Edward/Kolety-Wakool system Environmental Flows Newsletter

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Edward/Kolety-Wakool Monitoring, Evaluation and Research Program

Field team from Streamology, Yarkuwa Indigenous Knowledge Centre, Murray-Darling Wetlands Working Group, and Charles Sturt University in Werai Forest in January 2022 doing research on groundcover vegetation. See story on page 4 (Photo: Streamology)

What's in issue #11

Welcome to the issue 11 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 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/
https://www.csu.edu.au/research/ilws/research/environmental-water

Spotlight on Werai Forest

Werai Forest, located on the Edward/Kolety River downstream of Deniliquin, is part of the NSW Central Murray Forests Ramsar site. The health of the forest has been negatively impacted by logging, cattle grazing, drought, past management practices, and altered water regimes that have resulted in a reduction in the frequency and duration of spring wetland inundation. The Werai Forests are currently managed by the National Parks and Wildlife Service and are in the process of being transferred to the Werai Land and Water Aboriginal Corporation through an Indigenous Land Use Agreement.

Informal meetings of Wemba Wemba and Perrepa Perrepa Traditional Owners, other stakeholders and water managers identified some key information that is needed to inform the future management of the forest and delivery of Commonwealth environmental water to the forest. The Edward/Kolety-Wakool Environmental Flows Team has been able to address some of these information needs through research projects funded by the Commonwealth Environmental Water Office Flow-MER Program. This new research builds on the Werai Water Management Plan (Webster and Nias 2017) based on work done by the late Rick Webster from the Murray-Darling Wetlands Working Group.

In this newsletter we provide updates on three projects currently being undertaken in Werai Forest:

- The first story describes hydrological modelling that has examined the relationships between flows downstream of Stevens Weir and patterns of inundation in the forest. This inundation modelling, undertaken by 2rog Consulting, is essential to underpin forest management.
- The second story (page 4) describes an innovative project that is evaluating effectiveness of drones for assessing the response of groundcover plants to inundation. This project is being undertaken by Streamology scientists in collaboration with the Kolety Werkul Rangers employed through Yarkuwa Indigenous Knowledge Centre, and scientists from Charles Sturt University and the Murray-Darling Wetlands Working Group.
- The final story (page 6) describes an experiment being undertaken by researchers from La Trobe University and Charles Sturt University to examine primary productivity in flooded areas of Werai Forest following an unregulated flow event in December 2021. There were very high rates of productivity in the flooded part of the forest.

Characterising the Hydrology of Werai Forest

River regulation (dams, levees, weirs and regulators) has led to the disconnection of the Werai Forest from the Edward/Kolety River. Under current river operations, water levels are actively managed to keep flows within the main channel, and the forest regulators are in poor condition and are not designed to deliver environmental water to the forest. With the current river operating rules and infrastructure, only unregulated flow events inundate the forest, and the forest is in poor health.

We currently have limited understanding of the inundation patterns within the forest. This study aimed to help build understanding of the relationship between flow and inundation in the forest. This project was undertaken by scientists from 2rog Consulting.

River discharge data from the gauge downstream of Stevens Weir was linked to Sentinel-2 satellite imagery to analyse patterns of inundation from past flooding events. Six flow periods from January 2016 to February 2022 were analysed using 41 cloud-free Sentinel-2 images (Figure 1).

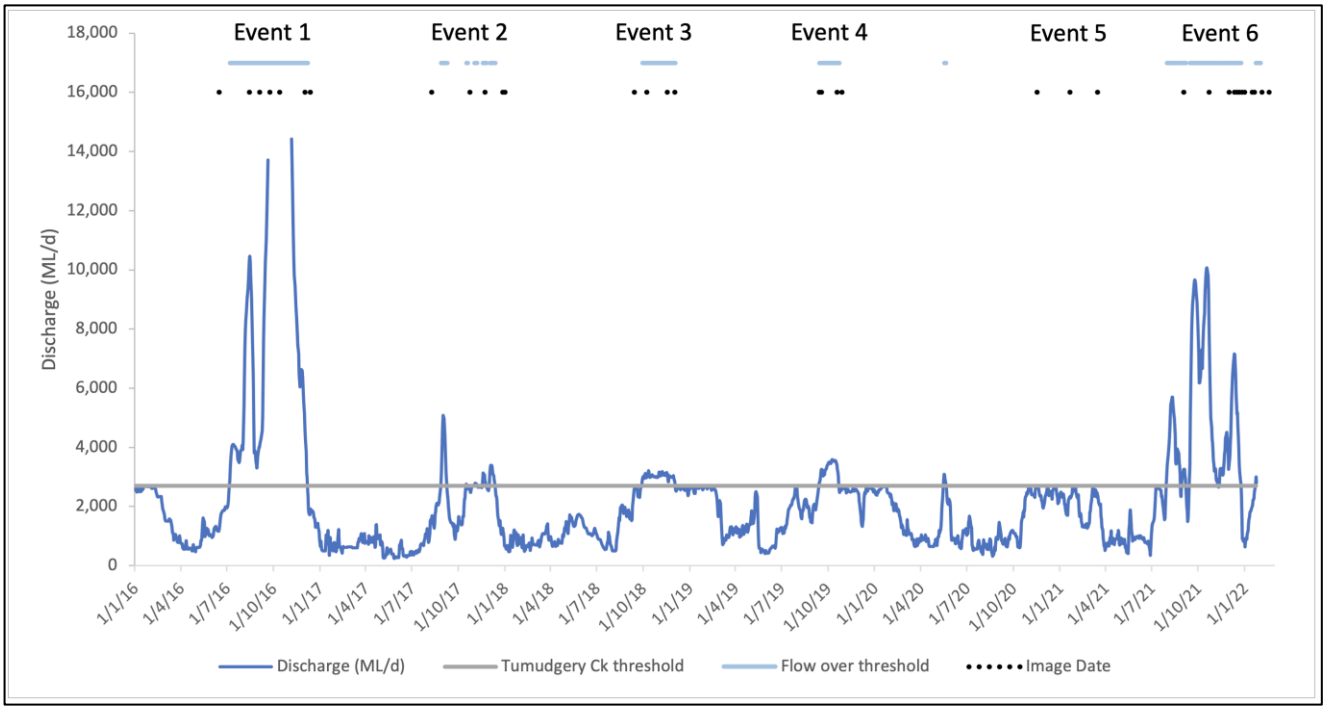

Figure 1. *Discharge @ DS Stevens Weir from January 2016 to February 2022. Tumudgery Creek Regulator threshold (2,700 ML/d) is indicated by the solid grey line. At the top of the figure is information on the timing of six key flow events and the dates of accompanying Sentinel-2 images (dates of images obtained for this study are indicated by the black dots).*

The Modified Normalised Difference Water Index (MNDWI) was applied to each of the 41 Sentinel images to map the extent of surface water inundation. Our analysis showed that flows via Tumudgery Creek inundate only the south-eastern part of the forest bounded by Colligen Creek and the Edward/Kolety River. Flows enter the forest via Tumudgery Creek, fill the low-lying areas, and during some events the water returns to the Edward/Kolety River to the north or to Colligen Creek to the south (Figure 2). The north-western part of Werai Forest is inundated by flows from the Edward/Kolety River entering via the Niemur and Reed Beds regulators further downstream.

This study focussed on the hydrology of the south-eastern part of Werai Forest. Key findings were:

1. Flows into Werai Forest via Tumudgery Creek commenced when the discharge downstream of Stevens Weir was a little less than 2,700 ML/d.
2. Even small events (<3,500 ML/d downstream of Stevens Weir) can inundate approximately 200 ha of the forest.
3. Return flows from the forest into the Edward/Kolety River commenced when the discharge downstream of Stevens Weir was between 3,152 - 3,237 ML/d (Figure 2). Return flows from Tumudgery Creek into Colligen Creek commenced when the discharge DS Stevens Weir was between 5,471 ML/d and 9,340 ML/d.
4. The duration of inundation of the forest after flooding was short-lived, with a rapid decrease in inundation extent even following large floods. For example, during Event 1 the area inundated decreased from 2,746 ha (13/10/16) to 236 ha (2/12/16) about 7 weeks after the peak of the event.
5. The rapid loss of surface water on the floodplain following flooding was observed for each of the six events and is likely due to the flood runners having good connections with the Edward/Kolety River and Colligen Creek, and the highly permeable floodplain soil with a high sand content.

Upgrading of the forest regulators will enable water for the environment to be delivered to inundate a substantial part of the forest and help to restore the forest ecosystem. Further research is needed to understand the hydrology of the north-western part of the forest and the Banangalite precinct of the forest that is on the north side of the Edward/Kolety River.

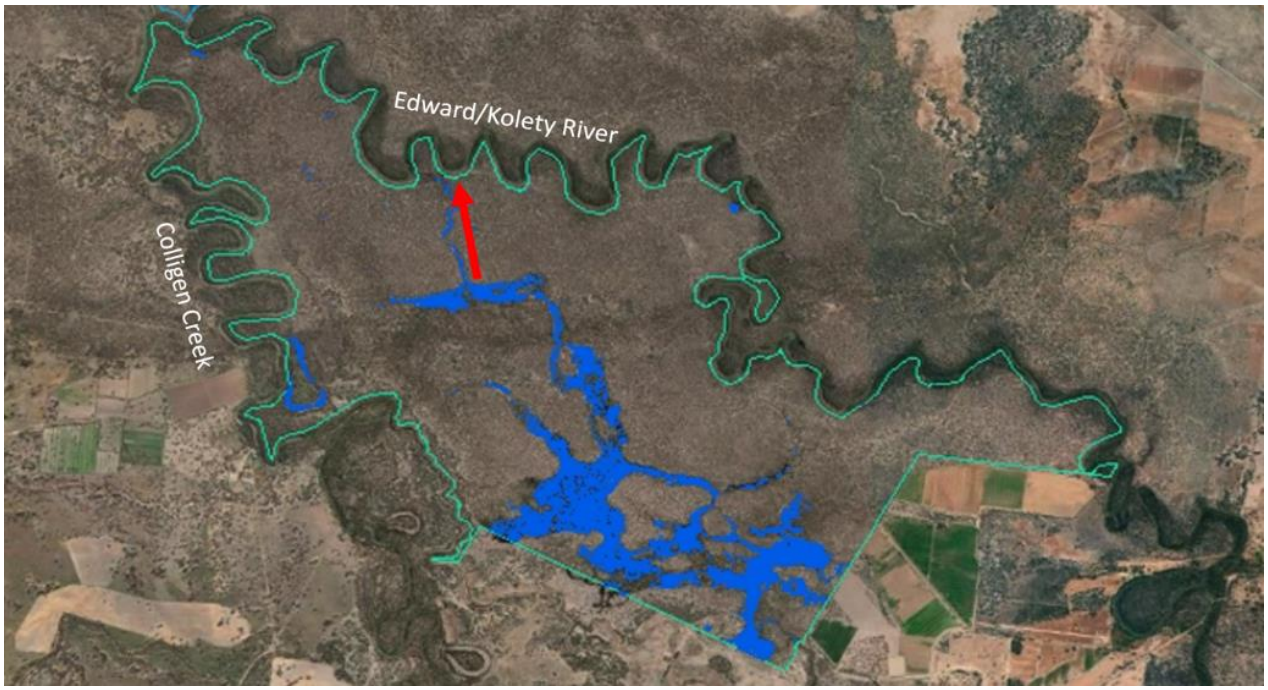

***Figure 2**. Image of the southern zone of Werai Forest. Red arrow indicates the connection of a flood runner with the Edward/Kolety River on 1/12/21 when discharge downstream of Stevens Weir was 3,257 ML/day.*

Werai Groundcover Vegetation Research

The team from Streamology, Yarkuwa Indigenous Knowledge Centre, Murray-Darling Wetlands Working Group, and Charles Sturt University were out in Werai Forest in January and March conducting multispectral drone mapping and ground cover surveys. The project is aiming to answer the question of whether we can effectively assess ground cover vegetation in the forest, from above the canopy, using drones.

Drone imagery of three different forest areas was captured in both visible, and near infrared wavelengths, with simultaneous ground truthing of the ground vegetation at dozens of representative plots to determine the percentage cover of different vegetation types (Figure 3).

***Figure 3.** Left -Yarkuwa, CSU and MDWWG team conducting ground truthing. Right - Streamology drone taking off for vegetation surveys. (Photos: Streamology)*

While multispectral drone imagery is commonly used to assess vegetation condition and coverage in agriculture, the challenge in a setting such as Werai Forest is 'seeing through' the eucalyptus canopy to the understory plants. The team at Streamology have developed a method the draws on the 3D elevation data from the drone surveys to 'see around' the canopy, to reveal the ground cover that would ordinarily obscured by the tree canopy (Figure 4).

***Figure 4**. Left - An aerial photo with ground cover obscured by tree canopy. Right - raster image generated after the canopy has been removed. Note: some shadows remain after canopy removal (dark patches in right image), and some holes (blue areas) occur where groundcover vegetation cannot be assessed.*

Once the canopy is removed the different wavelengths are combined to create vegetation indices that can reveal differences in vegetation cover. For example, visible red light is combined with near infrared to generate NDVI imagery that is good at highlighting the dense vegetation versus bare earth (Figure 5).

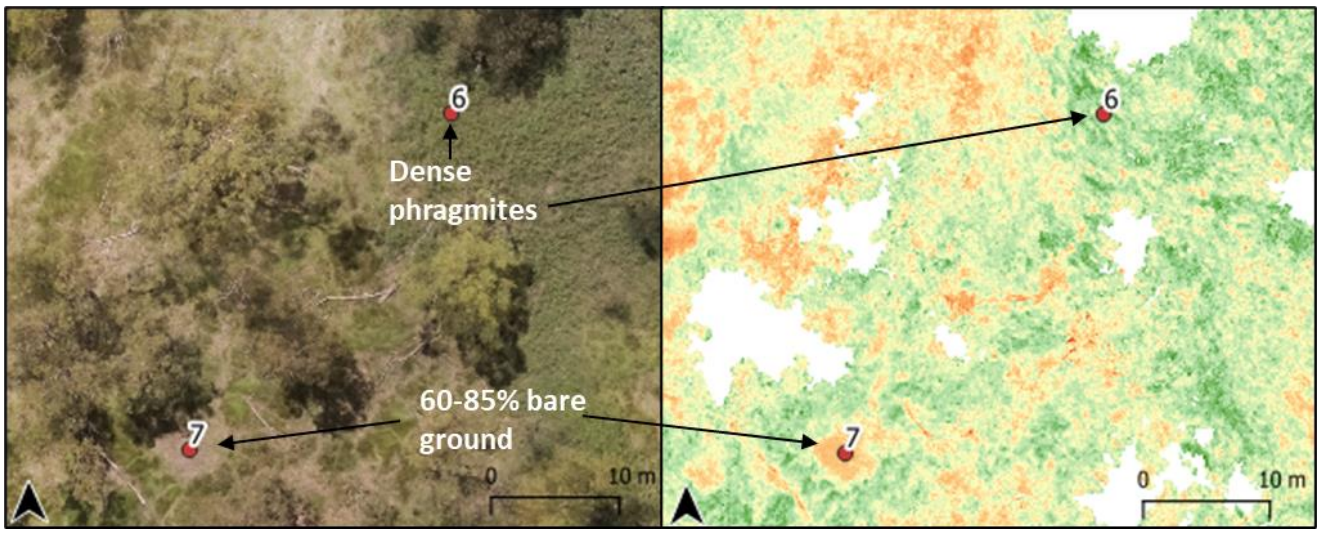

***Figure 5**. Left - Normal colour image. Right - NDVI drone imagery showing the difference in appearance of different cover types. In the NDVI figure the orange areas indicate bare ground and the green areas indicate living vegetation cover.*

Processing of the drone imagery from the latest visit is ongoing, and when complete will allow the team to explore the difference in ground cover vegetation condition between January and March, as the forest dried off. The project will determine how useful multispectral drone technologies can be when used in this way, and what value they can provide to help understand changes in ground vegetation in complex systems like the Werai Forest.

If the drone methodology can accurately assess ground cover vegetation and the response of vegetation following the delivery of environmental water it may be possible to use drones to survey large areas of the forest more efficiently, and to monitor areas that are difficult to access following floods.

High Rates of Primary Production in Werai Forest

Field experiments were carried out from November 2021 to January 2022 to examine the response of primary production to an unregulated flow pulse that inundated areas within Werai Forest. The amount of oxygen produced and consumed by plants, algae and bacteria was measured before, during and after the inundation event using dark/light incubation bottles (Figure 6). Primary production was measured in Tumudgery Creek, flood runners and flooded areas of the floodplain within Werai Forest, as well as in Colligen Creek and the Edward/Kolety River close to where water from the forest returns to these systems (Figure 7).

Results from the experiment indicate that:

- Primary production within the river channels followed a seasonal trend, increasing as temperatures increase through summer
- Flooded off-channel areas have higher rates of productivity than the river channels
- Aquatic plants and attached algae in inundated floodplains and flood runners can have very high rates of productivity (up to 10 x that of algae in the water column), with productivity being highest at peak flows

The next stage of the project will be to compare these rates to results from ongoing monitoring of primary production in creeks and rivers throughout the Edward/Kolety-Wakool system, including Yallakool Creek, Wakool River and the Edward/Kolety River.

Figure 6. *Left - Incubation bottles used for measuring primary productivity. Right - Experiment in Colligen Creek (Photos: Andre Siebers).*

Figure 7*. Left - Standing floodwater in an open area adjacent to Tumudgery Creek. Right – John Trethewie measuring water quality in a small, highly productive flood runner within Werai Forest (Photos: Andre Siebers)*

Juvenile Fish Recruitment Survey Update

Every year during late summer and early autumn we undertake a survey of juvenile Murray cod (*Maccullochella peelii*), silver perch (*Bidyanus bidyanus*) and golden perch (*Macquaria ambigua*) at 16 sites in the Wakool-Yallakool system. The aim of this survey is to determine how well these species are surviving from their larval stages and to determine their growth rates for comparison with previous years. The survey is undertaken in two parts starting with electrofishing each site using either a backpack unit or small boat depending on the depth of water at the site. Silver perch can be evasive when using electrofishing methods, so to target them we return to each site and use setlines and conventional angling using very small hooks and worms for bait.

The focus of this survey is on fish that hatched in the preceding spring spawning season, referred to as young-of-year (YOY), as well as fish that hatched in the spring the year before that are just over one year old (1+). To accurately determine a fish's age, we need to extract bony structures from inside the fish's head called otoliths or "ear bones" (Figure 8). Otoliths are composed calcium carbonate and protein, and as the fish grows this material forms translucent and opaque bands that are akin to the rings inside a tree. Counting these rings gives an accurate estimate of the age in days for YOY fish and in years for older fish. By accurately aging fish their growth rate can be compared to other years or regions to inform management of the system.

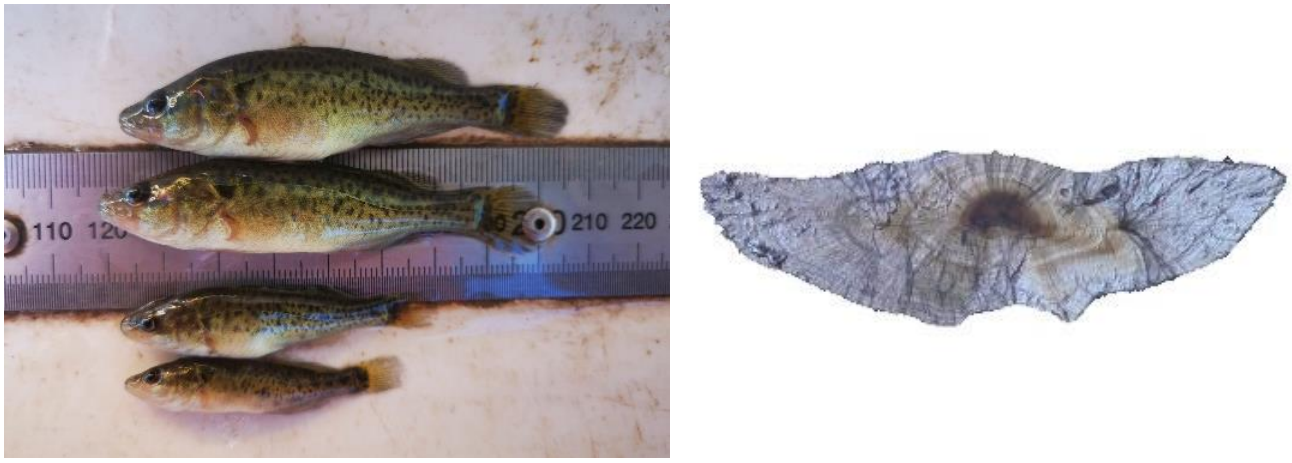

***Figure 8**. Left - Juvenile young-of-year Murray cod. Right -A Murray cod otolith (ear bone) with daily growth rings (Photos: John Trethewie)*

This year's survey found good numbers of silver perch juveniles in the 1+ size range and several larger than average YOY Murray cod that appear to have had a good start to life (Figure 9). The last two years of surveys have seen the appearance of small golden perch which have previously been absent in our recruitment surveys.

Full results and analysis from this year's survey will be made available in the Edward/Kolety-Wakool Environmental Water Technical Report for 2021-22.

***Figure 9**. Left - Juvenile golden perch. Right - Juvenile silver perch (Photos: John Trethewie).*

Edward/Kolety-Wakool Environmental Water Reference Group

The Edward Kolety-Wakool Environmental Water Reference Group (Reference Group) was formed in early 2016 to ensure a local voice in the use of environmental flows in the Edward Kolety-Wakool River systems. The Reference Group is supported by the Commonwealth Environmental Water Office. The Edward/Kolety-Wakool Flow-MER team provide regular updates on the outcomes of the monitoring and research at each of the Reference Group meetings.

In 2021, the CEWO progressed a refresh of the membership of the Reference Group to ensure that representation remains current and can incorporate new and emerging community interests and voices. For more information about this group see https://www.awe.gov.au/water/cewo/catchment/mid-murray/edward-wakool-ewrg

Members of the Edward/Kolety-Wakool Environmental Water Reference Group visiting Pollack Swamp after a meeting in March 2021 (Photo: Robyn Watts)

More information

To join the newsletter mailing list please subscribe here or contact Professor Robyn Watts, Institute for Land, Water and Society, 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.

Watts R.J., Frazier P., Winkle S., Gower T., Siebers A., Trethewie J. (2022) Edward/Kolety-Wakool System Environmental Flows Newsletter, Issue 11. Charles Sturt University.