Yalyal and Moondah Brook - Carter's Mussel and Rakali Survey

Prepared by the Chittering Landcare Centre

175 Old Gingin Road,

MUCHEA WA

For

Department of Biodiversity, Conservation and Attractions

Parks and Wildlife

MUNDARING

Acknowledgements

Calvin Fidge, NRM Officer, Chittering Landcare Centre

Sam Grigsby, NRM Officer, Chittering Landcare Centre

Jemma Simpson, NRM Officer, Chittering Landcare Centre

Liz Kington, NRM Officer, Chittering Landcare Centre

Matt Barbour, Environmental Officer, WA Parks and Wildlife (DBCA), Kensington.

Rosanna Hindmarsh, Executive Officer, Ellen Brockman Integrated Catchment Group.

Robert Huston, District Coordinator, Parks and Wildlife (DBCA), Mundaring

Dr Geoff Barrett, Regional Ecologist, Parks and Wildlife (DBCA), Crawley.

Summary

This report describes the results from a survey of Carter's Mussels and Australian Water Rat (Rakali), at Yalyal Brook, which now lies within the Ioppolo Nature Reserve, 20km south of Gingin, 50km northeast of Perth. It is paired with a second report, prepared by Chittering Landcare Centre, which describes the condition of the vegetation on the same Brook (Chittering Landcare Centre 2023).

The presence of Carter's Mussel at five perennial freshwater streams within 20km of Gingin is confirmed (Yalyal, Moondah, Wowra, Lennard and Nullilla Brooks), and community-based survey methods for the two species were road-tested, refined and made ready for use by other community groups across other parts of the southwest.

Water quality data presented in this report supports the conclusion that Yalyal Brook is ideal habitat for Carter's Mussel, with large, healthy animals persisting in good numbers. There are some concerns, however, over the gradual increase in salinity, in Yalyal Brook which if unchecked, will make the habitat less suitable.

Finally, this report provides a basis for further survey work to establish whether Carter's Freshwater Mussels and Rakali will persist in the landscape around Gingin, which is towards the northern part of their distribution, as we move into a hotter, dryer climate.

1. Introduction

Carter's Freshwater Mussel (*Westralunio carteri*) is a southwest endemic, that has declined significantly in range and abundance, resulting in it being listed as Vulnerable under State (BC Act 2016) and Federal (EPBC Act 1999) legislation. Recently, a genetic analysis of Carter's identified three, distinct species of Carter's Mussel across in the southwest, one of which occurs in the Swan Region (Klunzinger *et al*. 2022).

Threats to Carter's Mussel include poor water quality, salinity, reduced flow rates (particularly in summer) and loss of riverine habitat. They require a soft (sandy or muddy) stream bed, woody debris and water plants (macrophytes), which support the native fish species that the mussels require to host their larva (Glochidia).

Carter's Mussel is also preyed on by the Native Water Rat or Rakali (*Hydromys chrysogaster*) which, like the freshwater mussel, has undergone extensive decline (Trocini *et al*. 2015). The Rakali has been placed on the State Priority Fauna list, considered a species at risk and in need of monitoring (Priority 4 species; Western Australian Department of Parks and Wildlife). Like the Carter's Mussel, Rakali are dependent on summer water flows, woody debris and an intact riverine habitat. So, these two species co-exist, are dependent on similar habitat but also compete, with the Carter's Mussel being particularly vulnerable to predation by Rakali during summer when the water levels drop (Geoff Barrett DBCA, pers comm.).

There remains some speculation over the true status of freshwater mussels, as they are under-surveyed and will persist undetected in small, isolated streams where the conditions are favourable (Klunzinger *et al*. 2015), see also Figure 1. Carter's Mussel has been located at Yalyal Brook, near Gingin, 50km northeast of Perth, by Beatty *et al*. (2010), who emphasised the need for a broader survey and assessment of Carter's populations in the local area.

This report presents the results of such a survey. In addition to Yalyal Brook, surveys for Carter's Mussel were carried out in Moondah, Wowra, Lennard and Nullilla Brooks, to see whether they are in fact persisting in other small, isolated streams within 20km of Gingin (Figure 2). While surveying for Carter's Mussel, any signs of Rakali activity were also recorded.

The persistence of Carter's Mussel at Yalyal Brook is largely due to the good condition of the fringing vegetation and the water quality (Figure 3), for details about the vegetation, see the associated TRONOX report by Chittering Landcare Centre (2023). The Yalyal Brook Water quality has been monitored since 2006 and some of these water quality measures are also presented in this report.

2. Aims

The aims of the project are to:

- Confirm the presence of Carter's Mussel and Rakali in Yalyal Brook carry out opportunistic surveys for both species at other, similar brooks within 20km of Gingin (Moondah, Wowra, Lennard and Nullilla Brooks).
- Estimate the density of Carter's Mussels and Rakali in Yalyal and Moondah Brooks.
- Compare the average size of Carter's Mussels in Yalyal and Moondah Brooks.
- Document the water quality in Yalyal Brook.
- Develop a method for community surveys of Carter's Mussel and Rakali.

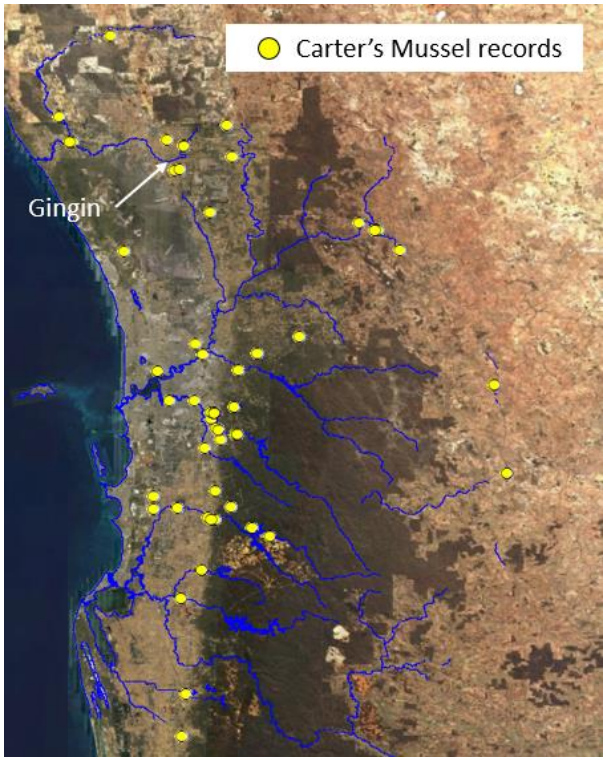


Figure 1: Carter's Mussel records in the Swan Region (yellow dots)

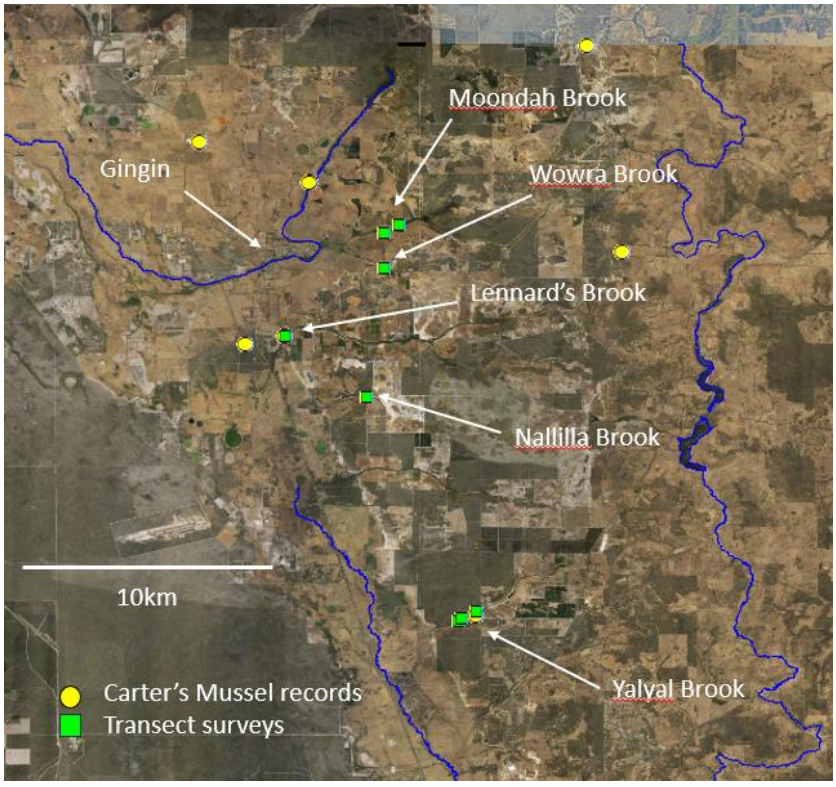


Figure 2: Transect surveys for Carter's Mussel and Rakali were done at Yalyal, Moondah, Wowra, Lennard's and Nullilla Brooks, near Gingin.

3. Description of the study area

The Yalyal, Moondah, Wowra, Lennard and Nullilla Brooks are all perennial freshwater streams that flow from the Dandaragan Plateau to the Swan Coastal Plain, Muchea, WA. They are thought to be surface expressions of the much larger Leederville aquifer. The upper reaches of the Yalyal catchment, flows through farming properties before reaching Reserve Road and the Ioppolo Nature Reserve before again flowing through agricultural properties to the Ellen Brook and, during wet years, Chandala Lake (Figure 3). For more information on the study area, see Chittering Landcare Centre (2023).

Maps showing the location of each Carter's Mussel/Rakali transect are below (Figures 4 to 7) and further details are presented in Table 1.

Figure 3: Yalyal Brook, clean spring water.

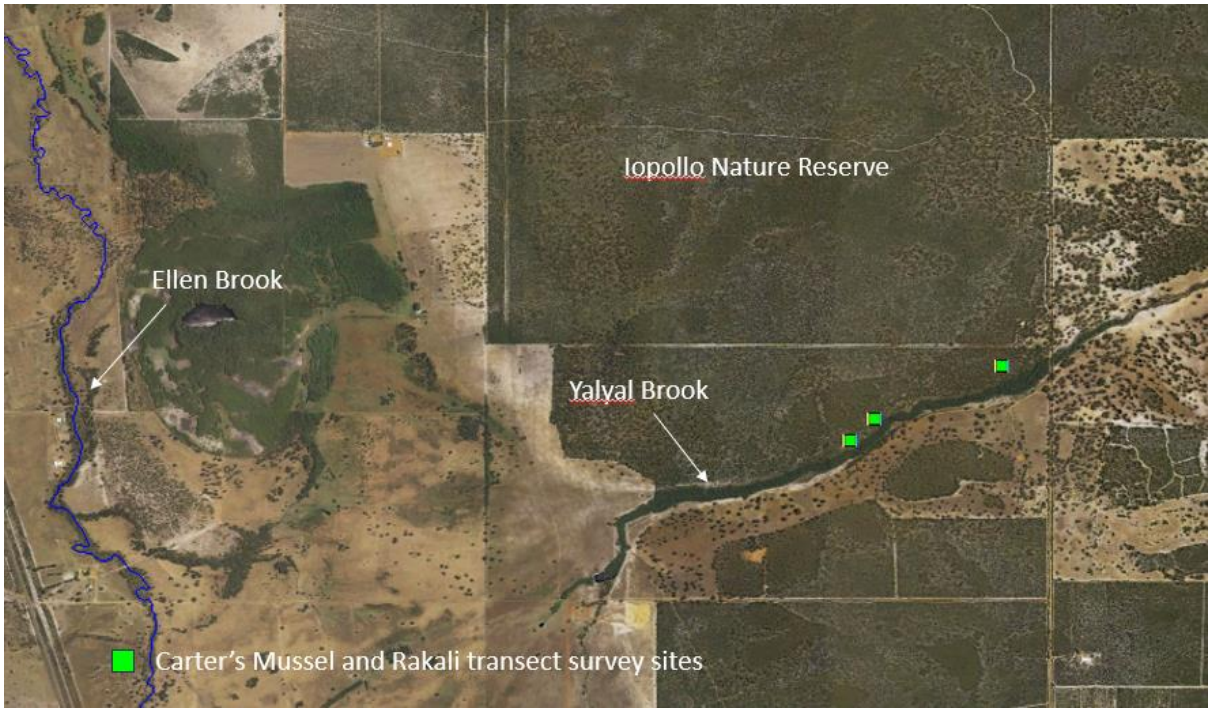


Figure 4: Location of three survey transects along Yalyal Brook in Ioppolo Nature Reserve.

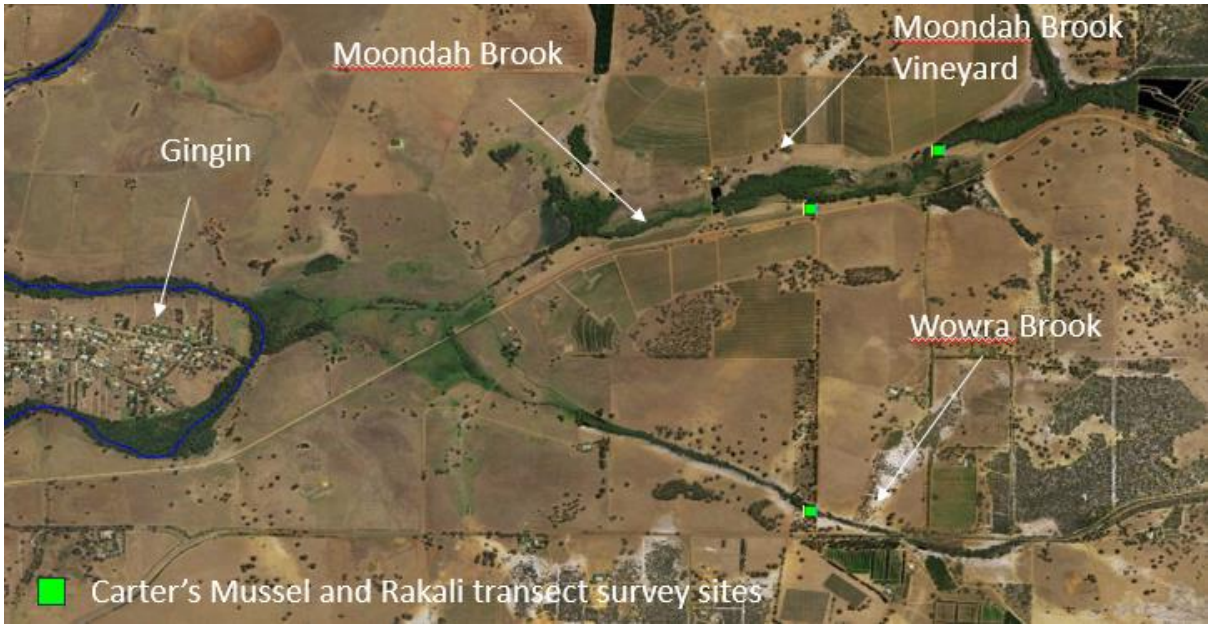


Figure 5: Location of three survey transects along Moondah and Wowra Brooks 2km east of Gingin.

Figure 6: Lennard Brook Transect (where Cockram Rd passes over Lennard Brook)

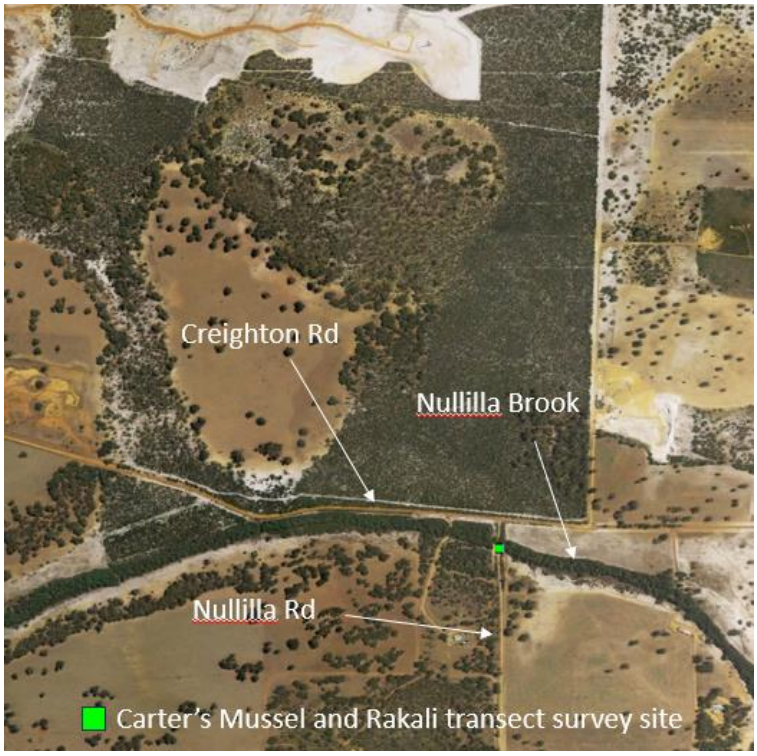


Figure 7: Nullilla Brook transect (near intersection of Creighton Rd and Nullilla Rd)

Table 1: Transect details

Location	Transect No	Transect Length (m)	Latitude	Longitude	Map Figure (above)
Yalyal Brook Lower	1	250	-31.50472	115.9888	4
Yalyal Brook Mid	2	250	-31.50361	115.99	4
Yalyal Brook Upper	3	250	-31.501	115.9963	4
Moondah Brook	1	250	-31.50225	115.99880	5
Moondah Brook	2	250	-31.331389	115.96275	5
Moondah Brook	3	250	-31.334444	115.95611	5
Wowra Brook	1	150	-31.35	115.95611	5
Lennard Brook	1	50	-31.38017	115.91264	6
Nullilla Brook	1	50	-31.40676	115.94858	7

4. Survey Methods

Carter's Mussel population density

Transect surveys were carried out to create an estimate of Carter's Mussel abundance along a given stretch of each Brook, using a method adapted from Klunzinger et. al. (2011).

Observers walked a 250m transect and at five points 50m apart, two 1m x 1m quadrats were cast into the water, where mussels were seen to be present. These two quadrats were at least 10m apart. The number of mussels was counted visually, without entering the water or disturbing the mussels, which lay on the bed of the stream. The quadrats were cast towards areas where the mussels were most common and when mussels were absent, a zero count was recorded. This gave a total of 10 quadrat counts per 250m transect survey. The mussels are hard to see in the winter, when flow rates are high and the water murky (as they sit on the stream bed), so Carter's Mussel surveys were restricted to the spring/summer months (see Appendix 1 for survey instructions).

For the opportunistic surveys in Wowra, Lennard and Nullilla Brooks, the length of the transect varied depending on site accessibility and were shorter that 250m (see Table 1 for details).

Carter's Mussel shell size

The average size of Carter's Mussel shells can serve as an indicator of predation pressure. At sites where predation by Rakali is high, one would expect the larger animals to be eaten. Note that the introduced Laughing Kookaburra (*Dacelo novaeguineae*) has also been observed eating Carter's Mussels on the Serpentine River, 20km south of Perth (Midge Richardson, Lowlands property, 2021). Shell size may also be an indicator of the health of the brook and availability of food (Klunzinger *et al*. 2011), with healthy, well-fed animals being larger.

On Yalyal Brook, at each of the five points along the 250m transect where mussels are sampled using the quadrat, a sub-sample of up to 20 Carter's Mussels was lifted from the stream bed, measured and replaced, following the procedure outlined in Klunzinger *et al*. (2011, Figures 8 and 9). Note that a DBCA Section 40 Licence to Disturb is required for this procedure: https://www.dbca.wa.gov.au/licences-and-permits/fauna/authorisation-take-and-disturb-threatened-fauna.

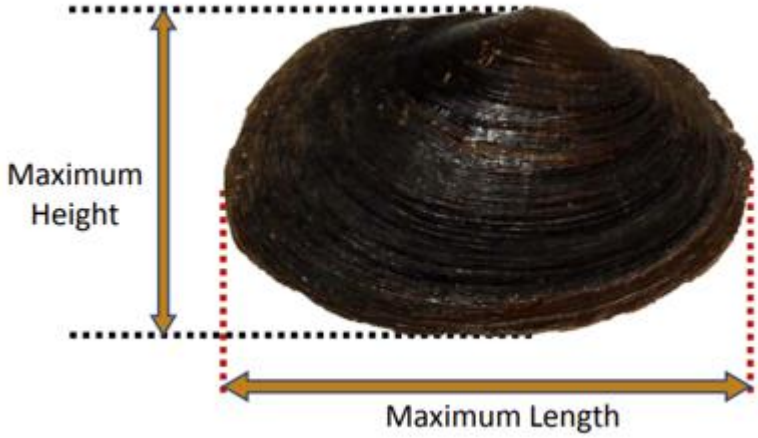


Figure 8: The maximum Length and Height of Carter's Mussel shells was measured at the Yalyal Brook transects (from Klunzinger *et al*. 2011).

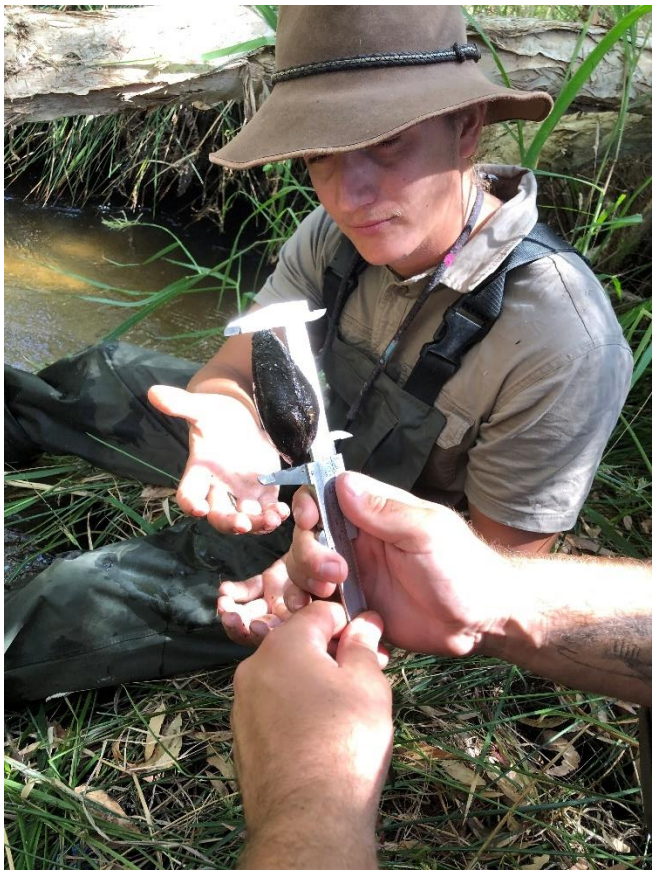


Figure 9: Carter's Mussel shell being measured at Yalyal Brook

Rakali

The 250m transects used for the Carter's Mussel surveys on Yalyal and Moondah Brooks, were also used for the Rakali surveys, following the method described in Trochini *et al*. (2015). Although always on the lookout for evidence of Rakali, formal Rakali surveys were not done on the shorter transects in Wowra, Lennard and Nullilla Brooks (150m and 50m in length, Table 1).

Observers walked along the brook for the length of the 250m transect, searching for rakali feeding stations or middens, footprints or scats. Rakali middens are 'disks' of feeding refuse, or remains of crayfish or mussels, usually deposited on a partially submerged rock or log (Figure 10). A single rakali will have a number of middens within its territory, so a count of these middens represents a measure of rakali activity rather than number of individuals. Middens will tend to be washed away during winter when the water flows are high, so rakali surveys were restricted to the spring/summer months (see Appendix 2 for survey instructions).

Rakali Footprints

Mussels at rakali feeding station

Rakali droppings

Crayfish midden

Figure 10: Evidence for Rakali, footprints, feeding stations (middens) and scats.

5. Results

Carter's Mussel surveys

A total of 22 transect surveys were carried out across the five brooks through Autumn 2022 (starting on 16/5/22), Spring to Summer 2023 (ending on 31/1/23), there were no Winter surveys as the water is too high and murky to survey Carter's Mussels (Table 2).

Carter's Mussels were recorded in all five brooks. Density estimates were based on counts from a total of 172 quadrats and ranged from a high of 18.4 mussels per m^2 during summer in Yalyal Brook, to one mussel per m^2 at Nullilla Brook. Note, however, the small sample size at Nullilla (n=5, Table 2, Figure 11).

There was seasonal variation, with more mussels being recorded during the summer in the same brook, particularly at Yalyal Brook. This was primarily due to the water levels being lower and the water being clearer during summer (e. g. Figures 11 and 12). Note Autumn surveys were only carried out at Yalyal Brook (Table 2).

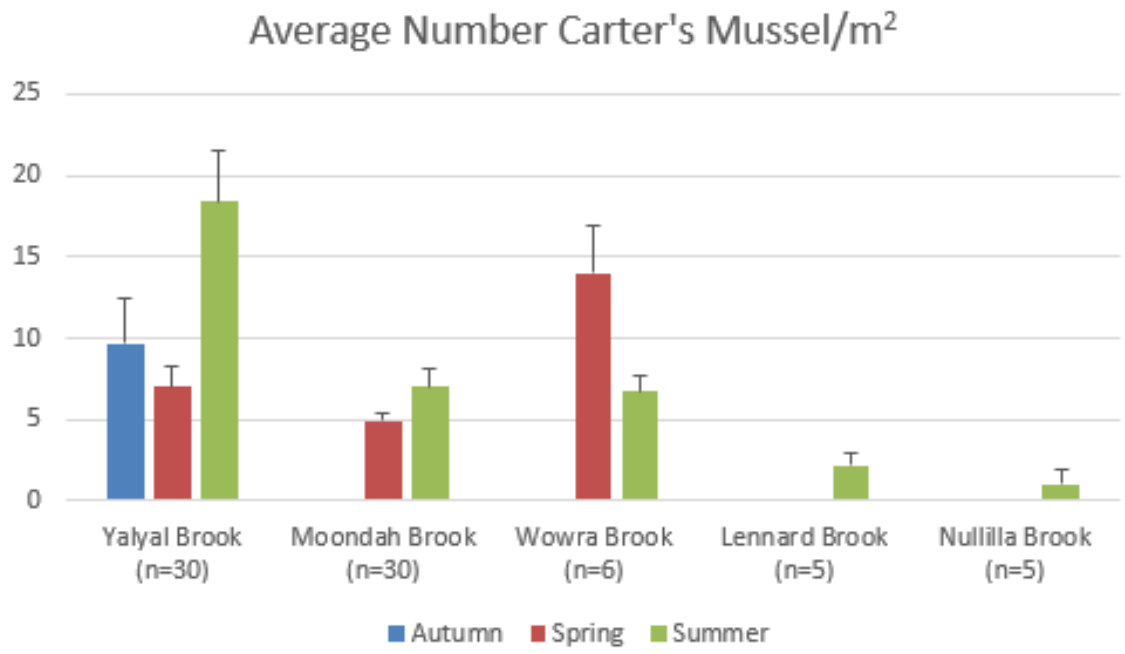


Figure 11: Average number of Carter's Mussel in Yalyal, Moondah, Wowra, Lennard and Nullilla Brooks, during Autumn, Spring and Summer.

Table 2: Carter's Mussel and Rakali surveys

Location	Season	No. Surveys	No. Quadrats	n	# Mussels per m^2	Rakali Present	% Surveys with Rakali	Figure above
Yalyal Brook	Autumn	3	10	30	9.7	No	0%	3
Yalyal Brook	Spring	3	10	30	7.0	No	0%	3
Yalyal Brook	Summer	6	10	30	18.4	Prints + Middens	50% (3/6 surveys)	3
Moondah Brook	Spring	3	10	30	4.9	No	0%	4
Moondah Brook	Summer	3	10	30	7.0	Prints + Middens	66% (2/3 surveys)	4
Wowra Brook	Spring	1	6	6	14	N/A	N/A	4
Wowra Brook	Summer	1	6	6	6.7	N/A	N/A	4
Lennard Brook	Summer	1	5	5	2.2	N/A	N/A	5
Nullilla Brook	Summer	1	5	5	1.0	N/A	N/A	6

Figure 12: Carter's Mussels were easier to count during summer, as the water is shallow and clear.

Rakali surveys

Evidence of Rakali activity was recorded at both Yalyal and Moondah brooks but only during the summer surveys (Table 2). At both sites, feeding middens were found with Marron and Carter's Mussel remains (Figure 13), and also Rakali footprints (e.g. Figure 10). The summer reporting rate for Rakali was three out of six surveys (50%) at Yalyal Brook and two out of three surveys (66%) for Moondah Brook (Table 2).

While opportunistic surveys for Rakali were carried out at the other three brooks, no evidence was recorded on these shorter transects (Table 2).

Figure 13: Rakali midden at Yalyal Brook, with remains of Carter' Mussel shells.

Size of Carter's Mussel Shells

Carter's Mussel shell measurements were carried out at the three transects on Yalyal Brook, with two surveys occurring at each transect (n=6 surveys). The average shell length was 48.2mm (n=238 mussels measured) and the average shell height was 23.7mm (n=177 shells measured).

The average length of the mussels in Yalyal Brook was 48.2mm (n=238) which is large. Although mussel shell measurements were not made at other locations as part of the present study, data from outside this study confirm this. The average maximum shell length of Carter's Mussels at Lefroy Brook near Pemberton, WA has been recorded as 4.8mm (n=46), at Serpentine River 20km south of Perth it is 6.7mm (n=21), and for the Canning River, east of Perth, 5.7mm (unpublished data from Geoff Barrett and Matt Barbour, DBCA). The larger mussels at Yalyal will undoubtedly be due to the reduced predation pressure from Rakali, particularly compared with locations like Lefroy Brook to the south. However, the fresh, good quality water in Yalyal Brook will also have played a role on supporting a healthy population of Carter's Mussel there.

Water Quality (Yalyal Brook)

Measures of water quality for Yalyal Brook were provided for this report by Chittering Landcare, and summarised here to provide additional context for the present study.

Specific conductivity, which is a measure of salinity, has increased slightly since 2018 and is the main cause for concern over the future wellbeing of the Brook (Figure 14). However, there is a high level of variability and the trend is weak, probably due to drying climate conditions. Chittering Landcare is keeping a close eye on this parameter.

Similarly, the pH is trending upwards, staying above value of 6.5 (Figure 15), the minimum pH considered acceptable for a stream like Yalyal brook, and as long as we don't reach a pH of 8, there is no major cause for concern. Associated with the drying climate, is a gradual increase in the temperature of Yalyal Brook (Figure 16). As with the specific conductivity, these two parameters will continue to be monitored closely.

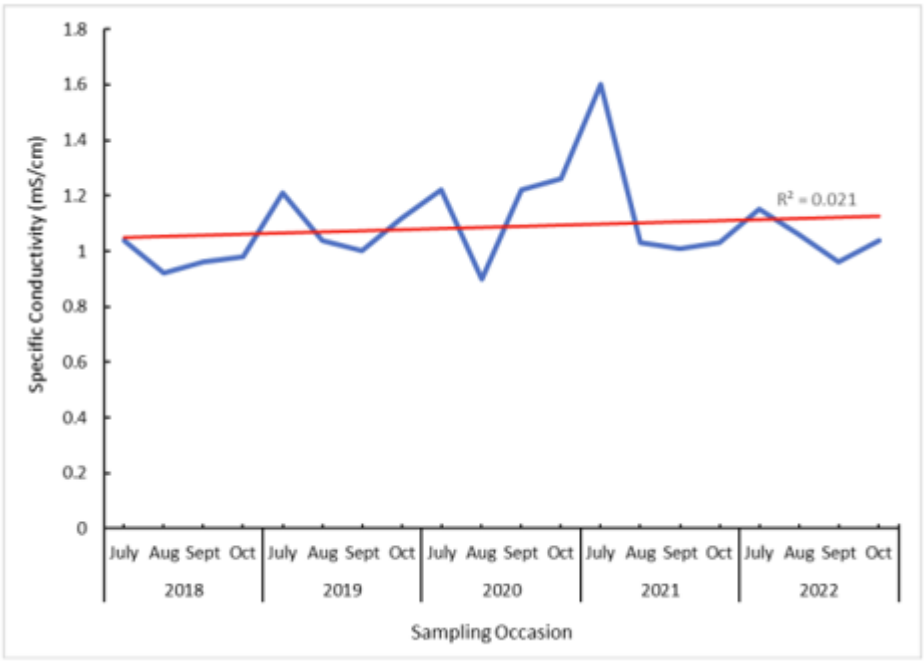


Figure 14: Specific conductivity (a measure of saltiness) has trended upwards at Yalyal Brook since measurements began in 2018 (sampled during July-October months).

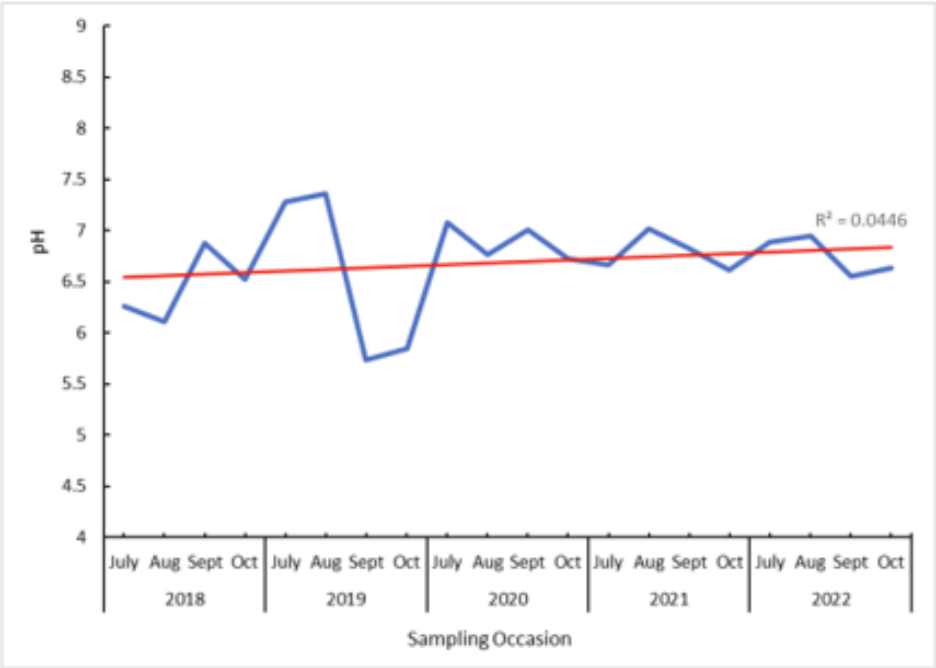


Figure 15: pH levels have trended upwards at Yalyal Brook since measurements began in 2018 (sampled during July-October months).

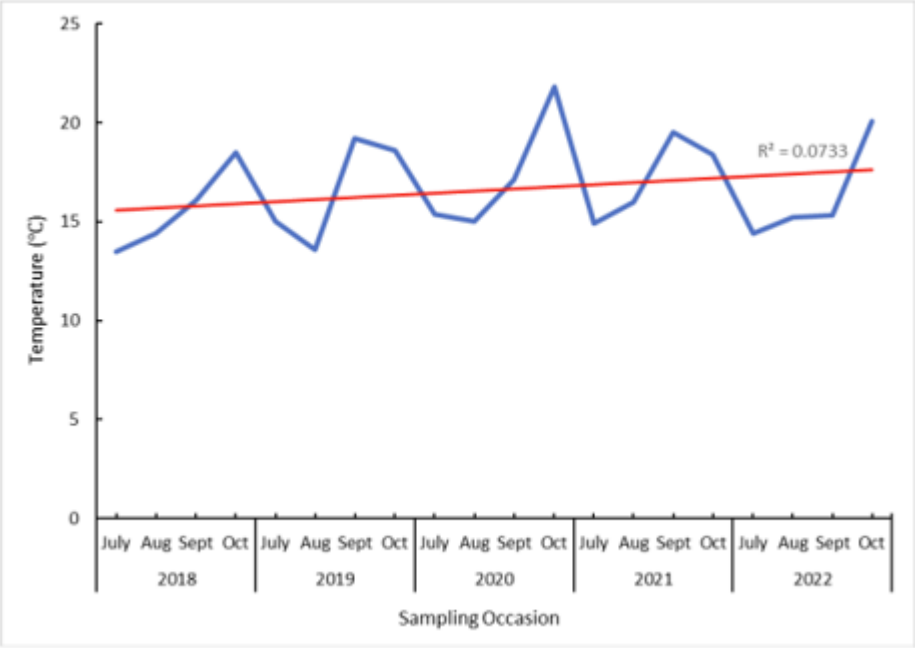


Figure 16: Temperature levels have trended upwards at Yalyal Brook since measurements began in 2018 (sampled during July-October months).

6. Conclusion

This report has confirmed the presence of Carter's Mussel at all five perennial freshwater streams surveyed (Yalyal, Moondah, Wowra, Lennard and Nullilla Brooks), supporting the view of Beatty *et al*. (2010), that more surveys need to be done to properly understand the conservation status of Carter's Mussel. The results also highlight the importance of small, groundwater fed, freshwater streams in protecting this species.

The Yalyal Brook surveys show that season is important for both Carter's Mussel and Rakali surveys, with the raised water levels and murky water making Winter and Spring surveys less optimal. Measurements of Carter's Mussel shell size suggest that Yalyal Brook is ideal habitat for Carter's Mussel and that they can thrive alongside Rakali a major predator of mussels. The water quality data presented here supports this, with salinity, pH and temperature levels, all consistent with a healthy aquatic ecosystem. There are some concerns over the gradual increase in salinity, which if unchecked, will remove the Carter's Mussel populations (Klunzinger *et al*. 2015).

Finally, this report provides a basis for further survey work to establish whether Carter's Freshwater Mussels and Rakali will persist in the landscape around Gingin, which is towards the northern part of their distribution, as we move into a hotter, dryer climate. The Chittering field surveys have provided an opportunity to develop and refine the DBCA Carter's Mussel and Rakali survey methods, so that they can be adopted for use by other community organisations, in other landscapes (Appendices 1 and 2).

7. References

Beatty, S. J., D. L. Morgan, M. Klunzinger and A. J. Lymbery (2010). Aquatic macrofauna of Ellen Brook and the Brockman River: fresh water refuges in a salinised catchement, Centre for Fish & Fisheries Research, Murdoch University, WA.

Trocini, S., G. Barrett, K. Howard and C. Ramalho (2015). Rakali Community Survey 2014-2015, Report prepared by WWF-Australia and the Western Australian Department of Parks and Wildlife. WWF-Australia, Perth, WA.

Klunzinger, M. W., S. J. Beatty, D. L. Morgan, M. G. Allen and A. J. Lymbery (2011). Ecology of aquatic fauna in the Serpentine River in response to land use practices & recommendations for improving freshwater ecosystem health. Murdoch University, Centre for Fish & Fisheries Research, Report to Lowlands Conservation Association, Serpentine River Group and the Government of Western Australia.

Klunzinger, M. W., S. J. Beatty, D. L. Morgan, A. M. Pinder and A. J. Lymbery (2015). "Range decline and conservation status of *Westralunio carteri* Iredale, 1934 (Bivalvia : Hyriidae) from south-western Australia." Australian Journal of Zoology **63**(2): 127-135 (https://doi.org/110.1071/ZO15002).

Chittering Landcare Centre (2023). Yalyal Brook Riparian Vegetation Report Produced by the Chittering Landcare Centre for Department of Biodiversity, Conservation and Attractions, Parks and Wildlife, MUNDARING, WA.

Klunzinger, M. W., C. Whisson, A. Zieritz, J. A. Benson, B. A. Stewart and L. Kirkendale (2022). "Integrated taxonomy reveals new threatened freshwater mussels (Bivalvia: Hyriidae: *Westralunio*) from southwestern Australia." Scientific Reports **12**.

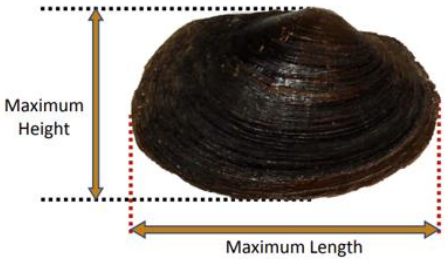
8. Appendix 1 Carter's Freshwater Mussel Survey Method

(Developed by Dr Geoff Barrett DBCA Swan Region)

Aim: The aim of the transect surveys is to create a measure of Carter's Mussel (*Westralunio carteri*) abundance along a given stretch of river or wetland margin.

Method: Walk along a river, creek or edge of wetland for 250 metres

- A slow walk is preferred but transect surveys can also be done while kayaking, fishing etc.
- Record the following information:
    - Start and Finish point of the transect
    - Number of mussels in ten 1m x 1m quadrats*
        - Randomly throw two (1m x 1m) quadrats towards an area of the stream bed where mussels are most dense, at five 50m intervals, along the 250m transect.
        - Visually count the number of freshwater mussels within the 1m x 1m quadrat. If there are no mussels present, record a zero count for that quadrat. (Attach quadrat to string so it can be retrieved after each count)
    - Date survey was done.
    - Presence of Rakali middens, scats or footprints.
    - For confirmation, take photos of rakali middens, scats, footprints.
    - Measure maximum length and height of at least two mussels per quadrat, see figure below from Klunzinger *et al*. (2011). (DBCA Section 40 License Required if doing this):



- If possible, have at least three 250m transects per stream (upper, middle and lower stream)

*Adapted from Klunzinger *et al*. (2011)

Mapping Data: The start and finish points of the transect can be recorded using a GPS, identified on Google Map, or identified by providing a specified map details (for example, the transect ran between the Southwest Hwy bridge and the Richardson Rd rail bridge on the Serpentine River).

Reference for survey method:

Klunzinger, M. W., S. J. Beatty, D. L. Morgan, M. G. Allen and A. J. Lymbery (2011). Ecology of aquatic fauna in the Serpentine River in response to land use practices & recommendations for improving freshwater ecosystem health. Murdoch University, Centre for Fish & Fisheries Research, Report to Lowlands Conservation Association, Serpentine River Group and the Government of Western Australia.

9. Appendix 2 Rakali Survey Method

(Developed by Dr Geoff Barrett DBCA Swan Region)

Aim: The aim of the transect surveys is to create a measure of rakali presence/activity along a given stretch of river or wetland margin.

Method: Walk along a river, creek or edge of wetland for at least 150 metres

- A slow walk is preferred but transect surveys can also be done while kayaking, fishing etc.
- Record the following information:
    - Record the following information:
        - Start and finish point of the transect
        - Number of rakali feeding stations seen
        - Length of the transect surveyed
        - Date survey was done
        - Presence of Rakali scats or footprints
        - Presence of Carter's Mussel
        - If mussel shells occur in middens, measure max length of at least three opened shells in midden.
        - For confirmation, take photos of middens, scats, footprints.

What is a feeding station?

- A feeding station is where there are opened mussel shells and/or crushed remains of crayfish, usually on the riverbank or over the water. For example, on a log lying across the river or on a partially submerged rock. There will often be distinctive rakali scats near the middens.
- Droppings (scats) are long and tube shaped, with plenty of fibre, often forming small piles on the feeding stations.
- A single feeding station is defined as being at least 10m from another. So, if a 100m transect along a river has continuous evidence of feeding by Rakali, there are a maximum of ten feeding stations (one every 10 metres).
- Either have a measuring tape with you or calibrate your steps so you are able to pace out a distance of 10m (about 12 big steps).

Mapping Data

The start and finish points of the transect can be recorded using a GPS, identified on Google Map, or identified by providing a specified map details (for example, the transect ran between the Southwest Hwy bridge and the Richardson Rd rail bridge on the Serpentine River).