Edward/Kolety-Wakool system Environmental Flows Newsletter

Issue Number 16 | 1 April – 30 June 2023

Edward/Kolety-Wakool Monitoring, Evaluation and Research Program

Adult Murray cod captured and released during electrofishing operations in May 2023 (Photo: Justin Stanger).

What's in issue 16

Welcome to issue 16 of the Edward/Kolety-Wakool Environmental Flows Newsletter - a quarterly newsletter that provides an update on our progress as we monitor and undertake research on the ecosystem outcomes of Commonwealth environmental watering actions in the Edward/Kolety-Wakool system.

The Edward/Kolety-Wakool Flow-MER Program is a collaboration between universities, state government agencies, consultants, and local community organisations. More information on the program can be found at: https://flow-mer.org.au/selected-area-edward-kolety-wakool/

Update on river flows and environmental watering actions

Throughout the second half of 2022 there were long periods of unregulated flows in the Edward/Kolety system, resulting in extensive flooding in rivers, creeks, forests and on private property in the region (see newsletter #14). As a result of this flooding hypoxic blackwater conditions developed, with much of the mid Murray experiencing low dissolved oxygen concentrations that posed a risk to freshwater fish and other organisms. During this period of unregulated flows environmental water was delivered to rivers in the Edward/Kolety-Wakool system from 16 Murray Irrigation Limited escapes to create small patches of higher dissolved oxygen in rivers and tributaries that serve as small refuges for fish and other aquatic biota (see story on pages 4-6 of this newsletter about monitoring of the environmental watering from the Edward Escape).

For most of the first six months of 2023 there have been operational flows in the system. There was an environmental watering action in the Yallakool-Wakool and Colligen-Niemur systems in March/April (Figure 1), increasing connectivity and flow variability in these tributaries. There was also a cease to flow in Yallakool Creek, Wakool River and Colligen Creek in late May/early June 2023 while maintenance was being undertaken on Stevens Weir.

With the catchment remaining wet and Dartmouth Dam and Hume Dam near their full capacities, the mid Murray and many of the tributaries are currently receiving unregulated flow in late June 2023. This will increase connectivity and provide opportunities for fish movement.

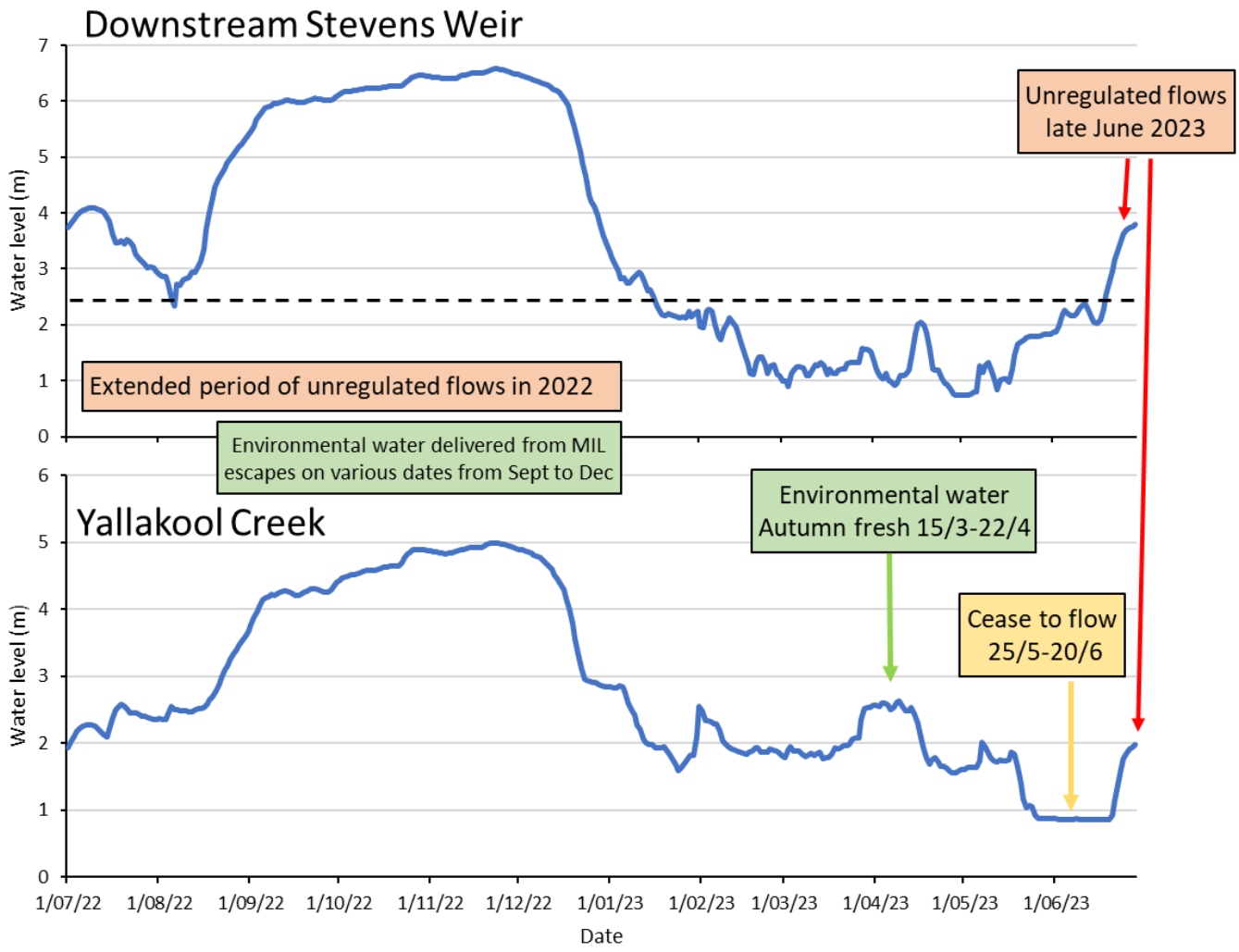

Figure 1 *Hydrographs for the flow gauge downstream Stevens Weir (top) and at the Yallakool Creek offtake (bottom) showing daily discharge from 1/7/2022 to 30/6/2023 (Data source: WaterNSW). The dotted black line in the Stevens Weir hydrograph indicates the water level of 2.4 m (discharge of approximately 2700 ML/d) at which water commences to flow into Werai Forest via the Tumudgery Creek regulator.*

Annual mid-Wakool River fish survey

NSW Department of Primary Industries (Fisheries), with assistance from Charles Sturt University, have completed the annual survey of fish populations in the mid-Wakool River, marking the ninth year in a row this annual survey has been undertaken since the LTIM/Flow-MER project began. These annual surveys are conducted using a combination of boat-mounted electrofishing, fyke nets and bait traps at ten sites. These surveys complement the larger scale fish survey that is undertaken at 20 sites across the Edward/Kolety-Wakool River system every three years. This years' survey was undertaken following the widespread flooding in late 2022 and provides an opportunity to compare the results to monitoring undertaken after the last flooding event in 2016 that triggered large fish kills due to hypoxic blackwater.

The variety of fish survey methods used enables researchers to target a range of species from tiny, small-bodied fish all the way up to adult Murray cod more than one metre in length (Figures 2 and 3). Once fish are captured, they are all identified and counted. The large-bodied species are measured and weighed. The information collected allows trends in the populations of native and introduced species to be examined over time to better inform decisions regarding river management.

In autumn 2023, nine native and four introduced species were caught in the mid-Wakool River, which is similar to the number of species caught in previous surveys.

Figure 2 *Left: John Trethewie (CSU) measuring an adult Murray cod (Photo: Justin Stanger NSW DPI) Right: A juvenile golden perch (Photo: John Trethewie CSU)*

Figure 3 *Left: First river blackfish caught in the mid-Wakool River since the fish monitoring surveys began in 2014 (Photo: John Trethewie CSU) Right: One of thousands of goldfish captured during the survey (Photo: John Trethewie CSU)*

Some of the key observations from the autumn 2023 fish surveys include:

- There was a huge increase in the number of carp, goldfish and Australian smelt compared to previous years, indicating a large recruitment event on the back of widespread unregulated flooding.
- There were fewer Murray cod in 2023 than in 2022, but there were more adult Murray cod this year (some up to one metre in length) than in 2017 after the last major flood event in 2016.
- No young of year Murray cod were captured indicating a poor year for recruitment.
- There were increased numbers of golden perch in 2023 compared to 2022 surveys, and more than in 2017 following the last major flood in 2016. There continues to be a trend of gradual increase in golden perch juveniles since 2020-21. Prior to that, no juvenile golden perch had been captured in these surveys. As there is no evidence of golden perch spawning in the system these fish are likely to have immigrated into the Edward/Kolety-Wakool system from elsewhere in the Murray-Darling Basin.
- River blackfish were captured at the mid Wakool study site for the first time, indicating an expansion of range from populations of blackfish known to exist in the upper Wakool River and Yallakool Creek.

The data collected from this survey are being analysed and will be reported in the 2022-23 Edward/Kolety - Wakool Flow-MER Technical Report available later in 2023. It should provide some interesting results given the major disturbance caused by the widespread flooding in 2022.

Monitoring of environmental watering from irrigation escapes

In 2022-23 unregulated flooding occurred throughout the Murray River catchment following record-breaking rainfall in parts of the catchment. By September there was a high risk that hypoxic blackwater conditions would develop and the risk was likely to continue for some time as water temperatures increased in summer. In spring the unregulated flooding throughout the Murray catchment triggered the development of hypoxic blackwater conditions and resulted in localised mortality of fish and crustaceans.

In response to this risk of hypoxic blackwater, Commonwealth environmental water was delivered from sixteen Murray Irrigation Limited (MIL) irrigation escapes throughout the Edward/Kolety-Wakool system on various dates between September and December 2022 (Figure 1) to create small refuge patches that had higher dissolved oxygen concentrations.

To provide rapid feedback to water managers and increase knowledge about the effectiveness of using environmental water to create refuges, scientists from Charles Sturt University (CSU) (Figure 4), local citizen scientists and scientists from La Trobe University, monitored water quality and fish responses to environmental fish refuge flows from the Edward Escape via Mulwala Canal and Niemur Escape via Northern Branch Canal (also see story in newsletter #14).

Figure 4 *Dr Xiaoying (Shasha) Liu and Chris Davey taking water samples and monitoring water quality near the Niemur escape to the Niemur River. (Photo: Margrit Beemster).*

Water quality monitoring

Water quality was monitored upstream and downstream of both the Edward and Niemur irrigation escapes. CSU researchers collected water samples each fortnight for laboratory analysis of dissolved organic carbon and nutrients (Figure 4). They also measured dissolved oxygen, water temperature and other parameters at sites where the water samples were collected. Measuring water quality from flooded riverbanks can be difficult because results can be affected by local conditions, such as dense cover of aquatic plants or quiet backwaters. To complement the monitoring done by the CSU team, citizen scientists from Deniliquin undertook boat transects along the Edward/Kolety River upstream and downstream of the escapes (see newsletter #14) recording water quality parameters at sites along the river and within in the irrigation escape from Mulwala Canal.

Between October and December 2022 dissolved oxygen (DO) concentrations in the Edward/Kolety River upstream and downstream of the Edward irrigation escape were below 4 mg/L (range of concern for fish) and at times were below 2 mg/L (can be lethal for fish). The observed dark-coloured blackwater was consistent with higher dissolved organic carbon (DOC) concentrations analysed from the water samples.

The environmental watering actions from the irrigation escapes created only a very small refuge areas in the river during the peak of the flood. However, as the flood receded after the peak flow, the size of the refuge created by the environmental water increased, because at this time the environmental water contributed a greater proportion of the total flow in the Edward/Kolety River.

The water quality monitoring showed that during the delivery of environmental water the DO concentrations in the river at the exit of the escape and downstream of the escape were noticeably higher than the DO upstream of the escape. During December, the dissolved oxygen concentrations in the Edward/Kolety River gradually improved, and by mid-January 2023 the DO concentrations were above the level of concern for fish.

Monitoring of fish in refuges created by environmental water

To examine the effect of the oxygen refuges on fish populations, members of the Centre for Freshwater Ecosystems at La Trobe University and John Trethewie from Charles Sturt University used SONAR imagery to survey fish occurring near the escape exits and in the adjacent upstream and downstream reaches (Figure 5). These SONAR cameras can capture near video quality footage in highly turbid conditions making them effective tools in these types of systems (Figure 6).

Figure 5 *Left: Sam Lewis taking water quality measurements downstream of the Edward Escape (Photo: John Trethewie CSU). Right: John Trethewie conducting sonar surveys of fish at the Edwards irrigation escape (Photo: Sam Lewis CFE).*

The surveys showed fish were utilising the oxygen refuge created by the irrigation escape water, particularly native Murray cod which were seen in higher numbers clustered around the escape in December 2022 but more spread out in January 2023 (Figure 7). This suggests that the oxygen refuge created by the environmental water was having a positive effect during the poor water quality conditions in December 2022, and that as conditions had improved during January 2023 fish had dispersed throughout the system. The impacts of the environmental water on other large bodied and small bodied species were also examined.

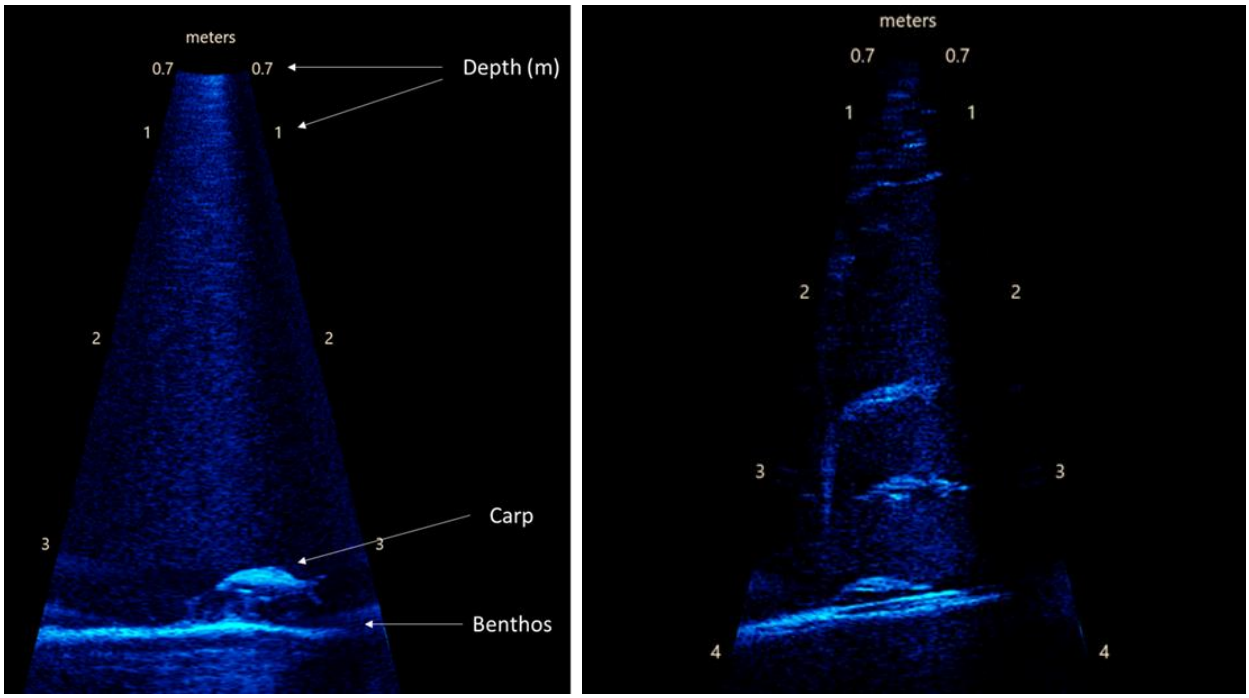

Figure 6 *Screen shots of sonar footage taken at the Edward escape. The depth of water is indicated by the vertical line of numbers.*

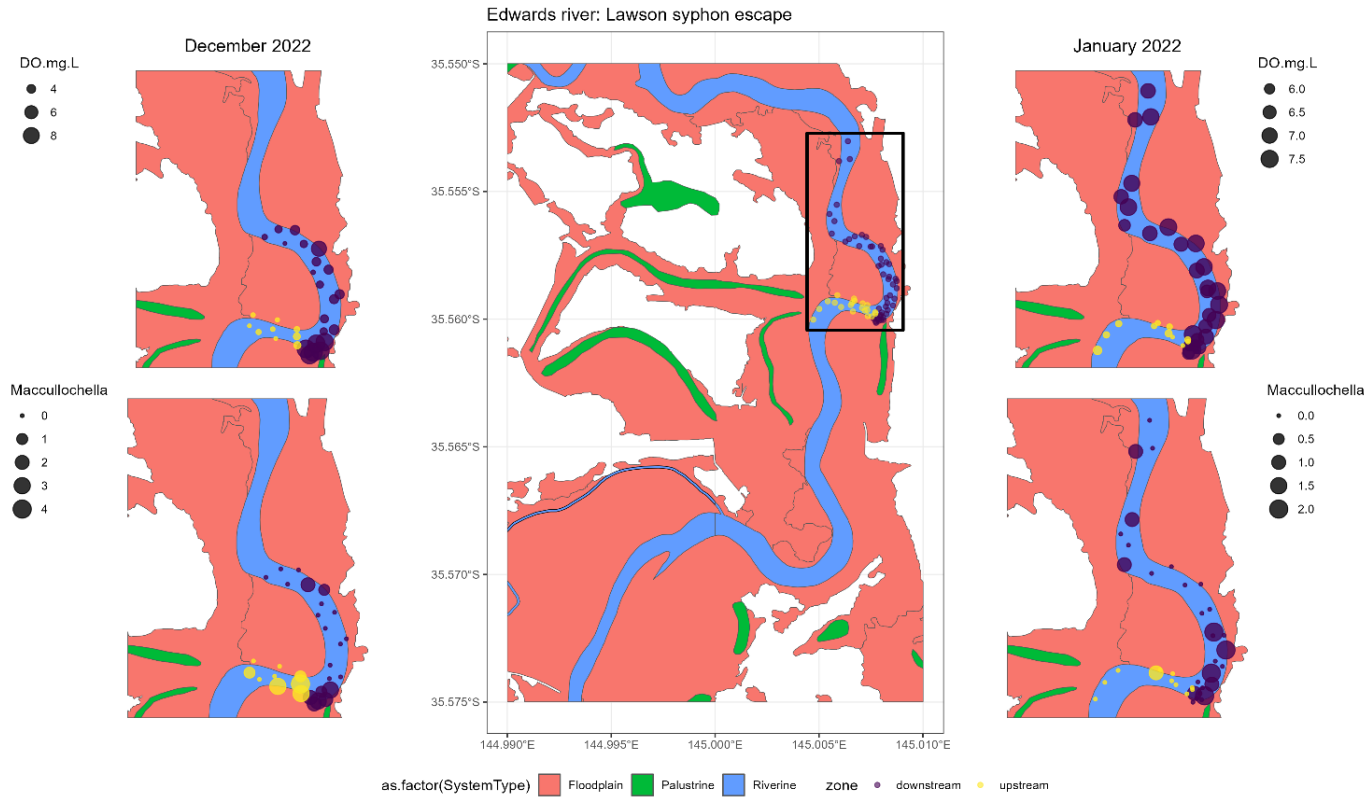

Figure 7 *Bubble plot of sample points overlaid on ANAE wetlands geospatial layer at the Edwards irrigation escape. Middle figure shows location of all sample points taken in December 2022 and January 2023. Left panel shows dissolved oxygen values and Murray cod (Maccullochella) abundances in December 2022. Right panel shows dissolved oxygen values and Murray cod abundances in January 2023. Point size equal values, sample metrics are listed in legends.*

Further information about this study

The preliminary results from this monitoring were used to guide real time management of Commonwealth environmental watering during the hypoxic blackwater event. When the data analysis is completed the results of the study will also contribute to future adaptive management of environmental watering. We are looking forward to presenting our key findings to CEWH staff, relevant agencies and to other key stakeholders. The results from this study will be presented in a report that will be available on the CEWH website later in 2023.

Ephemeral creeks monitoring completed

As reported in Issue #13 of this newsletter, Charles Sturt University in collaboration with NSW DPI Fisheries, Kolety Werkul River Rangers and staff from NSW Department of Planning and Environment set out to investigate the effects of environmental watering on vertebrate species in six ephemeral creeks within the Edward/Kolety-Wakool system: Tuppal Creek, Thule Creek, Cockrans Creek, Jimaringle Creek, Murrain Yarrein Creek and Yarrein Creek. Initially researchers planned to conduct surveys before, during and after environmental watering events. However, this plan changed as widespread unregulated flooding moved through the entire system. The researchers changed the study design to compare surveys from before the creeks began to flow to monitoring undertaken after the flows ceased.

Two sampling methods were used for this monitoring (Figure 8):

- Traditional fish survey methods using backpack electrofishing and fykes nets
- Environmental DNA (eDNA) sampling that can be used to identify a wide range of vertebrate taxa such as fish, birds and mammals from a simple water sample, through a process called eDNA metabarcoding.

Two rounds of eDNA and traditional fish surveys have now been completed at the six ephemeral creeks. Four eDNA samples were collected from each site by filtering water with the e-DNA backpack. The fish surveys were undertaken with 1200 seconds of electrofishing and a combination of two small mesh and two large mesh fyke nets set overnight. The first round of surveys was conducted in August-September 2022 prior to inflows commencing. The second round of sampling was conducted in May 2023 once inflows had ceased.

Figure 8 *Left: John Trethewie (CSU) and Ty Ross (Kolety Werkul River Rangers) backpack electrofishing in Cockrans Creek (Photo: Dale Campbell NSW DPIE). Right: Elka Blackman (NSW DPI) taking a water sample for eDNA analysis (Photo: Chris Davey CSU)*

The eDNA metabarcoding was undertaken using a vertebrate assay and a fish-specific assay. The results from the first round of monitoring undertaken prior to the inflows revealed a total of 42 vertebrate species, which included 12 fish species across all sites. The large-bodied Murray cod and silver perch were detected at Cockrans Creek, and golden perch were detected at Murrain Yarrein Creek. Other species of note were the Murray-Darling rainbowfish, dwarf flathead gudgeon, Rakali, Australasian grebe, great cormorant, Eastern sign-bearing froglet, common froglet, spotted marsh frog, Peron's tree frog, Murray River turtle and Eastern long-necked turtle. There were also a range of introduced species present including common carp, goldfish, Eastern gambusia and oriental weatherloach. The introduced fish species were present at more sites than the native species.

Traditional fish sampling undertaken prior to the flows captured most of the species of fish detected by the eDNA analysis, with the exception of Murray cod, silver perch and golden perch. Native species, particularly carp gudgeon and flathead gudgeon, were more abundant at most sites prior to the flooding. Post flood sampling showed a dramatic increase in the abundance of introduced species, and in some sites the absence of native species detected prior to flooding.

The analysis of water samples from the second round of eDNA metabarcoding is underway and will give a more complete picture of the changes in the fish community post flooding. The results of this project will be presented a report that will be finalised later this year and will be available on the CEWH website.

Hidden from view - freshwater mussels

Freshwater mussels are of significant ecological importance to the rivers and wetlands they live in. Mussels are filter-feeders, filtering water to extract their food, and removing microscopic particles such as algae, bacteria, fine sediment and nutrients from the water. Not only do they have a role to play in improving water quality, but they are an important food source for Murray cod, Rakali (water rats) and water birds.

There are two main species of large, burrowing freshwater mussels in the southern-Murray Darling Basin – the river mussel '*Alathyria jacksoni*', and the billabong mussel '*Velesunio ambiguus*.' Like their names suggests, the river mussel is typically found in large, permanently flowing sections of rivers, while the billabong mussel can be found in slower flowing habitats such as wetlands, lakes, and slow flowing areas of smaller rivers and creeks.

Freshwater mussels are long-lived (we think they can live up from anywhere from 12-30 years!) and can grow to approximately 12 cm (billabong mussel) - 20 cm (river mussel). They have a remarkable life-history in that they have an early parasitic life stage (Figure 9). Young mussels (known as 'glochidia') are released from the female mussels each spring and summer. Then these glochidia must successfully encounter and attach to a fish host (attaching to the gills or tail of a fish as in Figure 10). Here, they will parasitise the fish for up to a couple of weeks, before dropping off their host as a fully formed juvenile mussel. Amazing!

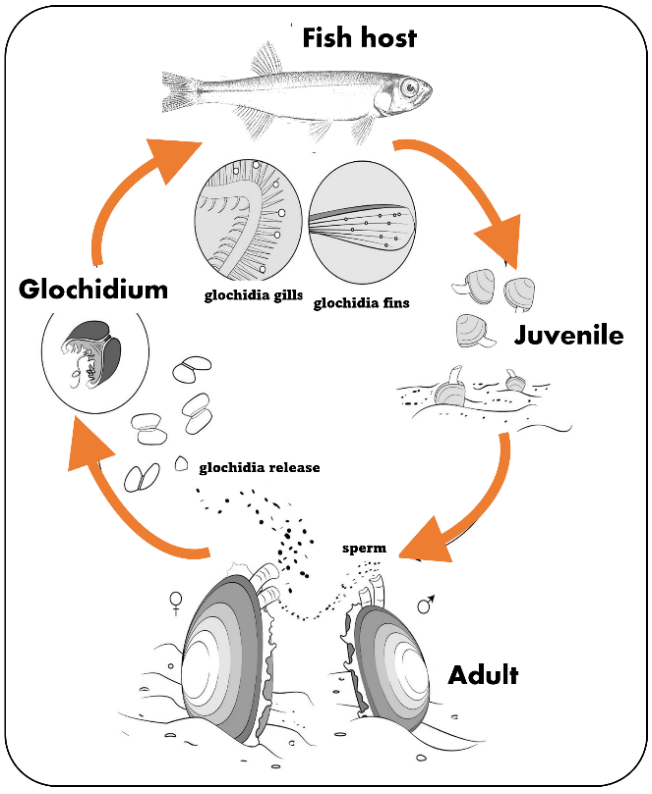

Figure 9 *Left: The life cycle of freshwater mussels (Adapted from Modesto et al. 2018) Right: A freshwater mussel filter feeding with its two siphons on display. The siphon at the bottom is known as the 'incurrent' siphon. Water enters the mussel's cavity through this siphon and moves across the mussel's gills. Food particles suspended in the water are trapped on the mussel's gills and are then moved by mucus towards the mussel's e mouth. Water that has been cleared of particles exits the mussel via the top siphon, called the 'excurrent siphon'. (Photo: Paul Humphries CSU)*

In the Murray-Darling Basin, freshwater mussels were once widespread and abundant, however river regulation causing changes to the flow regime are thought to have had a significant impact on their populations. Unfortunately, we have very little understanding of the current distribution and sizes of freshwater mussel populations in the MDB. This issue is compounded by the difficulty in sampling adult mussels in deep, turbid, lowland river and wetlands.

From July-September 2023, CSU researchers in collaboration with the Kolety Werkul River Rangers and Austral Consulting and Research are planning to conduct mussel surveys in Yallakool Creek and the Upper Wakool River (upstream of Wakool Reserve). Freshwater mussels have cultural importance to the First Nations peoples of the Murray Darling Basin, including the Barapa Barapa or Perrepa Perrepa, and Wamba Wamba or Wemba Wemba peoples of the Edward/Kolety River System. This project will provide opportunities to share knowledge and increase field experience for the River Rangers. The surveys will also provide water managers and the community with an improved understanding of the presence of freshwater mussels in the Edward/Kolety Wakool River system.

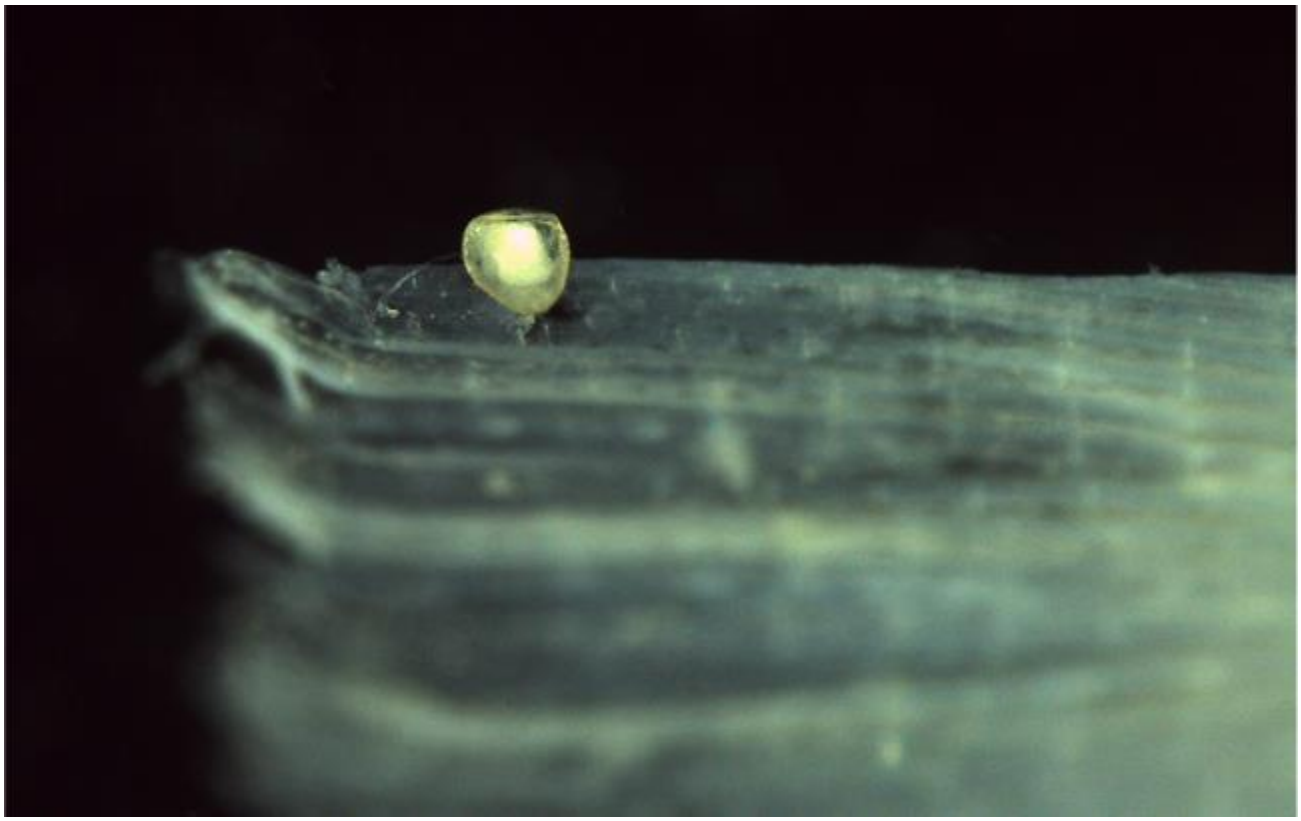

Figure 10 *A glochidium (approximately 0.25 mm in size) attached to the tail of its fish host (in this case, the tail of a carp gudgeon) (Photo: Nicole McCasker CSU)*

The abundance and distribution of mussels will be surveyed using two approaches:

- On-ground visual surveys: During the 2022-23 winter draw-down period when Yallakool Creek and the upper Wakool are near dry or experiencing cease-to-flow conditions, adult mussel distribution and abundance will be mapped at five sites in each river, for approximately 2 km each. This will be undertaken by walking along the riverbanks and mapping and recording exposed adult mussel beds.
- Side scan sonar: In August/September 2023 when flows have recommenced, we will map the same 2 km reaches using boat-mounted side scan sonar. We will evaluate how well sonar technology can detect mussels, by compare the distribution and population size estimates across both methods (ground-truth surveys vs side-scan sonar).

The comparison of mussel populations from two rivers that have contrasting flow histories (Yallakool Creek and the upper Wakool River) will provide some preliminary insight in the role that flow may have on shaping mussel populations. This will help guide the adaptive management of environmental watering in the Edward/Kolety River System.

Interested to find out more about the project? Contact CSU researcher Nicole McCasker nmccasker@csu.edu.au

For further general information on freshwater mussels: https://www.environment.nsw.gov.au/topics/animals-and-plants/native-animals/native-animal-facts/freshwater-mussels

Coming soon: An Interactive Online Flow Map of the Edward/Kolety -Wakool River System

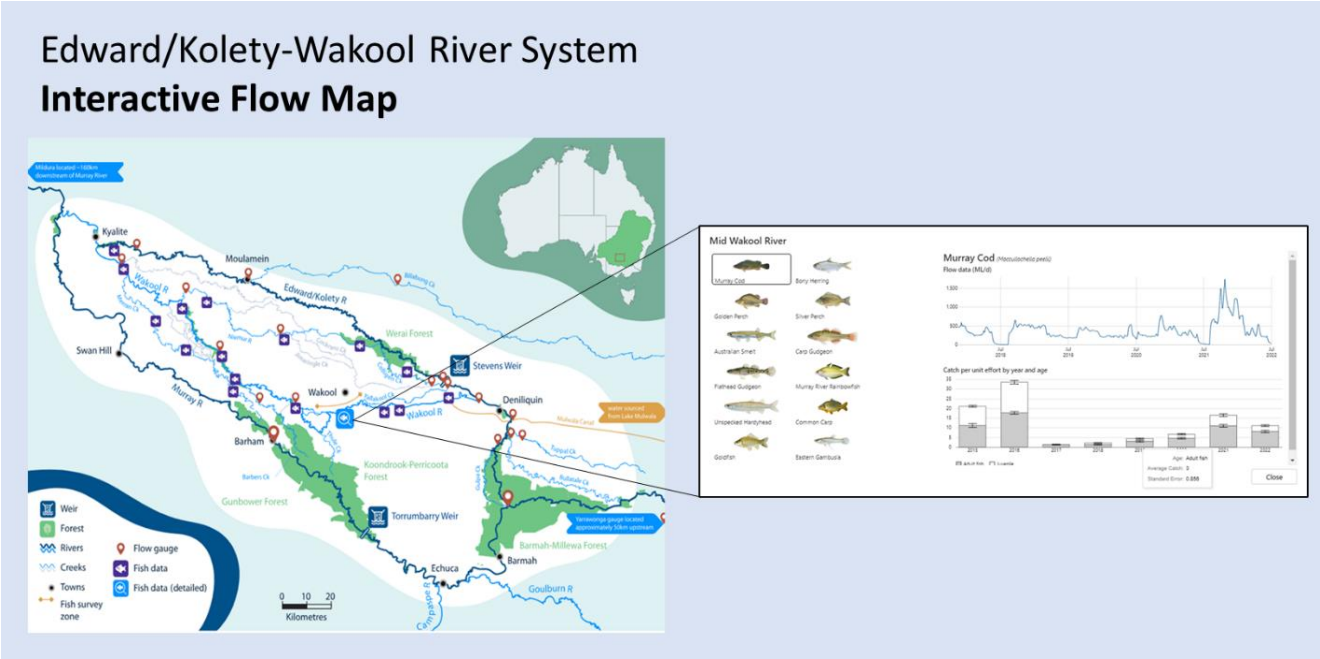

Figure 11 *A preliminary draft preview of the Interactive Flow Map of the Edward/Kolety-Wakool River System. The map will hosted on a new 'Mid-Murray Flows' website, allowing visitors to explore flow and fish data at key sites across the region (Image: DiscoverEI & CSU).*

Charles Sturt University researchers are partnering with data visualisation specialists from DiscoverEI to create an Interactive Flow Map for the Edward/Kolety-Wakool River System. The map will provide a user-friendly way for the community to access up-to-date flow information in the Edward/Kolety-Wakool River system and allow users to visualise the contribution of environmental water to flows at key sites. The map will also display the results of the long-term fish surveys (Figure 11) that have been carried out under the Long-Term Intervention and Flow-MER programs.

The map will be ready for stakeholder feedback in mid-late September, prior to going live online on a new 'Mid-Murray Flows' website. Further update on the map will be provided in the September 2023 quarterly Edward/Kolety-Wakool newsletter. Stay tuned!

More information

To join the newsletter mailing list please subscribe here or contact Professor Robyn Watts, Charles Sturt University, Albury NSW. rwatts@csu.edu.au

We respectfully acknowledge the Wamba Wamba or Wemba Wemba, and Perrepa Perrepa or Barapa Barapa peoples, traditional owners of the land on which the Edward/Kolety-Wakool program is focussed. We recognise their unique ability to care for Country and their deep spiritual connection to it. We honour Elders past, present and emerging whose knowledge and wisdom has ensured the continuation of culture and traditional practices. The Edward/Kolety-Wakool team would also like to acknowledge the local landholders with whom we work and thank them for their contribution to the monitoring and research.

Trethewie J.A., Watts, R.J., Duncan M., Lewis S., Liu X., and McCasker N. (2023) Edward/Kolety-Wakool System Environmental Flows Newsletter, Issue 16. Charles Sturt University.