Acoustic analysis and bat call identification for the Rosedale BDAR, New South Wales

Prepared for **Eco Logical Australia Pty Ltd**

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Summary

Bat identifications from bat detector sound files are provided from recordings made for the Rosedale BDAR, in forest habitat to the west of Rosedale and north of Tomakin, coastal New South Wales (**Table 1**; **Figure 1**). The dataset submitted for analysis included a total of 14,383 full spectrum WAV files recorded with four Titley Scientific Anabat Swift bat detectors at four recording sites over four nights between the 19 and 22 of January 2023.

The analysis was undertaken by Amanda Lo Cascio (ABN 59 357 037 376) who used a semi-automated analysis process on converted Zero Crossings representations of sound files in Titley Scientific Anabat Insight software. Ambiguous examples and calls from threatened species were also examined in the original full spectrum format where necessary.

At least 12, and up to 14, species of bat were identified as being present (**Tables 2** and **3**). Representative echolocation calls for each identification are illustrated (**Figures 2** – **4**), as recommended by the Australasian Bat Society (ABS 2006).

The scope of the analysis required particular attention be given to the identification and counting of echolocation sequences of species of conservation significance: the Eastern Bent-winged Bat *Miniopterus orianae oceanensis* and Large-footed Myotis *Myotis macropus. M. orianae* was detected at all survey sites from a combined total of 37 example echolocation call sequences. A further 49 call sequences combined from all four sites were attributable to either *My. macropus* or a species of long-eared bat *Nyctophilus* sp. (example call sequence in **Figure 3**). An unambiguous identification of this latter call type was not possible, and a trapping programme would be needed to confirm its source.

Methods

The WAV files were converted to Zero Crossings (ZC) format using Wildlife Acoustics Kaleidoscope version 5.4.9 software (without using the advanced signal processing option). Putative bat echolocation calls in ZC were marked using an 'All bats' filter (applying criteria based on smoothness, duration and characteristic frequency) in Titley Scientific Anabat Insight version 2.0.3 software. A total of 4,375 ZC files were marked as containing bat echolocation.

Call identification was based on call keys and descriptions for bat species in New South Wales (Pennay et al. 2004), and with further reference to information on bat species in southern Queensland (Reinhold et al. 2001), plus the authors' own resource of echolocation recordings (A. Lo Cascio unpublished data).

In addition to these automated steps based on the application of filters, all ZC files were inspected in the time-frequency domain in Anabat Insight software to check for calls that appear weaker or fragmented in ZC. Ambiguous examples were also examined in the original full spectrum format where necessary.

Nomenclature follows Jackson and Groves (2015). Identifications were supported by distribution information in a curated source of distribution records maintained by the Australasian Bat Society, Inc. (https://www.ausbats.org.au/batmap.html).

Comments on identifications for listed species

The majority of echolocation calls were able to be identified to a single species, but a significant proportion were reported as a composite identification or 'species complex'.

If an identification could not be made unambiguously from this dataset, then presence of the species is regarded as a possibility, and presence should be assumed in the first instance. If confirmation of the presence of any species listed here with an ambiguous identification is required, then further work would be necessary (see point 8 in the *Limitations* section).

Eastern Falsistrelle *Falsistrellus tasmaniensis*
There were relatively few (19) clear example search phase call sequences attributable to *F. tasmaniensis*, plus further examples of clutter type calls where there was insufficient detail of the initial portion of the call or characteristic frequency (c. 35 kHz) to allow separation from *Scoteanax rueppellii* or *Scotorepens orion.*

Eastern Coastal Free-tailed Bat *Micronomus norfolkensis*
This species can be identified reliably from representations in Zero Crossings format. The alternating pattern of high and low characteristic frequency in successive pulses combined with the pulse shape (convex 'upside down cup shapes') is diagnostic, and attribution to this species was made for examples with these features. Sequences of pulses with a characteristic frequency in the range of c. 31 – 35 kHz, but without the alternating pattern, could have derived from either *M. norfolkensis* or *Ozimops ridei* and were thus assigned to a composite identification of these two species.

Eastern Bent-winged Bat *Miniopterus orianae oceanensis*
A broad statement on the difficulty of identifying *M. orianae* based on their echolocation calls is relevant to this project.

For a given recording dataset, it is not currently possible to make unambiguous identifications of all examples of echolocation calls that derive from *M. orianae*.

For pulses having a characteristic frequency in the range of 40 – 44 kHz, there are several features that can be used to attribute a call sequence to this species, or other candidates with similar calls such as *Vespadelus regulus* and *V. darlingtoni*. The search phase echolocation calls of *M. orianae* sometimes have 'drooped' (decreasing frequency) terminations to pulses, but pulses also terminate abruptly without increasing or decreasing terminating frequency sweeps. The presence of echoes can make interpretations of the character of pulse terminations difficult, especially in Zero Crossings format. The frequency characteristics of the feeding buzz can also be used to separate *Miniopterus* from vespertilionids, but there are typically relatively few feeding buzz examples in a given recording dataset. These features can be used in combination, when present, and as observed across several quality examples to make a relatively confident identification of *M. orianae* at a particular recording site. Other useful features for use in identification have been reported for *Miniopterus* species in the Solomon Islands (energy distribution at different points of the pulse; Pennay and Lavery 2017), but their applicability needs to be demonstrated further in Australia, as well as the degree to which such features are diagnostic.

Not all call sequences from *M. orianae* will contain enough information to allow a confident identification, so a 'composite' identification of *M. orianae* and *Vespadelaus* spp. will result in many cases.

Further, there is no standard tool (e.g., statistical classification model, or species-specific 'filter' in software like Anabat Insight) that will allow the consistent and accurate attribution of an identification of *Miniopterus* to a set of calls. This means there will be differences in the number of call sequences identified to *M. orianae* for a given dataset based on the method used, and the person undertaking the analysis. Thus, compilations of activity level of *M. orianae* will be influenced by any difference in interpretation between analysts, the analysis methods used, aspects of survey timing and detector placement, seasonality, and project areas. If activity levels are being used within a project to make biological interpretations, then there is an imperative to standardise the sampling and analysis to minimise the effect of confounding factors.

In the present analysis we have provided sufficient information for a simple assessment of presence/absence of *M. orianae* at each recording site, plus a general indication of activity level based on compiled ambiguous and unambiguous identifications. The applicability of the numbers of *M. orianae* calls reported here will be limited for a broader comparison of activity that spans multiple surveys, seasons, years and sites.

If additional information is required on the presence of *M. orianae* in this project, it will be necessary to consider other methods of bat survey (see point 8 in the *Limitations* section).

An example of a call sequence in full spectrum format attributable to *M. orianae* is presented in **Figure 4**.

Myotis macropus

Calls of *Myotis macropus*, and species of long-eared bat *Nyctophilus* spp. cannot be separated reliably. These species are typically reported as a species complex. An example of a call sequence in full spectrum format attributable to one of these candidate species is presented in **Figure 4**.

Greater Broad-nosed Bat *Scoteanax rueppellii*

The characteristic frequency of echolocation calls of this species overlaps with that in approach phase calls of *Ozimops ridei*. While some of the sequences were suggestive of *O. ridei*, whereby the initial portion of pulses was 'flatter' (narrowband) than would be expected for *S. rueppellii*, the pattern was not consistent. In these cases, a composite identification was assigned.

Limitations

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

1. The identifications made herein were based on the ultrasonic acoustic 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 information on the identification of bat species in the recordings provided. Further comment on these 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 not set up and supplied by Specialised Zoological. The equipment was operated by the third party during the survey.
4. Other than the general location of the study area, Specialised Zoological has not been provided with detailed information of the survey area, has not made a visit to observe the habitats available for bats, nor have we visited the specific project areas on a previous occasion.
5. Specialised Zoological has had no input into the overall design and timing of this bat survey, recording site placement, nor the degree of recording site replication.
6. The identifications listed herein have been made to the best of our ability given the available materials, and we reserve 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 based initially on the analysis of acoustic recordings undertaken and reported on here.
7. There are a variety of factors that affect the 'detectability' of each bat species, given the frequency, power and shape characteristics of their calls. Further information on the analysis and the various factors that can impinge on the reliability of identifications can be provided upon request.
8. The analysis of ultrasonic recordings is one of several methods that can be used to survey for bats, and comprehensive surveys typically employ more than one method. If an identification in the present report is ambiguous or in question, a trapping programme would help to resolve the presence of the possibilities in the project area.
9. 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

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Table 1. Geographic coordinates and numbers of WAV files for each recording night.

Site	Serial	Night of	Latitude	Longitude	No WAV files
Site 001	670970	19/01/2023	—	—	1145
Site 001	670970	20/01/2023	-35.8097	150.2016	1101
Site 001	670970	21/01/2023	-35.8095	150.2016	306
Site 001	670970	22/01/2023	-35.8096	150.2015	861
Site 002	670971	19/01/2023	—	—	592
Site 002	670971	20/01/2023	-35.8112	150.2009	560
Site 002	670971	21/01/2023	-35.8111	150.2007	468
Site 002	670971	22/01/2023	-35.8111	150.2009	1518
Site 003	670973	19/01/2023	-35.8069	150.2095	1210
Site 003	670973	20/01/2023	-35.8068	150.2105	1622
Site 003	670973	21/01/2023	-35.8074	150.2099	754
Site 004	670972	19/01/2023	-35.8142	150.2086	1308
Site 004	670972	20/01/2023	-35.8146	150.2083	1249
Site 004	670972	21/01/2023	-35.8144	150.2084	1689

Table 2. Species identified in the present survey from all sites combined.

RHINOLOPHIDAE	
Eastern Horseshoe Bat	*Rhinolophus megaphyllus*
VESPERTILIONIDAE	
Gould's Wattled Bat	*Chalinolobus gouldii*
Chocolate Wattled Bat	*Chalinolobus morio*
Eastern Falsistrelle	*Falsistrellus tasmaniensis*
Greater Broad-nosed Bat	*Scoteanax rueppellii*
Eastern Broad-nosed Bat	*Scotorepens orion*
Large Forest Bat	*Vespadelus darlingtoni*
Ambiguous identifications with additional species	
Large-footed Myotis	*Myotis macropus*
Unidentified long-eared bat	*Nyctophilus* sp.
Southern Forest Bat	*Vespadelus regulus*
Little Forest Bat	*Vespadelus vulturnus*
MINIOPTERIDAE	
Eastern Bent-winged Bat	*Miniopterus orianae oceanensis*
MOLOSSIDAE	
White-striped Free-tailed Bat	*Austronomus australis*
Ride's Free-tailed Bat	*Ozimops ridei*
Eastern Coastal Free-tailed Bat	*Micronomus norfolkensis*

Table 3. Number of sound files with echolocation sequences attributed to each species, or else to a call type with an ambiguous identification (see *Table 2* for common names).

Site	Site 001	Site 002	Site 003	Site 004	Totals
Swift serial number	**670970**	**670971**	**670973**	**670972**	
Unambiguous identifications					
Austronomus australis	5	1	0	0	**6**
Chalinolobus morio	24	14	7	174	**219**
Chalinolobus gouldii	16	12	132	332	**492**
Falsistrellus tasmaniensis	7	4	4	4	**19**
Micronomus norfolkensis	31	75	9	21	**136**
Miniopterus orianae	6	2	28	1	**37**
Ozimops ridei	56	45	79	27	**207**
Rhinolophus megaphyllus	0	0	3	4	**7**
Scoteanax rueppellii	0	0	5	0	**5**
Scotorepens orion	2	1	0	0	**3**
Vespadelus darlingtoni	24	118	5	0	**147**
Unresolved identifications					
Chalinolobus gouldii / Ozimops sp.	35	10	55	42	**142**
Chalinolobus morio / Vespadelus vulturnus	58	7		31	**96**
Falsistrellus tasmaniensis / Scoteanax rueppellii / Scotorepens orion	30	11	2	0	**43**
Falsistrellus tasmaniensis / Scotorepens orion	1	0	4	0	**5**
Micronomus norfolkenis / Ozimops ridei	14	10	13	8	**45**
Miniopterus orianae / Vespadelus darlingtoni / Vespadelus regulus	17	14	43	14	**88**
Myotis macropus / Nyctophilus sp.	9	20	1	19	**49**
Ozimops ridei / Scoteanax rueppellii	20	0	0	0	**20**
Vespadelus darlingtoni / Vespadelus regulus	4	28	3	2	**37**
Total files per site	**359**	**372**	**393**	**679**	

Figure 1. Location of the recording sites relative to Rosedale, New South Wales (on Google Earth). Four recording positions are shown, with some jitter due to GPS inaccuracy.

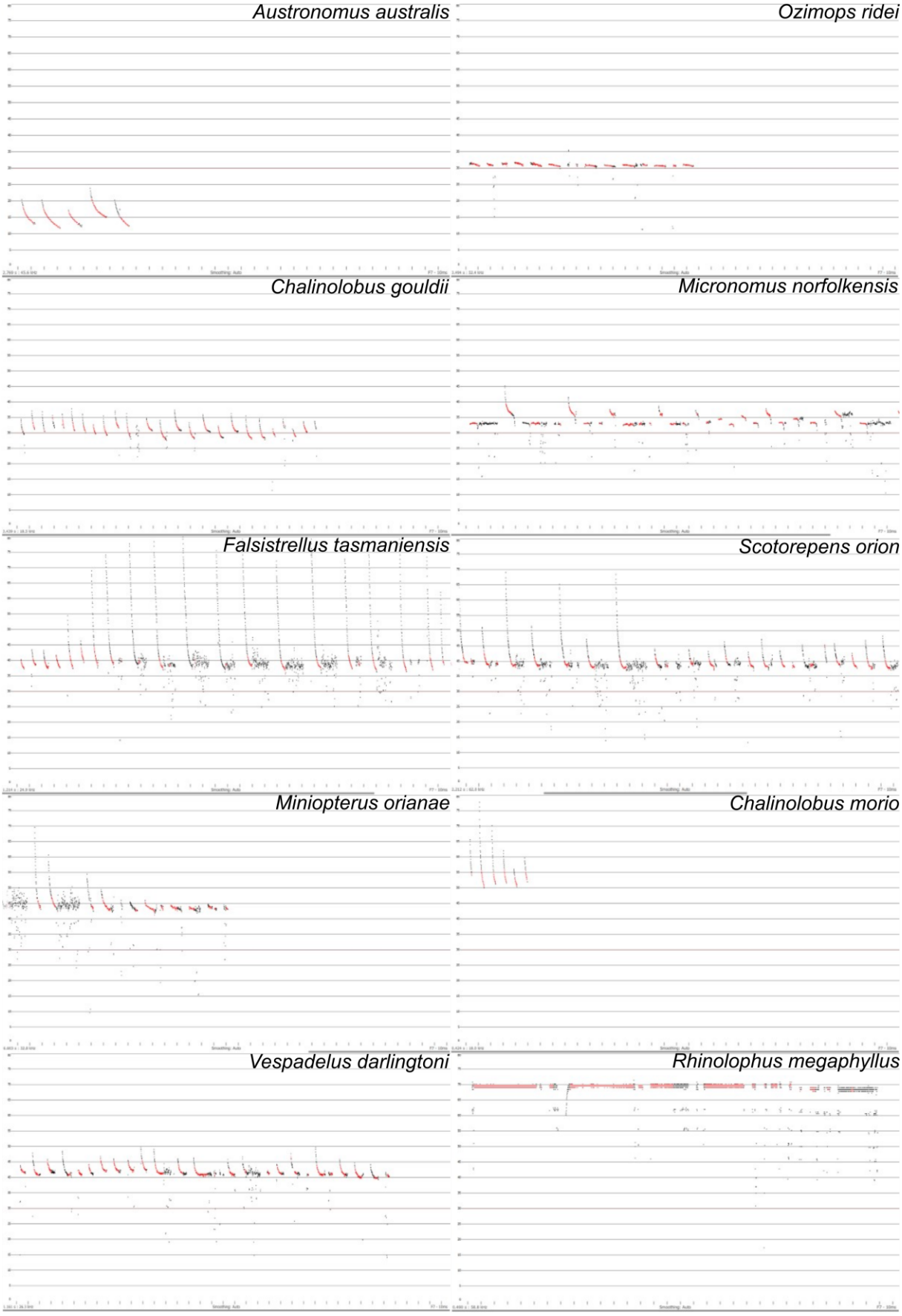

Figure 2. Representative echolocation call sequence portions of the species identified unambiguously (ordered by characteristic frequency of pulses; common names in *Table 2*).

Figure 3. Example echolocation call sequence portions with ambiguous identifications (ordered by characteristic frequency of pulses; common names in *Table* 2; note the scale of the y-axis varies).

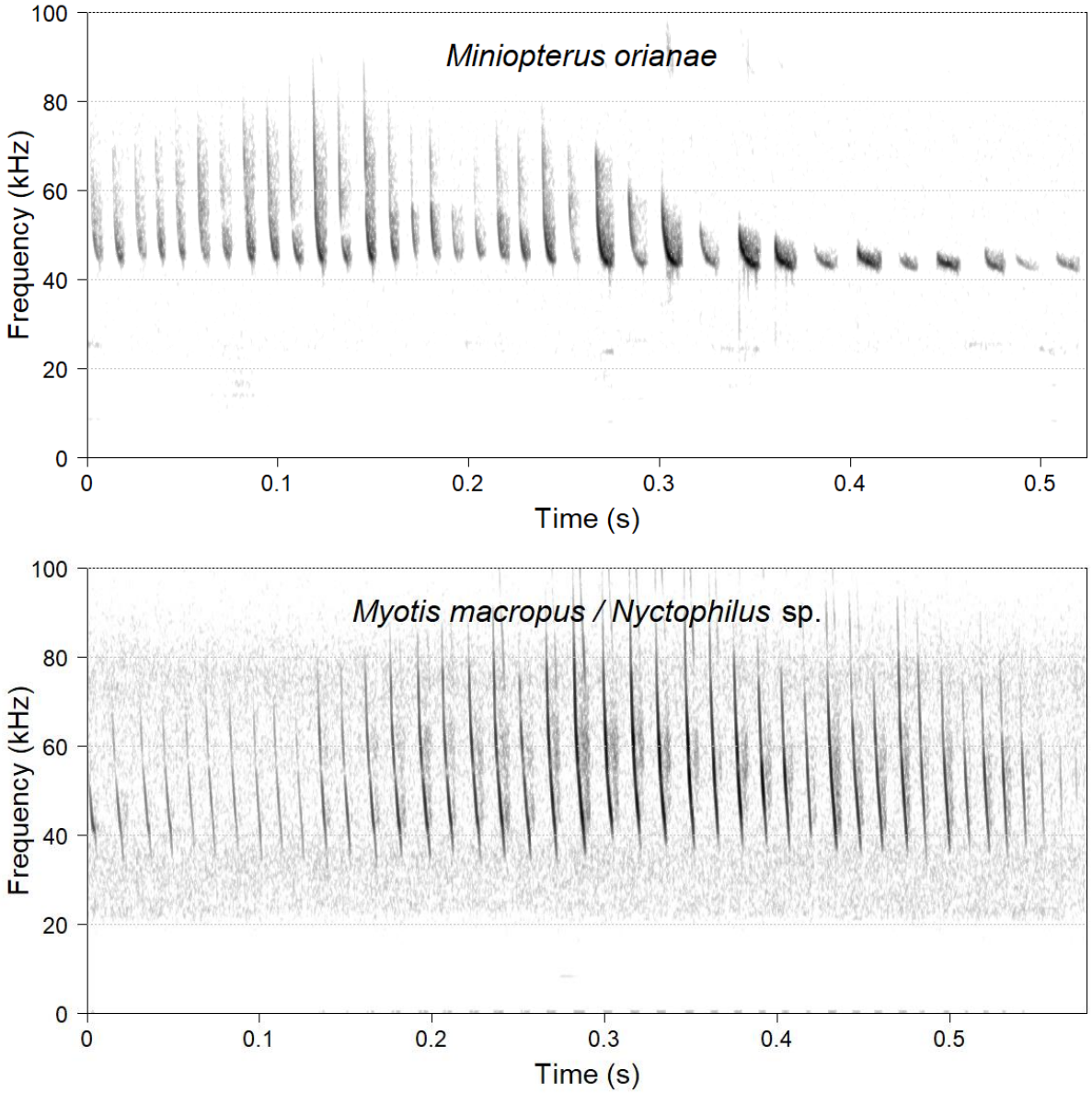

Figure 4. Examples in full spectrum format of echolocation call sequences identified as the Eastern Bent-winged Bat *Miniopterus orianae oceanensis*, and the Large-footed Myotis *Myotis macropus* / *Nyctophilus* sp. (time between pulses has been compressed).