (CGH200) with burnt, forested areas in the background, spring 2020 (Photo: J. Lehane).

Isabella Pond ISA1

Large pond south of Monash

2020 CHIP Result C- (Fair)		
2019 CHIP Result C- (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**20**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	**Degraded**	**2**
Riparian condition	**Poor**	**3**

Reach Facts

Reach network area: approx. 5.8Ha
Dominant land uses: Suburban

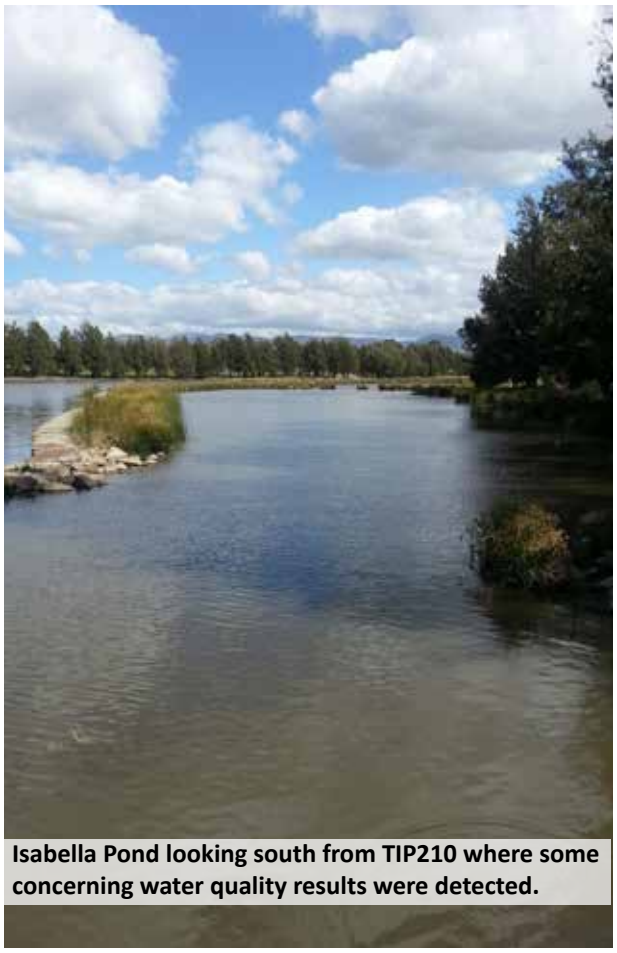
This reach is the main settlement pond for stormwater entering Lake Tuggeranong from the north eastern Tuggeranong suburbs. Water flows over a high weir at its western end into Lake Tuggeranong (TLT1).

Isabella Pond underwent an extensive facelift in 2018 as part of the ACT Healthy Waterways initiative with several hectares of wetland vegetation plantings. The aim is to trap nutrients that would otherwise be carried into the main lake which then contribute to toxic, blue-green algal blooms.

Monitoring had a hiatus until May due to COVID-19 and the Gudgenby Bush Regenerators kindly monitored the pond until September at which point Caroline Chisholm School made a welcome return.

Interpreting the results at this wetland proved challenging in 2020 given the variable range of water quality flowing off this highly urbanised landscape. The wetland appears to be meeting its aim, with phosphorus, nitrate and turbidity levels all lower at the downstream site (TIP050) than at the two inlet sites. That said, dissolved oxygen levels were very unstable, swinging between a low of 22% saturation to in excess of 110% super saturation on six occasions. Electrical conductivity (EC) was also a problem with some very high levels around 500µS/cm detected at TIP210. This site in particular had some of the highest phosphorus and EC readings and is a sub-catchment that may warrant further investigation.

Waterbug surveys revealed very low diversity and only pollution-tolerant bug types.



Isabella Pond looking south from TIP210 where some concerning water quality results were detected.

Lake Tuggeranong Wetlands TLT1

Drakeford Drive weir to South Quay foot-bridge weir

2020 CHIP Result C+ (Fair)

2019 CHIP Result C (Fair)

Parameter	Rating	No. Survey
Water quality	**Good**	**11**
pH	Good	
Turbidity	Good	
Phosphorus	Poor	
Nitrate	Good	
Electrical Conductivity	Good	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**2**
Riparian condition	**Fair**	**2**

Reach Facts

Reach network area: approx. 4.3Ha
Dominant land uses: Urban

This is the southern section of Lake Tuggeranong, upstream of the weir that runs under a pedestrian walkway near the South Quay Development. It forms a narrow neck at the southern end which is fed by a large zigzag dam wall which overflows from Isabella Ponds.

There is a healthy stand of Casuarinas on either bank of this stretch of the lake but very little in the way of other native plants. Part of the function of this body of water is to improve water quality before it enters Lake Tuggeranong proper.

Water quality this year saw an improvement in turbidity, but an increase in phosphorus with levels regularly reaching 0.07mg/L. Also dissolved oxygen (D.O) levels were low and went from *excellent* last year to *degraded* in 2020. In January, during the period of heavy bushfire smoke engulfing Canberra, D.O dropped to 39% saturation. A large fish kill event, of mostly feral Carp, occurred in this reach at that time.

The pleasant surprise this year was in the waterbug survey in autumn with enough diversity for waterbugs to achieve a *fair* score overall – up from *degraded* last year. Lots of sensitive Leptocerid 'stick' caddisfly larvae were seen for the first time in years. In October the team from Lake Tuggeranong College found ten Orders of waterbugs including pollution-sensitive mayfly and caddisfly larvae, as well as plenty of water mites.

Dead and dying Carp were observed in Lake Tuggeranong during a hot, dry January in 2020.

Lake Tuggeranong TLT2

Main lake body

2020 CHIP Result C- (Fair)		
2019 CHIP Result C- (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**36**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Degraded	
Electrical Conductivity	Good	
Dissolved Oxygen	Degraded	
Waterbug	**Poor**	**2**
Riparian condition	**Degraded**	**5**

Reach Facts

Reach network area: approx. 56Ha
Dominant land uses: Urban and recreation

This is the main body of Lake Tuggeranong, which is fed by the stormwater systems of thirteen southern suburbs. Two major gross pollution traps are at the northern end of this reach. Lake Tuggeranong wetlands (TLT1), to the south east, are immediately upstream of this reach.

The *degraded* riparian vegetation scores reflect the highly urbanised nature of the surrounding landscape.

Blue-green algal blooms occurred in the lake during the first three months of the year and again later in the year. These blooms are supported by elevated nutrient concentrations. University of Canberra studies show that large loads of nutrients enter the lake from the stormwater system. That said, the phosphorus levels recorded this year by our teams were *excellent* by CHIP standards (< 0.02mg/L). High nitrate concentrations were recorded at the northern sites, with concentrations rarely dropping below 3mg/L.

The Lake being a still waterbody will always have some bearing on the outcomes of waterbug surveys as many pollution-sensitive bugs favour systems with fresh running water where dissolved oxygen levels are higher.

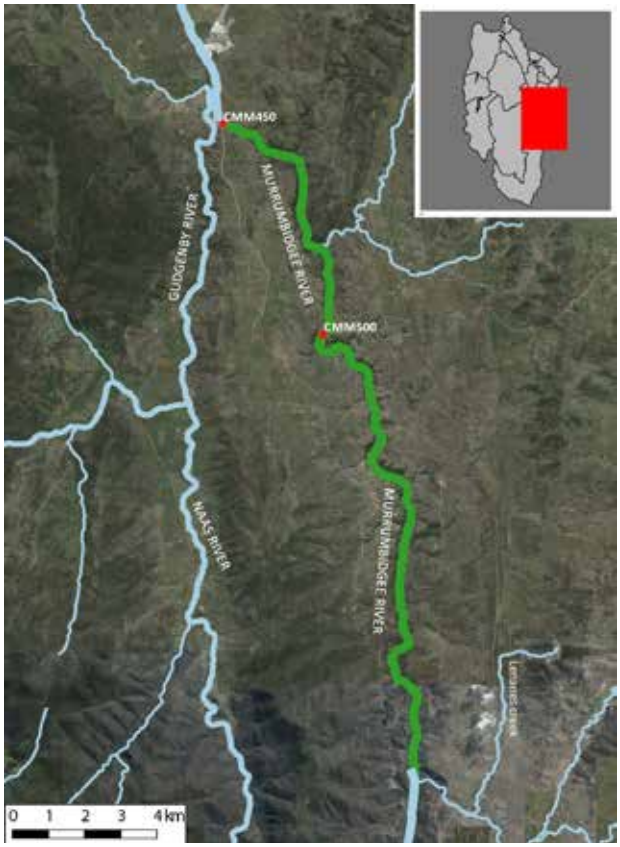
The waterbug survey in April at the Town Park Beach got a *degraded* score, driven by low numbers of most waterbug types other than water boatman. In September, however, the Lake Tuggeranong College students found nine Orders, including two types of mayfly larvae and caddisfly larvae. This was an improvement on last year.

Lake Tuggeranong below Wanniassa Creek gross polluant trap (MTW100).

Murrumbidgee River CMM7

Michelago Creek confluence to Tharwa Sandwash

2020 CHIP Result B (Good)		
2019 CHIP Result B+ (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**19**
pH	Excellent	
Turbidity	Fair	
Phosphorus	Fair	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Excellent	
Waterbug	**Good**	**2**
Riparian condition	**Fair**	**2**



Reach Facts

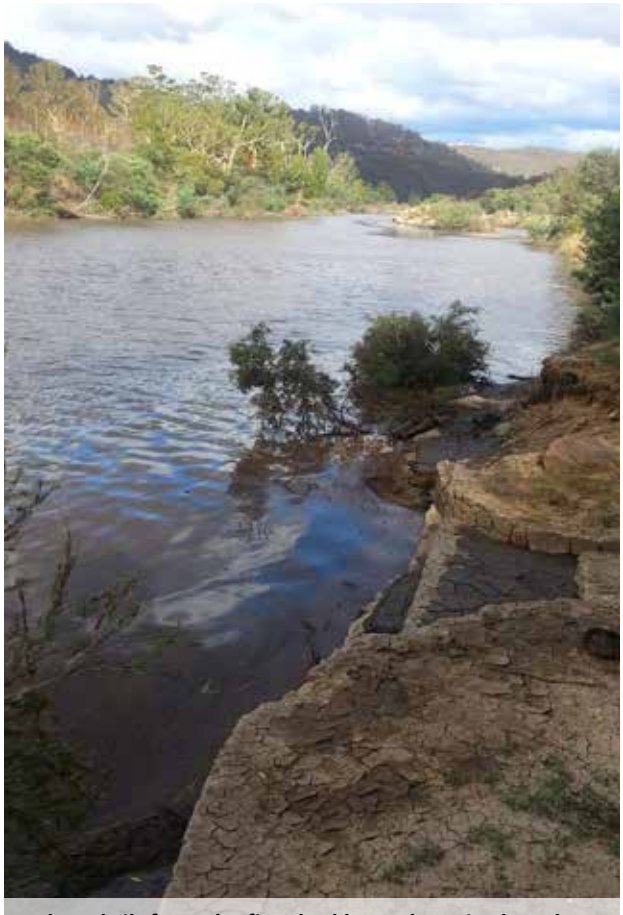
Reach network length: approx. 24km
Dominant land uses: Rural grazing and conservation

This stretch of the Murrumbidgee River begins at Willows Road NSW, includes Angle Crossing on the ACT/NSW border and runs through the Gigerline Gorge in the ACT. It ends in the area known as the Tharwa Sandwash in the Gigerline Nature Reserve.

Recreational fishing is banned in the ACT section of this reach and riparian vegetation is significantly healthier than downstream around the Tharwa township. Around Angle Crossing, however, there are limited amounts of emergent and edge vegetation although the abundant riffle zone usually provides good habitat for many sensitive waterbugs such as stonefly nymphs. Diversity of waterbugs remained healthy this year with eleven Orders found in both the spring and autumn surveys.

The start of 2020 saw flows reduced to a trickle. The water had a greenish brown colour and the reach was *"smokey"* from the NSW bushfires. In February high rainfall in the burnt, upstream catchment in NSW sent a plume of ash, silt and charcoal down the river. This resulted in *degraded* levels of turbidity (>400NTU) and phosphorus (0.8mg/L) in this reach. The water had a strong smell of ash and a thick layer of *"fine dark sticky mud"* settled on the steep banks at Tharwa Sandwash, according to Waterwatcher Deb.

The phosphorous levels in the water stayed relatively high all year (mostly above 0.03mg/L) and turbidity was also elevated as flows remained high over late winter and early spring.



Ash and silt from the fires had been deposited on the steps at Tharwa Sandwash (CMM450), February 2020.

Murrumbidgee River CMM8

Tharwa Sandwash to Point Hut Crossing

2020 CHIP Result B- (Good)		
2019 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**16**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Poor	
Waterbug	**Good**	**2**
Riparian condition	**Poor**	**2**

Reach Facts

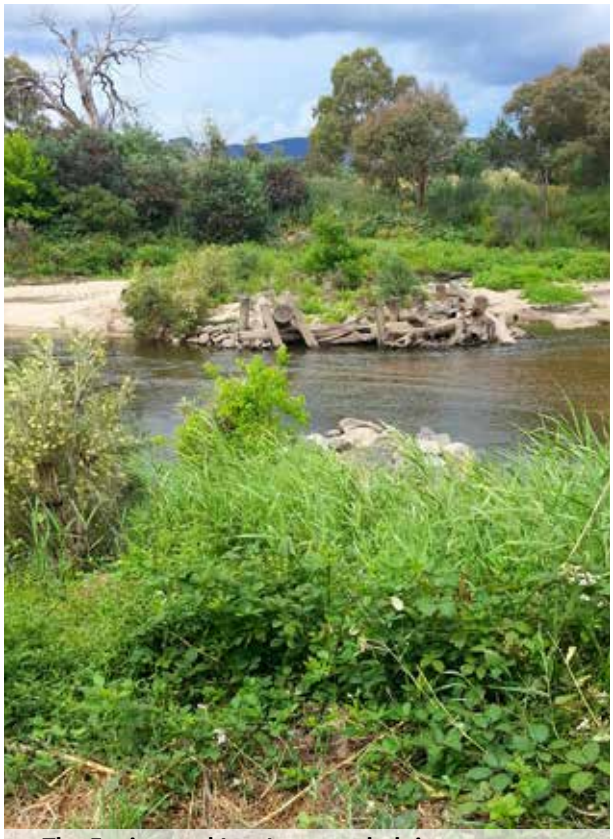
Reach network length: approx. 10km
Dominant land uses: Rural grazing and conservation.

This reach covers the stretch of Murrumbidgee River from Tharwa Sandwash to Point Hut Crossing. Most of the eastern bank of this reach borders Lanyon Homestead. The western bank flows past a number of properties including Castle Hill and Lambrigg Homesteads in the Tharwa district.

The riparian vegetation in this reach is extremely poor with very few mature canopy species. The shallow gradient of this section of river also compounds the problem of sediment build up which reduces the chances for in-stream habitat, such as riffles, to establish. The shallow depths combined with a lack of shading, means the average water temperature at Tharwa is often warmer than at upstream or downstream sites. These areas of the river make passage difficult for aquatic fauna such as native fish and Platypus.

A series of Engineered Log Jams, constructed over the past decade downstream of the Tharwa bridge, are looking to address the issue of connectivity and fish habitat. The Log Jams have deepened the adjacent channels in this reach considerably with juvenile Murray cod and Murray River crayfish having been observed.

This reach had high levels of silt and ash for most of the year due to fire-affected catchments upstream on the Murrumbidgee River in NSW and from the Gudgenby River, which flows out of Namadgi National Park. Phosphorus levels were particularly high (0.15mg/L) in the months following the fires.



The Engineered Log Jams are helping to improve fish habitat in this reach.

Murrumbidgee River CMM9

Point Hut Crossing to Kambah Pool

2020 CHIP Result C+ (Fair)		
2019 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**13**
pH	Excellent	
Turbidity	Poor	
Phosphorus	Degraded	
Nitrate	Good	
Electrical Conductivity	Good	
Dissolved Oxygen	Excellent	
Waterbug	**Fair**	**2**
Riparian condition	**Fair**	**2**

Reach Facts

Reach network length: approx. 7km
Dominant land uses: Urban, conservation and recreation

This reach covers the section of Murrumbidgee River from Point Hut Crossing to Kambah Pool, which includes Pine Island reserve and Red Rocks Gorge. Urban inputs such as Tuggeranong Creek, Stranger Pond and Point Hut Ponds are also received into this section of the Murrumbidgee River.

This stretch is unique for the Murrumbidgee in the ACT in that it has shown little variance in overall waterway health from year to year. The faster flows, deeper water and slightly more abundant riverbank vegetation give refuge to aquatic fauna and see the health of the Murrumbidgee River improve as it flows down from the sandy, shallow, treeless sections at Tharwa.

As with all other stretches of the Murrumbidgee River in 2020, this reach was affected by inflows from fire-affected catchments upstream in both the ACT and NSW. Phosphorus concentrations were above 0.05mg/L for most months at both Waterwatch sites with readings over 0.1mg/L on four occasions. Turbidity levels spiked at 300NTU directly following the fires in February and were over 30NTU for most of the year. The 'beach' at Kambah Pool was covered in a thick black layer of sticky ash that dried into a hard, cracked surface. This has slowly begun to dissipate.

The water bug surveys at Pine Island saw a marked improvement from *degraded* in autumn, with only six Orders detected of mostly pollution-tolerant types, to *good* in the spring. Bonython Primary School science group helped with the spring survey.

Bonython Primary School students helping out with a waterbug survey at Pine Island (Photo: S. Fletcher).

Murrumbidgee River CMM10

Kambah Pool to Uriarra Crossing

2020 CHIP Result B- (Good)		
2019 CHIP Result B- (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**22**
pH	Excellent	
Turbidity	Fair	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Poor	
Waterbug	**Good**	**2**
Riparian condition	**Poor**	**2**

Reach Facts

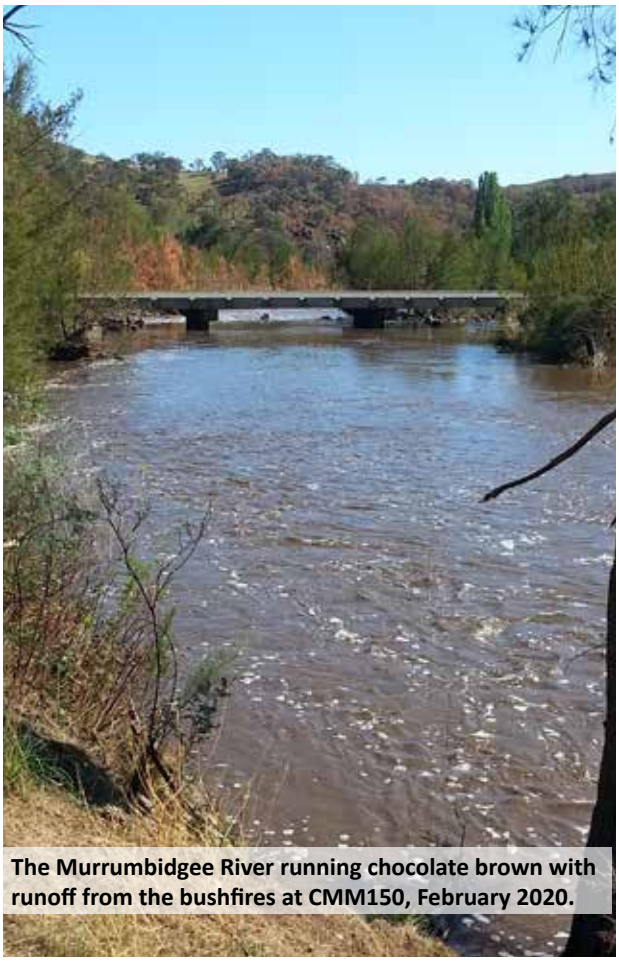
Reach network length: approx. 11km
Dominant land uses: Rural grazing, forestry, recreation and conservation

This reach covers the section of Murrumbidgee River from Kambah Pool to Uriarra Crossing. Much of it flows past old pine forest plantations and areas still used for grazing and farming. This section of the river receives inputs from both the Paddy's and Cotter Rivers entering just upstream of Casuarina Sands reserve (CMM200).

This reach was affected by inflows from fire-affected catchments upstream in both the ACT and NSW in early 2020. Heavy rains washed large amounts of ash and sediment down into this reach in February, 2020. In February, both sites had turbidity readings in excess of 400NTU and phosphorus concentrations of 0.6mg/L.

Thick deposits of ash sat two metres up the bank at Casuarina Sands and further rains throughout the year resuspended nutrients and increased turbidity during periods of high flows. Ashen deposits and fine sediments could be seen on the river bed throughout the remainder of the year. This shows the downstream effects of bushfires impacting areas many kilometres away.

That said, waterbug surveys at both sites hosted a pleasing diversity of species in 2020. This included two freshwater mussels at Uriarra Crossing in autumn and key sensitive species, stonefly, mayfly and caddisfly larvae, at Casuarina Sands in spring.

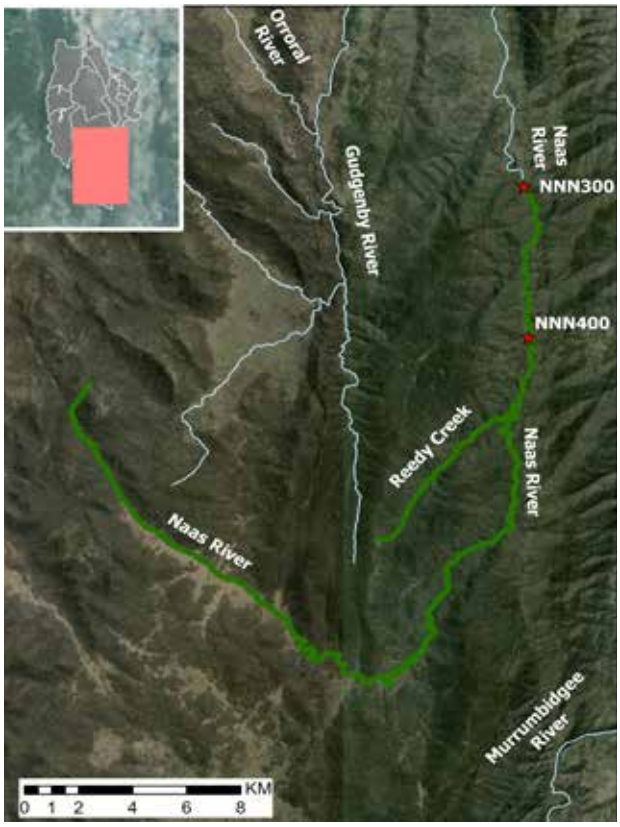


The Murrumbidgee River running chocolate brown with runoff from the bushfires at CMM150, February 2020.

Naas River NAA1

Headwaters to boundary of Namadgi National Park

2020 CHIP Result B+ (Good)		
2019 CHIP Result B+ (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**8**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Fair	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Excellent	
Waterbug	**Good**	**1**
Riparian condition	**Fair**	**2**



Reach Facts

Reach network length: approx. 34km
Dominant land uses: Conservation

The Naas River runs south through Namadgi National Park then hooks east and flows north just inside the ACT border and parallel to the Murrumbidgee River. This reach covers the section of river within the national park. The lower, rural section of the river is now being assessed separately with its own reach report card to better reflect catchment condition.

Bushfires at the start of the year meant there was no access for monitoring until May. The surrounding catchment in the national park area was extensively burnt, with significant loss of the tree canopy, understorey (shrubs) and ground cover.

The water quality results were surprisingly good given the recent history of the river. It was mostly dry in 2019. The fires at the start of this year then delivered significant amounts of ash and sand. Phosphorus levels, high for these conservation sites (up to 0.1mg/L), were better than downstream in the rural section (NAA2). There was evidence of flooding prior to May and this may have flushed the upper reach.

A waterbug survey in October found hundreds of 'nosey tiger' beetle larvae and a high diversity of caddisfly larvae including micro caddis, 'bandit', 'hunter' and 'stick' varieties. Other sensitive species such as stonefly and mayfly nymphs were also present in good numbers.

Other signs of life included sightings of Red-necked wallabies and Eastern grey kangaroos in May and two Rosenberg's monitors in December, one with a tracking device.

Spring waterbug survey at NNN300, assisted by Namadgi Rangers and volunteers.

Naas River NAA2

Above Carwoola Farm to Gudgenby River confluence

2020 CHIP Result C+ (Fair)		
NEW REACH		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**8**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Poor	
Nitrate	Good	
Electrical Conductivity	Fair	
Dissolved Oxygen	Poor	
Waterbug	**Poor**	**2**
Riparian condition	**Fair**	**2**

Reach Facts

Reach network length: approx. 6km
Dominant land uses: Rural residential, grazing,

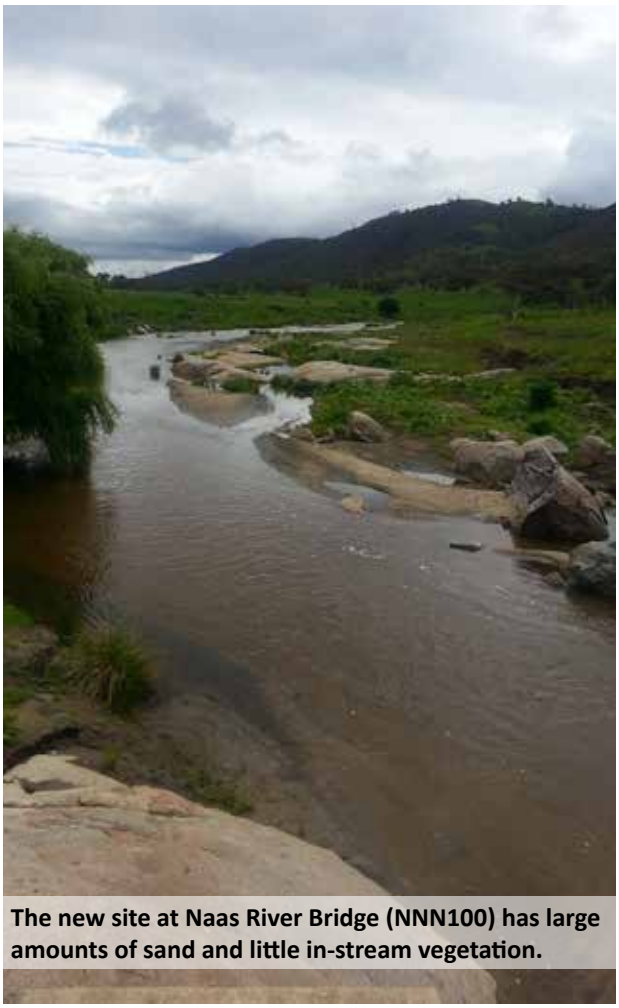
This reach runs from just above Caloola Farm, below the boundary of Namadgi National Park, to the confluence with the Gudgenby River. This is a new reach that separates the upstream section of the Naas River in Namadgi National Park from the downstream, rural section. This is aimed at better reflecting the response of the catchment to the change in land use.

Historic and existing grazing activities in this reach have resulted in significant erosion and large amounts of sand and sediment being washed into the river and smothering available aquatic habitat. The Actions for Clean Water (ACWA) Plan sets out a strategy for improving water quality (targeting turbidity) in the upper Murrumbidgee catchment. This reach is a high priority ACWA catchment with six key erosion sites identified.

No data was collected for this reach before May 2020 due to access issues as a result of the summer bushfires.

Phosphorus levels were high, even in the upstream, conservation sections of the Naas River, which is most likely a result of the summer bushfires. That said, this reach detected even higher levels, regularly reaching 0.07mg/L, which may suggest that the rural sites are receiving phosphorus from other sources such as that made available through erosion.

The riparian condition assessment of *fair* reflects a combination of the Naas Valley Bridge site (NNN100) with its complete lack of trees and very few native plants, and Caloola Farm (NNN200) that has a native canopy but with a mostly weedy understorey and ground cover plants.

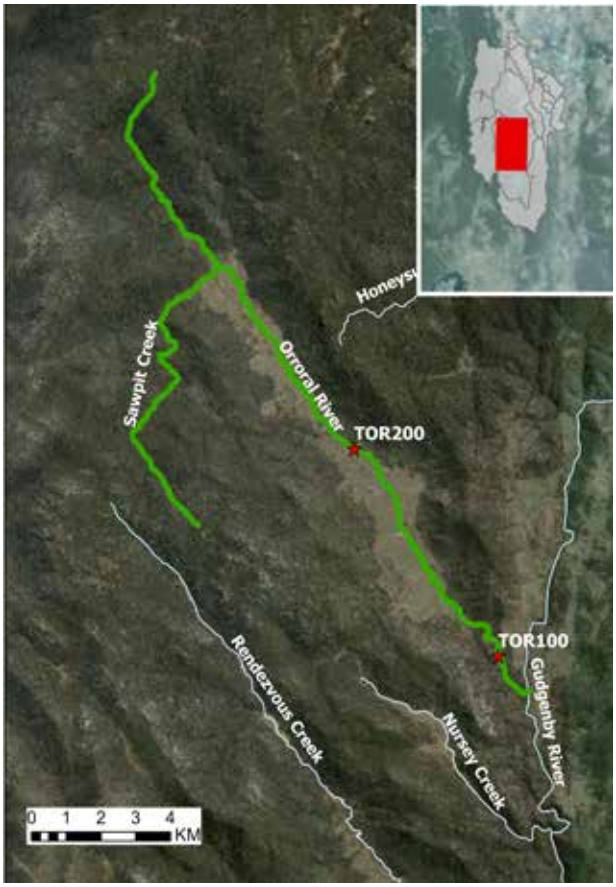


The new site at Naas River Bridge (NNN100) has large amounts of sand and little in-stream vegetation.

Orroral River ORR1

Headwaters to Gudgenby River confluence

2020 CHIP Result B (Good)		
NEW REACH		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**14**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Good	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**1**
Riparian condition	**Good**	**1**



Reach Facts

Reach network length: approx. 26km
Dominant land uses: Conservation and Recreation

The Orroral River arises in the ranges east of the Cotter catchment in Namadgi National Park and flows south east through a valley hosting an extensive upland fen wetland. This area hosts a range of submerged macrophytes (water plants) as well as large stands of Phragmites. The river then flows through rocky cascades, past the Orroral campground, and ends at the confluence with the Gudgenby River.

The landscape was extensively cleared for grazing from the 1830s and from 1965 until the mid-1980s the valley hosted a NASA tracking station of which the foundations and surrounding landscaping still exists.

This is a new reach as it now receives its own report card. In previous CHIP reports it was assessed as part of the broader Gudgenby catchment.

The area near the tracking station was the point where the Orroral Valley Fire began in January 2020, subsequently burning 80% of the surrounding National Park. Large plumes of sand washed down from the fire-affected hills in the south west, covering parts of the adjacent road and on into the river. Ash and sediment were also washed into the upper stretches and much of the normally abundant Phragmites reedbeds were burnt.

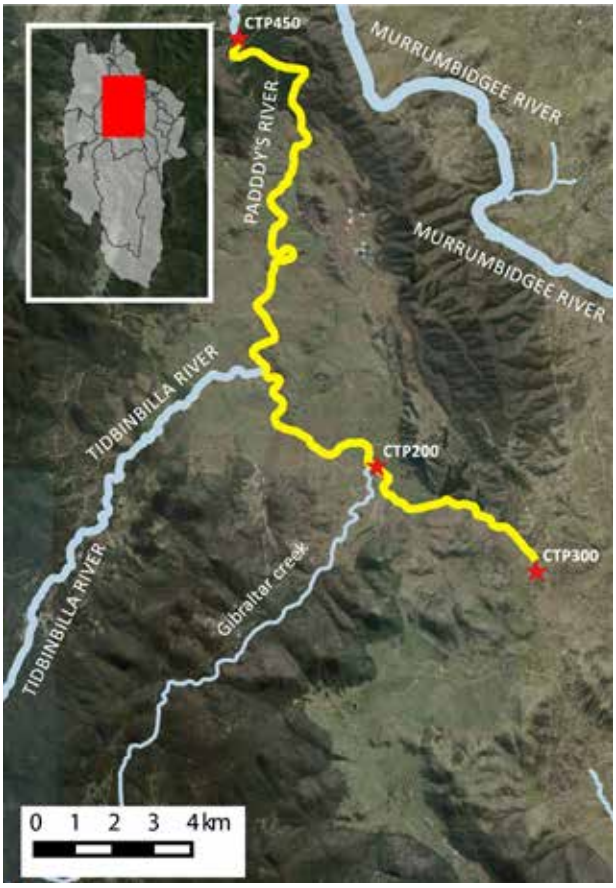
As access was limited due to the fires, water quality was not comprehensive for the year. That said, what was collected show fairly good results with slightly elevated nutrients and electrical conductivity, and lower dissolved oxygen saturation – all of which align with fire impacts.

Evidence of ash and sand deposited in the Orroral River channel after the summer bushfires.

Paddy's River PAD1

Tidbinbilla Road bridge to Murray's Corner

2020 CHIP Result C+ (Fair)		
2019 CHIP Result B- (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**30 (2 dry)**
pH	Excellent	
Turbidity	Poor	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Excellent	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**3**



Reach Facts

Reach network length: approx. 24km
Dominant land uses: Rural grazing, forestry and recreation

Paddy's River runs mostly through active grazing properties and softwood plantations that also provide public access dirt roads, popular with recreational off-road drivers. This reach covers the section below the headwaters on Booroomba Station.

The river is subject to erosion after large flooding events. The result is a sandy river bed lacking habitat complexity along much of its length similar to the Murrumbidgee near Tharwa. Steep unstable soils in the headwaters of the Booroomba Homestead are a key contributor. Much of the riparian zone along Paddy's River lacks significant native vegetation.

The 105mm of rainfall in February pushed large volumes of ash and sediment from the Orroral Valley bushfires down the Paddy's River. This left sticky ash deposits on the riverbank up to 20 metres wide at Murray's Corner (CTP150). Turbidity was over 400NTU and phosphorus over 0.2mg/L and similar results were detected upstream at Tidbinbilla Road Bridge (CTP300). This ash continued to be detected in the reach throughout the year as it was remobilised every time water levels rose, increasing turbidity and phosphorous levels.

The diversity of waterbugs usually found at Murray's Corner were absent in autumn, resulting in a *degraded* score. This improved markedly by spring with stonefly larvae returning along with a good number of other pollution-sensitive bugs such as two types of mayfly larvae. Interestingly, the only caddisfly larvae present were "naked", with families that build casings absent.

Motorbike tracks on the ash-laden bank of the Paddy's River (CTP150), February 2020.

Point Hut Ponds MPG1

Headwaters of Conder Creek to Murrumbidgee River confluence

2020 CHIP Result C (Fair)

2019 CHIP Result C (Fair)

Parameter	Rating	No. Survey
Water quality	**Good**	**36 (2 dry)**
pH	Excellent	
Turbidity	Fair	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Fair	
Dissolved Oxygen	Degraded	
Waterbug	**Poor**	**2**
Riparian condition	**Poor**	**4**

Reach Facts

Reach network length: approx. 2.5km
Dominant land uses: Urban

The drainage line that feeds this reach arises in the Rob Roy Nature reserve and flows down through the suburbs into Conder Wetland, which then drains to Point Hut Pond, a sediment control pond in Gordon. Together they make up a stormwater system that has been engineered with flow reduction features and verge vegetation to reduce some of the negative impacts from suburban runoff. The water from this system then flows into the Murrumbidgee River just downstream of Point Hut Crossing.

Waterwatcher Alan retired after eight years of monitoring here in March 2020. In February he noted "*This was the first test in three months as the water (was) too low... Over 100mms of rain in past week filled pond to capacity…*". Sediment-laden water poured in and a turbidity reading of 180NTU was recorded.

High turbidity, low dissolved oxygen levels and high electrical conductivity (up to 570µS/cm) are all regular water quality issues for this reach. Phosphorus concentrations can fall into the *poor* range, especially after rain. This contributes to blue-green algae which was noted by volunteers in both March and November.

Litter can be an issue in these ponds and plenty was washed into the system in February after the long dry period. Thankfully Waterwatcher Tom thought he'd do something about it and pulled out six bags worth, while paddling around on his kayak!

The shoreline was exposed and subject to erosion, during the extended dry period, January 2020 (Photo: L. Harrison).

Stranger Pond MSP1

Stranger Pond in North Bonython

2020 CHIP Result B- (Good)		
2019 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**23**
pH	Excellent	
Turbidity	Good	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Good	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**2**
Riparian condition	**Fair**	**2**

Reach Facts

Reach network area: approx. 4Ha
Dominant land uses: Urban.

The 'Stranger Pond' system consists of Upper Stranger and Lower Stranger Ponds connected by a tapped pipe (normally closed) under Drakeford Drive. The whole system is immediately to the south of Lake Tuggeranong and provides stormwater treatment to the suburb of Bonython. Overflow enters the Murrumbidgee River at Pine Island reserve. Waterwatch monitoring has only been conducted at Lower Stranger Pond.

While the water quality in Stranger Pond saw little change in 2020, there were some interesting issues concerning nutrient readings earlier in the year. With the pond receding in what was a hot and smoky January, Waterwatcher Colin recorded a phosphorus reading of 0.15mg/L after a "*light rain in the previous 24hrs*". In February, another spike of phosphorous (0.2mg/L) and an high nitrate reading of 50mg/L were then recorded at the inlet of the pond after 56mm of rain fell in the previous 24 hours. This appears to have flushed a lot of accumulated organic matter out of the upstream gross pollutant trap (GPT). This was reported to the ACT Government and the following month Colin reported that the GPT had been cleaned out and water quality was more "*typical*" for this urban waterbody.

Ten different waterbug Orders were detected in the autumn survey, higher than most of the Southern ACT's urban waterways that season. Limited numbers of pollution-sensitive bugs in both surveys gave this reach a *fair* waterbug score, improving Stranger Pond's overall CHIP score.

Feral fish such as Eastern gambusia, Carp and Redfin perch are all regularly seen in the lower pond.

Stranger Pond was looking full with lush surrounds by December 2020.

Tidbinbilla River TID1

Headwaters of Tidbinbilla River & Ashbrook Ck to Gilmores Rd crossing

2020 CHIP Result B- (Good)		
2019 CHIP Result B- (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**46 (3 dry)**
pH	Good	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Degraded	
Waterbug	**Poor**	**2**
Riparian condition	**Good**	**5**

Reach Facts

Reach network length: approx. 8.5km
Dominant land uses: Conservation, tourism and rural grazing

This reach covers most of the Tidbinbilla River and the adjacent artificial wetlands (the 'Sanctuary'). Most of the reach is in the Tidbinbilla Nature Reserve and also includes Ashbrook Creek, a small upland stream on the western edge of the reserve.

While the summer bushfires didn't directly burn much of the Tidbinbilla River, it did burn areas of the upper catchment. This was followed by intense flooding in February which flushed large amounts of sand and ash downstream into unburnt areas. Waterwatcher Fiona noted phosphorus levels at the upper site (CTT070) as high as her kit would measure (0.25mg/L) as well as electrical conductivity four times higher than what is usually detected at that site (430µS/cm).

A survey of all the ponds in the Sanctuary mid-year to assess Platypus food supplies showed only *fair* to *degraded* levels of waterbugs. The river had low numbers for all of the types found apart from fly larvae. The only other bugs found in any abundance were water boatmen, a very pollution tolerant insect. This is possibly a hangover from the previous year's drought.

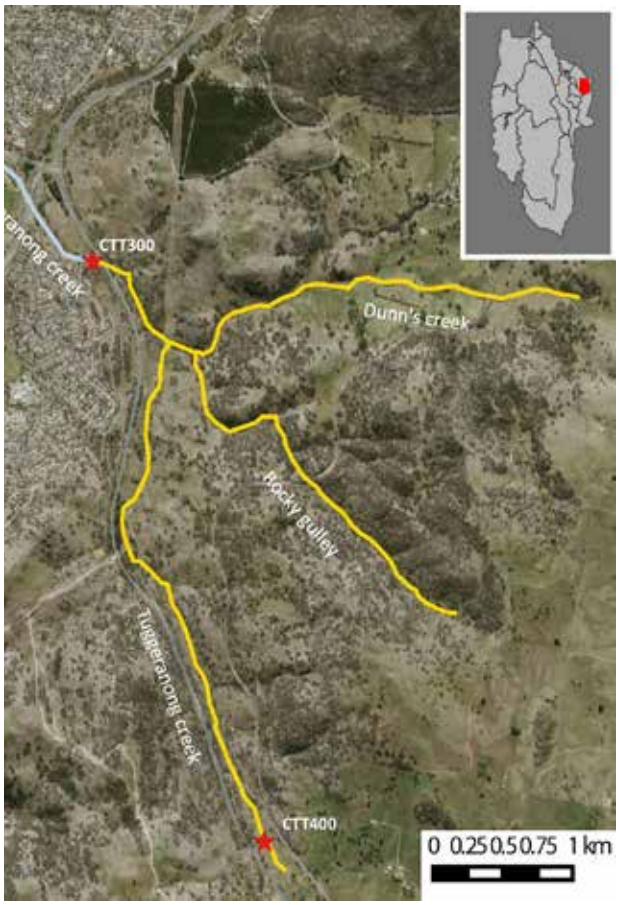
The spring waterbug survey at CTT060 found plenty of pollution-sensitive caddisfly larvae and some very sensitive stonefly larvae. Curious was the complete absence of mayfly larvae which one would also expect to be in abundance given the healthy flows at the time.

Animal tracks in the ash-laden sediment at CTT070, washed down from the fire grounds (Photo: F. Spier).

Tuggeranong Creek, Upper TUG1

Headwaters of Tuggeranong Creek catchment to Theodore

2020 CHIP Result C+ (Fair)		
2019 CHIP Result C (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**17 (2 dry)**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	**Good**	**2**
Riparian condition	**Poor**	**2**



Reach Facts

Reach network length: Monks Creek (upper arm 3.2km), Tuggeranong Creek (lower arm) 4km
Dominant land uses: Rural grazing

The system is fed from Monk's and Dunn's Creeks to the east and Tuggeranong Creek to the south. The Tuggeranong Creek arm runs adjacent to the Monaro Highway. The upper creek arises from farming country with smooth ignimbrite bedrock and minerals released can result in high electrical conductivity. The lower site, next to the Monaro Highway, is a hotspot for rubbish dumping.

The riparian vegetation comprises mostly weed species. The canopy is almost exclusively poplars with many of their wilding saplings as the understorey.

Like many small tributaries in 2020, upper Tuggeranong Creek started off the year bone dry at both sites. By February, however, the high rainfall resulted in cool, clear water flowing from the head to the concrete drain that continued for most of the year. Electrical conductivity and dissolved oxygen can be an issue in this reach, particularly at the headwaters site (CTT400), during low/no flow periods.

Two waterbug surveys found up to eleven different Orders with stonefly larvae, a very sensitive type, being detected in this reach for the first time. The autumn survey was conducted before the surrounding poplars dropped their leaves making sampling much easier. The diversity of bugs detected doubled from autumn 2019 to autumn 2020.

The water was running cool and clear with an absence of poplar leaves at the autumn waterbug survey, CTT200.

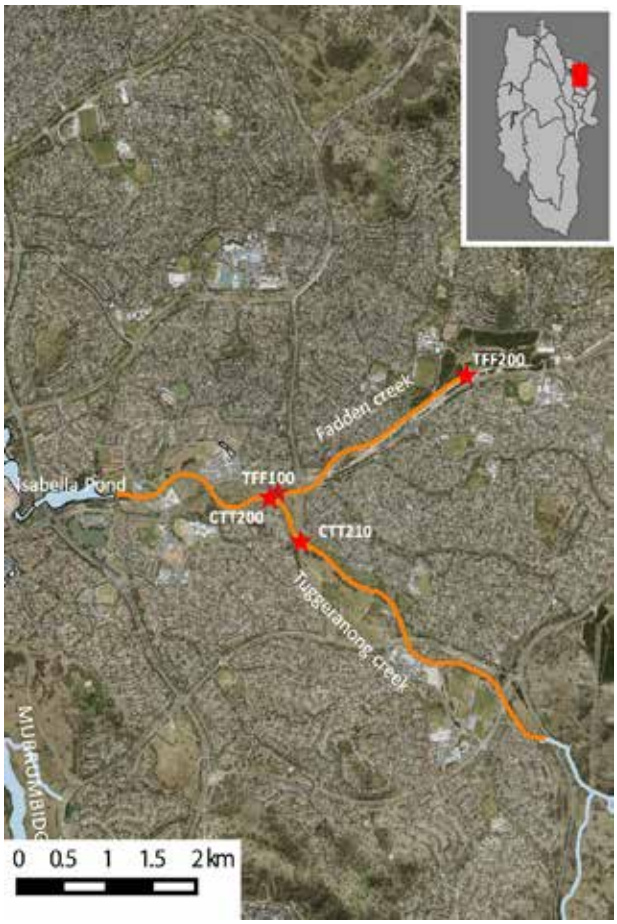
Tuggeranong Creek, Middle TUG2

Concrete drain system upstream of Isabella Pond

2019 CHIP Result D (Poor)

2019 CHIP Result C- (Fair)

Parameter	Rating	No. Survey
Water quality	**Fair**	**28 (1 dry)**
pH	Degraded	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Degraded	
Waterbug	**Degraded**	**2**
Riparian condition	**Degraded**	**4**



Reach Facts

Reach network length: approx. 8km
Dominant land uses: Urban.

This reach consists of a Y shaped network of two concrete stormwater channels. The main arm runs north west from Leinhop Street in Theodore. This joins another channel following south west from Fadden near Isabella Drive where the channel then flows into Isabella Pond.

No riparian vegetation, other than algal filaments, and almost no aquatic organisms are found in this reach as it consists entirely of concrete. As a result CHIP assessments for this reach only vary because of changes in water quality. Consequently, the highest score this reach can attain is *fair* if all the water quality parameters are *excellent*. This reach is important in demonstrating the crucial roles waterbug and riparian surveys play in assessing waterway health. A concrete drain is a barren habitat.

For most of the year there was a steady, low flow through the system. Most if the data collected was from May onwards, when volunteers could return after COVID-19 lockdowns. For much of the remaining year, three out of the four sites in this reach experienced super-saturated dissolved oxygen levels, that is, in excess of 100%. This is most likely a result of the continuous flows maintaining an array of algae in the channel which spend their daylight hours photo-synthesising. A by-product of this process is oxygen which can be detrimental when it occurs at such extreme levels as this. Interestingly, another effect of photo-synthesis is that it can drive up pH levels and, again, these sites had pH readings above 8.5 on ten occasions in 2020.

Algae forming on the edges of the Tuggeranong Creek and Fadden stormwater channel (Photo: R. Knee).

Tuggeranong Creek, Lower TUG3

Tuggeranong Creek to Murrumbidgee River confluence

2020 CHIP Result C+ (Fair)		
2019 CHIP Result B- (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**11**
pH	Excellent	
Turbidity	Good	
Phosphorus	Fair	
Nitrate	Good	
Electrical Conductivity	Good	
Dissolved Oxygen	Fair	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**1**

Reach Facts

Reach network length: approx. 1.8km
Dominant land uses: Suburban reserve

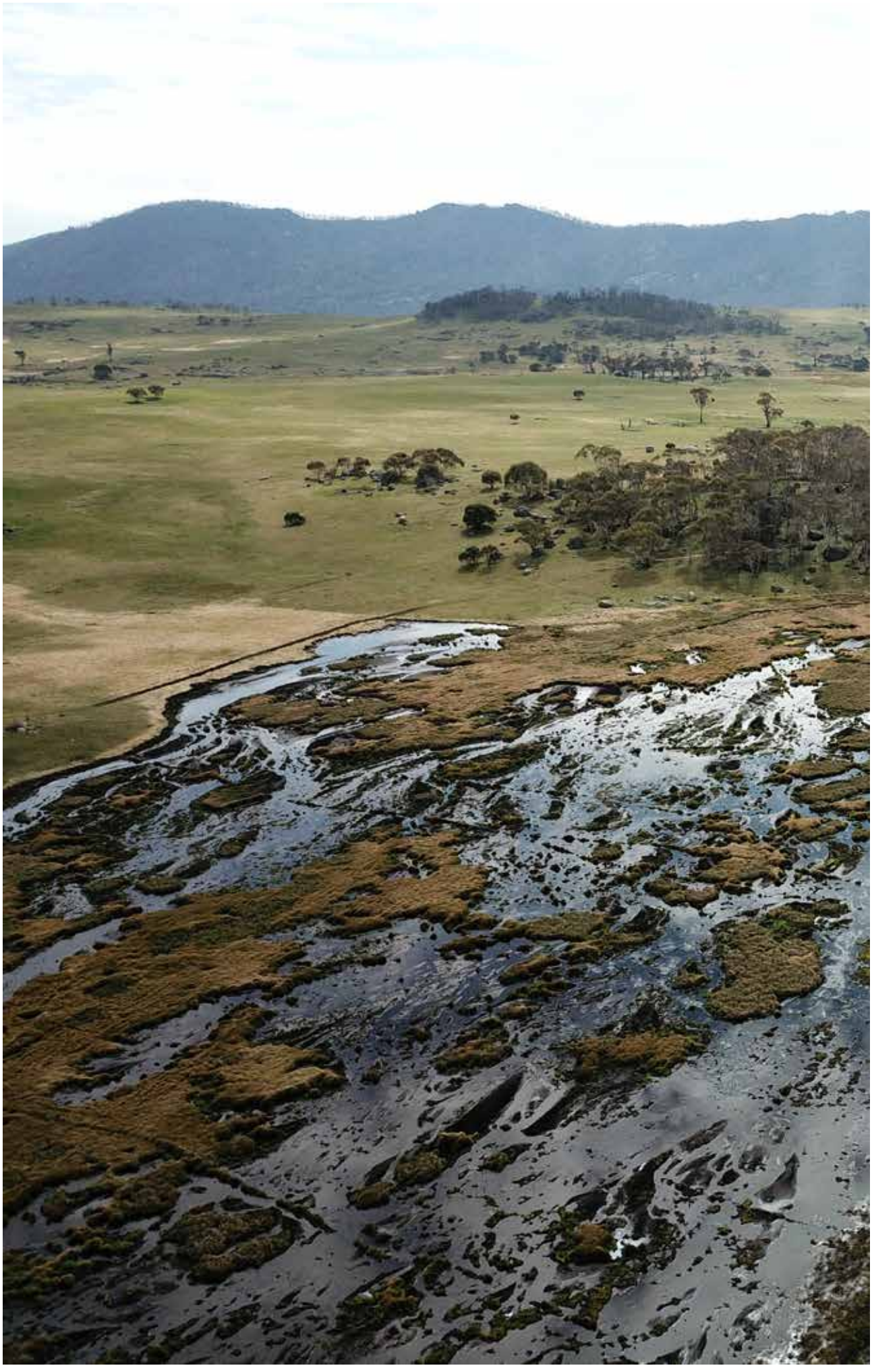
This reach includes the natural stretch of Tuggeranong Creek fed by Lake Tuggeranong. The creek enters the Murrumbidgee River two kilometres downstream of Pine Island reserve.

Although well lined with Casuarinas, most of the understorey along the creek consists of weed species. The creek itself is heavily overgrown with algae for most of the year. This is driven by the high levels of nutrients often coming into the water from the surrounding catchment. Water quality is also affected by the same seasonal issues that occur in our other small creeks. This includes a loss of dissolved oxygen when the water warms beyond optimum temperatures.

High nutrient measurements were recorded in this reach several times in 2020, with concentrations of high as 0.07mg/L phosphorus and 3mg/L nitrate in April. It's possible that nutrients were being flushed through Lake Tuggeranong more this year due to the above average rainfall.

A good diversity of waterbugs were found in both seasons. Predatory naked caddisfly larvae were found in high numbers in the riffle zone, along with house building varieties such as stick caddis, in spring. Mayfly larvae were also found in small numbers although these were mainly the Caenid variety that have specially formed covers over their gills to prevent them getting clogged by silt – thus making them more tolerant to disturbance. Most other bug types detected were ones that can tolerate the high nutrient and comparatively low oxygen levels of this creek.

Waterwatcher Ross sampling the good flows of lower Tuggeranong Creek, August 2020.



Yass Catchment Facts

The Yass catchment is approximately 2,800km^2 , and is situated to the north of the ACT. It is made up of two major rivers. The first is the Yass River that has its headwaters approximately 100km to the southeast around Wamboin. The river flows northwest past Sutton and downstream to the township of Yass and then through steep gorge country until it flows into Burrinjuck Dam from the east. The major tributaries of the Yass River include Brooks Creek, Gundaroo Creek, Murrumbateman Creek, Dicks Creek and Manton Creek.

The second major river is the Murrumbidgee River that becomes part of the Yass catchment (in terms of the CHIP report) below the confluence with Ginninderra Creek just after both waterways exit the ACT. The Murrumbidgee runs north through Wallaroo and Cavan, to the west of Murrumbateman, before entering Burrinjuck Dam from the south. This lower section of the Murrumbidgee has large sand deposits resulting from reduced flows and the impounded waters of Lake Burrinjuck. The natural river bed is smothered by the sand creating wide shallow sections with little or no in-stream structure.

A large portion of this catchment is cleared grazing land and, as a result, major issues include dryland salinity and erosion. Many of these issues could be ameliorated through stock exclusion and the regeneration of the riparian zone. This is occurring on a number of fronts throughout the region with the Yass Area Network of Landcare Groups (YAN) playing a major role.

Yass Catchment Health Summary

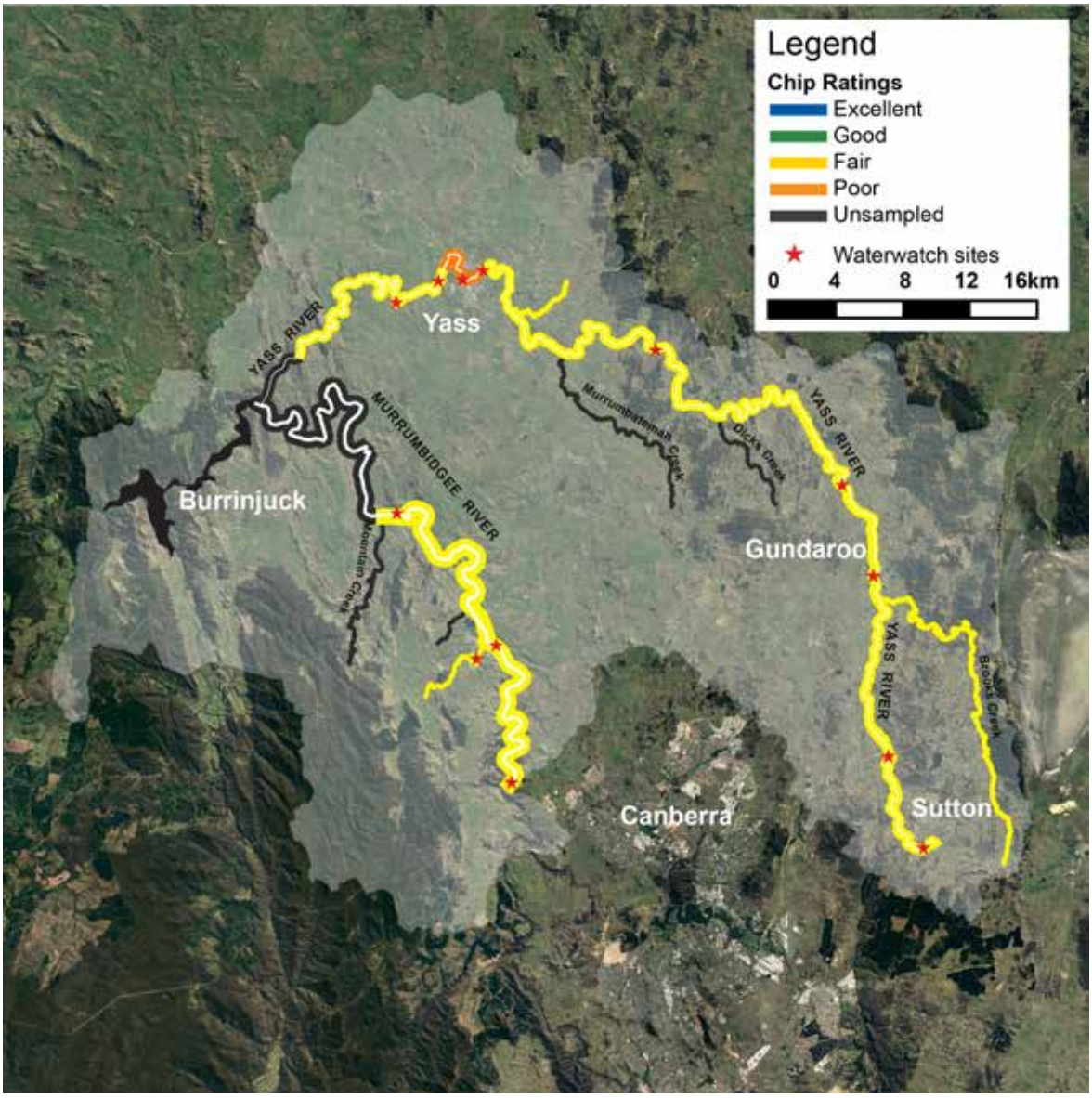
This is the sixth year that data has been collected in the Yass catchment thanks to all the volunteer efforts. Overall, five reaches had fair scores and one had a poor score in the Yass region. The only reach that changed (YAS3) dropped the score from *fair* to *poor*, otherwise reaches maintained a fair score.

It seems the main reason for the decline in score in YAS3 was a deterioration in the waterbug and riparian conditions scores. The flooding events in 2020 have brought large amounts of organic materials and silt from the surrounding landscapes and increased turbidity levels. These might have influenced the reduced amount of waterbugs in the surveys, where the majority were pollution-tolerant species.

Generally, the rains in 2020 increased the flows in the Yass catchment but we were still not able to see a great recovery from the last few years of drought. It might take another year of regular and gentle rainfall to improve overall scores in the region.

Although bushfires did not directly affect areas in the Yass catchment during the summer of 2020, impacts on the river were still felt in the form of ash and sediment being washed down from the firegrounds in both Namadgi National Park and the upper Murrumbidgee River in the Cooma region. After heavy falls in mid February, volunteers recorded concentrations of phosphorus and turbidity so high that it exceeded the measurement limit of some of the Waterwatch gear. The resident volunteer at Wallaroo thoughtfully referred to the Murrumbidgee as '*the chocolate river*'.

Elevated nitrate readings continue to be detected in the Murrumbidgee River with up to 10mg/L recorded. The Lower Molonglo Water Quality Control Centre (LMWQCC) is a likely contributor to these high readings. The lower Yass River (YAS4) also continues to get elevated nitrate results of up to 6mg/L below the township, while the sites upstream of the township detect low concentrations.



Murrumbidgee River CMM12

Ginninderra Creek confluence to above Mullion Creek confluence

2020 CHIP Result C+ (Fair)		
2019 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**9**
pH	Excellent	
Turbidity	Fair	
Total Phosphorus	Excellent	
Nitrate	Degraded	
Electrical Conductivity	Poor	
Dissolved Oxygen	Excellent	
Waterbug	**Fair**	**1**
Riparian condition	**Fair**	**2**

Reach Facts

Reach network length: approx. 18km
Dominant land uses: Grazing, conservation

This Murrumbidgee River reach starts at the confluence with Ginninderra Creek and ends above the confluence with Mullion Creek in Wallaroo.

The riparian condition varies considerably through this reach. The upper section contains some of the most intact remnant patches in the area with steep rough terrain providing refuge for native species. In contrast the lower section has many areas dominated by exotic weed species, which are surrounded by sheep farms. In a few notable places, private landowners are undertaking riparian vegetation replanting to improve river condition

The most concerning parameter in this reach over the past few year is nitrate, where concentrations have reached up to 30mg/L (*degraded* levels are >2.6mg/L). Due to the increased flow in 2020, the maximum concentration was lower at 10mg/L in April and July. The source of this is most likely the Lower Molonglo Water Quality Control Centre.

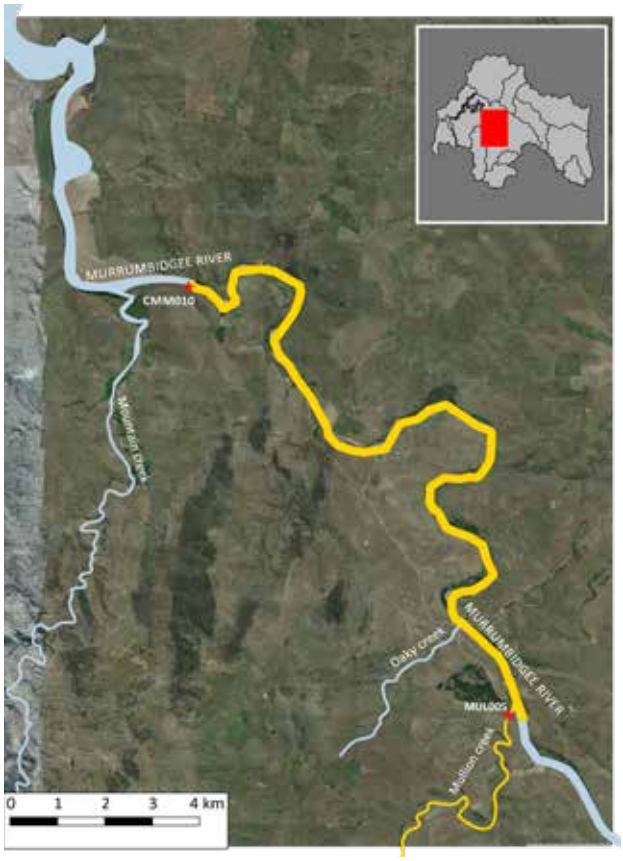
Evidence of the summer bushfires were felt even this far down the Murrumbidgee River. Ash was observed suspended in the water and lying thick on the banks throughout 2020. After the early rains in February, the amount of ash was so high that phosphorus concentrations were 0.25mg/L and turbidity levels were in excess of 400NTU – both as high the Waterwatch equipment can measure. Waterwatcher Fiona took photos at her downstream site at Wallaroo (CMM110) where the river looked like a chocolate milkshake.

The Murrumbidgee River looked like a chocolate milkshake at CMM110, February 2020 (Photo: F. Hamer).

Murrumbidgee River CMM13

Mullion Creek confluence to Taemas Bridge above Burrinjuck Dam

2020 CHIP Result C (Fair)		
2019 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**13**
pH	Excellent	
Turbidity	Fair	
Total Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Poor	
Dissolved Oxygen	Excellent	
Waterbug	**Degraded**	**2**
Riparian condition	**Poor**	**2**



Reach Facts

Reach network length: approx. 20km
Dominant land uses: Rural

This reach is the most downstream of the 13 reaches on the Murrumbidgee River. The bottom site at Taemas Bridge is immediately upstream of the impounded waters of Lake Burrinjuck. Much of this catchment is cleared grazing land, with poor in-stream habitat and a narrow and degraded riparian zone. Stock have direct access to the river in many places, further impacting condition.

Low water levels and flows are common in this reach, and this is particularly evident at site CMM010, where the Murrumbidgee River is shallow, has a sandy bottom and little in-stream habitat. The large 'sand slugs' (a large intrusion of sand within a river channel) in this lower section are mainly a result of upstream land use practices as well as the damming of the river at Burrinjuck Dam.

In 2020, with above average rainfall, influenced by the La Niña event, this reach saw higher water levels, with water backed up from the Burrinjuck Dam. This was a contrast from the past few years where sand banks were exposed in the middle of river.

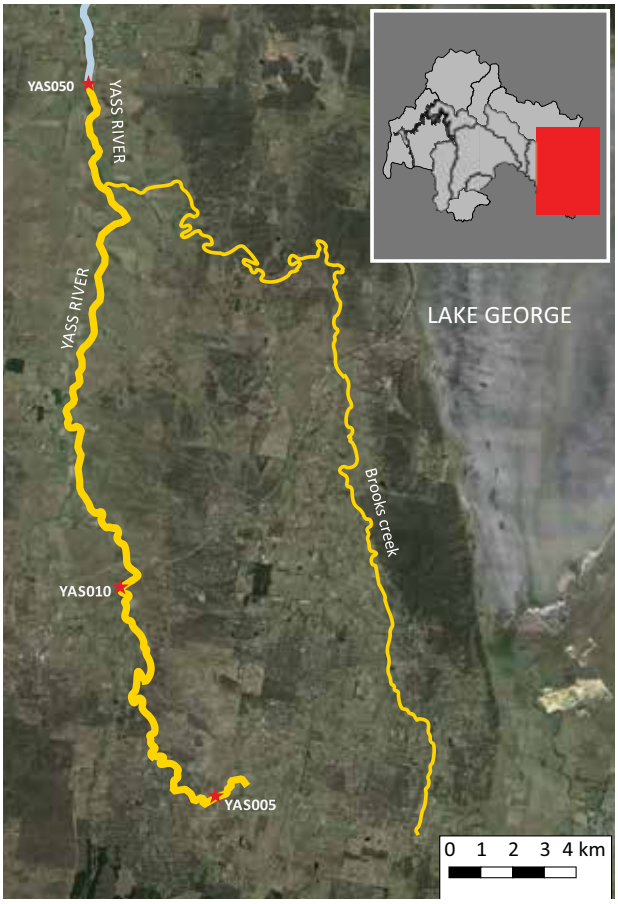
Even at this most downstream reach in the upper Murrumbidgee catchment, there was evidence of the summer bushfires with ash noted on the riverbank during the autumn waterbug survey. With all the available phosphorus flowing in to Burrinjuck Dam over 2020, it is not surprising that it is suffering from a large blue green algae outbreak at the time of writing this report.

The Murrumbidgee River at Taemus Bridge, CMM010.

Yass River YAS1

Headwaters to Brooks Creek confluence, including Brooks Creek

2020 CHIP Result C+ (Fair)		
2019 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**12**
pH	Excellent	
Turbidity	Excellent	
Total Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**3**
Riparian condition	**Poor**	**3**



Reach Facts

Reach length: approx. 60km
Dominant land uses: Rural, rural residential

The upper Yass River and Brooks Creek represent the top of the Yass River catchment. Although good ground cover is present throughout this reach, with the presence of tussock grasses, the overall amount of native vegetation is still limited.

This reach has a new site in Yass River after the confluence with Brooks Creek (YAS050). It will help to improve the coverage in the upper sections of Yass River and understand the changes in water quality as the river moves downstream, passing through Gundaroo and the Yass township.

In 2020, the volunteers observed this reach coming back to life, following years of dry conditions. Waterwatchers Carol and Clive noted several bird species, such as reed warbler, blue wren and ducks, in addition to frogs croaking in YAS010, and Paul recorded a Rakali (native Water rat) in YAS005. Improved flows in Yass River upstream from YAS005 resulted in ribbon weed (actually an important native aquatic plant) being observed. The rains also saw large amount of yellow cape weed (an actual weed!) take hold in the adjacent landscape.

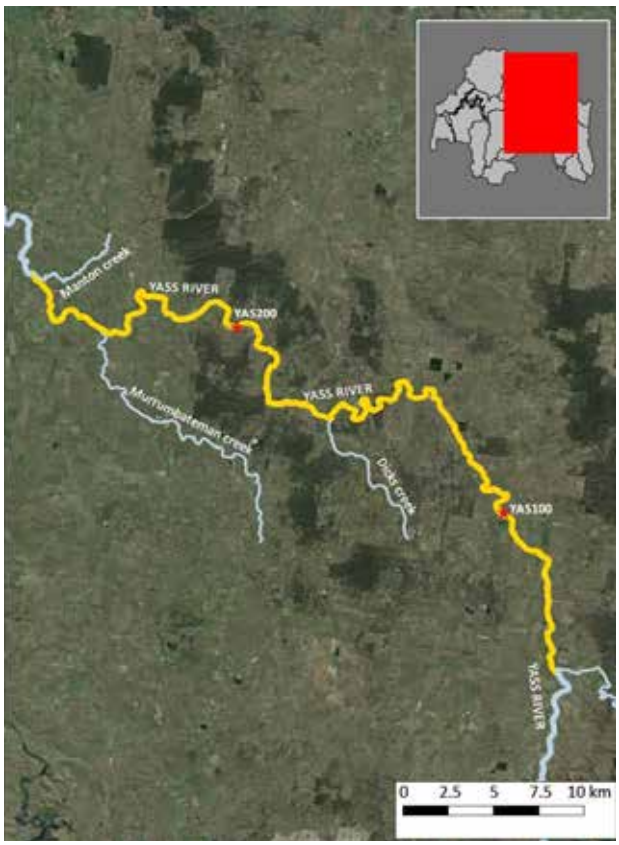
Waterbug surveys also benefited from the increased rainfall in 2020, as water levels were back to normal in YAS005 and eleven Orders of waterbugs were recorded in the spring survey. The most common type was the diving beetle (adults and larvae), with more than 60 individuals. Adult diving beetles, also known as “nature’s scuba divers”, carry an oxygen bubble below the water surface and use it to breath underwater.

The Yass River near Sutton Road at Gundaroo (YAS050).

Yass River YAS2

Dicks Creek confluence to Manton Creek confluence

2020 CHIP Result C+ (Fair)		
2019 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**12**
pH	Excellent	
Turbidity	Excellent	
Total Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**2**
Riparian condition	**Fair**	**2**



Reach Facts

Reach length: approx. 30km
Dominant land uses: Rural

This mid-section of the Yass River contains the major tributaries of the Murrumbateman and Manton creeks. The catchment is largely cleared and used for grazing. Riparian condition is generally poor, with pasture improvement right up to the river bank and stock access to the river evident. Erosion and in-stream sedimentation, are issues in this reach, and high electrical conductivity due to a combination of historical land use and geology.

Good riparian condition can be found at 'Goldenholm' (YAS200) with native canopy cover, midstorey and groundcover, supporting a highly functional riparian zone. Conversely Booth's Crossing (YAS100) has minimal canopy cover and depauperate groundcover, pulling the overall riparian score for the reach down to a *fair* rating.

In 2020, Waterwatcher Iain noted the extreme readings of electrical conductivity (EC) at YAS100 and how they relate to rainfall. In January, for example, at the height of the drought, EC was reached 1690µS/cm, with anything >404 µS/cm considered *degraded*. Lower water levels in dry times usually result in higher concentration of salts and minerals in the water which increases EC readings. In contrast, after 65mm of rain in February had a diluting effect on the Yass River, Iain recorded an EC of 210µS/cm which is low for this site.

Carp leaping and splashing around on the water surface are a common sighting during spring in this reach.

Volunteer Mary helping out with waterbug surveys at 'Goldenholm' on the Yass River (YAS200).

Yass River YAS3

Yass township

2020 CHIP Result D+ (Poor)		
2019 CHIP Result C (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Fair**	**11**
pH	Excellent	
Turbidity	Poor	
Phosphorus	Good	
Nitrate	Degraded	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	**Degraded**	**2**
Riparian condition	**Poor**	**2**

Reach Facts

Reach network length: approx. 10km
Dominant land uses: Urban/Rural Fringe

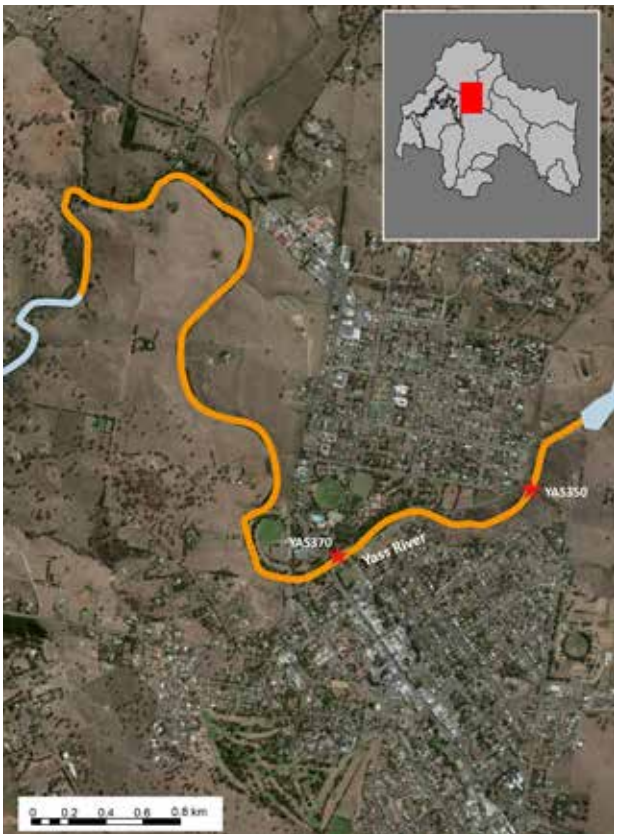
This section of the Yass River includes the township of Yass. Flow is heavily influenced by Yass Dam located just above the town, and urban inputs are also likely to influence water quality in this reach. There is ongoing habitat rehabilitation occurring in the Yass Gorge at the top of the reach. The township of Yass was named after Yarrh or Yharr, the word for running water in the Ngunnawal language.

The Yass Gorge (YAS350) is a heritage site and one of the most conserved sections of Yass River, with good numbers of large, native trees, shrubs and lomandra plants. The Friends of Yass Gorge have been instrumental in restoring this landscape and controlling weeds.

The presence of in-stream vegetation in YAS370, such as native ribbon weed, serves as habitat for waterbugs, fish and turtles. Wood ducks, Coots and Dusky moorhens are commonly observed and Pobblebonks *Limnodynastes dumerilii* are often heard calling.

In 2020, Waterwatcher Rebecca noticed signs of erosion at YAS370, as well as an increase in weeds such as hemlock, prickly lettuce, soldier thistle, poplars and blackberry. Waterwatcher Hannah also noticed the presence of exotic weeds close to her sampling site in YAS350. The increased weed growth this year is most likey related to the extra rainfall following the years of dry conditions

Nitrate, presumably from urban inputs, continues to be a problem in this reach.

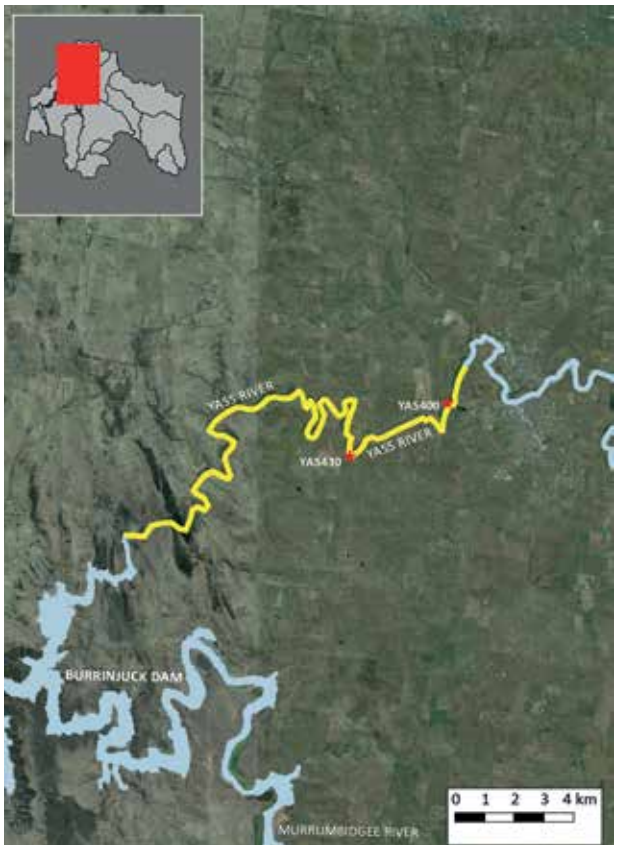


Waterwatcher Hannah at the Yass Gorge (YAS350).

Yass River YAS4

Hattons Corner to Burrinjuck Dam

2020 CHIP Result C+ (Fair)		
2019 CHIP Result C (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Fair**	**9**
pH	Excellent	
Turbidity	Poor	
Phosphorus	Good	
Nitrate	Degraded	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Excellent	
Waterbug	**Poor**	**2**
Riparian condition	**Fair**	**2**



Reach Facts

Reach network length: approx. 23km
Dominant land uses: Rural Fringe

This downstream section of the Yass River runs through gorge country and farmlands before flowing into Lake Burrinjuck. This reach is marked by its scenic beauty and significant geological history. The Hume Limestone, which caps the escarpment above the River at Hatton's Corner, is particularly rich in fossils. Habitat restoration projects are underway, led by landowners below the township. This should have a positive impact on the catchment health over the long term

Despite the presence of reeds along the River and some patches of native tree regeneration, most of the riparian zone is lacking good canopy cover and shrubs, which are necessary to provide shade, erosion control, and habitat for birds and other fauna

In 2020, the effect of high flows has been felt in this reach with more water moving along the system, bringing sediments, silt and organic materials. As a consequence, there were a few spikes in phosphorus (0.05-0.08mg/L), and turbidity (30-35NTU), where clear water is measured at <9NTU. Nitrate were also high and this is possibly a result of an increase in urban run-off from the Yass township (see also reach YAS3)

During the November sampling, Waterwatcher Rebecca noted 'bank shape has totally changed due to flooding. Large gravel deposition area and shrubs washed away'. She also observed a very thick growth of weeds on the riverbank, such as blackberry, wild radish, black oats and dock.

Yass River at Hattons Corner (YAS400).

Special Fire Report

Water quality in the Upper Murrumbidgee River following the 2020 bush fires

O'Connell, Joseph and Ubrihien, Rodney, Centre for Applied Water Science, University of Canberra.

Background

The upper Murrumbidgee catchment includes large areas that have high conservation values. Undisturbed forested catchments such as this include heavily vegetated areas that are ideal for environmental conservation and water collection. These densely vegetated areas can be particularly susceptible to bushfires. Bushfires can have negative implications for conservation efforts and water quality. Bushfires have a history of impacting aquatic habitats and reducing water quality in Australia with city water supplies being affected in Sydney in 2001, Canberra in 2003, Adelaide in 2007 and Melbourne in 2009. In 2020 there were fires in the Upper Murrumbidgee catchment that have potential to reduce water quality both in the short and long term.

After bushfires the combination of increased runoff and sediment transport can lead to reduction in water quality and degradation of aquatic habitat. The primary impact of bushfires is the combustion of organic material. This combustion initiates many processes that severely impact terrestrial and aquatic habitat. The loss of vegetation leads to a reduction in evapotranspiration: the loss of moisture from the soil due to respiration by foliage. Additionally, the deposition of ash clogs soil pores and reduces infiltration. In post-fire rain events, this reduction in evapotranspiration and infiltration causes a greater proportion of the rainwater to runoff into waterways. The sediment loads in this runoff also increase because of the removal of vegetation that normally impedes flow, aids infiltration and supports soil structure. Ash particles are also deposited in the catchment during the fire. When high flow conditions after fires the unconsolidated soil and ash particles are readily transported into waterways.

The upper Badja River catchment was nearly entirely burnt in the fires (Photo: A. Brademann).

The increased runoff and sediment transport have both short and long-term effects on the waterways. In the short-term water quality changes include increased turbidity, nutrient concentrations, metals and other contaminants that can impact the organisms that occupy the waterways, and in extreme cases, lead to mass mortality events, such as fish kills. In the longer term, the deposition of material from the catchment leads to large sediment loads entering streams and rivers, often resulting in "sand slugs" (discrete bodies of sand deposited into the body of a stream) that alter structure, impacting the availability of viable habitat for some aquatic species. In receiving water bodies, increased deposition of nutrient rich sediment can lead to potentially toxic algae blooms. The effect of increased sediment loads on stream morphology and the addition of nutrients to receiving waters can last for decades.

The 2020 Fires

The Orroral Valley fire started on the 27th January 2020 (Figure 1). The fire burnt 80% of Namadgi National Park and 22% of Tidbinilla nature reserve, burning an area of 88,000 ha (ACT Government, 2020). Additional to the Orroral Valley fire, the Adaminaby fire complex (late December to late January) burning to the southwest of the ACT and the Badja fire (1st to 7th January 2020) to the southeast of the ACT also impacted the Upper Murrumbidgee catchment area.

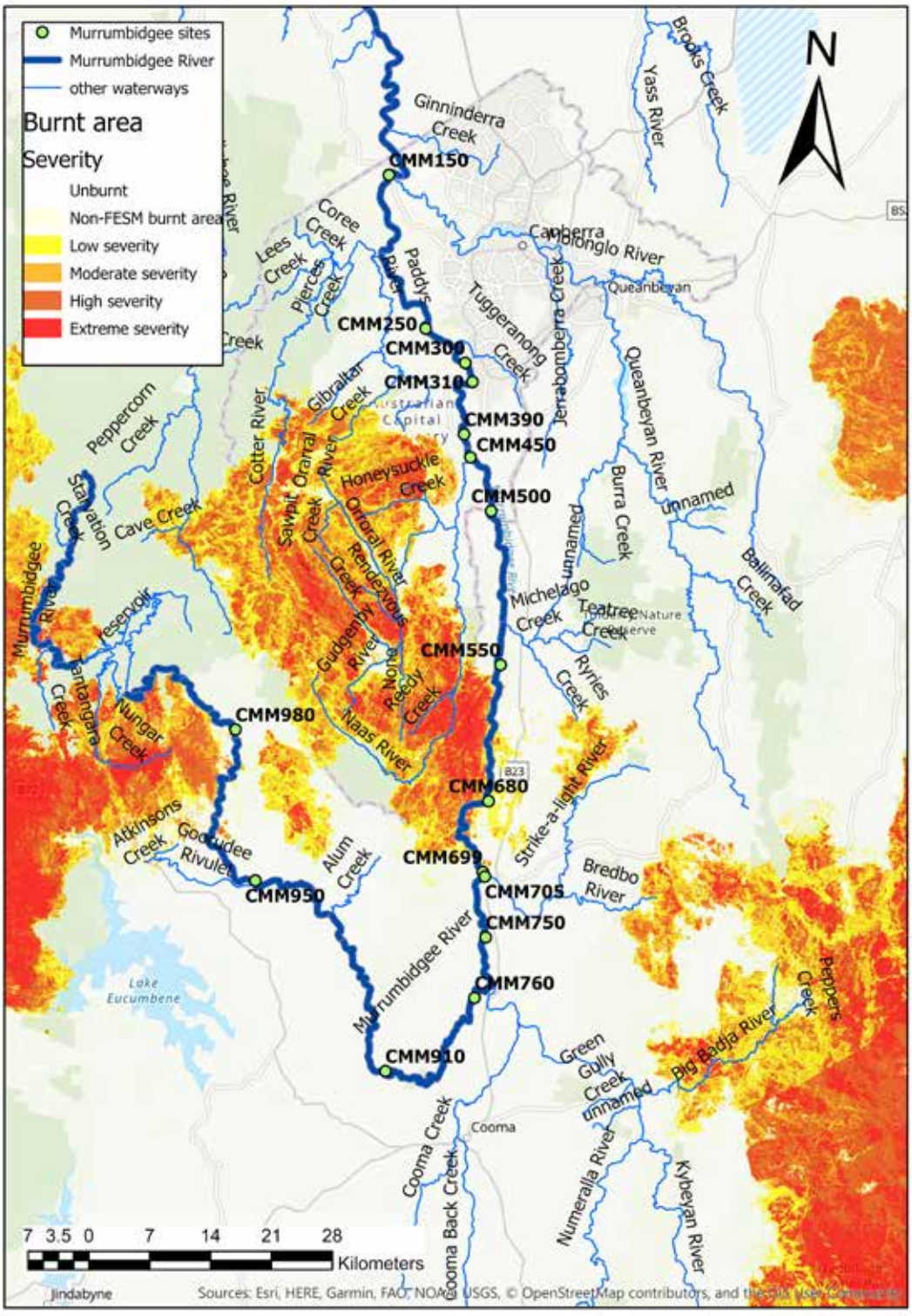


Figure 1. Map of Upper Murrumbidgee catchment area with fire intensity for the 2019/2020 bushfires and relevant Waterwatch sampling sites.

Results and discussion

The 2020 bushfires in the ACT and surrounds had a clear impact on local water quality, particularly turbidity (Figure 2). Although spikes in turbidity were evident in the data prior to the fires, the spike following the 2020 bushfire is of a greater magnitude (Figure 2A). The reduction of water transparency results from larger quantities of ash and sediment being transported into the Murrumbidgee River following the bushfire. This influx of sediment can often be accompanied by the development of sand slugs. These sand slugs can smother streambeds and banks, reducing viable habitat for many native fish, amphibian and macroinvertebrate species. Two examples of the impacts to aquatic organisms that occur in the Upper Murrumbidgee catchment after bushfires are the loss of breeding habitat for two species of native fish, the Mountain Galaxias and two-spined blackfish that require cobble streambeds for deposition of eggs, and the increased mortality of freshwater crayfish due to increases predation because of reduced stream and riparian cover. Plant communities are also impacted by decreased light penetration in the water from increased turbidity, and the deposition of large amounts of sediment smothering existing in stream vegetation.

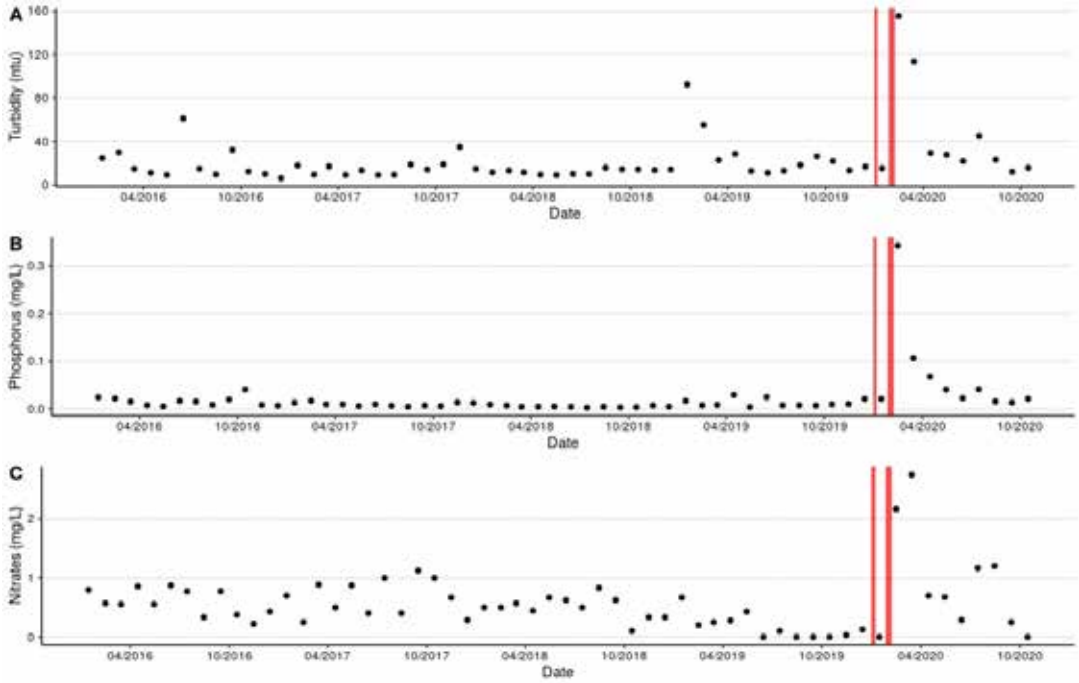


Figure 2. Mean monthly A) turbidity, b) phosphorus and C) nitrate at Waterwatch sites on the Murrumbidgee River in the Upper Murrumbidgee catchment for the period January 2016 to October 2020. The red bars show the timing of the Badja and Orroral Valley fires. Sites included in the analysis are CMM750, CMM705, CMM699, CMM680, CMM550, CMM450, CMM390, CMM310, CMM300, CMM250 and CMM150.

Parts of the Gudgenby River catchment were still devoid of vegetation six months after the fires (Photo: W. O'Reilly).

The spikes in turbidity following the 2020 bushfires are accompanied by increase in nitrate and phosphorus concentrations in the rivers (Figure 2B and 2C). In the historical data, the concentrations of nitrate and phosphorus have been relatively consistent since 2016. The large increase in nutrient concentrations after the fires could be directly related to the release of nutrients during the fires as well as the increased movement of nutrients associated with ash and sediment. Increased nutrient loads entering the waterways can lead to eutrophication of waterbodies which occurs when a water body becomes overly enriched by nutrients. Eutrophication can cause a myriad of flow-on effects such as blue green algae blooms, highly turbid water, shifts in plankton communities and reductions in aquatic plant and animal populations.

Ash flow from the fireground affected the lower Badja River (Photo: A. Brademann)

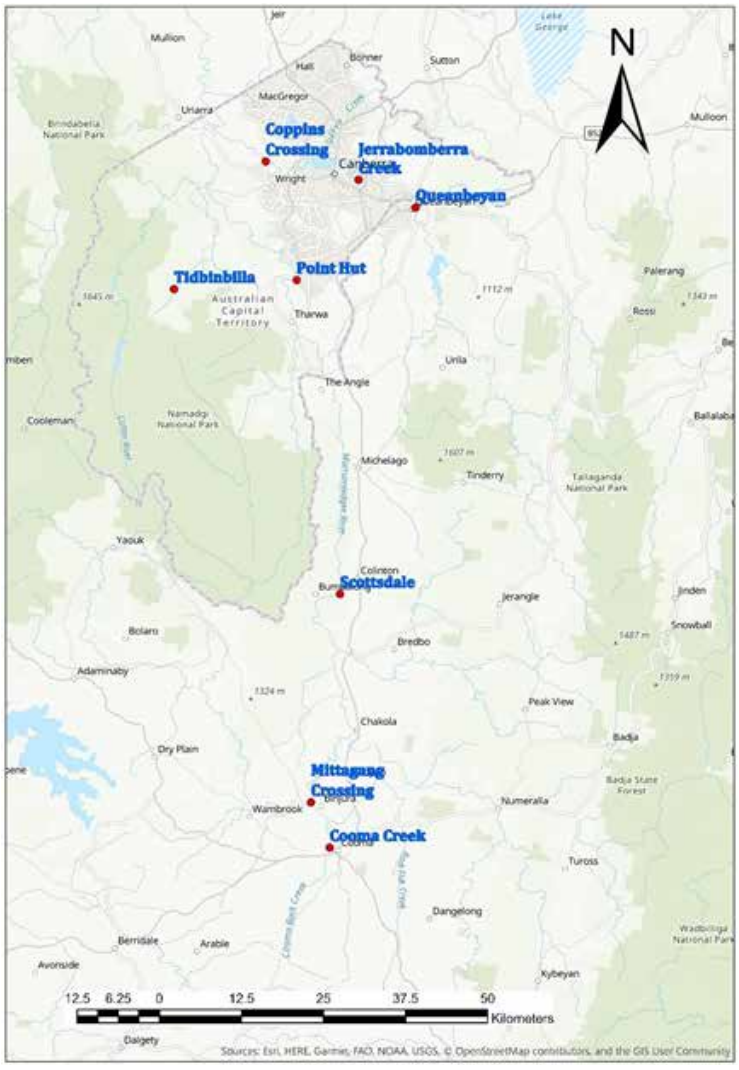
The changes to the aquatic ecosystems following a bushfire can also have long-term environmental effects. Sand slugs are notorious for slowly travelling downstream, impacting the stream bed and banks along its entire path for extended periods. In receiving waters, such as lakes, eutrophication can persist for decades before returning to pre-fire condition. The impacts to ecological communities resulting from altered streambeds and cyanobacteria blooms are long lasting. The immediate effects of the 2020 fires on the water quality in the Murrumbidgee River can be seen in Figure 2, but ongoing effects are likely to be present for many years to come.

The Murrumbidgee River running brown with ash and sediment in February 2020 (Photo: W. O'Reilly).

Platypus Month 2020

Platypus Month 2020 found Upper Murrumbidgee Waterwatch monitoring a very different river system to 2019. The record-breaking drought of 2018/2019 saw many of the smaller tributaries (ie. creeks and streams) of the upper Murrumbidgee catchment cease to flow or dry up altogether. For the month of August 2020, 105mm of rain was recorded on top of an already wet year.

Of further interest this year are two of our Murrumbidgee River sites (Point Hut and Scottsdale), which were impacted either directly or indirectly by the February 2020 fires. The volumes of sediment and ash that washed into the river from the heavy, post fire rain, smothered much of the river substrate. This is key habitat of waterbugs which are the primary food source of Platypus.



Map 1: Thirty-four group surveys were conducted at eight sites across the ACT region.

Fortunately, the wet conditions did not deter the Platypus or the volunteers from showing up to the surveys. Over **300 volunteers participated** in the surveys and noted **31 individual Platypus over eight 'river reach' sites across the ACT region!** The big increase (up from eleven in 2019) was in part due to the additional three sites monitored due to the heightened interest in Platypus Month from the community in 2019. The new sites were the Queanbeyan River, Queanbeyan, Mittagang Crossing on the Murrumbidgee near Cooma and the Sanctuary Wetlands at Tidbinbilla. Four surveys were conducted at each and these three sites combined produced 16 of 31 individual Platypus that were detected this year. Tidbinbilla and Queanbeyan in particular, are known Platypus hotspots so it was good to see the survey results reflecting this with seven and five individuals recorded respectively (Table 1).

The Mittagang Crossing site on the Murrumbidgee River near Cooma was originally surveyed back in 2015 but has not been monitored since 2017. Waterwatch has historically only picked up one individual at this site so it was encouraging to record four Platypus on the last survey there. This section of the Murrumbidgee River was not fire affected.

Even without these additional three sites in the mix, volunteers still detected more Platypus at the five sites that were surveyed last year, with fifteen individual Platypus detected. Jerrabomberra Creek saw one additional Platypus and the Molonglo River below Coppins Crossing recorded two Platypus after not detecting a single individual last year.

Location	Surveys	Number of Individual Rakali (Water Rat)	Number of Individual Platypus
Molonglo River below Coppins Crossing	4	2	2
Jerrabomberra Creek within Nature Reserve	4	2	3
The Sanctuary, Tidbinbilla Nature Reserve	4	0	7
Queanbeyan River, Queanbeyan	4	3	5
Murrumbidgee River, Point Hut Crossing	4	2	4
Murrumbidgee River, Scottsdale Bush Heritage Reserve	6	0	5
Murrumbidgee River, Mittagang Crossing (Near Cooma)	4	0	4
Cooma Creek, Cooma	4	0	1
Total	**34**	**9**	**31**

Table 1: Number of Rakali and Platypus detected during Platypus Month 2020 surveys.

Point Hut Crossing on the Murrumbidgee River had high volumes of ash and sediment deposited at the site from the February fires. This was due to flows coming down the Murrumbidgee River from NSW and outflows from the Gudgenby River, which flow out of Namadgi National Park. Thus, it was pleasing that four individual Platypus were detected at Point Hut crossing which was up from three in 2019. The Murrumbidgee River at Scottsdale Bush Heritage Reserve experienced fire both close to the river edge as well as impacts from fires upstream. It was a relief for volunteers to detect up to five individual Platypus during the surveys which was the same number as last year.

ABOVE: Perfect Platypus spotting conditions on the Queanbeyan River.

Finally, one Platypus was detected at three out of the four surveys at Cooma Creek located in Cooma township. The volunteers said there was a distinct difference in size between the ones seen so it may be that the Cooma creek still has the pair of Platypus which diligent Cooma residents have recorded in previous years. While the Cooma creek was not fire affected per se, the creek experienced very low water levels and turned black during January after people washed off the ash from the New Years Eve firestorms off their houses and cars. This area continues to get attention from some dedicated locals who conduct litter removal and habitat restoration works aimed at improving this creek for Platypus.

Of note was the **complete absence of Rakali** at half of the sites surveyed. While historically they have not been sighted at Tidbinbilla, they have been previously recorded during Platypus Month at the three Cooma-Monaro sites (Cooma, Mittagang Crossing and Scottsdale) so further monitoring in these areas is warranted. On a positive note, Phil Palmer (Reserve Manager at Scottsdale) has since seen some Rakali tracks along the river since the surveys. Rakali do seem to be faring better in the ACT riverine sites (two detected at each) as well as on the Queanbeyan River where up the three individuals were spotted.

ABOVE: Rakali on the Queanbeyan River. Photo: Claudia Munera.

So overall it appears that the increased flows through the system due to the wet weather this year has positively outweighed any negative effects that fires may have had on Platypus at the sites surveyed. Past research by the Australian Platypus Conservancy has suggested that a wet Autumn and Winter may support a successful breeding season in the Spring. The general increase in Platypus activity across all sites this year appears to support this notion.

One thing that we can all do to help Platypus right now, is to **pick up litter.** There are too many examples of hair ties or plastic milk bottle rings getting caught around Platypus which can rub through their fur and compromise their ability to maintain body temperature. This often leads to death. Another common scenario is Platypus getting caught in discarded fishing line or fishhooks and drowning. In fact, two volunteers captured images of Platypus entangled in litter during Platypus Month (see next page).

Given everything that 2020 has thrown at us, Waterwatch are very proud to say that Platypus Month 2020 was our best yet with more Platypus spotted than ever before and ever increasing interest and support from the community in the ACT and surrounding NSW region. Waterwatch are continuing to work towards strengthening the methods for collecting Platypus data so that it can be used to better gauge the status of Platypus populations in the ACT region. Waterwatch also have a grant submitted that would seek to map Platypus distribution in some of our fire-affected catchments through what's known as eDNA (find out more here).

ABOVE: Platypus at Jerrabomberra Creek with a fishhook in its back. Photo: David Cunningham.

ABOVE: Platypus at Queanbeyan River with what looks like a band around its body. Photo: Dylan Jones.

As mentioned last year, if you are keen to do more Platypus data collecting between now and next August, we have set up some sites on the Australian Platypus Conservancy's (APC) Australian Platypus Monitoring Network page. The sites overlap with our survey areas and are aimed at gaining a better understanding of Platypus numbers over the course of the year (ie. beyond Platypus Month). This suits people who would regularly visit these areas and can look for Platypus there preferably once or twice a week for around ten minutes at a time. The more people signing up to a site the better, as this will increase the number of data points for that site and improve confidence in the data. We did not get any uptake to these in 2019 but I urge you to get in touch with us if you think you may be interested and were happy to talk through what is involved. Go to 'View Findings' on the APMN homepage to see the sites and contact Waterwatch or Geoff Williams (APC).

Thanks also to staff at Scottsdale Bush Heritage Reserve and at Tidbinbilla Nature Reserve who collaborated with Waterwatch to conduct ten of the 34 group surveys. This adds valuable data to the mix that Waterwatch would not otherwise have the capacity to collect. And finally, thank you to the volunteers for your support and interest. Know that Waterwatch will continue to work hard to raise awareness and increase our understanding of Platypus in the region. Platypus Month couldn't happen without you.

FrogWatch 2020 Highlights

By Frogwatch Coordinator, Anke Maria Hoefer

The ACT and Region FrogWatch Program (FrogWatch) is run by the Ginninderra Catchment Group. FrogWatch has been engaging volunteers since 2002 to monitor, restore and protect local frog habitat, and to raise awareness and educate. The program covers the ACT and its surrounding NSW region from Cooma in the South to Gundaroo in the North and from the Cotter River in the West to Captains Flat in the East. Since 2020 FrogWatch and Waterwatch have adopted a more formal partnership to bring together these two highly successful citizen science programs and enable them both to better inform the management on our aquatic habitats and creatures within them.

As we all know, 2020 was very special in many ways. The year started with fire, smoke, and a once-in-a-lifetime hail storm, followed by Covid-19, which made business-as-usual impossible.

'Tadpole Soup' on the Molonglo River. Photo: Deb Kellock

All awareness raising events and activities were brought to a halt and most people had to quickly adapt to do online meet ups only - while projects, face-to-face get-togethers and hands-on activities had to be cancelled or delayed. A pretty tough situation when community engagement and citizen science is your thing. But this did not mean that there was nothing to do in the FrogWatch office- quite the opposite. A broken-down data portal needed reviving, radio interviews, news articles and social media posts were great means to stay in touch, and small-scale walks and talks (once permitted) were important to keep people motivated and engaged.

Luckily, the largest and most important FrogWatch events are in spring (October), by which time the restrictions had eased and people were more than ever interested in getting safely out and about.

FrogWatch Coordinator, Anke Maria Hoefer gives a presentation on frogs to the Waterwatch volunteers. October 2020

Frogs and Turtles team up

FrogWatch kicked into action in September- with monitoring TURTLES! Truly crazy times! This latest project is a brainchild of the strong FrogWatch and Waterwatch partnership, funded through two Community Environment Program Grants (Fenner and Canberra). It investigates the effects of urbanisation on the distribution and survival of frogs and turtles in the ACT by examining important habitat features for frogs and turtles, the persistence and functionality of urban aquatic and terrestrial wildlife corridors, and turtle nesting habitat choices. Plus, it is almost as popular as FrogWatching!

Tadpole Kits ready to go out to schools.

Tadpole Kits

In mid-October the annual Tadpole Kits for Schools Program, made possible through Icon Water funding, caused teachers and students of 120 schools across the Capital Region to be absolutely mesmerized by the amazing transformation of tiny vegetarian aquatic tadpoles into meat-eating land-lobbing frogs. Ongoing support and mentoring during the 9 weeks program were provided through weekly emails, educational video clips, instruction movies and the occasional school visit.

Frogwatch site ARA100, Aranda Paddock Dam. Photo: Antonia Gamboa.

FrogWatch Census

In late September the annual October FrogCensus was rolled out and every available seat in the five training seminars (at Jerrabomberra Wetlands and Cooma) were snapped up quickly. Plenty of media attention helped getting the word out and raising awareness about the great contributions our volunteers make. Almost all of the 250+ FrogWatch sites were adopted for monitoring by keen volunteers and the warm weather and plenty of rain provided many great survey opportunities, especially in early October. After a couple of very dry years ponds were full or almost full again and busy with frog activities. Thanks to our vigilant volunteer Chris Mobbs, a calling Eastern sedge frog (Litoria fallax) was identified and removed from the Mount Majura Nature Reserve. This species is common along the east coast of Australia, between Cairns and Ulladulla, is often accidentally translocated with fruit boxes and might pose a threat to our local frog fauna by increasing competition for resources. Well done!!

Volunteer list

Cooma

Alison Dooley
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Catherine Dodd
David Harkins
Edel Stephans
Emily Griffin-Morton
Gill Robinson
Ingrid Hagstrom
Jim Wharton
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John Corcoran
Julee Harden
Kerryn Milligan
Louise Jenkins
Maria Linkenbagh
Mario Russo
Marissa Blunden
Mark Kent
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Karen Khoo
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Kathy Jiang
Kathryn Vincent
Kerry Smith
Louise Amos & Lyn Grigg
Maree Latimer
Mel McRoberts
Melissa Varty
Mike Harrison
Mike Sim
Miranda Gardner
Oliver Andrews
Peter Abbott & Fraser Argue
Peter Robertson & Deb Shaw
Philippa Russell Brown
Plaxy McCulloch
Rocky
Royalla Landcare
Sandy Lloyd
Sarah Essex
Sue Gibson
Tahni Chan
Thea Zhu
Tim Yui (ANUgreen)
Tony Patis
Wendy & Steve Hodgman
Woo O'Reilly
Yan Jiang

Southern

ACT Parks & Conservation Service Rangers

Alannah Alley-Freeman

Angus Phillips

Anthony Cory

Carers of Point Hut Pond (Alan Parker, Stephen Dellar & Laureen Harrison)

Caroline Chisholm High School

Catherine Gray

Conder Wetlands Waterwatch (Vera Kurz)

Cooleman Ridge Parkcare (Pat Ryan)

David Cahill

Davina Savang

Emily Brooks

Friends of Stranger Pond (Colin Carpenter)

Friends of Tidbinbilla Parkcare Group

Gudgenby Bush Regenerators Parkcare Group (Martin Chalk, Michaela Popham and Samatha Donohoe)

Hannah Zurcher

Icon Water (Kate Rhook)

Jan Koehler

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Lake Tuggeranong College 'Sustainability Unit'

Paddy's River Waterwatch Group (Maree Blume and Jill Smith)

Parkcarers of Southern Murrumbidgee (P.O.S.M) (Deb Kellock)

Richard Bland

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'Sands' Waterwatch Group (Wendy Rainbird and Anne I'Ons)

Sijia Ding

Southwell Scout Group Venturers

Uriarra Parkcare (Barbara Mackin)

Tidbinbilla Sanctuary Volunteer Assist Program

Tom Nilsen

Vanya Munibi

Wendy Warren

William McNaughton

Yana and Ilya Nazarova

Yass

Carol and Clive Boughton

Richard Bland

Kate Wilson

Jane Major

Fiona Hamer

Rebecca Widdows

Paul Churcher

Iain Fyfe

Jill McGovern

Hannah Edwards

Mary Bonet

Glossary

Baseline monitoring: The collection of data prior to a planned intervention/project

Confluence: The intersection of two waterways

Cyanobacteria: Photosynthesizing bacteria often responsible for blue-green algae blooms

Data deficient: Being either unsampled or having insufficient information to provide a confident assessment

Dissolved oxygen: The amount of oxygen present within water, either presented as an absolute amount (mg/L) or as a percentage of the total oxygen saturation at a given temperature

Eastern gambusia: A small invasive pest fish introduced from north America also known as Mosquito fish

Electrical conductivity: A measurement of the total combined salts/minerals in water and used as a proxy for salinity

Ephemeral: Contains water intermittently, as opposed to permanent

Erosion: The loss of soil from the land into waterways

Eutrophication: The rapid blooming of algae and cyanobacteria in nutrient-rich water, which can lead to depletion of dissolved oxygen

Fish kill: A natural or artificially induced mass die-off of fish occurring in a small space of time, often related to rapid depletion of dissolved oxygen

Flashy: A term used to describe the temporal response of river discharge following intense rain

Fragmented: Areas of habitat that have become disconnected due to habitat change

Frost hollow: An area of land that is subject to severe frosts. Often occurs near waterways

Galaxias: A small species of native freshwater fish

Gorge: A narrow, steep-sided, often rocky area immediately adjacent to a waterway

Groundwater: Water that is sourced from deep within the soil

Hydrograph: The relationship between river discharge and time

Leachate: Liquid effluent containing harmful substances

Macrophytes: Aquatic plants

Nitrate: A naturally occurring form of Nitrogen. High levels can indicate excessive nutrient inputs into waterways

pH: A measure of the acidity or basicity (alkalinity) of a solution

Phosphorus: A naturally occurring element essential to life. High levels are often implicated in algal blooms in waterways. Measured as Orthophosphate in the CHIP

Rakali: Indigenous name for the native Water-rat

Reach: A length of waterway defined by hydrological, environmental, landuse and social attributes for the purpose of reporting on ecosystem health

Riparian: The zone immediately adjacent to a waterway, which both directly receives and contributes to the aquatic ecosystem

Runoff: Water that flows into a waterway after rain

Sand slug: A large intrusion of sand within a river channel

Sediment: Soil that has become washed into a waterway

Stormwater: Water that flows into a waterway after rain from through the urban stormwater system

Stressors: Natural and man-made processes that can negatively affect natural ecosystem function

Turbidity: The degree of suspended solids in water that gives it a muddy colour

Willows: an introduced riparian tree species

Abbreviations

ACWA: Actions for Clean Water Plan (an initiative to reduce turbidity in the upper Murrumbidgee)

mg/L: Milligrams per Litre

µS: MicroSiemens

NTU: Nephelometric Turbidity Units

N: Nitrogen

QAQC: Quality Assurance, Quality Control

RARC: Rapid Appraisal of Riparian Condition

TSR: Travelling Stock Reserve

UMDR: Upper Murrumbidgee Demonstration Reach

Appendix I

Cooma region CHIP scores by parameter

Reach	pH	Turbidity	TP	NO3	EC	DO sat	WQscore	WBscore	RARCscore	CHIPscore	Letter
BAD1	3	1	2	1	1	5	2.17	2	2	2.06	B+
BAD2	1	1	1	1	1	5	1.67	2.5	3	2.39	B
BRD1	1	1	4	1	2	5	2.33	2.5	3	2.61	B
BRD2	1	1	2	1	4	5	2.33	2	4	2.78	B-
CMM1	1	1	1	1	1	1	1	2	3.5	2.17	B+
CMM2	1	1	1	1	1	1	1	2.5	4	2.5	B
CMM3	1	1	1	1	1	1	1	2.5	3	2.17	B+
CMM4	1	3	1	1	1	1	1.33	2.5	4	2.61	B
CMM5	1	1	2	1	1	1	1.17	3	4	2.72	B-
CMM6	1	2	1	1	1	3	1.5	3	3	2.5	B
COB1	1	1	5	1	5	5	3	3	4	3.33	C+
COO1	2	2	5	2	5	5	3.5	3	4	3.5	C
COO2	1	1	5	2	5	5	3.17	3	4.5	3.56	C
COO3	1	1	5	5	5	5	3.67	3	4	3.56	C
GUD1	2	1	1	1	5	3	2.17	3	4	3.06	C+
KYB1	1	1	2	1	2	5	2	3	4	3	C+
MIC1	1	1	2	1	5	5	2.5	3	4	3.17	C+
NUM1	1	1	1	1	4	5	2.17	3	4	3.06	C+
NUM2	1	1	4	1	3	5	2.5	4	3	3.17	C+
NUM3	1	1	1	1	2	3	1.5	2.5	3	2.33	B+
NUM4	1	1	2	2	2	5	2.17	4	4.5	3.56	C
ROC1	1	1	4	1	5	5	2.83	4	5	3.94	C-
STR1	1	1	3	2	4	5	2.67	3.5	4	3.39	C

1 = Excellent	2 = Good	3 = Fair	4 = Poor	5 = Degraded

Molonglo region CHIP scores by parameter

Reach	pH	Turbidity	TP	NO3	EC	DO sat	WQscore	WBscore	RARCscore	CHIPscore	Letter
BUR1	1	1	1	1	4	5	2.17	3	4	3.06	C+
DIC1	1	3	1	1	2	1	1.5	3	3	2.5	B
GGG1	1	1	2	5	5	5	3.17		3	3.08	C+
JER1	1	1	1	2	4	5	2.33	2.5	3	2.61	B
JER2	1	3	1	1	4	5	2.5	3	4	3.17	C+
LYN1	1	3	2	2	2	5	2.5	4	4	3.5	C
MOL1	DD	DD	DD	DD	DD	DD	DD	2	4	3	C+
MOL2	2	1	1	1	4	5	2.33	2	1	1.78	A-
MOL3	1	1	2	1	4	5	2.33	2.5	3	2.61	B
MOL4	1	1	2	2	4	5	2.5	2.5	4	3	C+
MOL5	1	3	1	2	4	5	2.67	3	4	3.22	C+
MOL6	1	3	1	2	3	5	2.5	3	4	3.17	C+
MOL7	1.5	1	4	5	5	3	3.25	4	3	3.42	C
PRI1	1	1	1	1	5	5	2.33	2.5	4	2.94	B-
QUE1	1	1	1	1	1	5	1.67	2.5	3	2.39	B
QUE2	1	1	1	1	5	1	1.67	3	3	2.56	B
QUE3	1	1	2	1	4	2	1.83	3	4	2.94	B-
SCA1	1	1	2	1	2	2	1.5		2	1.75	A-
SUL1	1	1	3	2	4	5	2.67	3	4	3.22	C+
SUL3	1	3	5	1	4	5	3.17	3	4	3.39	C
SUW1	1	2	1	4	2	5	2.5	4	3	3.17	C+
SUW2	1	1	2	2	3	5	2.33	3	3	2.78	B-
WAT1	1	1	1	1	2	4	1.67	3	4	2.89	B-
WES1	1	1	4	2	4	5	2.83	3	4	3.28	C+
WOO1	1	1	2	1	5	5	2.5	3	4.5	3.33	C+
YAN1	1	1	2	1	1	5	1.83	2.5	2.5	2.28	B+
YAR1	1	1	1	1	4	5	2.17	4	3	3.06	C+

1 = Excellent	2 = Good	3 = Fair	4 = Poor	5 = Degraded

Ginninderra region CHIP scores by parameter

Reach	pH	Turbidity	TP	NO3	EC	DO sat	WQscore	WBscore	RARCscore	CHIPscore	Letter
CMM11	1	3	4	5	3	1	2.83	5	4	3.94	C-
GDC1	1	1	1	1	4	5	2.17	3	4	3.06	C+
GIN1	1	3	1	5	4	5	3.17	3	4	3.39	C
GIN2	1	3	1	1	4	5	2.5	3	4	3.17	C+
GIN3	1	1	1	1	4	5	2.17	5	4	3.72	C-
GIN4	1	1	2	2	4	5	2.5	3	4	3.17	C+
GIN5	1	1	1	2	4	1	1.67	4	4.5	3.39	C
GIN6	1	1.5	1.5	2	4	1	1.83	3	3	2.61	B
GOO1	1	1	2	2	5	5	2.67	3	5	3.56	C
GUN1	4	1	4	1	5	5	3.33	3	4	3.44	C
GUN2	1	1	1	1	4	5	2.17	3	4	3.06	C+
KIP1	1	2	5	5	5	5	3.83	5	4	4.28	D+
MCW1	1	1	1	2	1	5	1.83	3	4	2.94	B-
MFL1	1.5	1	4	2	1	5	2.42	3	3.5	2.97	B-
YER1	1	1	1	2	4	5	2.33	3	4	3.11	C+

1 = Excellent	2 = Good	3 = Fair	4 = Poor	5 = Degraded

Southern region CHIP scores by parameter

Reach	pH	Turbidity	TP	NO3	EC	DO sat	WQscore	WBscore	RARCscore	CHIPscore	Letter
BOG1	1	1	2	2	2	5	2.17	2.5	3	2.56	B
CGG1	1	1	2	1	2	1	1.33	2.5	4	2.61	B
CMM10	1	3	2	1	2	4	2.17	2.5	4	2.89	B-
CMM7	1	3	3	1	2	1	1.83	2.5	3.5	2.61	B
CMM8	1	1	2	1	2	4	1.83	2.5	4	2.78	B-
CMM9	1	4	5	2	2	1	2.5	3.5	3	3	C+
COT1	2	1	1	2	1	2	1.5	3	3	2.5	B
COT2	1	1	1	2	1	1	1.17	2	2	1.72	A-
COT3	1	1	1	2	1	1	1.17	2.5	3	2.22	B+
GIB1	1	1	1	1	1	2	1.17	2	1.5	1.56	A
GUI1	1	1	2	5	5	5	3.17	4	4	3.72	C-
HOS1	1	1	2	1	3	2	1.67	2	3	2.22	B+
ISA1	2	1	1	1	4	5	2.33	5	4	3.78	C-
MMB1	1	1	2	1	4	5	2.33	4	3	3.11	C+
MPG1	1	3	1	1	3	5	2.33	4	4	3.44	C
MSP1	1	2	1	2	2	5	2.17	3	3.5	2.89	B-
NAA1	1	1	3	1.5	4	1	1.92	2	3	2.31	B+
NAA2	1	1	4	2	3	4	2.5	4	3.5	3.33	C+
ORR1	1	1	2	2	2	5	2.17	3	2	2.39	B
PAD1	1	4	2	2	1	1	1.83	3.5	4	3.11	C+
RAN1	3	3	5	1	2	5	3.17	4	4	3.72	C-
TID1	2	1	1	1	2	5	2	4.5	2	2.83	B-
TLT1	2	2	4	2	2	5	2.83	3	3.5	3.11	C+
TLT2	1	1	1	5	2	5	2.5	4	5	3.83	C-
TUG1	1	1	1	1	4	5	2.17	2.5	4.5	3.06	C+
TUG2	5	1	1	2	5	5	3.17	5	5	4.39	D
TUG3	1	2	3	2	2	3	2.17	3	4	3.06	C+

1 = Excellent	2 = Good	3 = Fair	4 = Poor	5 = Degraded

Yass region CHIP scores by parameter

Reach	pH	Turbidity	TP	NO3	EC	DOSat	WQscore	WBscore	RARCscore	CHIPscore	Letter
CMM12	1	3	1	5	4	1	2.5	3	3.5	3	C+
CMM13	1	3	1	2	4	1	2	5	4	3.67	C
YAS1	1	1	1	1.5	4	5	2.25	3	4	3.08	C+
YAS2	1	1	2	2	4	5	2.5	3	3.5	3	C+
YAS3	1	3	2	5	4	5	3.33	5	4	4.11	D+
YAS4	1	3	2	5	5	1	2.83	3	4	3.28	C+

1 = Excellent	2 = Good	3 = Fair	4 = Poor	5 = Degraded

Appendix II

CHIP Methodology

Upper Murrumbidgee Waterwatch (Waterwatch) produces an annual catchment health report called the Catchment Health Indicator Program (CHIP), based upon the data collected by volunteers throughout the preceding year. This report is a key output of this program, and is used as both a communication tool and to inform management and policy regarding water resource use and protection. Multiple complex calculations are involved in producing the CHIP, and numerous catchment groups around Australia produce similar (albeit slightly different) CHIPs. Specific details regarding these CHIPs are not generally forthcoming and so this document aims to clearly outline the underlying philosophy and methodology regarding the Waterwatch CHIP reports.

Multiple Types of Data

Waterwatch volunteers and coordinators collect data relating to water quality, macro-invertebrate abundance and diversity, and riparian condition. Each of these data sources are 'indices' or 'parameters', which, when combined, form an 'indicator'. Currently, the goal for volunteers is to collect water quality data every month, at every site. Volunteers and coordinators also collect aquatic macro-invertebrate data twice a year, in Spring and Autumn at key sites within each reach, generally near the bottom of each reach (to provide an indication of the entire reach). Finally, Rapid Appraisal of Riparian Condition (RARC; Jansen et al. 2005) assessments are conducted by volunteers and coordinators at each site once every 2 years (biennially). RARCs are conducted at lower frequency, as riparian condition changes at a slower rate than macro-invertebrate assemblages, and water quality. All these parameters are combined into the CHIP. Finally, additional data regarding algae abundance, river flow and height, diversity and frog abundance and Platypus abundance are used to provide context regarding catchment health. These, however, are not formally included in the CHIP calculations (Table 1). More details regarding these additional data sources can be found in the section "Additional Data".

Water Quality Parameters

Currently, volunteers strive to collect water quality data for multiple parameters every month (Table 1). These parameters have been widely established as the best indicators of water quality while being relatively easy to measure and have been discussed in detail elsewhere (eg. Waterwatch Victoria 1999). While there are known (and unknown) site-specific variations in these parameters, it is generally accepted for a majority of these that a specific range of values indicate good catchment health (eg. ANZECC 2000). Deviations away from these ideal values indicate declining health of the waterway. It is this philosophy that underpins the computations of the CHIP, and the grading of catchment health (see Appendix III).

Table 1. Summary of waterway health parameters collected by volunteers and coordinators, that are included in the CHIP.

	Parameter	Frequency	Number of sites
Water Quality	pH	Monthly	All sites
	Electrical Conductivity	Monthly	All sites
	Turbidity	Monthly	All sites
	Phosphorus	Monthly	All sites
	Nitrate	Monthly	All sites
	Dissolved oxygen	Monthly	All sites
	Temperature	Monthly	All sites
Macro-invertebrates	SIGNAL 2.0	Biannual (Spring & Autumn)	Key sites (min 1/reach)
Riparian Condition	RARC	Biennial	All sites

Macro-invertebrates

Aquatic fauna (and flora) are ideal indicators of catchment health, as they are entirely dependent on the waterway for their existence. Aquatic macro-invertebrates differ greatly in their requirements, and their tolerances to changes in their aquatic environment. Numerous programs exist to assess waterway health based upon abundance and diversity of macro-invertebrate assemblages (eg. AUSRIVAS, SIGNAL, ALT) and are similar in many respects. Waterwatch uses SIGNAL 2.0, with macro-invertebrate identification to the order level (not family as with AUSRIVAS). Specific details of the sampling methodology are outlined in the SIGNAL 2.0 user manual (Chessman 2001; Chessman 2003).

The SIGNAL 2.0 score obtained at each site receives an additional calculation to produce a modified stream pollution index based on the diversity of macro-invertebrates found at a site. We have included an additional criteria that examines whether the three key sensitive orders of Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) are present, to aid with standardising scoring across the three data sources (Water Quality, Waterbugs and RARC). This number is transformed into an index score (similar to the water quality parameters, above), and the median value of all the sampling periods within the reach (including spring and autumn surveys), before being included in the CHIP (Table 2). Further details are present in Appendix III.

Table 2. Summary of SIGNAL 2.0 scores, and thresholds between the CHIP score categories.

Number of Taxa	SIGNAL Score	EPT Present	EPT Absent
>7	> 5.5	Excellent	Good
>7	≤ 5.5	Good	Fair
≤ 7	> 5.5	Fair	Poor
≤ 7	≤ 5.5	Poor	Degraded

Riparian Condition

The riparian zone along a waterway is integral to waterway health. The riparian zone performs several important functions, including acting as a buffer and filter to incoming runoff, and extracting nutrients from the waterway itself. Currently, RARC assessments are conducted biennially at all sites.

RARC was developed for use along the Murrumbidgee River in open floodplains dominated by a River Red Gum overstorey. As such, its applicability to the upper Murrumbidgee River catchment, urban environments and non-riverine habitats is questionable. However, it is still likely to be an effective tool for recording changes in riparian composition over time, irrespective of the score. The thresholds applied in the CHIP are as follows (Table 3). These thresholds may be revised in the future, to better reflect the actual distribution of RARC scores present in the Upper Murrumbidgee River catchment.

Table 3. Summary of RARC scores, and thresholds between CHIP score categories.

RARC Score	CHIP Parameter
41–50	Excellent = 1
31–40	Good = 2
21–30	Fair = 3
11–20	Poor = 4
0–10	Degraded = 5

Combining Water Quality, Macro-invertebrate and RARC Data

Using the scores calculated for water quality, macro-invertebrates and RARC assessments, these values are averaged for each site. Currently, water quality, macro-invertebrates and RARCs are equally weighted in the CHIP. However, in the event that one of these is missing, a CHIP score is still produced. If two of the three assessments are missing for a reach, no CHIP score is produced.

Data Density

A potential source of bias can arise from insufficient data collection at sites within reaches. In order to overcome some of these issues, a rule has been applied to the water quality data to ensure a minimum amount of data is present, before a CHIP score is produced. Currently, a minimum of 25% of total potential water quality data must be present for a CHIP score to be produced. This is calculated by dividing the total number of sampling events available for analysis in the preceding year, by the number of sites within a reach, multiplied by the number of total sampling events that should have occurred (12). This provides a proportional measure of the amount of sampling that has taken place within a reach in the preceding 12 months. In the event that <25% of data was collected, the water quality data is not included in the computation of a CHIP score.

The CHIP Score

The resulting CHIP score for each reach provides an indication of the overall health of that particular reach. While specific site-level variations (eg. some sites have naturally high electrical conductivity, low pH etc) may receive lower scores, it therefore requires that careful interpretation of these CHIP values be undertaken prior to making inferences of catchment health. In addition, the application of SIGNAL 2.0 in non-flowing aquatic habitats and RARC assessments in heavily urbanised environments may produce unusually low scores. In these instances, comparing within reaches, between years will be more appropriate than comparing between reaches, within years. These considerations must be taken into account when using and interpreting the CHIP. Finally, vitally important context is provided by the Waterwatch coordinators, who know the underlying geology, hydrology, landuse and history of the catchments. Their expert knowledge is critical to valid interpretations of the CHIP scores.

References

ACT Government (2005) Environment Protection Regulation (2005)

ANZECC (2000) Australian and New Zealand guidelines for fresh and marine water quality Volume 1. October 2000

Chessman, B. (2003) New sensitivity grades for Australian river macroinvertebrates. *Marine and Freshwater Research* 54: 95-103

Chessman, B. (2001) SIGNAL 2. A scoring system for macro-invertebrates ('water bugs') in Australian rivers. Version 2. November 2001.

Jansen, Robertson, Thompson and Wilson (2005). Rapid Appraisal of Riparian Condition. Version 2. Land and Water Australia

Walker, J. and Reuter, D.J. (1996) Indicators of catchment health. A technical perspective. CSIRO Publishing

Waterwatch Victoria (1999) Specific Indicators [Online] Available at: http://www.vic.waterwatch.org.au/file/file/Data%20Interpretation%20Manual/Pages%20from%20WW_DI_MANUAL_PART%20B%20%28p_19-35%29.pdf accessed 10/09/2014

Appendix III

Refining macroinvertebrate scores

Background

As part of the continual process of improving the rigour and transparency behind the calculation of CHIP scores, Waterwatch re-evaluated the process regarding how macro-invertebrate survey data contributes to producing final reach scores.

Throughout the 2013-2014 and 2014-2015 CHIP reports, macro-invertebrate scores have been based upon the divisions defined in the SIGNAL 2.0 manual (Chessman 2003; Table 1).

Table 1. Previous approach to computing CHIP scores based on macro-invertebrate sensitivities and and abundance, as defined by SIGNAL 2.0 (Chessman 2003).

	Number of macroinvertebrate orders	
SIGNAL SCORE	**0 - 7**	**>7**
>5.5	Fair	Excellent
≤ 5.5	Poor	Good

Macro-invertebrate surveys are categorised into 1 of 4 categories based on the number of taxonomic groups (Orders) and the weighted sensitivity of those orders collected (Chessman 2003). For example, where the weighted sensitivity is >5.5 and the number of taxa >7, will result in a CHIP score of "Excellent". Conversely, a weighted sensitivity of ≤ 5.5 and ≤ 7 taxa would result in a CHIP score of "Poor".

Unfortunately, this did not fit well with our five category ranking of catchment health. Indeed, under the previous scheme, it would be impossible to score a reach as *degraded*, as there is no *degraded* category for macro-invertebrates.

Adjusting the score to 5 levels

To make the adjustment to a 5-level scoring system for macro-invertebrates, Waterwatch incorporated an additional criteria to the computation of the CHIP score for each macro-invertebrate survey (Table 2). This additional criteria examines whether all three EPTs (Ephemeroptera, Plecoptera and Trichoptera) are present. If 2 or less are present (eg. any one or more of these taxonomic groups are missing), then scores are penalised (Table 2).

Table 2. New macroinvertebrate scoring system for the 2015-16 CHIP.

Number of Taxa	SIGNAL Score	EPT Present	EPT Absent
>7	>5.5	Excellent	Good
>7	≤5.5	Good	Fair
≤ 7	>5.5	Fair	Poor
≤ 7	≤ 5.5	Poor	Degraded

Why EPTs?

The "EPTs" (Ephemeroptera, Plecoptera and Trichoptera) are the three orders of highly sensitive water bugs – the mayflies, stoneflies and caddisflies. These three orders are generally present where both water quality and aquatic habitat are in excellent condition. Indeed, in all surveys undertaken in the Upper Murrumbidgee catchment by Waterwatch in the previous two CHIPs, all surveys listed as "Excellent" contained these three orders. Both nationally and internationally, there is a strong focus on the EPTs as they are universally considered to be good indicators of good catchment health (eg. Marchant et al. 1995).

What do these changes mean for the CHIP?

The main effect this change has on the CHIP report is providing greater differentiation between Good, Fair and Poor reaches. Furthermore, is now mathematically plausible to score a reach as "Degraded". All previous sites scored as Excellent are unlikely to change, however reaches scored as Good, Fair and Poor have greater scope to shift downwards, if these three important taxa are missing from their macro-invertebrate surveys.

How does this change the previous CHIP?

By way of examination of these changes on the CHIP result, here we present a comparison of CHIP scores from the 2014–2015 CHIP report, with the old CHIP scores (Table 3).

Table 3. Summary of changes to the reach scores from the 2014-15 CHIP with the update in macroinvertebrate scoring.

SCORE	OLD	NEW
Excellent	4	4
Good	45	34
Fair	36	42
Poor	5	10
Degraded	0	0

In all reports following the 2015-2016 CHIP, Waterwatch has used the new macro-invertebrate scoring methodology.

References

Chessman, B. (2003) New sensitivity grades for Australian river macroinvertebrates. *Marine and Freshwater Research* **54:** 95-103

Marchant, R., Barmuta, LA., and Chessman, B. (1995) Influence of sample quantification and taxonomic resolution on the ordination of macroinvertebrate communities from running waters in Victoria, Australia. *Marine and Freshwater Research* **46:** 501-506.

Appendix IV

Refining water quality thresholds for the CHIP

Background

In developing the 2013–2014 CHIP, a set of thresholds had to be applied to the water quality parameters in order to produce water quality scores. These are summarised in Table 1.

Table 1. Summary of 2013–2014 water quality thresholds for the CHIP report.

Indicator Rating	Excellent - 1	Good - 2	Fair - 3	Poor - 4	Degraded - 5
pH	6.0 – 6.9	5.5 – 5.9 or 7.0 – 7.9	8.0 – 8.5	5 – 5.5 or 8.5 – 8.9	<5 or >9
EC (µS/cm)	<= 65	<= 200	<= 350	<= 400	> 400
Turbidity (NTU)	<= 10	<= 12.5	<= 15	<= 20	> 20
Dissolved oxygen (mg/L)	*(Not included in CHIP)*				
Dissolved oxygen saturation (%)	95 – 105	85 – 95 or 105 – 110	75 – 85	65 – 75 or 115 – 120	< 65 or > 120
Phosphorus (mg/L)	< 0.01	0.01 – 0.02	0.02 – 0.05	0.05 – 0.09	> 0.09
Nitrate (mg/L)	< 1.0	1 – 4.9	5 – 9.9	10 – 15	> 15

These thresholds were based largely on those developed by the Molonglo CHIP report (M-CHIP). The M-CHIP values were developed in 2 parts – an urban and rural scale. The rural-scale values were used for the 2013–2014 CHIP report, with a few minor tweaks (mostly to dissolved oxygen) before being implemented. Unfortunately, there is no clear evidence trail of how these thresholds were developed, and so Waterwatch treated them as based upon expert knowledge.

For the 2014–2015 CHIP report, Waterwatch aimed to develop a new set of thresholds based upon water quality data collected in the ACT region. The key issues in developing these thresholds are outlines below.

Identifying a data set: independence, data quality and reference sites

Numerous sources (ANZECC, ACT Water Regulations, other catchment report cards) promote the development of meaningful thresholds based upon a 'training dataset'. A training dataset is a relevant water quality dataset used to determine thresholds which can be applied to data collected throughout the catchment for the purposes of reporting. The strengths of this approach are that thresholds are locally relevant, are developed in a transparent manner and are updateable and repeatable.

Ideally, an independent dataset would be used to redefine thresholds. This has two major benefits.

Firstly, an independent dataset would not be burdened with any real or perceived data quality issues that volunteer collected data may have. Key issues regarding sampling bias, accuracy and precision of equipment and reporting of data can be eliminated. Secondly, thresholds developed from an independent dataset may be retrospectively applied to all Waterwatch data. The use of Waterwatch data would prevent the application of thresholds to data used to define the thresholds (a problem of circularity).

There are limited sources of data available in the ACT region which may be used to develop thresholds. The most obvious data sources are those collected and maintained by the ACT Government, Icon Water and University of Canberra.

In examining the external water quality data to develop thresholds, a key consideration is the choice of sites with which to use to create new thresholds. Obviously, the choice of sites will have a major impact on the threshold values produced. Sites that are considered to represent 'reference condition' are preferred over all others. Reference condition is defined, for the purposes of the CHIP, as sites that represent minimally impacted areas in the ACT region. Ideally, these sites will exist in minimally impacted agricultural or conservation managed lands, without significant impacts from urban centres or major developments.

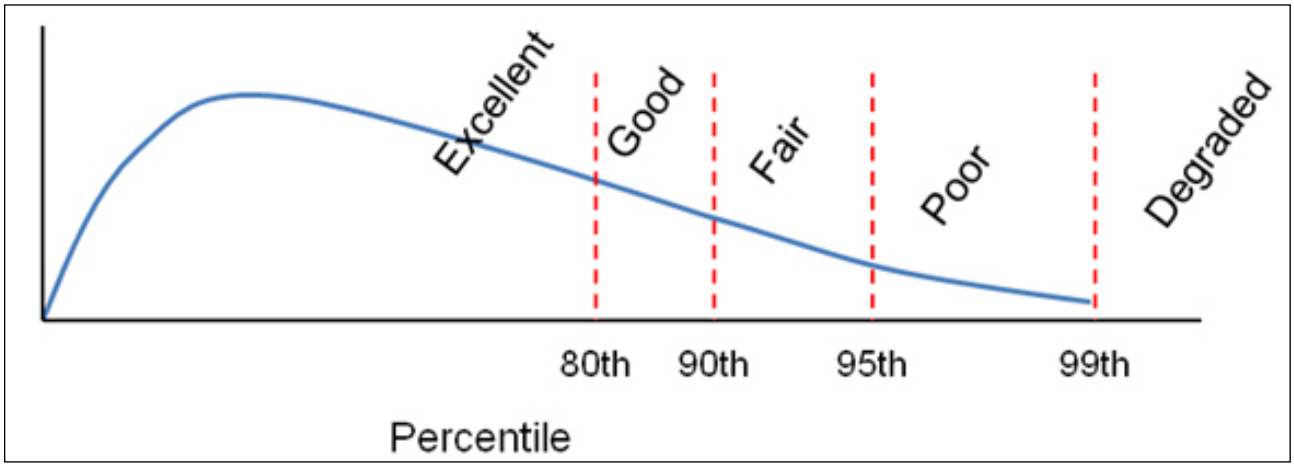
A second key issue is the amount of data available. This is further complicated by the impact that the millennium drought had on reference site condition. For example, data from reference sites of the AUSRIVAS macro-invertebrate monitoring program showed major declines in the relative health of some reference sites during the millennium drought. This is not surprising, but including data that shows negative impacts of drought would influence the discriminatory power that the reference condition approach could provide. These impacts are likely to be present in water quality data that exists from the same time period.

Defining the thresholds

There are numerous ways water quality data could be categorised to produce a score, but Waterwatch have chosen to use percentiles derived from a frequency histogram of water quality data taken from reference sites to define the thresholds for the CHIP.

Our approach is outlined in figure 2. After creating a frequency histogram from reference condition data, the threshold values for each parameter are defined using the 80th (Excellent), 90th (Good), 95th (Fair), 99th (Poor) and >99th (Degraded) percentile. The implicit assumption is that parameter values that occur in excess of 80% of the time in the reference sites reflect *excellent* quality, with rarer occurring events being of lower quality. Finally, it is assumed that *degraded* water quality would only be observed <1% of the time in a reference condition site.

Figure 2. Depiction of defining thresholds based upon a frequency distribution of data.



Identification of 'reference sites'

The selection of sites from which to produce thresholds will have a major impact on final scores produced in the CHIP report. Site selection is critical to how scores are interpreted. While arguably the score is irrelevant, and rather the change in any site/reach through time is more important, the reality is that scores will be interpreted directly without appropriate thought to how they were derived.

Preference will be to select sites that exhibit minimal levels of agricultural and urban impacts. Avoiding urban influences should be relatively straightforward, however agriculture is widespread throughout the upper Murrumbidgee catchment, hence obtaining sites without agricultural impacts will be difficult. Furthermore, historical impacts from agriculture, mining and land clearing may still be having pervasive impacts on water quality, which may be hard to identify in the first instance, and may not be readily avoidable, in any case. As such, 'reference condition' must not be interpreted as 'pristine'. Rather, it reflects the condition of minimally impacts sites within the catchment. As such, long-term goals aspiring towards water quality in sites equivalent to that of reference condition is a worthy goal, yet by no means suggests a return to pristine or non-impacted conditions.

There are limited sites in the upper Murrumbidgee River catchment that have long-term data records from which to derive frequency distributions. Data available from Icon water for the Upper Cotter River catchment (above, and including Corin reservoir) and water quality collected from the Goodradigbee River catchment represent the most practical 'reference condition' datasets for the CHIP.

The catchments to the east of the Murrumbidgee River have a different underlying geology compared to the catchments west of the Murrumbidgee River (eg. The Cotter River, and Goodradigbee River.) Likewise, the Ginninderra and Yass catchments may tend to exhibit high electrical conductivity compared to other catchments. With additional data, electrical conductivity thresholds could be developed for the Molonglo, Ginninderra and Yass catchments, provided suitable data from 'reference condition' sites could be found. This is highly unlikely to occur.

Data availability

Icon Water generously provided water quality data for 2 riverine sites upstream of Corin reservoir, three sites within the upstream-most section of Corin reservoir, and data from 3 sites on the Goodradigbee River, and 3 sites on tributaries of the Goodradigbee River, collected by University of Canberra (Table 1).

Table 1. Summary of sites used to define reference condition for CHIP thresholds.

Site Name	Years of data	Parameters
Cotter Hut	2007-2014	pH, turbidity, EC, DO
Gingera	2003-2015	pH, turbidity, EC, DO
Corin Reservior site 7	1994-2015	TN, TP
Corin Reservior site 8	1993-2015	TN, TP
Kangaroo Ck	2003-2015	TN, TP
Goodradigbee River site 1	2006-2015	pH, Turbidity, EC, TN, TP
Goodradigbee River site 2	2006-2015	pH, Turbidity, EC, TN, TP
Goodradigbee River site 3	2006-2015	pH, Turbidity, EC, TN, TP
Goodradigbee Tributary 1	2006-2015	pH, Turbidity, EC, TN, TP
Goodradigbee Tributary 2	2006-2015	pH, Turbidity, EC, TN, TP
Goodradigbee Tributary 3	2006-2015	pH, Turbidity, EC, TN, TP

Data analysis

Data analysis involved producing frequency histograms of each of the water quality parameters at each site. Firstly, the impact of the millennium drought was explored by comparing histograms for data collected 2010-current, against pre-2010 data. If no observable difference in distributions was present, data was combined. If significant differences were present, only data post-2010 was considered for threshold production.

After identifying non-drought impacted data, sites were combined and examined. If substantial differences in distributions were evident across sites, they were not combined. Conversely, if no major discrepancies were present, data across sites was combined. The exception to this rule was made for electrical conductivity – the upper Cotter River is very low in electrical conductivity, compared to the Goodradigbee catchment. Waterwatch chose to combine data from the Cotter River and Goodradigbee River to produce electrical conductivity thresholds for the CHIP as this will better reflect the apparent naturally higher electrical conductivity readings from other areas in the catchment such as the Molonglo and Ginninderra.

Current thresholds

Table 2 presents the threshold values applied in the current CHIP. Thresholds were developed based upon the 80th (Excellent), 90th (Good), 95th (Fair), 99th (Poor) and > 99th (Degraded) percentiles, for each parameter. For pH and dissolved oxygen, the 10th and 90th (Excellent), 5th and 95th (Good), 2.5th and 97.5th (Fair), 0.5th and 99.5th (Poor) and <0.5th and >99.5th (Degraded) percentiles were used to define thresholds. These thresholds were redefined for the 2014-15 CHIP report onwards.

Table 2: Water quality CHIP thresholds.

Parameter	Excellent	Good	Fair	Poor	Degraded
pH	6.6 – 7.8	6.1 – 6.5, 7.9 – 8.0	5.7 – 6.0, 8.1 – 8.2	5.4 – 5.6, 8.3 – 8.6	< 5.4, > 8.6
EC (µS/cm)	≤ 98	99 – 156	157 – 212	213 – 404	> 404
Turbidity (NTU)	≤ 10	11 – 16	17 – 36	37 – 90	> 90
DO (mg/L)	*(Not included in CHIP)*				
DO Sat. (%)	88 – 99	84 – 87, 100	81 – 83, 101 – 106	78 – 80, 107 – 115	< 78, > 115
Phosphorus (mg/L)	< 0.02	0.02 – 0.03	0.04 – 0.05	0.06 – 0.08	> 0.08
Nitrate (mg/L)	< 1.0	1.0 – 1.3	1.4 – 1.7	1.8 – 2.6	> 2.6

Going forward: interpreting the CHIP

Interpreting CHIP scores must explicitly consider how the scores were derived. The data used to derive the water quality thresholds come from water quality monitoring sites in the upper Cotter River catchment and the Goodradigbee River catchment.

As such, all WQ CHIP scores are to be considered in relation to the 'reference condition'.