Acoustic lure detection distance: A trial to inform guidelines for the use of acoustic lures in bat roosting areas

A report to the Department of Conservation Bat Recovery Group

Gillian Dennis & Moira Pryde

July 2022

Introduction

Acoustic lures for bats are devices that alter bat behaviour by broadcasting recordings of natural or synthetic ultrasonic sounds. While some species may be repelled by lure calls (e.g. Loeb and Britzke, 2010), others are attracted to them, and this can be used to improve survey detections or capture rates (e,g, Hill and Greenaway, 2005; Samoray *et al*., 2017).

Currently, the most commonly used acoustic lure device in New Zealand is the Sussex AutoBat (Electronics Workshop, School of Life Sciences, University of Sussex, U.K.). This lure has proved effective in increasing the capture rates of long-tailed bats (*Chalinolobus tuberculatus*) and lesser short-tailed bats (*Mystacina tuberculata*) in harp traps or mist nets (I. Davidson-Watts and C. O'Donnell, unpublished data, 2019). However, the reason that bats respond to acoustic lures is unknown. Hill and Greenaway (2005) suggested that attraction to lure calls could represent aggression or other social interactions, and therefore advised caution in their use to reduce potentially disruptive effects. Their recommendations included keeping playback times brief and avoiding frequent use at the same site.

Caution should also be taken when playing lures in bat roosting areas because of the potential to cause disturbance to roosting bats, particularly during the breeding period when non-volant young. are present. Furthermore, roosts could be occupied by large number of bats that could potentially inundate mist nets or unattended free-standing harp traps at emergence, or large numbers of bats could be lured to traps set near roosts during dawn swarming.

Ultrasonic lures are reported to broadcast over 'short distances', since high frequency sounds attenuate rapidly in air. In acoustic lure trials, Samoray *et al*. (2017) and Loeb and Britzke (2010) reported that lures only attracted bats 'in the vicinity' but did not define the effective range of the lures. The current study investigates the distance over which synthetic ultrasound calls broadcast from the Sussex AutoBat lure can be detected on acoustic recorders and hand-held bat detectors. The results will be used to inform recommendations for lure use around roost sites to reduce the risk of disturbance and disruption of local bat populations.

Method

The trial was conducted at the Department of Conservation (DOC) campground at Pelorus Bridge Scenic Reserve, SH6, Marlborough on 4 August 2021, between 11.30 am – 2.00 pm. The weather was clear and calm, and the temperature c. 13^{o}C throughout the trial period.

Two Sussex AutoBat acoustic lures (prototype and Mark 2 models: Figure 1) were used to play a series of synthetic ultrasonic 'calls' developed from the actual calls of British and New Zealand bat species (Appendix 1). The prototype model was used to provide the 'short-tailed bat' track (STB). One of the tracks provided on both lure models (NATT1) was used to calibrate the volume settings.

Figure 1. Sussex AutoBat acoustic lures: prototype model (left), and Mark 2 model (right) used in the lure detection distance trial, DOC Campground, Pelorus Bridge Scenic Reserve, Marlborough, August 2021.

A lure was set up at one end of the vacant campground, with the lure speaker attached to a pole at a height of c. 1.3 m. Two acoustic recorders (AR4, Department of Conservation, New Zealand) were attached to each of 16 stakes spaced at 5 m intervals in a straight line extending 80 m at zero degrees to the direction of the speaker (Figure 2). In a pilot trial, a single AR4 was attached to each stake, but analysis of recordings showed that some units failed to record consistently, i.e. they failed to record some of the playbacks that were detected on recorders that were placed further from the lure. Each track on the Mark 2 model was played in turn for c. 4 minutes at standard volume[1], with the start time of each track recorded by an observer. The procedure was then repeated, with each track played at maximum volume. Two tracks on the prototype model were then played in turn at maximum volume (as there was no standard volume recommended for this device).

[1] The volume recommended by the New Zealand supplier, Ian Davidson-Watts, who was involved with testing the lure's effectiveness with New Zealand's bat species.

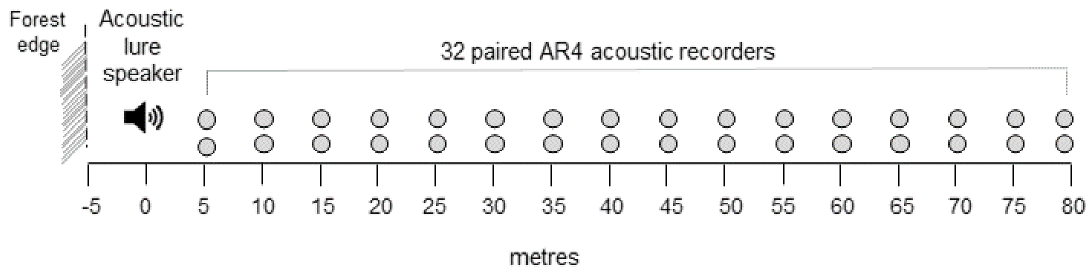

Figure. 2. Diagrammatic representation of the set-up of the trial to determine the maximum distance at which each of 15 Sussex AutoBat lure tracks could be detected on AR4 acoustic recorders. The lure speaker was attached to a pole placed at 0 m, and two acoustic recorders were attached to each of 16 stakes placed at 5 m intervals, in a line extending 80 m directly in front of the lure speaker. The trial was carried out at the DOC campground at Pelorus Bridge Scenic Reserve, Marlborough, August 2021.

While each lure track was playing, the detection distance of a Pettersson D100 hand-held bat detector (Pettersson Elektronic AB, Uppsala, Sweden) was tested. This had proved to be the most sensitive detector of three brands trialled in the pilot. The two less sensitive brands were Magenta Bat4 (Magenta Electronics Ltd, Burton on Trent, U.K) and Stag Batbox III (Stag Electronics, Sussex, U.K). One person took the hand-held detector (HHD) to each of the stakes with the paired AR4s, starting at 5 m and moving towards 80 m. At each stake, with the microphone of the HHD directed towards the lure speaker and the volume of the detector set at maximum, the observer adjusted the frequency dial (from 40 kHz through to 0 kHz) while listening to assess whether the lure track was audible. A second person recorded each distance at which the lure track could be heard on the HHD. If a lure track was heard on the HHD at 80 m, the observer tested the device at additional 5 m intervals until the track was no longer audible.

Analysis of files recorded on each AR4 acoustic recorder was performed using the BatSearch software programme (custom developed by the Department of Conservation, New Zealand). A positive detection of a particular lure track at a staked location was noted in a spreadsheet if one or both AR4s from that location recorded the call.

Figure 3. A. MP overseeing the lure operation beside the speaker during the pilot. The line of stakes at 5 m intervals extends 80 m directly in front of the speaker. **B.** Paired AR4 acoustic recorders attached to each stake **C.** GD manually assessing the detection distance of a hand-held detector, DOC campground, Pelorus Bridge Scenic Reserve, Marlborough, Aug. 2021.

Results

The detection distance of the 15 lure calls tested varied depending on speaker volume, detection device and the call track played (Appendix 1). The maximum detection distance among the call tracks when played at maximum volume was 45 m (BARB, WHISKER, NATT1, NATT2) on the acoustic recorders (AR4s), and 80m (NATT2, WHISKER, LEISLER) on the hand-held detector (HHD). When the call tracks were played at standard volume, the maximum detection distance was 35 m (BARB, WHISKER, NATT1, NATT2) on the AR4s, and 65 m (NATT2) on the HHD.

Calls played at maximum volume on the Mark 2 model lure were in most cases detected on like devices at greater distances than the same calls played at standard volume. On AR4s, calls were detected 5 to 15 m further when played at maximum volume compared to standard volume. On the HHD, calls were detected 0 to 40 m further at maximum volume compared to standard volume. Detection distance using the HHD was greater than with the AR4s when comparing the same call played at the same volume (detected 5 to 30 m further on the HHD than on AR4s when played at standard volume, and 10 to 40 m further on the HHD than on AR4s when played at maximum volume).

Call characteristics also affected detection distance; calls with high amplitude components at low frequencies (e.g. NATT2) were detected at greater distances than other calls, on both types of detection devices at both standard and maximum volumes.

The calibration track (NATT1) was detected by AR4s at the same maximum distance when played at maximum volume on both lure models. Therefore, comparison of the detection distance of the STB track played at maximum volume on the prototype model with other tracks played at maximum volume on the Mark 2 model was considered valid.

Discussion and recommendations

Measurement of the distances over which bats can detect ultrasound appears to have received limited attention, since sparse coverage of this topic was found in the published literature. Most of the studies found focused on the distances over which bats could detect prey by listening to echoes of their own calls. For example, the intensity of echolocation calls was measured by Surlykke and Kalko (2008) to estimate detection distances of 9 - 17 m for nine species of free-living aerial hawking and trawling bats targeting large invertebrate prey. However, bats have also been observed to eavesdrop on the echolocation calls of other bats over greater distances to learn about feeding and roosting opportunities. Dechmann *et al.*, (2007) estimated a maximum hearing distance of 30 - 40 m in eavesdropping lesser bulldog bats (*Noctilio albiventris)*, while Barclay (1982) reported that little brown bats (*Myotis lucifigus*) may be able to hear the echolocation calls of other bats up to 50 m away.

The hearing distances of New Zealand bat species have not been studied. We therefore used acoustic detection devices as a coarse proxy to estimate the maximum detection distance at which synthetically-produced bat calls broadcast from a Sussex Autobat lure might be audible to free-living New Zealand bats.

Our method of measuring the maximum detection distance of lure calls on detection devices had several limitations, including; the limited variety of electronic devices tested; the innate hearing sensitivity of the observer using the hand-held detector; and the effects of ambient noise on the observer's sound detection ability. These factors may have reduced the maximum detection distance in our trial. Furthermore, environmental conditions (wind, temperature, humidity etc) at the time of day and season of the trial (i.e. day time in winter) would likely have affected the propagation distance of sound waves differently to the conditions encountered during summer evenings, when acoustic lures are typically used in New Zealand. For example, the reversal of air temperature gradients between day and night results in opposite effects on sound wave refraction; sound may be audible at greater distances at night than during the day, although this effect is probably negligible over short distances (Hannah, 2006). Conversely, conducting the trial in relatively open space may have extended the maximum detection distance. Most lured trapping of New Zealand bat species is done within or immediately adjacent to the edge of forested areas, where acoustic signals could be distorted or attenuated by vegetation clutter (Freeze *et al*., 2021).

Until more is known about the ultrasound detection range of bats and the effect of acoustic lures on the behaviour of New Zealand's bat species, we recommend adopting a cautious approach when using lures in bat roosting areas.

- We recommend that acoustic lures <u>are not used within 80 m of active bat roosts</u>. Any known roosts within an 80 m radius of the site where lured trapping or mist netting is planned for the coming night should be checked for activity at dawn or at emergence on the day of trapping.

- Even if no activity is detected at dawn or at emergence, restricted use of lured traps/nets within 80 m of a roost site is recommended, as bats could use the roost from dawn the following day. Therefore, we recommend that lured traps/nets <u>are not used within 80 m of any known roosts (even if previously unoccupied) during the dawn twilight</u>, when bats are returning to roost sites.

- At most locations where bats are monitored not all roosts are known, so occupied roosts within 80 m of trap sites could go undetected. This risk may be greater at locations where there has been limited or no roost finding effort, and at small reserves or forest remnants with relatively high roost density. At these sites, lured traps should be monitored at dusk and dawn, or checked one hour after sunset and no later than half an hour before sunrise. The lure should be switched off if catch numbers suggest a nearby roost.

Appendix 1. Maximum distances (metres) that Sussex AutoBat lure calls, played at standard (STD) and maximum (MAX) volumes, were detected on AR4 acoustic recorders spaced at 5 m intervals directly in front of the lure speaker, and on a hand-held Pettersson D100 bat detector (HHD). All lure tracks were played on the same lure device, except for STB and NATT1 (calibration) tracks that were played on an earlier prototype model. Standard volume is that recommended by the lure supplier[2]. Maximum detection distances are highlighted for standard (yellow) and maximum (blue) volumes.

LURE TRACK	VOL.	AR4 limit	HHD limit
BECH1	STD	25	35
	MAX	35	45
BECH2	STD	15	35
	MAX	30	45
LTB1	STD	20	30
	MAX	30	70
LTB2	STD	25	45
	MAX	35	45
NZLONG	STD	25	40
	MAX	35	60
AURITUS	STD	25	35
	MAX	30	75
BARB	STD	**35**	55
	MAX	**45**	55
WHISKER	STD	**35**	50
	MAX	**45**	**80**
NATT1	STD	**35**	60
	MAX	**45**	60
NATT2	STD	**35**	**65**
	MAX	**45**	**80**
LEISLER	STD	30	50
	MAX	35	**80**
MULTI	STD	20	40
	MAX	30	65
NATHUS	STD	30	50
	MAX	35	60
MIXED	STD	30	35
	MAX	35	75
STB (Prototype model)	MAX	35	75
NATT1 (calibration) (Prototype model)	MAX	**45**	75

Abbreviations for bat species names used on lure tacks

BECH	Bechstein's bat (*Myotis bechsteinii*)
LTB	NZ long-tailed bat (*Chalinolobus tuberculatus*)
NZlong	NZ long-tailed bat (*Chalinolobus tuberculatus*)
AURITUS	Brown long-eared bat (*Plecotus auritus*)
BARB	Barbastelle's bat (*Barbastella barbastellus*)
WHISKER	Whiskered bat (*Myotis mystacinus*)
NATT	Natterer's bat (*Myotis nattereri*)
LEISLER	Leisler's bat (*Nyctalus leisleri*)
NATHUS	Nathusius' pipistrelle (*Pipistrellus nathusii*)
STB	NZ short-tailed bat (*Mystacina tuberculata*)

[2] Ian Davidson-Watts, who was involved with testing the lure's effectiveness with New Zealand's bat species.

References

Barclay, R.M.R. (1982). Interindividual use of echolocation calls: Eavesdropping by bats. *Behavioral Ecology and Sociobiology*, **10**, 271–275.

Dechmann, D. K. N., Heucke, S. L., Giuggioli, L., Safi, K., Voigt, C. C., and Wikelski, M. (2009) Experimental evidence for group hunting via eavesdropping in echolocating bats. *Proceedings of the Royal Society B*, **276**, 2721–2728

Freeze, S. R., Shirazi, M., Abaid, N., Ford, M., Silvis, A., and Hakkenberg, D. (2021) Effects of Environmental Clutter on Synthesized Chiropteran Echolocation Signals in an Anechoic Chamber. *Acoustics*, 30200, 391–408.

Hannah, L. (2006) Wind and temperature effects on sound propagation. Unrefereed article. *New Zealand Acoustics*, **20** (2), 22-29.

Hill, D. and Greenaway, F. (2005). Effectiveness of an acoustic lure for surveying bats in British Woodlands. *Mammal Review*, **35**(1), 116–122.

Loeb, S. C. and Britzke, E. R. (2010). Intra- and interspecific responses to Rafinesque’s big-eared bat (*Corynorhinus rafinesquii*) social calls. *Acta Chiropterologica,* **12,**329–336.

Samoray, S. T., Gumbert, M. W., Roby, P. L., Janos, G. A., and Borthwick, R. R. (2019). Effectiveness of Acoustic Lures for Increasing Indiana Bat Captures in Mist-Nets. *Journal of Fish and Wildlife Management*, **10**(1), 206-212.

Surlykke, A, Kalko, E. K. V. (2008) Echolocating Bats Cry Out Loud to Detect Their Prey. *PLoS ONE*, **3**(4) e2036.