Detecting the Bare-rumped Sheath-tailed Bat at Knox Plains, Western Australia

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Summary

This report assesses the likelihood of roost habitat of the Threatened-listed Bare-rumped Sheath-tailed Bat *Saccolaimus saccolaimus* (BRSB) occurring in an area planned for native vegetation clearing within the Knox Creek Plain Irrigation Development project. The assessment required a field survey of 26 trees that contained hollows considered large enough in a previous survey by biological consultants for potential use by the BRSB. Consideration was given mainly to whether a tree hollow could support a colony of individuals for a relatively long period of time, rather than one or two individuals over a few nights.

Specialised Zoological provided advice on an appropriate survey design, provided the equipment to implement that design, and was tasked with reviewing the data collected and making a determination of whether any of the hollows were likely to be used by the BRSB. The methods included making a simple inspection of hollow features, and making video recordings and bat detector recordings. Video and bat detector recordings made at tree hollows at the time of bat emergence just after sunset were limited. Determinations of the likelihood of roosting in flagged tree hollows was based primarily on an inspection of the supplied observations of the hollows, as well as a video-based inspection during the daytime.

Based on all the observations and data provided, there was no evidence of the use of the hollows by the BRSB. Given the size of both the trees and hollows and the height of the hollows from the ground, it is unlikely that any of the structures would be used by a colony of the BRSB.

Background

As part of the wider Ord-East Kimberley Expansion Project, the Knox Creek Plain irrigation development seeks to extend the Ord River Irrigation Area by an additional c. 5,500 hectares of farmed land and c. 700 hectares of infrastructure and water balancing areas on the Knox Creek Plain, 35 kilometres north-east of Kununurra in Western Australia (Kimberley Boab Consulting 2014). The proposal expands on, and is integrated with, the adjacent Weaber Plain (Goomig) irrigated agriculture development.

Specialised Zoological has provided advice and examined field data on previous surveys, which can be found in three letters to the Commonwealth Department of the Environment and Kimberley Boab Consulting (Specialised Zoological 2014 in litt., 2015 in litt. a,b).

A subset of the land is planned for clearing in the shorter-term. Within this area, there are a total of 26 trees with hollows that were suggested in a previous biological survey might provide roosting habitat for the Bare-rumped Sheath-tailed Bat *Saccolaimus saccolaimus* (BRSB). This species is listed as Vulnerable under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Recommended survey methods and other information and resources are available in DEWHA (2010) and Armstrong et al. (2021).

Scope

The scope of involvement by Specialised Zoological in the present field survey and assessment was:

1. Provide initial verbal advice on how tree hollows might be assessed for use by the BRSB;
2. Compile equipment for an optimised survey of tree hollows in the study area, supply instructions for the field survey and use of equipment (Specialised Zoological 2022), and provide technical troubleshooting advice during the survey where required;
3. Analyse acoustic and video recordings, and any genetic sequencing results; and
4. Make a determination about whether any of the target tree hollows are likely to represent BRSB habitat.

Recommended methods

Equipment supply

The set of equipment supplied was compiled to meet several goals:

- Use methods that allow unambiguous identification of all bat species encountered, especially the BRSB.
- Use more than one method so that identifications can be corroborated with a different dataset or observation type.
- Plan for a survey as soon as possible after engagement, assuming also that the survey will be conducted over the period of a week, with consequent constraints for power supplies to electronic equipment (everything to run from AA batteries; supply AA battery backup trays to camera traps).
- Correct function of all equipment needed to be tested before freighting to the survey.

Survey timing

All fieldwork was led by staff from the Western Australian Department of Primary Industries and Regional Development (DPIRD). Tree hollows were inspected and documented initially between 2 and 6 May 2022. The survey of tree hollows with the equipment provided by Specialised Zoological was undertaken between 10 and 18 May 2022.

Acoustic detection

Record bat echolocation with Anabat Swift bat detectors for at least one night at each of the target trees. The recording should start by sunset and the microphone should point directly at the tree hollow of interest. The critical recording period is just after sunset when bats might start to emerge, if they are present. The BRSB can be distinguished with a relatively high level of confidence based on characters described in my recent paper Armstrong et al. (2021).

Video detection

While bats emerging from a tree hollow within a few metres of a bat detector will produce call types different from those they use to forage in the open spaces further from the roost, the presence of such call types would not provide a completely unambiguous determination of the presence of BRSB in a particular hollow. Having an image of any bat that might leave a hollow can help corroborate any positive acoustics-based identification of the BRSB. Camera traps set to capture still images based on a trigger from passive infrared (PIR) sensors are likely to miss a fast-moving bat. However, the model of camera trap tested and supplied to the survey (Nextech QC8051 4K Outdoor Trail Camera; Jaycar Electronics) can make continuous back-to-back 3-minute recordings until the memory card is full. The units were also set so that the infrared flash array is constantly illuminated. It was anticipated that a large bat seen emerging at the same time as diagnostic echolocation calls were recorded would provide sufficient evidence of diurnal roosting in the structure by the BRSB.

One issue with the supplied camera traps is that the built-in infrared light array (of small low-power LEDs) does not provide a broad coverage or range of illumination. Therefore, a separate higher-power quad-array of 3 Watt infrared LEDs (also 850 nm wavelength; ideal imaging distance within 3 m) was provided that run from the supplied 12 Volt AA battery tray. When positioned close to the hollow on the extendable fibreglass poles provided, they can illuminate a hollow sufficiently for the camera trap to record video images of bats.

The camera traps were supplied with sufficient power and memory resources so that at least two hours post sunset could be recorded, in addition to any lead-time required to place multiple sets of the equipment at up to six target trees during the late afternoon.

An SD card reader was supplied so that recordings could be downloaded, and viewed if required the following day in case follow-up examinations were required for a particular tree.

Genetics-based confirmation of identification

If there was still ambiguity about whether a large bat seen at the entrance to a hollow was the BRSB, or a species of similar appearance, the Yellow-bellied Sheath-tailed Bat *Saccolaimus flaviventris*, then equipment and instructions were provided to collect genetic samples. Clean sheeting was suggested to be laid in front of each tree hollow, and examined at pick-up for bat scats.

The likelihood of being able to access the bottom of tree hollows for scat material is very low, so it was suggested that a sterile alcohol swab could be wiped over tree hollow rims, and the samples sent to a service provider that specialises in ‘environmental DNA’ (eDNA) analysis. This can involve sequencing with genus-specific mitochondrial DNA primers (Armstrong et al. 2021).

Results

Inspection of roosts to document structure

A data matrix of the features of hollows was supplied by DPIRD, and a summary is presented in **Table 1**.

Acoustics-based identification using bat detectors

A bat detector was placed for a full night of recording at six trees (**Table 1**). Data was only available from one unit (450007 at Tree 19 on the night of 2022-05-17). WAV-format sound files were analysed with the method and resources as described in Armstrong et al. (2021). No calls of the BRSB were observed in the recording, but there were unambiguous calls of the closely-related Yellow-bellied Sheath-tailed Bat, which are separable using the characters described in Armstrong et al. (2021) (**Figures 1** and **2**).

Infrared video recordings of post-sunset bat emergence at hollows

One post-sunset recording of a tree hollow (Tree 23, Hollow 23.1) was made (**Table 2**). The hollow was insufficiently illuminated after sunset, so no observations were possible. No other post sunset recordings were available.

Daytime inspections with video

A total of 16 trees, and 18 tree hollows were inspected by continuous video during the day. The camera trap was set recording, hoisted on a 7 metre telescopic fibreglass pole and positioned briefly at the hollow entrance. Each of the resulting video files was watched and notes were made on the structure, condition and likelihood of use by the BRSB. A screenshot (single still image) was made of each hollow and these are presented in **Appendix 1**. Most could be ruled out as roost habitat unambiguously because of their size, condition or occlusion with detritus. For the remainder, the depth of the hollow could not be determined (**Table 2**).

Genetics-based identification

No scats or swabs were collected from tree hollows. However, clean sheeting was spread below some of the hollows. No scats were observed on any of the sheeting.

Discussion

Relatively few tree roosts of the BRSB have been discovered across its northern Australian range that extends from the Kimberley region of Western Australia to the eastern coast of northern Queensland (McKenzie et al. 2018). The first roost of the species was located in Kutini-Payamu NP in the trunk of a dead *Eucalyptus tetrodonta* in *E. tetrodonta*-dominated savanna woodland. This hollow contained up to 15 individuals, which vacated the roost when the observer moved close to the tree (Murphy 2002).

In addition, two roosts in large melaleuca are used by a colony of at least 20 individuals at Centenary Lakes, Cairns, Queensland (Armstrong et al. 2021). These are relatively large hollows positioned at least seven metres high on the tree (K.N. Armstrong pers. obs.).

Museum specimens of the BRSB have been collected after tree collapse elsewhere in their range but the details of these hollows are not available.

The key feature of all three documented roosts is that they are large, mostly vertical in their orientation, in relatively large trees, relatively high on the tree, and on or near the main part of the trunk.

By contrast, the general features of tree hollows in the present study area were:

- Relative narrow or shallow (see notes in **Table 2**);
- In trees that appear to be smaller than the documented examples in the literature (5 – 10 m high; **Table 1**);
- Not situated in the upper part of the tree (hollows at heights 1.5 – 4 m; **Table 1**);
- No bats vacated the roost when daytime inspections with a camera trap on a pole were made.

The key consideration here is whether a tree hollow could support a colony of BRSB individuals for a relatively long period of time, rather than one or two individuals over a few nights. None of the tree hollows examined in the study area were similar to those documented previously in Queensland (Murphy 2002; Armstrong et al. 2021). Few of the structures appeared large enough or were in adequate condition to support bats, much less a colony of larger-bodied bats such as the BRSB.

Conclusions

1. No direct evidence of the BRSB was observed in any of the data collected and submitted for analysis.

2. There were no observations that suggested a high likelihood of the BRSB using any of the tree hollows documented, and certainly not a large colony of this species.

3. Some determinations were limited by the lack of available data or observations.

Limitations

The results presented in this report have been made within the following context:

1. The identifications and determinations made herein were based on the ultrasonic acoustic recordings, video recordings and associated site data recorded and provided by a 'third party' (the client named on the front of this report).
2. The scope of this report extended to providing advice on appropriate survey methods for the Bare-rumped Sheath-tailed Bat, providing a set of appropriate, pre-tested and functional survey equipment, and analysing the returned data to make identifications of the species and determinations of tree hollows as potential roosts. Further comment on this species and the possible impacts of a planned project on bat species were not part of the scope.
3. In the case of the present report, the recording equipment was tested, set up and supplied by Specialised Zoological. The equipment was operated by the third party during the survey.
4. Some digital information on the survey area was provided, but Specialised Zoological has not made a visit to observe the habitats available for bats, nor have we visited the specific project area on a previous occasion.
5. Specialised Zoological has given advice on an appropriate set of survey methods for the target species in the project area, but timing of this bat survey, operation of equipment and recording site placement was the responsibility of the third party.
6. While Specialised Zoological has made identifications to the best of our ability given the available materials, and reserves the right to re-examine the data and revise any identification following a query, it is the client's and / or proponent's responsibility to provide supporting evidence for any identification, which might require follow-up trapping effort or non-invasive methods such as video recordings. Specialised Zoological bears no liability for any follow-up work that may be required to support an identification or determination based on the analysis undertaken and reported on here.
7. The Bare-rumped Sheath-tailed Bat *S. saccolaimus* can be identified from its echolocation call characteristics and distinguished from other low-frequency-emitting (LFE) bat species across most of its range in northern Australia, except where this coincides with the distribution of the Papuan Sheath-tailed Bat *S. mixtus* on Cape York Peninsula (Armstrong et al. 2021a). Both DEWHA (2010) and Armstrong et al. (2021) give further advice on how to survey for and detect the presence of *S. saccolaimus* in this region.
8. This version of the document supersedes any previous version. Previous drafts are not authorised by us for submission to the regulator or the public domain.

References

Armstrong, K.N. (2014 in litt.). Advice on the presence and future management of the bare-rumped sheath-tailed bat *Saccolaimus saccolaimus* on the Knox Creek Plains Irrigation Development. Letter of advice from Specialised Zoological to Dr Debra Pearce, Kimberley Boab Consulting, 24 September 2014, project reference SZ352.

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DEWHA (2010). Survey guidelines for Australia's threatened bats. Guidelines for detecting bats listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999. Department of the Environment, Water, Heritage and the Arts, Canberra.

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Specialised Zoological (2022). Bat detector and video instructions. Equipment guide prepared by Specialised Zoological for Helena O'Dwyer, 10 April 2022, project reference SZ607.

Table 1. Details of trees and hollows examined, and comments from the field inspection (Date: date of discovery; Tree H x circ: tree height by circumference; Hollow H x diam: height of hollow from ground by entrance diameter; CT: camera trap number; Serial: bat detector serial number; dataset modified from that supplied by DPIRD).

Tree ID	Tree sp.	Date	Tree H x circ	CT	Serial	Hollow ID	Hollow H x diam	Bats?	Comments	Latitude	Longitude
Tree 03	Eucalyptus	2022-05-02	8 m x 45 cm			3.1		No	No hollows	-15.4302219	128.9998924
Tree 04	Eucalyptus	2022-05-02	6 m x 45 cm			4.1	4 m x 10 cm	No	Branch broken	-15.404857	128.999825
Tree 05	Eucalyptus	2022-05-02	8 m x 50 cm	V4	642029	5.1	4 m x 10 cm	No		-15.4060446	128.9944141
Tree 06	Eucalyptus	2022-05-02	8 m x 75 cm	V5	450008	6.1	3.5 m x 10 cm	No		-15.4080283	128.9914564
Tree 07	Eucalyptus	2022-05-02	6 m x 45 cm	V6		7.1	2.5 m x 12 cm	No		-15.4078749	128.9886441
Tree 08	Eucalyptus	2022-05-02	8 m x 60 cm	V3	450083	8.1	3.5 m x 15 cm	No	No evidence of use	-15.4071707	128.9865896
Tree 09	Eucalyptus	2022-05-02	8 m x 35 cm	V2		9.1	3.5 m x 15 cm	No		-15.4072066	128.9854588
Tree 11	fallen	2022-05-03							No hollows	-15.4573711	128.993668
Tree 12	Eucalyptus	2022-05-03	6 m x 20 cm	V1		12.1	2 m x 5 cm	No	Multiple hollows	-15.4562189	128.9948798
Tree 13	Eucalyptus	2022-05-03	8 m x 25 cm	V2	450083	13.1	2.5 m x 12 cm	No		-15.4550085	128.9941163
Tree 14	Eucalyptus	2022-05-06	4.5 m x 30 cm			14.1	2.5 m x 10 cm	No	Several < 2 m height	-15.5201302	128.9700966
Tree 15	Eucalyptus	2022-05-06	6 m x 30 cm			15.1	1.5 m	No	Too low	-15.526604	128.9703115
Tree 16	stump	2022-05-03				16.1			Burnt-out stump	-15.4361199	128.9914243
Tree 17	Bauhinia	2022-05-03	5 m x 20 cm			17.1		No	No hollows	-15.435475	128.9904669
Tree 18	stag	2022-05-03	4.5 m x 40 cm	V6	642149	18.1	4 m x 10 cm	No		-15.4352723	128.9904565
Tree 19	Eucalyptus	2022-05-03	7 m x 20 cm	V5	450007	19.1	2 m	No	Large shallow	-15.4359287	128.9908208
Tree 20	Eucalyptus	2022-05-03	8 m x 50 cm	V4		20.1	4 m x 5 cm	No		-15.4352898	128.9901661
Tree 21	Eucalyptus	2022-05-06	6 m x 30 cm			21.1	2.5 m x 15 cm	No	Multi stem, burnt	-15.5884459	128.9820579
Tree 22	Eucalyptus	2022-05-06	8 m x 25 cm			22.1	2.5 m x 10 cm	No		-15.5884625	128.9820572
Tree 23	Eucalyptus	2022-05-06	9 m x 25 cm			23.1	2.25 m x 15 cm	No	Multiple hollows	-15.5884472	128.9820785
Tree 24	Eucalyptus	2022-05-06	10 m x 45 cm			24.1	4 m x 15 cm	no	Full of bees	-15.6254186	128.9778877
Tree 25	Eucalyptus	2022-05-06	5 m x 40 cm			25.1	3 m x 10 cm	No		-15.6254065	128.9779165
Tree 26	Eucalyptus	2022-05-06	8 m x 30 cm			26.1	2.5 m x 10 cm	No		-15.625593	128.9777392
Tree 27	Eucalyptus	2022-05-06	10 m x 50 cm			27.1	3 m x 20 cm	No	Hollow fractured	-15.62934	128.972823
Tree 28	Eucalyptus	2022-05-06	10 m x 40 cm			28.1		No	No visible hollows	-15.6293774	128.9728205
Tree 29	Eucalyptus	2022-05-06	9 m x 50 cm			29.1	4 m x 10 cm	No	Shallow, at trunk join	-15.6294521	128.9727059

Table 2. Interpretation of all videos made at tree hollows (CT: camera trap number) (*continued next page*).

Tree	Hollow	CT	Survey date	Observation and interpretation
Tree 05	5.1	V4	2022-05-10	Daytime inspection. Limited hollow development (length and width), too small to be used by a colony of the BRSB.
Tree 06	6.1	V4	2022-05-10	Daytime inspection. Limited hollow development (length and width), unlikely to be used by a colony of the BRSB.
Tree 08	8.1	V4	2022-05-10	Daytime inspection. Depth of lower fully enclosed section not able to be determined. No scats or other signs of presence at the upper level. Unambiguous conclusion cannot be made, but unlikely to be used by the BRSB.
Tree 09	9.1	V4	2022-05-10	Daytime inspection. Hollow completely full of detritus. Not used by the BRSB.
Tree 15	15.1	V4	2022-05-11	Daytime inspection. Hollow containing detritus, open at bottom. Not used by the BRSB.
Tree 18	18.1	V4	2022-05-16	Daytime inspection. Dead stag, poor condition, hollow depth unknown, no signs of use. Unambiguous conclusion cannot be made, but unlikely to be used by the BRSB.
Tree 20	20.1	V4	2022-05-11	Daytime inspection. Limited hollow development (length and width), unlikely to be used by the BRSB.
Tree 21	21.1	V4	2022-05-11	Daytime inspection. Hollow depth unknown, no signs of use in the detritus accumulated on the sloped floor. Unambiguous conclusion cannot be made, but unlikely to be used by the BRSB.
Tree 21	21.2	V4	2022-05-11	Daytime inspection. Hollow contains detritus, cobwebs, lizard, open to sunlight, no signs of use by bats. Not used by the BRSB.
Tree 22	22.1	V4	2022-05-11	Daytime inspection. Hollow completely full of detritus. Not used by the BRSB.
Tree 22	22.2	V4	2022-05-11	Daytime inspection. Limited hollow development (length and width), not used by the BRSB.
Tree 23	23.1	V2 V5	— 2022-05-18	Daytime inspection, three videos. Relatively deep but narrow. No scats or other signs of presence, mosquitoes present. Unambiguous conclusion cannot be made, but appears too small for a colony of the BRSB to be present.
Tree 23	23.1	V4	2022-05-17	Set before sunset 16:06, collected 20:33, no infrared illumination of hollow, unable to see detail after end of civil twilight. Relatively small and appears shallow, unlikely to be used by the BRSB.
Tree 24	24.1	V4	2022-05-16	Daytime inspection. Horizontal hollow, relatively short, detritus at entrance looks to contain old scat material. This hollow probably used by a smaller bat species in the past. Unlikely to be used by the BRSB.
Tree 25	25.1	V4	2022-05-16	Daytime inspection. Narrow, downward-facing hollow, very unlikely to be used by any bat

Tree	Hollow	CT	Survey date	Observation and interpretation
				species.
Tree 26	26.1	V4	2022-05-16	Daytime inspection. Hollow completely full of detritus, very small. Not used by the BRSB.
Tree 27	27.1	V4	2022-05-16	Daytime inspection. Hollow completely full of detritus, very small. Not used by the BRSB.
Tree 29	27.1	V4	2022-05-16	Daytime inspection. No significant degree of hollow development. Not used by the BRSB.

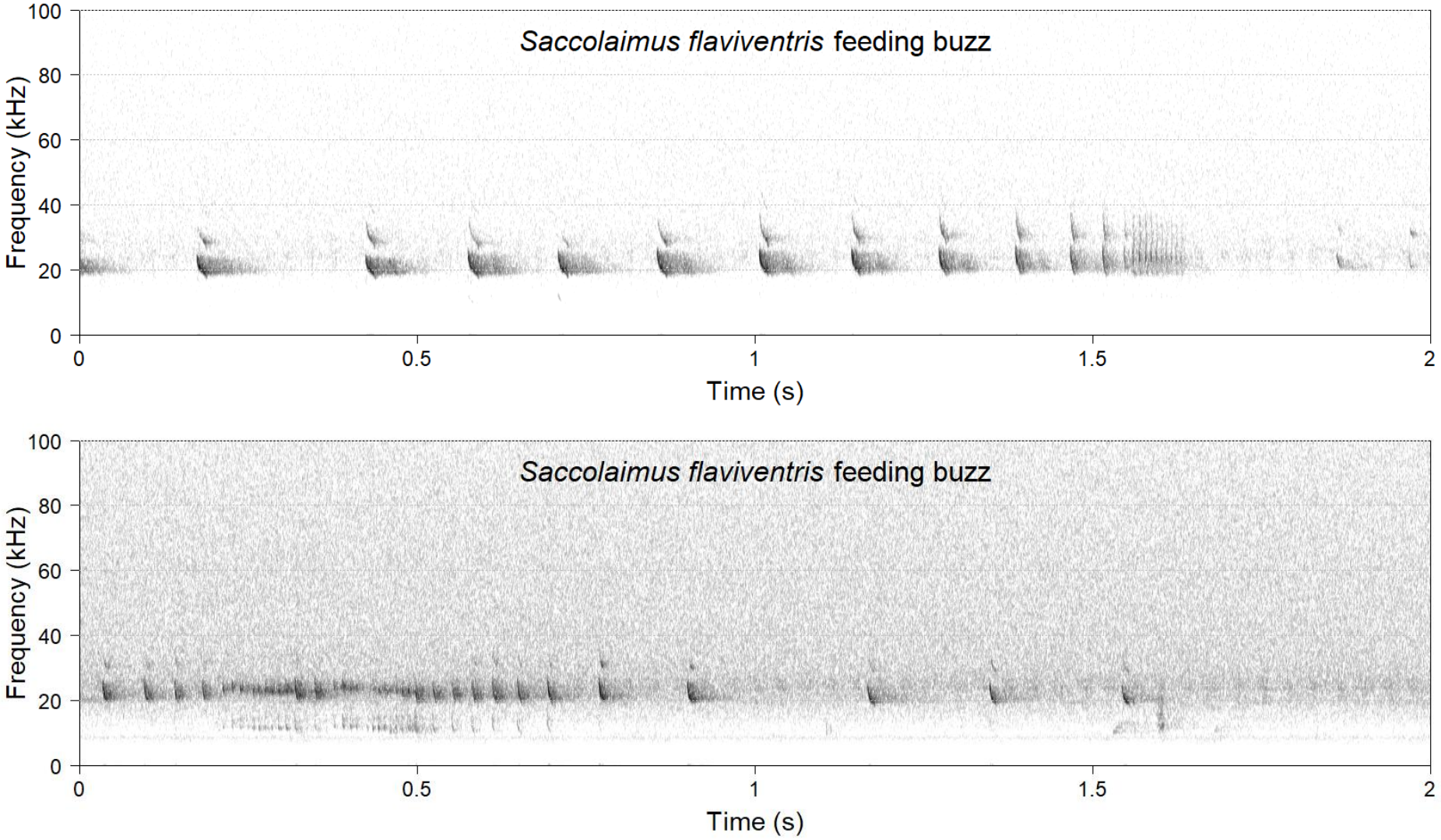

Figure 1. Two example echolocation sequences of the Yellow-bellied Sheath-tailed Bat *Saccolaimus flaviventris*, which contain a feeding buzz at the end of the search phase sequence, composed of pulses in a shape characteristic of this species.

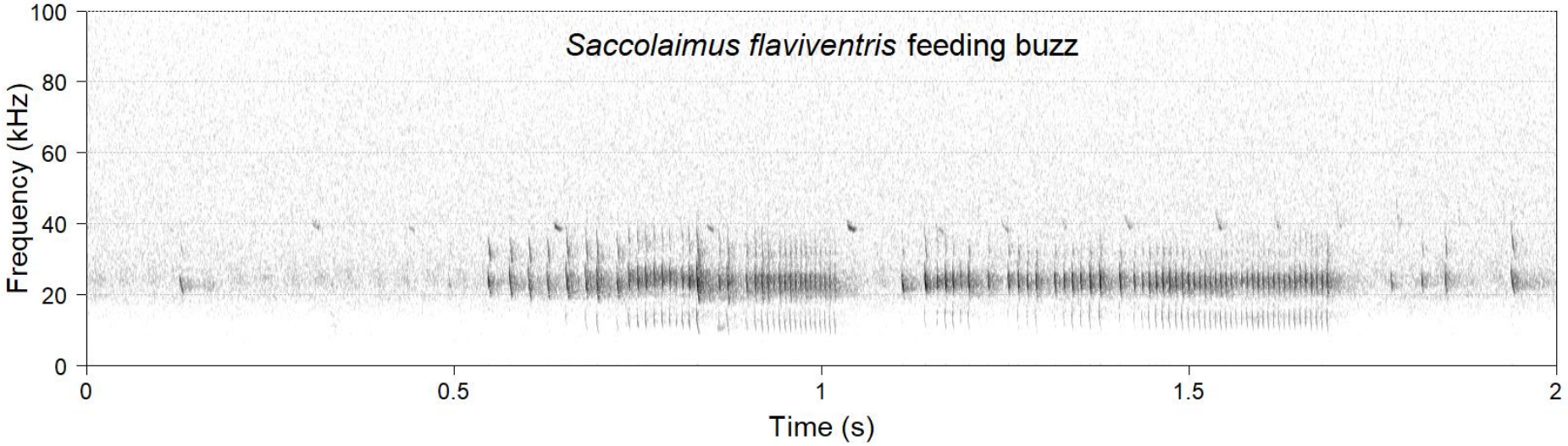

Figure 2. Example extended feeding buzz of the Yellow-bellied Sheath-tailed Bat, which shows clearly the correct harmonic profile for the species, and the relatively straight (cf. 'serpentine' in the BRSB) shape of the pulses.

Appendix 1. Still images of hollows taken from daytime inspection videos.


Tree 05


Tree 06


Tree 08


Tree 09


Tree 15


Tree 18


Tree 20


Tree 21 Hollow 21.1


Tree 21 Hollow 21.2

Appendix 1. Still images of hollows taken from daytime inspection videos—*continued*.


Tree 22 Hollow 22.1


Tree 22 Hollow 22.2


Tree 23


Tree 24


Tree 25


Tree 26


Tree 27


Tree 29