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Bat Conservation, Citizen Science and Heritage Tourism: An Intersection at Joker's Tunnel, Western Australia

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Abstract

Abandoned mine tunnels can provide critical roosting habitat for cave-dwelling bats. Joker's Tunnel, a 19th-century gold-mining adit and tourist attraction in Western Australia's Midwest, is publicly accessible and receives visitation, including for its roosting bat populations. We conducted harp-trapping, acoustic monitoring, and roost emergence surveys between 31 October and 5 November 2025 to determine species use, confirm maternity roosting, and assess the site's suitability for citizen science. Two species were confirmed using the tunnel as a maternity roost: Finlayson's cave bat (*Vespadelus finlaysoni*) and Hill's sheathtail bat (*Taphozous hilli*), the latter recorded outside its previously known distribution. Additional species were detected in surrounding foraging areas and at the Yalgoo town dam. Roost emergence observations demonstrated that citizen scientists could successfully collect useful data on emergence timing and occupancy by multiple species. As an openly accessible site, Joker's Tunnel illustrates both the potential for disturbance to a sensitive roost and the importance of carefully managing visitor access, as normally, roost locations are kept confidential to minimise these impacts. At the same time, the site presents an opportunity to integrate bat conservation with heritage tourism and community-based monitoring, providing a model for accessible, low-impact citizen science initiatives.

INTRODUCTION

Abandoned mine tunnels can provide critical roosting habitat for cave-dwelling bats, with roughly one-third of bat species globally reliant on caves or cave-like structures for breeding and shelter (Hall *et al*., 1998*). In Australia, there are at least 50 000 recorded abandoned or disused mines (Unger *et al*. 2012), including underground pits, voids and shafts (Gorokhovich *et al*. 2003). In Western Australia, disused mines are common but rarely recognised as both a heritage asset and valuable wildlife habitat. Many are often unstable making them a concern for public health and safety and susceptible to closure (Donnelly and McCann 2000). Despite this, abandoned mine structures can provide important habitat for a range of species, including bats.

Mines are frequently used by bats as roost sites, and in some cases support maternity colonies. Maternity bat roosts are particularly important because they provide a secure environment for females to give birth and rear their young. There are examples of mines being used as bat maternity sites in Australia (e.g. Hoye 2000*; Armstrong 2001; Bat Call WA 2021*). However, the factors influencing maternity use of mines for most subterranean species remain poorly understood, and their suitability and longevity are highly variable, often influenced by external disturbances such as adjacent mining activity, or rehabilitation works (Williams 2021). Maternity roost suitability is likely to depend on both internal roost conditions and the availability and condition of surrounding habitat capable of supporting lactating females and developing pups, including access to foraging habitat and water sources, and the level of disturbance in the landscape (e.g. Legros *et al*. 2024). Direct human disturbance to maternity colonies can have serious consequences, including pup mortality, roost abandonment, and reduced reproductive success (e.g., Ancillotto *et al*. 2019).

Joker's Tunnel, situated within the wildflower-rich Yalgoo bioregion (Desmond and Chant 2002*), is a 19th-century gold-mining adit tourist attraction that is advertised as a heritage site and known to be used for roosting by bats (Shire of Yalgoo n.d.*). The site is readily accessible by road and receives visitation throughout the year, with activity peaking during the wildflower season (July–October), a period that attracts tourists from across the region and internationally (Yalgoo Caravan Park staff, personal communication, November 2025; Australia's Golden Outback, n.d.*). Human visitation may impact roosting bats, and the intersection of heritage value, accessibility, and ecological importance at Joker's Tunnel highlights the need for careful management, while also providing opportunities for public education, citizen science, and research.

The objectives of this study are to determine whether Joker's Tunnel functions as a maternity roost, identify which species use the site, and assess its potential as a model for citizen science and ongoing bat research.

MATERIALS AND METHODS

Bats were surveyed at Joker's Tunnel (28.4398°S, 116. 7520°E) and Yalgoo town dam (28.3431°S, 116.6946°E) for 5 nights from 31/10/2025 – 5/11/2025 with fieldwork conducted alongside four participating citizen scientists. The town dam was selected as a survey site as it was the only freshwater body identified within 50 km of the roost site (~12 km) and likely to be an important local site for foraging and drinking.

All survey nights had overnight temperatures above 10 °C, were dry, and experienced moderate to strong winds, which may have reduced bat activity. Trapping at Joker's Tunnel concluded early due to strong winds, while trapping at the Yalgoo town dam was curtailed due to lightning storms.

Bat trapping surveys

A single double-bank harp trap (Austbat, Faunatech, Victoria, Australia) was deployed on the first night at Joker's Tunnel entrance to

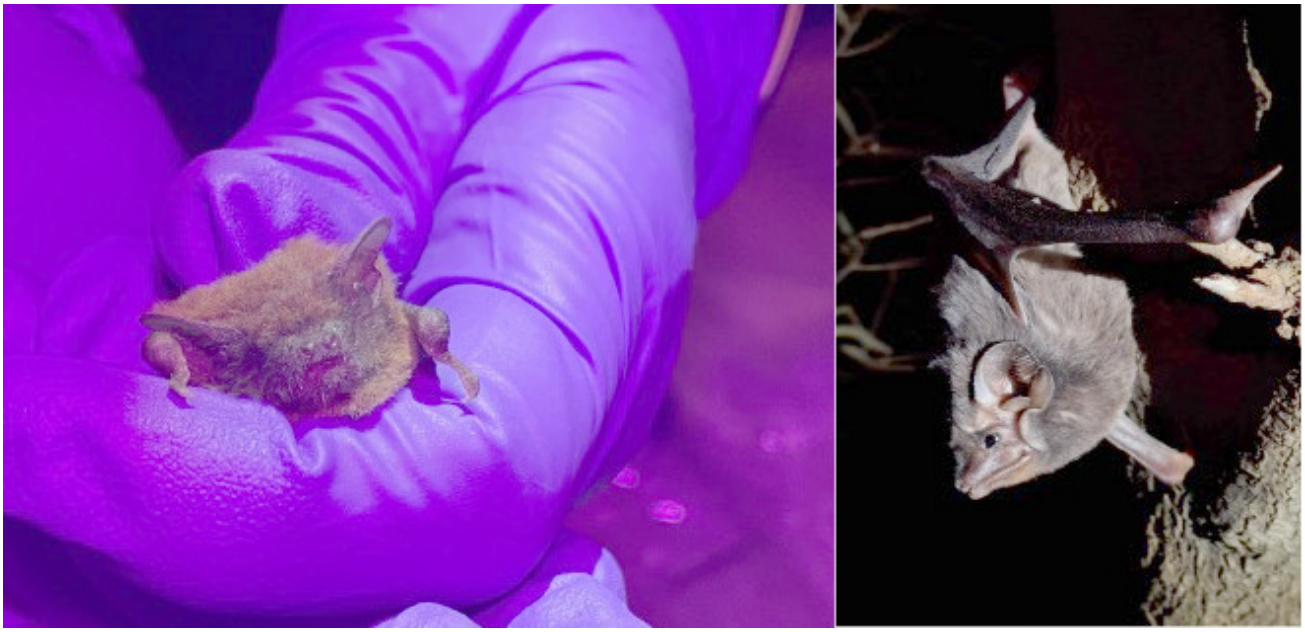

Figure 1. LEFT: Finlayson's cave bat (*Vespadelus finlaysoni*) captured at the roost. RIGHT: Hill's sheathtail bat (*Taphozous hilli*) also captured at the roost during the study.

determine roosting species (total trap hours = 2). Three harp traps including one equipped with an Autobat acoustic lure (Essex, UK) were set on the second and third nights ~500m from the Tunnel (total trap hours = 7), and on the fourth and fifth night at the Yalgoo town dam (total trap hours = 5). Acoustic lures are known to improve capture rates (Hill *et al*. 2015). Social calls of European bats, serotine (*Eptesicus serotinus*), Leisler's (*Nyctalus leisleri),* Daubenton's (*Myotis daubentonii*), Bechstein's (*Myotis Bechsteinii)* and brown long-eared (*Plecotus auritus*) were played on the lure. These calls were used as they have been shown to increase capture rates of a range of species in multiple regions, including in Australia, and due to the limited research of Australian bat social calls, local calls were not available. Traps were set at sunset and checked every 30 minutes.

Captured bats were identified to species (Braasch *et al*. 2024*), sexed, aged, temporarily marked with non-toxic chalk, and measured to collect biometric data (forearm length, mass, reproductive condition) recorded before release at point of capture. Reference calls were collected to aid subsequent acoustic analysis (Supplementary Materials). All procedures followed Wildlife Animal Ethics Permit WAEC 23-10-60.

Acoustic surveys

Passive acoustic surveys were conducted concurrently over the five nights (total recording hours = 60 hours) using Wildlife Acoustic Song Meter Mini Bat and Titley Swift detectors (Titley Scientific, Brendale, QLD, Australia) supplemented by Echo Meter Touch 2 (Wildlife Acoustic, Maynard, MA, USA) for reference call recordings and roost emergent surveys. Passive detectors were positioned ~ 100m from the trapping site throughout the trapping survey and additionally at the rear tunnel exit for the study period to determine emergent and return times. Recordings were manually identified in Kaleidoscope Pro v.5.4.1 (Wildlife Acoustics) with sequences of fewer than three pulses excluded. Remaining sequences were identified to species using regional reference calls collected during the study and with reference to published keys and literature (e.g. Braasch *et al*. 2024*; McKenzie and Muir 2000; Reinhold *et al*., 2001*; Sheldrick *et al*. 2025; McKenzie *et al*. 2002; Milne 2002*; Pennay *et al*. 2004*; McKenzie and Bullen 2009).

Roost emergence observations

Roost emergence at Joker's Tunnel was observed for 1.5 hours from sunset on 02/11/2025. One citizen scientist was stationed at the front and another at the rear of the tunnel, positioned so as not to obstruct the emerging bats' flight paths. Bat detectors (Echo Meter Touch 2, Wildlife Acoustics) and a red light were used. Emergence times and species identities were recorded. Exact counts of bats were not attempted because individuals leaving and re-entering the tunnel could not be reliably distinguished, and simultaneous exits from multiple points created a high risk of double-counting. Observations were therefore used to determine occupancy during the emergence period rather than precise abundance.

This approach is considered suitable for citizen science applications, as trained volunteers can reliably detect presence, record emergence timing, and identify species acoustically, with recordings subsequently verified by an expert. Ad-hoc observations throughout the year could provide valuable information on long-term occupancy and help detect changes or disturbances to populations.

RESULTS

Roost occupancy

Finlayson's cave bat (*Vespadelus finlaysoni*) and Hill's sheathtail bat *(Taphozous hilli)* were confirmed using the tunnel as a maternity roost, based on captures of pregnant or lactating females of both species during roost entrance trapping (Fig. 1, Table 1).

Roost emergence survey indicated the first bats (Finlayson's cave bats) emerged from the rear entrance ~11 min after sunset, and from the front entrance ~20 min after sunset. The passive acoustic survey indicated the last returning bat (Finlayson's cave bat) was detected ~20 min before sunrise. Presence of citizen scientists did not appear to deter bats from emerging.

Table 1. Species captured at roost entrance. All adult females were lactating or pregnant, except one Finlayson's cave bat, which was post-lactating.

	Male		Female	
Species	**Adult**	**Juvenile**	**Adult**	**Juvenile**
Finlayson's cave bat (*Vespadelus finlaysoni)*	5	3	13	7
Hill's sheathtail bat (*Taphozous hilli)*	0	0	2	0

Table 2. Bat species detected and the number of captures at Joker's Tunnel roost, the area surrounding Joker's tunnel and Yalgoo town dam based on trapping and acoustic surveys

		Tunnel roost		Area surrounding roost		Yalgoo Dam		
Common name†	**Scientific name**	**Captured**	**Recorded**	**Captured**	**Recorded**	**Captured**	**Recorded**	**Confidence**
Finlayson's cave bat	*Vespadelus finlaysoni*	28	√	–	√	2	√	High
Hill's sheathtail bat	*Taphozous hilli*	2	√	–	√	–	√	High
Lesser long-eared bat	*Nyctophilus geoffroyi*	–	–	2	√	7	√	High
White-striped freetail bat	*Austronomus australis*	–	–	–	√	–	√	High
Gould's wattled bat‡	*Chalinolobus gouldii*	–	–	–	-	–	√	Moderate
Inland broad-nosed bat	*Scotorepens balstoni*	–	–	–	√	–	√	Moderate
Inland forest bat	*Vespadelus baverstocki*	–	–	–	√	–	√	Moderate

‡ Detected when recording reference calls from captured animals.

Bat trapping and acoustic surveys

Bat species potentially present within 50km of the study area were identified using the Australasian Bat Society Bat Map (Australasian Bat Society 2025*). Hill's sheath-tailed bat and the inland forest bat occur within 50 km of the site but are not known from the immediate vicinity of Joker's Tunnel or the Yalgoo town dam. The chocolate wattled bat (*Chalinolobus morio*) is considered likely to occur in the broader area but was not detected during this survey. Four species were confirmed present at the site with high confidence, and two species with moderate confidence (Table 2). An additional species was recorded when collecting reference calls (Table 2). Some echolocation calls could not be identified to species due to overlapping call parameters and the influence of artefacts (e.g. wind).

DISCUSSION

These findings confirm that Joker's Tunnel functions as a maternity roost for both Hill's sheath-tailed bat and Finlayson's cave bat, highlighting the site's importance for local reproduction and population persistence. Although both species are currently listed as non-threatened at the state and federal levels, they rely on secure roosting sites, particularly during the breeding season (Armstrong 2021a*, 2021b*). Disturbance or loss of such roosts can lead to abandonment or reduced reproductive success, underscoring the need for ethical tourist visitation, community engagement, and education (Ancillotto *et al*. 2019).

New distributional records

Breeding female Hill's sheathtail bats at Joker's Tunnel may reflect a local range extension of ~20 km southeast, as a previous study at Joker's Tunnel in 2000 did not detect this species (Metcalf 2000*). Although a modest extension, Bat Map reports several outlier records further southeast suggesting that the species may occur sporadically beyond its currently mapped range. Regardless of the mechanism driving this distribution, the presence of a breeding population around Joker's Tunnel warrants continued monitoring and targeted surveys within the surrounding landscape to assess population extent, stability, and connectivity.

Acoustic records of inland forest bats at both Joker's Tunnel and the town dam indicate occurrences ~40–60 km northwest of the currently mapped distribution limit. Further research is required to confirm these records, refine species distribution mapping, and determine the specific habitats used at these locations, including whether they represent novel habitat types for the species.

Citizen science potential

Our study demonstrates Joker's Tunnel has potential as a site for structured citizen-science engagement and future research. The tunnel is accessible, easily monitored acoustically, and generates public interest due to its historic and ecological significance. Citizen scientists could contribute to long-term acoustic monitoring and broader public education initiatives (e.g., Barlow *et al*. 2015). Furthermore, given disused mines may be susceptible to collapse and entomb bats, citizen science monitoring (e.g., via the use of standardised photograph sampling) can help land managers identify obvious signs of structural frailty at the tunnel entrance and instigate remedial work that ensures this important site remains available for bats, but also to secure the site's heritage value. However, any community involvement must be carefully managed to avoid disturbance, particularly during the maternity season when the risk of pup mortality and roost abandonment is highest. This includes refraining from entering the tunnel or interacting with bats in other ways (e.g., spotlighting bats with white light). With appropriate training, supervision, and seasonal restrictions, citizen-science participation could increase monitoring coverage, strengthen local stewardship of the site and assist in reducing roost disturbance (e.g. Bat Conservation Trust 2025*; Wisconsin Department of Natural Resources n.d.*).

Conservation significance and management considerations

Joker's Tunnel provides a roosting habitat for lactating female bats and has the advantage of the proximity to freshwater at the Yalgoo town dam (Kurta *et al*. 1990; Speakman 2008). While other mining structures exist nearby, almost all are vertical shafts, with the nearest comparable horizontal adit over 30 km away (https://trilobite.solutions/maps/; Yalgoo Caravan Park and Shire of Yalgoo personal communications, November 2025). Although some Australian mine-roosting bats are often observed in adits (Armstrong 2001; Gonsalves *et al*. 2021), their use of mines likely depends on internal roost conditions (e.g. temperature, humidity, disturbance) and surrounding habitat quality, including access to foraging resources and water, than on the mine structure alone (Gonsalves *et al*. 2021).

The conservation importance of Joker's Tunnel is further supported by historical evidence of long-term maternity use (Metcalf 2000*). During this 2000 study, a maternity roost of Finlayson's cave bat was recorded at the site, with males and females roosting together. Metcalf (2000*) also reported polyoestry with reproductive activity throughout the year and a peak from late winter to early spring. This suggests that disturbance risk may not be confined to a narrow maternity season; however, as the Metcalf (2000*) study coincided with an unusually high rainfall year, reproductive timing and roost use may have been influenced by favourable conditions, highlighting the need for repeat monitoring across multiple years.

Given the apparent scarcity of suitable roosts in the region, and our evidence of maternity use, Joker's Tunnel may be particularly vulnerable to human impacts. Careful management is therefore essential: the tunnel should not be entered during maternity periods, signage could be used to communicate restrictions to visitors, and any maintenance or works should be undertaken in consultation with an experienced bat ecologist to ensure the protection of both roost integrity and bat safety.

Limitations and future directions

While this study provides evidence of Joker's Tunnel being used as a maternity site there are some limitations to consider when assessing its significance for local bat populations. The survey was undertaken over a short period in spring in a single year, with few repeats, so it is unclear how the tunnel is currently used across different seasons. Future surveys should sample in multiple seasons, as bat activity can vary among seasons (e.g., Gonsalves *et al*. 2014*; Gonsalves and Law 2018) and to identify optimal timeframes for citizen scientists to detect population trends with sufficient power (Law *et al*. 2015; Gonsalves *et al*. 2024). Long-term monitoring using citizen science could address these gaps and is an aspect of bat research that has been notably absent (Law 2018).

CONCLUSIONS

Joker's Tunnel represents an important maternity roost and provides opportunity for non-invasive research and citizen-science engagement. Despite limitations in temporal coverage and survey effort, our results show that the site is suitable for long-term monitoring. Future research, including multi-season surveys, assessment of surrounding roosts, and species-specific ecological studies, could further enhance understanding of these understudied bats and inform conservation management.

ACKNOWLEDGEMENTS

We acknowledge that Joker's Tunnel is a publicly known bat roost. Bat roosts are highly sensitive to disturbance, particularly during the maternity period, and human visitation can result in roost abandonment; for this reason, we do not disclose the locations of other roosts, which are generally kept confidential.

We sincerely thank Natasha Batten for bringing the bats at Joker's Tunnel to our attention and for her dedication to their conservation. We also thank Zoe Holdaway and Karl Hellberg for their valuable assistance with fieldwork, and Brenden Metcalf for reviewing the manuscript and generously sharing insights from his previous work. We also thank the Yalgoo community for their hospitality and support during our visit, the Yalgoo Primary School for inviting us to engage with students, and the students for their enthusiasm. Support for this study was provided by the Shire of Yalgoo and the Conservation Council of Western Australia.

We acknowledge the Traditional Owners of the lands where this study took place, the Badimaya and Widi peoples and recognise their continuing connection to Country.

Notes on References

References marked with an asterisk (*) in the text are grey literature sources. These are not included in the reference list but are instead provided in full in Appendix Table 1.

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APPENDIX

Appendix Table 1. List of "grey" literature cited in text (i.e., unpublished reports available through government agencies either on-line or through their libraries).

Authors	Title	Source
Armstrong, K. N. (2021a)	*Taphozous hilli* (amended version of 2020 assessment). The IUCN Red List of Threatened Species 2021: e.T21457A209524440.	https://dx.doi.org/10.2305/IUCN.UK.2021-3.RLTS.T21457A209524440.en
Armstrong, K.N. (2021b)	*Vespadelus finlaysoni*. *The IUCN Red List of Threatened Species* 2021: e.T7924A22118503.	https://dx.doi.org/10.2305/IUCN.UK.2021-3.RLTS.T7924A22118503.en
Australasian Bat Society (2025)	*Bat Map.*	https://www.ausbats.org.au/batmap.html
Australia's Golden Outback (n.d.)	*Top wildflower locations in Australia's Golden Outback*.	https://www.australiasgoldenoutback.com/blog/the-top-wildflower-locations-throughout-australias-golden-outback
Bat Call WA (2021)	*A review of ghost bat ecology, threats and survey requirements* (Report prepared for the Department of Agriculture, Water and the Environment, Canberra)	https://www.dcceew.gov.au/sites/default/files/documents/review-ghostbat-ecology-threats.pdf
Bat Conservation Trust (2025)	*National Bat Monitoring Programme*	https://www.bats.org.uk/our-work/national-bat-monitoring-programme
Braasch, H., Churchill, S., & Thomson, B. (2024)	*Australian Bats Field Guide* (Version 1.0.3) [Mobile app]	https://www.auswildlife.com/field_guide_to_australian_bats_mobile_app/
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Gonsalves, L., Law, B., Wilmott, L., Wearne, P., Byrne, J., & Ashworth, D. (2014)	*A strategic approach to prioritising disused mine management for bats along the Illawarra Escarpment.*	Unpublished report prepared for NSW Derelict Mines. New South Wales Department of Primary Industries and Regional Development.
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Metcalf, B. (2000)	*Effect of the reproductive cycle on the microclimatic requirements of microchiropteran bats*	Unpublished Honours thesis. Murdoch University, Perth.
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Reinhold, L., Law, B., Ford, G., & Pennay, M. (2001)	*Key to the bat calls of south-east Queensland and north-east New South Wales*. Queensland Department of Natural Resources and Mines, QLD, Australia.	https://catalogue.nla.gov.au/catalog/1164754
Shire of Yalgoo. (n.d.)	*Jokers Tunnel [Attraction]*	https://www.yalgoo.wa.gov.au/tourism/attractions/jokers-tunnel.aspx
Wisconsin Department of Natural Resources. (n.d.)	*Bat roost monitoring*. Wisconsin Bat Program.	https://wiatri.net/inventory/bats/volunteer/roosts/

SUPPLEMENTARY MATERIALS

WAV (Waveform Audio File Format) files of bat reference calls

Download: https://rswa.scholasticahq.com/article/159401-bat-conservation-citizen-science-and-heritage-tourism-an-intersection-at-joker-s-tunnel-western-australia/attachment/339234.zip