Bats: roost occupancy and indices of bat activity—automatic bat detectors

Version 1.0

This specification was prepared by Jane Sedgeley in 2012.

Contents

Inventory and monitoring toolbox: bats

DOCDM-590899

Department of Conservation
Te Papa Atawhai

Synopsis

Both long-tailed bats and lesser short-tailed bats can be surveyed remotely at roost sites by using automated devices to record and store ultrasonic calls bats make as they fly out of their roosts. Bat calls are picked up on bat detectors and are heard on the detector as a series of clicks as a bat flies into and out of range. A series of audible clicks is defined as a 'bat pass'. For more information, see 'Background to bat detectors' in the 'DOC best practice manual of conservation techniques for bats' (docdm-131465)

Several automated detection and recording systems have been developed which use different types of bat detectors and different methods for storing data. Consequently, relative effectiveness and costs vary. Many systems include timers, delay switches or voice-activated tape recorders that allow units to be left unattended in the field and activated only when a bat call is detected. This means that units can be left in the field for several nights. DOC has developed a device that is in common use and is known as an automatic bat monitor or ABM (Fig. 1; see 'ABM instructions'—olddm-759839). However, at least two new kinds of automatic systems are being developed at the time of writing, and the DOC Electronics Workshop should be contacted to find out more about recent developments.

To improve chances of recording the calls of exiting bats, ABMs should be placed as close as possible to a known or suspected roost. DOC uses the Batbox III bat detectors as its standard. These detectors are best tuned to 40 kHz to pick up calls of long-tailed bats, and 28 kHz to pick up calls of lesser short-tailed bats. Units should be in place at least an hour before sunset. A permanent record of part of a night, a whole night or several nights' bat activity can be recorded.

Bat detection and recording devices can be used to determine simple presence or absence of bats at roosts. Additionally, systems which have good storage capability and timing mechanisms can be left in the field for long periods to monitor roost occupancy over time.

Automatic bat detection and recording devices *should not* be used for recording *exact numbers* of bats exiting a roost, nor for monitoring *numbers* of bats over time. The number of bat passes recorded from a bat detector may not correspond with the number of bats exiting a roost. Automatic bat detection and recording devices *only* provide indices of activity and crude estimates of how many bats are using a roost (i.e. none, few, or many).

The 'Introduction to bat monitoring' (docdm-590958) contains summary tables of methods that can be used for making more accurate counts of bats exiting roosts. These include 'Bats: roost occupancy and indices of bat activity—infrared beam counters' (docdm-131260) and 'Bats: exit counts at roosts—simple visual counts' (docdm-590804).

Figure 1. This figure shows one of DOC's automatic bat detection and recording devices (known as an automatic bat monitor or ABM). These units incorporate a voice-activated tape recorder and a timer which enable the unit to be run in the field for several days. The DOC Electronics Workshop should be contacted to find out more about recent developments.

Assumptions

- Bats leave the roost.
- All bats leave the roost, and all bats are detected.
- All bat calls heard on the detector are made from bats leaving the roost and not by bats foraging nearby.
- All exit holes have been accounted for.

Advantages

- This technique can be used for both New Zealand bat species.
- Automatic bat detection and recording units are less expensive than camera and video systems.
- Automatic bat detection and recording units can operate remotely and be timed to record activity over several nights.

Disadvantages

- Calls heard on the detector may be made by bats foraging nearby and not from bats leaving the roost.
- A bat pass may not directly correspond with number of individuals present, for example:
    - The detector picks up a series of calls that are made by a single bat.
    - A series of bats exiting in close succession may not be counted as separate events.
    - Bats circling outside the exit will inflate counts.
- The exit holes for long-tailed bat roosts in trees can be high above the ground and it may be difficult to pick up their calls or distinguish them from bats foraging in the area.

- Extracting and processing bat call data (e.g. listening to cassette tapes, downloading computer files) and interpreting results (e.g. computer sound analysis packages) can be time consuming. Listening to cassette tapes can be particularly problematic if tapes are full of environmental noise such as rainfall.

Suitability for inventory

Automatic bat detection and recording units can be used to determine simple presence or absence at roosts. Systems which have good storage capability and timing mechanisms can be left in the field for long periods to monitor *roost occupancy* over time.

Automatic bat detection and recording devices *should not* be used for recording *exact numbers* of bats exiting a roost, nor for monitoring *numbers* of bats over time. The number of bat passes recorded from a bat detector may not correspond with the number of bats exiting a roost. Automatic bat detection and recording devices *only* provide indices of activity and crude estimates of how many bats are using a roost (i.e. none, few, or many).

Suitability for monitoring

Automatic bat detection and recording units are not suitable for monitoring bat populations at roosts. They could be used to monitor the presence and absence of use of individual roosts, but more informative techniques exist, e.g. ‘Bats: exit counts at roosts—cameras and recorders’ (docdm-590789).

Skills

Unless inventory and monitoring is to be undertaken at known roosts, workers will need skills to locate new roosts in addition to the skills necessary for using the automatic bat detection and recording devices.

Skills required for finding roosts

Workers must be able to:

- Demonstrate a basic level of bushcraft.
- Identify areas of bat activity by using bat detectors to survey for bat calls.
- Distinguish between long-tailed bats and lesser short-tailed bats by their calls.
- Set up harp traps or construct mist net rigs in areas of bat activity. The section ‘Catching bats’ in the ‘DOC best practice manual of conservation techniques for bats’ (docdm-131465) contains information on trap construction and how to place traps to optimise capture rates.
- Handle bats competently and humanely.
- Be able to identify species of bat; age, sex, and measure bats.

- Meet minimum standards—anyone wishing to catch and handle bats must receive appropriate training and must meet the minimum requirements for catching, handling, examining, measuring, and releasing bats described in the 'DOC best practice manual of conservation techniques for bats' (docdm-131465).
- Attach transmitters and use radio-tracking to follow tagged bats and locate their communal roosts (see 'Trapping bats at roosts: estimating survival and productivity'—docdm-590867).

Skills required for setting up automatic bat detection and recording devices at roost sites

- In theory, setting up automatic units in the field should be relatively simple. However, many of the ABMs used by DOC at the time of writing are technologically complex, and are often difficult to set up in the field. Moderate training is required to ensure units are functioning correctly and to undertake regular calibration and maintenance.
- Workers must be able to identify bat calls from other calls picked up on bat detectors, and be able to distinguish between long-tailed bats and lesser short-tailed bats calls. Sound files of example calls are available, see 'Sequence of long-tailed bat calls' (olddm-574297) and 'Sequence of lesser short-tailed bat calls' (olddm-574301). See 'Full details of technique and best practice' for further information.
- Calls recorded and collected from ABM surveys can be sent to more experienced bat workers to obtain assistance with identification. The DOC Bat Recovery Group leader or the DOC conservancy bat contact should be able to provide a list of useful people who can help with identification (see 'Bat Recovery Group contacts'—docdm-132033).
- Workers must be comfortable with working at night in the dark, and at times working alone.

Resources

This inventory and monitoring method may be costly in terms of equipment if multiple units are required to sample effectively. The ABM systems most commonly used in DOC can be purchased or borrowed from the DOC Electronics Workshop, Wellington. The DOC Electronics Workshop has some capacity to develop new automatic bat detection and recording systems and should be contacted to discuss new options.

It is important to allocate adequate time for extracting (e.g. listening to cassette tapes, downloading computer files), processing and interpreting bat call data (e.g. identifying bat species, counting calls and entering them into a spreadsheet and DOC database). This part of the process can be very time consuming. However, new systems that are under development may be able to provide a more automated method for identifying, counting and storing bat calls.

Minimum attributes

Consistent measurement and recording of these attributes is critical for the implementation of the method. Other attributes may be optional depending on your objective. For more information refer to 'Full details of technique and best practice'.

DOC staff must complete a 'Standard inventory and monitoring project plan' (docdm-146272).

Minimum attributes to record:

- Observer name and contact details
- Location (place name)
- GPS coordinates
- Type of roost
- Date
- Which unit was used at each location (ID number)
- Settings used, including:
    - Tape recorder model, sensitivity and voice activation level
    - Bat detector model and bat detector frequency
    - Timer settings (e.g. set to turn on at 19:00 hrs, off at 07:00 hrs)
- Number of nights units are left in place
- Number of bat passes and the times they were heard
- If possible, record dusk, daily maximum, and daily minimum temperatures
- Tally the number of bat passes heard per hour and tally up the totals per night

Minimum attributes can be recorded in the field on standardised recording sheets (see 'Blank field sheet: roost counts'—docdm-131425).

Data storage

Forward copies of completed survey sheets to the survey administrator, or enter data into an appropriate spreadsheet as soon as possible. Collate, consolidate and store survey information securely, also as soon as possible, and preferably immediately on return from the field. The key steps here are data entry, storage and maintenance for later analysis, followed by copying and data backup for security.

Summarise the results in a spreadsheet or equivalent. Arrange data as 'column variables', i.e. arrange data from each field on the data sheet (date, time, location, plot designation, number seen, identity, etc.) in columns, with each row representing the occasion on which a given survey plot was sampled.

If data storage is designed well at the outset, it will make the job of analysis and interpretation much easier. Before storing data, check for missing information and errors, and ensure metadata are recorded.

Storage tools can be either manual or electronic systems (or both, preferably). They will usually be summary sheets, other physical filing systems, or electronic spreadsheets and databases. Use appropriate file formats such as .xls, .txt, .dbf or specific analysis software formats. Copy and/or backup all data, whether electronic, data sheets, metadata or site access descriptions, preferably offline if the primary storage location is part of a networked system. Store the copy at a separate location for security purposes.

All new roosts should be recorded in the DOC bat database. Each DOC conservancy should have a separate Excel spreadsheet for this purpose (Fig. 2). Access rights are held by the conservancy bat contact (see 'Bat Recovery Group contacts'—docdm-132033). If a conservancy has not set up its own spreadsheet, one can be created using the 'National bat database template' (docdm-213136). See the 'Canterbury Conservancy bat database' (docdm-213179) for an example of a spreadsheet containing data.

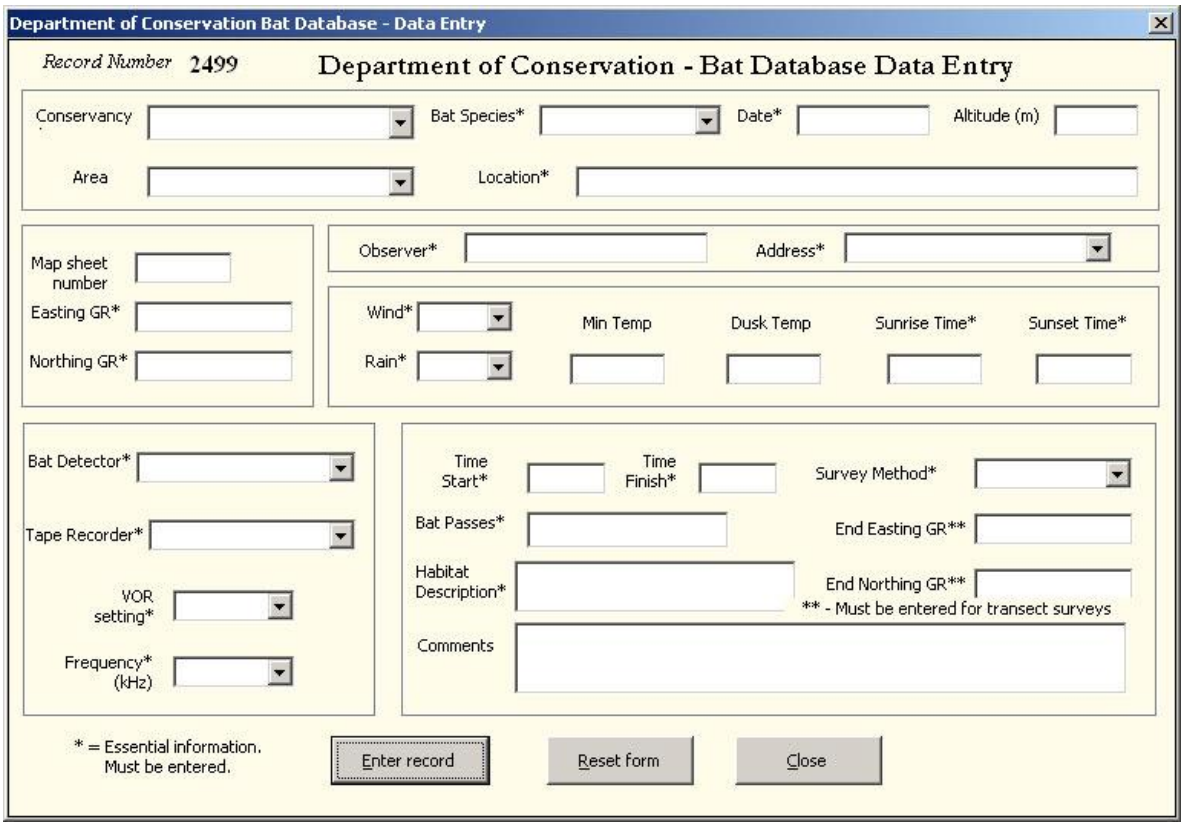

Figure 2. Screenshot illustration of data entry page from the DOC bat database.

Analysis, interpretation and reporting

Seek statistical advice from a biometrician or suitably experienced person prior to undertaking any analysis.

This method measures:

- Simple presence/absence
- Presence/absence over time (roost occupancy)
- Crude estimates of how many bats are using roost (i.e. none, few, or many)

Results are best summarised in a spreadsheet (e.g. Excel). Columns in the spreadsheet should include all data recorded on the field sheet because the influences of factors such as weather conditions, observer, temperature, etc. need to be accounted for in any analysis.

Interpretation is limited. Simple statistics and maps can be reported for a study area, such as:

- Distribution maps of bat roosts
- Duration or frequency of occupancy of roosts
- Dates of occupancy and whether occupied by few or many bats

Case study A

There is no case study available for this method.

Full details of technique and best practice

Types of automatic detection and recording devices

Several automated systems have been developed that use different types of bat detectors and different methods for storing data. Consequently, relative effectiveness and costs vary. Many systems include timers, delay switches or voice-activated tape recorders that allow units to be left unattended in the field and activated only when a bat call is detected. In the past, data was most frequently stored on cassette tape, but some systems incorporate compact flash card recorders. For more information, see ‘Background to bat detectors’ in the ‘DOC best practice manual of conservation techniques for bats’ (docdm-131465).

DOC has developed several automatic systems. One of the earliest systems in use in New Zealand (O’Donnell & Sedgeley 1994) was relatively simple and cheap, but had several drawbacks. The improved system, known as an automatic bat monitor (ABM), is based around a Batbox III heterodyne tuneable detector, a voice-activated tape recorder, an electronic controller (which replaces the mechanical talking clock used in earlier models) and a 12V/7Ah gel battery. The units can be run in the field for several days and the components are housed inside a robust and fully waterproof container (Fig. 1). Unfortunately, the DOC system has several practical limitations: (1) the units are technologically complex; (2) the separate components all require regular maintenance; (3) the units are relatively expensive to buy making it costly to purchase multiple units for good survey coverage; (4) the units are fairly large and heavy, making it difficult to carry several units around in the field; and (5) extracting bat calls, i.e. listening to cassette tapes can be very labour intensive.

At least two new kinds of automatic systems are being developed at the time of writing. The DOC Electronics Workshop should be contacted to find out more about recent models which are likely to be less costly, more lightweight and easier to maintain.

Standardisation, calibration and maintenance

Automatic units will vary in their sensitivity to bat calls. This may be because they use different types of operating systems, or simply because the settings on individual bat detectors or tape recorders are not standardised. It is important to test bat detectors before use, particularly if using old, used equipment, and then calibrate and standardise as closely as possible before use in the field. Ability to detect bat calls can be tested either with an artificial signal generator or if possible against a known bat population.

Sensitivity between Batbox III units can vary (O'Donnell & Sedgeley 1994; Arkins 1999). The most common causes are under-charged batteries, damaged microphones and misaligned frequency dials. The easiest way to check and to calibrate detectors is with the use of a 40 kHz signal generator. If a detector is working adequately, the signal tone should be audible through the detector's speaker at a distance of 40−50 m, provided the detector is pointed directly at the signal generator. The generator can also be used as a guide to re-align the frequency dial to the correct setting (O'Donnell & Sedgeley 1994). The DOC Electronics Workshop should be contacted for advice.

It is recommended that all equipment is regularly serviced, recalibrated and repaired.

Bat passes and examples of calls

Bat calls are heard on the detector as a series of clicks as a bat flies into range. A series of audible clicks is defined as a 'bat pass'. Passes are defined as a sequence of two or more echolocation clicks, and a period of silence separating one bat pass from the next. The following audio files contain examples of calls of long-tailed bats and lesser short-tailed bats obtained using Batbox III detectors:

- 'Sequence of long-tailed bat calls' (olddm-574297)
- 'Sequence of lesser short-tailed bat calls' (olddm-574301)

The calls were recorded onto audio cassette tapes and converted to Windows Media Player files. Please note, these files are quite large, and the long-tailed bat file in particular will take about a minute to open if using the DOC computer system.

The 'Sequence of long-tailed bat calls' contains a total of six long bat passes. The bat sometimes sounds like it is going away and then flies back towards the microphone. The hissing noise is the sound of the tape recorder switching on and off between events. The 'Sequence of lesser short-tailed bat calls' contains seven bat passes. They are of shorter duration and have a faster pulse repetition rate compared with the long-tailed bat calls. The recordings were made using an automatic system with a bat detector linked to a voice-activated tape recorder.

The dials on bat detectors should be set to 40 kHz to record long-tailed bats and 28 kHz to record lesser short-tailed bats. See 'Background to bat detectors' in the 'DOC best practice manual of conservation techniques for bats' (docdm-131465) for more information on bat calls and distinguishing between sounds on the bat detector.

Best practice for using automatic bat detector and recording devices at roosts

There are no strict guidelines describing sampling effort for surveying and monitoring bats at roost sites using automatic devices to record their calls. Recommendations for the number of sampling nights will vary according to objectives (i.e. presence/absence, monitoring longer-term roost occupancy), and the number of automatic systems available. If the objective is simply to determine presence of bats, and calls are recorded the first night, units may be moved on to a new site. However, because bat activity is strongly influenced by weather conditions, it is frequently necessary to leave the units in place for several nights to ensure the sampling period includes nights of fine weather.

The following list includes practical guidelines for increasing chances of recording bats at roosts if they are present.

Practical best practice for using automatic bat detector devices at roost sites

- Equipment must be tested before use in the field and users must be familiar with operating systems (setting timers, recording modes, etc.) and attachment systems before use in the field.
- General disturbance must be minimised at roost sites, i.e. keep noise levels to a minimum.
- Units can be placed on the ground but must be located as close to exit holes as possible with the microphones pointing towards the exit hole.
- Always use blank cassette tapes for each new session (new tapes or cleaned tapes).
- Heterodyne bat detectors (e.g. Batbox III detectors which are most commonly used by DOC) need to be tuned to 40 kHz to pick up calls of long-tailed bats and 28 kHz to pick up lesser short-tailed bats.
- To record exiting bats, recording must begin at least 30 minutes before sunset for long-tailed bats, and at sunset for lesser short-tailed bats.
- Environmental variables including temperature and weather conditions must be recorded in order to interpret results.
- Allocate sufficient time for reviewing tapes, charging batteries and on-going repairs.
- All equipment should be serviced and repaired at the end of the season.

References and further reading

Arkins, A.M. 1999: Tararua Forest Park bat survey, 1998/1999. Report to the Department of Conservation, Masterton (unpublished).

Greaves, G. 2004: Modelling the distribution of New Zealand bats as a function of habitat selection. MSc thesis, University of Otago, Dunedin.

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O'Donnell, C.F.J.; Christie, J.E.; Simpson, W. 2006: Habitat use and nocturnal activity of lesser short-tailed bats (*Mystacina tuberculata*) in comparison with long-tailed bats (*Chalinolobus tuberculatus*) in temperate rainforest. *New Zealand Journal of Zoology 33*: 113–124.

O'Donnell, C.; Sedgeley, J. 1994: An automatic monitoring system for recording bat activity. *Department of Conservation Technical Series No.5*. Department of Conservation, Wellington.

Parsons, S.; Orbist, M.K. 2004: Recent methodological advances in the study of chiropteran sonar signal in the field. In Thomas, J.A.; Moss, C.F.; Vater, M. (Eds): *Echolocation in Bats and Dolphins*. University of Chicago Press, Chicago.

Appendix A

The following Department of Conservation documents are referred to in this method:

olddm-759839	ABM instructions
docdm-132033	Bat Recovery Group contacts
docdm-590789	Bats: exit counts at roosts—cameras and recorders
docdm-590804	Bats: exit counts at roosts—simple visual counts
docdm-131260	Bats: roost occupancy and indices of bat activity—infrared beam counters
docdm-131425	Blank field sheet: roost counts
docdm-213179	Canterbury Conservancy bat database
docdm-131465	DOC best practice manual of conservation techniques for bats
docdm-590958	Introduction to bat monitoring
docdm-213136	National bat database template
olddm-574301	Sequence of lesser short-tailed bat calls
olddm-574297	Sequence of long-tailed bat calls
docdm-146272	Standard inventory and monitoring project plan