Surveying for bats – guidance for community groups

Bat Recovery Group
Version 1, September 2025

Introduction

New Zealand is home to three endemic bat species: the long-tailed bat, the lesser short-tailed bat, which has three sub-populations, and the greater short-tailed bat. The long-tailed bat belongs to the Vespertilionidae family, and the lesser and greater short-tailed bats are part of the Mystacinidae family. The greater short-tailed bat may be extinct, with no confirmed sightings since 1967.

Risks to the continued viability of bat populations have been identified, with declines resulting from a combination of threats, particularly predation and competition, habitat degradation, and disturbance. Rats, cats, possums and stoats are all predators of bats (Daniel & Williams 1984, O'Donnell 2000a, O'Donnell et al. 2011, Scrimgeour et al. 2012, O'Donnell & Borkin 2021, Parsons & Toth 2021, Borkin et al. 2022). In urban and rural areas bats also face impacts from development, such as roading, housing and industrial development, and rural land use changes. This can result in direct effects, such as death and injury during tree-felling, and indirect effects such as bats having fewer (and poor quality) roosts, habitat fragmentation and less habitat from which to find valuable resources (Borkin & Parsons 2014, Borkin et al. 2019, Jones et al. 2019, Sedgeley & O'Donnell 2004). As a result, under the New Zealand Threat Classification System, they are classified as follows:

Taxon	**Scientific name**	**Conservation status**
long-tailed bat	*Chalinolobus tuberculatus*	nationally critical
greater short-tailed bat	*Mystacina robusta*	data deficient
northern lesser short-tailed bat	*Mystacina tuberculata aupourica*	nationally vulnerable
central lesser short-tailed bat	*Mystacina t. rhyacobia*	declining
southern lesser short-tailed bat	*Mystacina t. tuberculata*	recovering

Long-tailed bats are widely distributed from the north of the North Island, through the South Island, to Halfmoon Bay on Stewart Island, but there are now significant gaps in this distribution, especially in the South Island. Historical anecdotes, and monitoring since 1990, indicate that long-tailed bats are now rare or absent at many sites where formerly they were common. The results from the few places where intensive monitoring has occurred, indicate that the species is in decline. Lesser short-tailed bats were also once widespread. Surveys show populations survive in several areas in the North Island, while in the South Island they are now only known from Fiordland and Whenua Hou (Codfish Island off Stewart Island).

Department of Conservation
Te Papa Atawhai

New Zealand Government

Why are bat surveys important?

Without knowing where bats are we cannot protect them from the threats they face, and there are still large gaps in knowledge of bat distribution. For example, a population of lesser short-tailed bats were recently (2022) found in the Remutaka Range in the lower North Island. While long-tailed bats are widely distributed in parts of the North Island, a lot of the finer detail on bat presence is unknown. This lack of detail means surveys to look for presence and distribution of bats are important.

As well as greater understanding of bats' distribution, bat surveys, particularly those undertaken by community groups, have been a useful tool for advocacy and education which can lead to greater protection for bats.

Purpose of this document

This guidance document focuses on surveying for bats. In this document 'bat survey' means looking for the presence of bats over a certain area. It is different from monitoring, which involves repeated sampling to quantify changes over time. This document has been developed for use by tangata whenua, councils/local government, community groups, individuals or Department of Conservation (DOC) staff wanting to find out where bats are present and to determine their general distribution over a specified area of interest. The design of each survey will depend on survey aims, habitat and resources available; therefore, these guidelines are a starting point for survey design rather than set procedures to follow. These guidelines should not be used to develop monitoring programmes.

For information on bat monitoring see bat monitoring guidelines on DOC's web page 'Resources for bat workers'. For information on roost finding - usually done by catching bats, attaching radio transmitters and tracking bats to their roost - see Best practice manual of conservation techniques for pekapeka/bats in Aotearoa New Zealand.

The National Bat Distribution database

DOC maintains a database of all present and historic bat data that DOC holds, including surveys done by Regional Councils, contractors and private individuals. This includes casual sightings, incidental capture such as domestic cat kills, and survey data. A link to a map of the records in the database is on DOC's web page 'Resources for bat workers'.

The database is gradually building an inventory of bat distribution and distributional changes over time. It can potentially be used to identify gaps in knowledge and identify sites which may be important for management. It is also often a first port of call for people wanting to know whether there are bats in their area of interest. The more survey data that is contributed, the more useful the database will be. Therefore, you are encouraged to send all reports of bats to the national bat database batdatabase@doc.govt.nz using the bat database spreadsheet. Permission should be sought from landowners before sharing survey results from private land.

The following should be considered when looking at the mapped database:

- The records are not validated by DOC.
- Areas on the distribution map with no records mean that either no bat surveys have been done in the area, or records have not been submitted to the database. They do not mean that bats are not present.
- A negative bat result does not necessarily mean there are no bats. Surveys must be assessed for adequacy to confirm absence.

For any enquiries email batdatabase@doc.govt.nz[1].

Looking for bats using handheld detectors on line transects

Handheld heterodyne bat detectors can be used to detect bats in real time. They convert the high-frequency sounds bats make into frequencies that humans can hear. Their simple technology reduces the risk of equipment failure compared to automated systems. For more information on different types of detectors, see chapter 4 of the Best Practice Manual of Conservation Techniques for pekapeka/bats in Aotearoa New Zealand.

When to use handheld bat detectors

Transect counts using these detectors are excellent for rapid inventories, one-off surveys and distribution studies of long-tailed bats. The method allows for sampling large areas and diverse habitats over one or a few nights. Transect techniques can be cost-effective because they require minimal equipment and can be conducted by volunteers. However, they can be labour-intensive, especially if the survey area is large.

Transect counts are much less suitable for lesser short-tailed bats because they largely forage within the forest interior where it is hard to survey at night, and they have very quiet calls meaning a much greater effort is required to detect them.

What to do

Set the detector on 40 kHz to pick up calls of long-tailed bats or 28 kHz to pick up lesser short-tailed bats. The transect count technique has been described in detail in O'Donnell & Sedgeley (2001), so is not discussed further here.

[1] Note that this email address is only checked once every two weeks

All reports of bats are encouraged to be sent to the national bat database batdatabase@doc.govt.nz using the bat database spreadsheet. For any enquiries email batdatabase@doc.govt.nz.

Survey design – Automated bat monitoring unit (ABM)

Looking for bats using ABMs

Automated bat monitoring units are devices that record ultrasonic bat calls and store them on a local drive, such as an SD card. When retrieved, the calls can be downloaded and classified as either long-tailed bats or lesser short-tailed bats. They detect both species of bats found in New Zealand.

ABMs can:

- Record the ultrasound that bats use to navigate, feed and socialise.
- Take a 'snapshot' of bat activity in one place over several nights.
- Detect bat calls out to 30-50m from the detector for long-tailed bats, and a shorter distance for lesser short-tailed bats.

ABMs can't:

- Decide whether what is detected and recorded is or isn't a bat call. This needs to be interpreted.
- Tell you how many bats are in the area.
- Tell you where bat roosts are or aren't.

When interpreted, surveys using ABMs tell you information about the immediate area around your detector for the time it was recording.

When to use ABMs

ABMs can be left out in the field to collect data remotely so are a lot less labour-intensive than using handheld detectors on transects. Data can be used to answer questions such as: Are there bats present in an area? What is their distribution in an area? Which species are present?

Bat detection and 'activity' (the rate at which bat calls are detected) depends on weather conditions (temperature, humidity, rainfall, wind), time of day, invertebrate activity and stage of the breeding cycle. Increasing the likelihood of bat detection also depends on placing recorders where they are most likely to detect bats. This requires understanding of how bats use their habitat and how their activity is influenced by factors such as proximity to artificial light, roads and noise.

Designing a survey to look for bat presence and distribution must consider that bat activity varies widely over both space and time. The following sections provide a guide for surveying to look for presence and distribution of long-tailed and lesser short-tailed bats; however, they are not a substitute for experience.

See also: Counting away from roost sites: automatic bat detectors in the DOC Inventory and Monitoring Toolbox.

When is the best time of year to do bat surveys?

To look at the presence and distribution of bats in an area, surveys can be conducted at any time of the year. However, since bat activity is influenced by temperature, with more bat activity when it is warmer, this should be considered when planning your survey. During colder months, recorders should be put out for longer periods than in warmer months.

If it is important to have high confidence in the presence or potential absence of bats, survey several times throughout the time of year when bats are most often detected (October to March).

Explanation

Research from Kinleith Forest in the central North Island indicates that the temperature 1-4 hours after sunset is an important predictor of long-tailed bat activity. Surveys were most effective at detecting bats on nights when the temperature at sunset was above 8ºC, and preferably when the temperature stayed in the 8-17ºC range during the night. The authors caution about extrapolating this to other regions (Borkin et al. 2023).

Results from Eglinton Valley in Fiordland also show higher activity rates at warmer temperatures (Fig. 1).

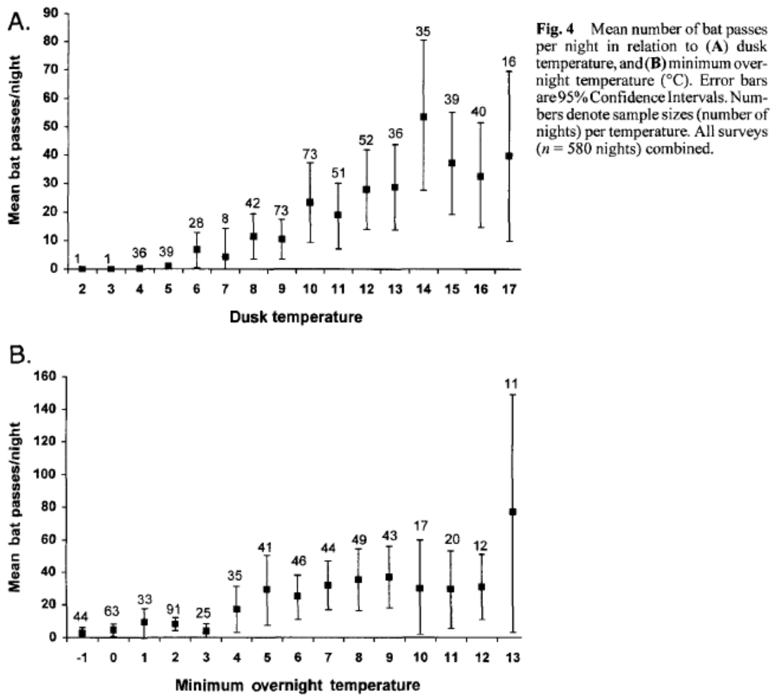

Figure 1. Long-tailed bat activity in relation to temperature in Eglinton Valley, Fiordland. From O'Donnell (2010)

Lesser short-tailed bat activity in winter is lower than in summer, with little or no activity on some winter nights interspersed with nights of high activity associated with warmer nights. Activity was recorded at temperatures as low as -1.6°C in Eglinton but not below 9°C in Northland (Christie & Simpson 2006).

The detection of bats is likely to be affected by breeding stages. Long-tailed bats have smaller home ranges (the area they regularly use) during pregnancy and early lactation, with ranges expanding in later lactation, with juvenile exploration and the mating period (O'Donnell 2001). This is likely to be the same with lesser short-tailed bats.

The area bats use may change throughout the year. This means that if you only survey at one time of year, you may miss bats using the site during other times. For example, in a large-scale survey in Southland, long-tailed bats were not detected at all during November but were present in February and March (Davidson-Watts Ecology (Pacific) Ltd, unpublished data).

ABMs - How long to leave recorders in one location?

There are no strict guidelines for the sampling effort required to survey bats; however, as a general guide, for bat surveys during warmer months (October – March), put ABMs out at the same location for two weeks. During colder months, put ABMs out for four weeks. If the goal is simply to determine the presence of bats and calls are recorded on the first night, the units can be moved to a new site.

Explanation

In addition to temperature, other weather variables including rain, wind, and humidity can also affect bat activity. A study in Southland showed that long-tailed bat activity decreased with rain and greater wind speeds had a strong negative relationship with bat activity (Kessels & Davidson-Watts 2024). A study in the central North Island found that when surveys were done at high humidity and a light breeze there was a slightly higher chance of detecting long-tailed bats (Borkin et al 2023).

Because long-tailed bat activity is strongly influenced by weather conditions it is often necessary to leave the units in place for longer than required to ensure the sampling period includes sufficient nights of fine weather.

Lesser short-tailed bat activity is less affected by rain, and because they live within the forest, is less impacted by wind. A study in Eglinton indicated the probability of lesser short-tailed bats being active in winter increased with overnight mean temperature, and if it was raining (Christie & Simpson 2006).

Wind and rain can also affect the detectability of recorded bat calls because they result in sounds of the same frequencies as bat calls. These sounds are picked up by ABMs, potentially obscuring bat calls. Weather also affects invertebrate activity levels, which in turn influences bat activity or can obscure recorded bat calls, so weather likely has both direct and indirect effects on bat activity (O'Donnell 2000b). Even under what we perceive as ideal weather conditions, variation in bat call counts can be high.

The relationship between bat activity and moon phase is uncertain, and likely interactive with other influences on bat activity. One study of long-tailed bats found no relationship between roost departure times and moon phase, and bats were more active on nights with a three quarter to full moon (Griffiths 2007). Another found that more moonlight was associated with less bat activity (Page-Corney 2024).

Experience over time with surveying in your particular area of the country and climatic zone will help with decisions on the number of sampling nights required at different times of the year. Number of nights will also depend on the number of available ABMs, resources (e.g., people), terrain, habitat type, and the area needing coverage.

What time of night should we survey?

The first four hours after sunset are the most important because this is when bats are most likely to be active and able to be detected. However, to increase the chance of detection, it is best to have detectors running throughout the night since bats are active all night. For long-tailed bats this is between 1 hour before sunset to 1 hour after sunrise. For lesser short-tailed bats this is sunset to sunrise.

<u>Explanation</u>

In the central North Island, long-tailed bat activity peaked 120 – 180 minutes after sunset with most detections in the first four hours (Borkin et al. 2023). Over spring, summer and autumn in Fiordland's Eglinton Valley long-tailed bat activity peaked in the first two hours after sunset, whilst in winter there was little activity during the first three hours after sunset or in the 5 hours before dawn (O'Donnell 2000).

Lesser short-tailed bats emerge from their roosts later and return earlier than long-tailed bats. A study in Eglinton found that individuals generally left communal roosts within 20-80 minutes of sunset during the summer months and were active throughout the night (Christie 2006). They are usually back in the communal roost within 30 minutes of civil twilight – that time of night when it starts to become light towards dawn.

It is recommended to set detectors to record all night, because costs do not increase substantially, other than potentially the time needed for analysis or if additional visits are needed to replace batteries or download data. Setting up detectors to record all night may be particularly important if populations are small, or the survey area is used infrequently (Borkin et al. 2023).

Where should recorders be placed?

The following are a guide for increasing the likelihood of detection and are not an indication of how bats use the landscape or how important each part of the landscape is to them.

Long-tailed bats use a wide range of habitats, and placement of recorders will depend on the purpose of the bat survey. If the purpose is to find out whether bats are present in the general area, then place detectors in edge habitats. If the purpose is to answer questions about which habitats are being used by bats, then place recorders in all habitats of interest, which may include open grassland away from trees.

Lesser short-tailed bats use forest interior more than open habitats. To maximise detection, focus effort within old age native forest >200 metres from the edge of the forest.

Place recorders about 1.5 to 2 metres off the ground, away from clutter, and be mindful of other noise sources which might limit detectability of bats, e.g., electric fences, noisy waterways. Consider the visibility of the recorders in areas where they might be stolen.

<u>Explanation</u>

Long-tailed bats and lesser short-tailed bats have different foraging strategies and consequently use habitat types in different ways.

Surveys to look for bat presence usually focus on places that contain areas thought to be suitable for foraging or places where there are anecdotal reports of bats. Placing detectors in areas where bats are more likely to be detected can focus survey effort.

Long-tailed bats use forest edge habitats more frequently than they do forest interior or open grassland. If you want to maximise your chances of detecting long-tailed bats, good places to put recorders are bush-grassland edges, along shelterbelts/hedges, on tracks or roads through bush, in bush clearings, along river valleys and by quiet streams and pools. The vegetation can be native or non-native, regenerating or mature.

Lesser short-tailed bats use forest interior more often than open habitats. Most detections of lesser short-tailed bats are in old age native forest >200 metres from the forest edge (O'Donnell et al. 2006); however, they can still be detected at forest edges and can cross open spaces (Bennett 2019). Forest terraces and saddles between catchments can be good locations. Place recorders where there are potential flyways, i.e., in areas with open understory.

For both species:

- Place recorders away from clutter, e.g., by hanging from a branch or on a pole, ensuring there are no obstructions within 2 metres. Clutter will absorb sound and so decrease the detection range.
- Be careful if attaching recorders to a post or tree, as these can act as a barrier to bat calls and limit the area from which calls can be detected.
- Place recorders away from other noise sources that emit frequencies like bat calls, making identifying bat calls more difficult, e.g., noisy streams, and potential

signal interferences, such as electric fences and cars. There is also some evidence that bats might avoid noisy waterways possibly due to the ultrasound that they produce (Frenckell and Barclay 1987).

- Also, consider the visibility of the recorders in areas where they might be stolen.

Placement (design of landscape scale surveys).

When designing placement of recorders over a landscape to find out whether bats are present, and their general distribution, consider:

- **The scale of the survey. Small areas can be surveyed more intensively, with more recorders per area, than larger areas.**
- **The number of recorders available compared to the size of the survey area. If the survey area is large, then recorders can be moved from place to place throughout the survey.**
- **The detection range of the recorders. Most current bat recorders can detect long-tailed bats from 30 to 50 metres away. However, lesser short-tailed bat calls are produced at a relatively low intensity and attenuate quickly, making them harder to detect compared to long-tailed bat calls. Detection distances may also be reduced within the forest interior due to clutter. Therefore, more recorders will be needed to cover the same area when looking for lesser short-tailed bats.**
- **Accessibility. Look for places which are easily accessible, e.g., along tracks, to make survey effort more efficient.**

<u>A hypothetical example</u>

Jane is a member of a community trapping group who'd like to find out if long-tailed bats are using the 50ha area she is trapping in. She only has five ABMs so she decides to put them out in areas where she thinks she is most likely to detect long-tailed bats: the edge of the farmers' bush block, the slow-flowing stream, and a calm pond further along the stream in her trapping area. Jane knows that she will only be able to tell whether bats are using those areas, and in the area 30-50m around those places, when she has the detectors out recording, and that she won't be able to tell how many bats there are or where roosts are, but that's okay with her.

She knows that if she wants to be able to compare activity rates over time that she'd need a more detailed monitoring programme, but that's not what the group wants to know right now.

They'll try and figure out where roosts are using a different method.

An example from Northland

Both short-tailed and long-tailed bats are known to be in the vicinity of Puketi-Omahuta Forest. The question for this survey was: what is the distribution of the two species in the c. 30,000 ha forest.

Twenty-four ABMs and nine (not necessarily consecutive) days were available for their deployment and collection. The time available did not allow survey of the whole forest so:

- A small area which had been surveyed the previous year was not repeated.
- ABMs were placed where there were historic records of short-tailed bats to confirm that they were still present in the area.
- ABMs were placed along tracks for ease of access, with approximately one recorder each kilometre of track.

Specific ABM placement avoided noisy streams and cluttered areas. Recorders took three days to deploy and were collected 9 to 10 days later. This was then repeated in another area of the forest, with ABMs deployed over two days and collected after 7 days.

The results showed that long-tailed bats were widely distributed through the forest, while short-tailed bats were probably more localised, or at a lower density which meant they were often not detected.

An area of higher short-tailed bat activity was found. This was used for a subsequent survey which aimed to look for roosts. During this survey ABMs were placed along suspected flyways within the area of high activity to identify places which were both suitable for placing mist nets and had high activity levels. Bats were then caught and transmitters attached to track the bats to their roosts.

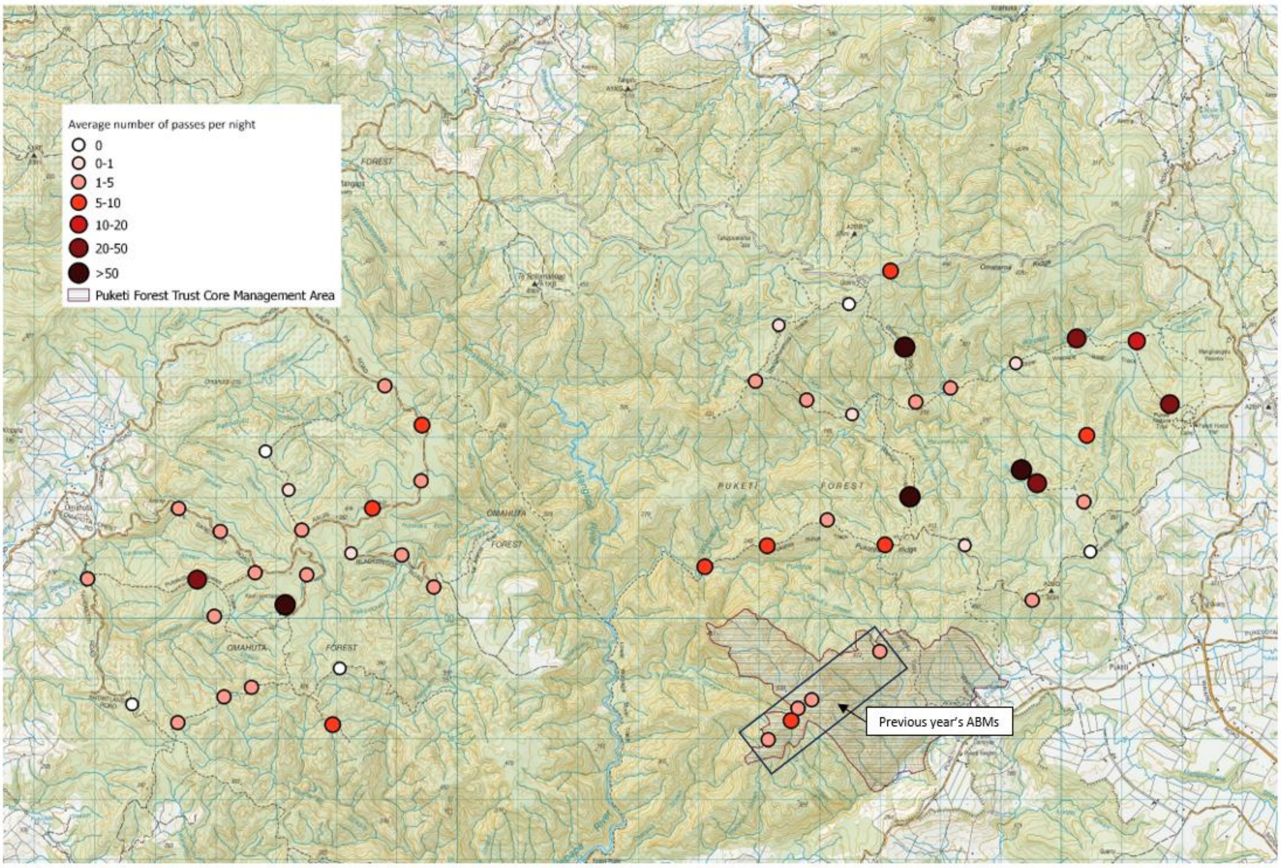

Figure 2. Long-tailed bat results of a survey in Puketi-Omahuta forest

Inferring roosting, abundance and absence from bat surveys

Information from ABMs can be a starting point for locating roosting areas, but detection of bats shortly after dusk does not necessarily mean that they are roosting nearby. Long-tailed bats can fly up to 60 km/hr, and short-tailed bats up to 44 km/hr (O'Donnell 2001, Christie 2006), so can be far away from roosts in a short time. Furthermore, many detections around dusk or dawn do not indicate a roost – this could be one or a few bats passing the recorder multiple times as they feed.

Acoustic surveys cannot estimate abundance. This is because:

- We don't understand the relationship between the number of bat passes and the number of bats in a population.
- Environmental conditions have a huge effect on activity levels.
- If bats are uncommon or patchily distributed, results can be very variable.
- Bat recorders only detect bats from 30-50m away.

It is difficult to infer absence of bats from surveys because activity is so variable, particularly when there are few bats. Bat recorders only detect bats from 30-50m away, so there will inevitably be large areas which are not surveyed.

Equipment – Automatic bat monitoring units

Different bat detector types use different systems for transforming bat calls and vary markedly in price, sensitivity to bat calls, frequency range that they can effectively record, quality of the calls collected, longevity of recording (i.e., battery life), the methods of storing, and post sampling visualising and analysing calls. This means you need to choose the right type of bat detector for the job at hand. For background information on the types of bat detectors and their relative advantages and disadvantages, as well as an overview of ABMs and recording systems, refer to chapter 4 of the Best Practice Manual of Conservation Techniques for pekapeka/bats in Aotearoa New Zealand.

Commonly used recorders

The AR4 acoustic recorder was developed by the Department of Conservation's electronics team to provide New Zealand conservation practitioners with a quality acoustic recorder at low cost. It was designed to be a light weight, weatherproof, small and easy to use device. The recorder uses AA batteries and SD cards.

For information on AR4s, user instructions, bat call reference library, maintenance tips, testing recorders, firmware updates and repairs go to the DOC electronics page www.doc.govt.nz\electronics. This page also has links to the "Bat Call Identification Manual" and its supplement "Is that a bat?". AR4 recorders are no longer available for purchase from DOC. They have been superseded by the AR5 model, essentially the same as the AR4, available from Alato (AR5 Acoustic Recorder).

Processing data and classifying recordings from AR4 and AR5 recorders is through the 'BatSearch' software, available from www.doc.govt.nz\electronics. This allows the user to look at an image of each spectrogram recorded which is then classified as one of the two bat species or 'non-bat'. AviaNZ has developed free, open-source software that can be used to automatically classify bat call data from AR4 and AR5 recorders. This software may fail to identify bat calls or mistakenly identify noise files as bat calls, so some manual assessment is still required. Despite these limitations, AviaNZ can still effectively be used to reduce time spent on post survey analysis.

Other relatively low-cost acoustic recorders from overseas are available from Titley and Wildlife Acoustics. Recording length and trigger frequency (to initiate recording) can be adjusted to reduce power consumption. Sensitivity settings can also be adjusted on some models. Read the user manuals and watch manufacturers training videos where available.

For these recorders there are a range of bat call classifiers which search for bat calls automatically in recordings. These classifiers only work with full spectrum WAV files and have the same limitations as AviaNZ software regarding accuracy of classifying bat calls. At present, identification packages available do not include New Zealand bat species, though some species can be used as an effective substitute. These packages get updated and improved regularly and it is likely that New Zealand bats will be added to these packages in future.

It is important to be aware that different ABM models—and even the same model with different settings—will yield different results. Therefore, keeping a note of the ABM model and the settings used for your survey is essential if comparison with other surveys is to be made.

What to do

Given the wide range of acoustic recorders available, projects should review different models of acoustic recorders to select one that suits the project and budget, noting that detection range is one of the key considerations.

Test recorders before each survey. This can be done by deploying the recorder at a site where bat activity is known to be regular, or by using the DOC – Bat Recorder Tester (Tussock Innovation Ltd) phone app available from the Google Play Store.

Care for and maintenance of recorders and batteries is essential for best performance.

Data keeping system

A lot of good organisation and systems are required to ensure recorders are retrieved, data stays associated with the correct recorder and the correct location, and data is stored in a way that can be retrieved and interpreted later.

The Department of Conservation keeps a National Bat Distribution Database to record the distribution of bats and changes over time. Data can be submitted to batdatabase@doc.govt.nz using the spreadsheet available from the DOC website: Resources for bat workers.

Resources and references

It is anticipated that the most common survey type will be to look for presence of long-tailed bats using acoustic recorders. Recommended key reading for this type of survey is highlighted below. If AR4 or AR5 recorders are used, the DOC Electronics web page is an important source of information.

I&M toolbox – counting bats away from roosts – acoustic recorders

Inventory and Monitoring Toolbox - Casual reports of bats.

Bennett RS 2019. Understanding movement and habitat selection of the lesser short-tailed bat to infer potential encounters with nearby anticoagulant bait. MSc thesis, Massey University.

Borkin KM, Parsons S 2014. Effects of Clear-Fell Harvest on Bat Home Range. PLoS ONE 9(1): e86163. doi:10.1371/journal.pone.0086163.

Borkin KM, Smith DHV, Shaw WB, McQueen JC 2019. More traffic, less bat activity: the relationship between overnight traffic volumes and *Chalinolobus tuberculatus* activity along New Zealand highways. Acta Chiropterologica 21(2): 321-329.

Borkin KM, Easton L, Bridgman L 2022. Bats attacked by companion and feral cats: evidence from indigenous forest and rural landscapes in New Zealand, New Zealand Journal of Zoology, DOI: 10.1080/03014223.2022.2098782.

Borkin K, Giejsztowt J, McQueen-Watton J, Smith D 2023. Influence of weather on long-tailed bat detection in a North Island exotic forest. New Zealand Journal of Ecology 47(1): 35-46.

Christie JE 2006. Nocturnal activity patterns of the lesser short-tailed bat (*Mystacina tuberculata*) in temperate rainforest, Fiordland, New Zealand. New Zealand Journal of Zoology33 (2): 125-132.

Christie JE, Simpson W 2006. Influence of winter weather conditions on lesser short-tailed bat (*Mystacina tuberculata*) activity in *Nothofagus* forest, Fiordland. New Zealand Journal of Zoology 33(2): 133-140.

Daniel MJ, Williams GR 1984. A survey of the distribution, seasonal activity and roost sites of New Zealand bats. New Zealand Journal of Ecology 7: 9–25.

Frenckell BV, Barclay RM 1987. Bat activity over calm and turbulent water. Canadian Journal of Zoology 65(2): 219-222.

Griffiths R 1996. Aspects of the ecology of a long-tailed bat *Chalinolobus tuberculatus* (Gray, 1843), population in a highly fragmented habitat. MSc thesis, Lincoln University.

Jones C, Borkin K, Smith D 2019. Roads and wildlife: the need for evidence-based decisions; New Zealand bats as a case study. New Zealand Journal of Ecology 43(2): 33-76.

Kessels G, Davidson-Watts I 2024. Addendum Report – Assessment of effects on the pekapeka-tou-roa (long-tailed bat) and its habitat at the proposed southland Wind Farm. Prepared for Contract Energy Limited. 186pp.

O’Donnell CJF 2000a. Conservation status and causes of decline of the threatened New Zealand long-tailed bat *Chalinolobus tuberculatus* (Chiroptera: Vespertilionidae). Mammal Review 30: 89–106.

O'Donnell CFJ 2000b. Influence of season, habitat, temperature, and invertebrate availability on nocturnal activity of the New Zealand long-tailed bat (Chalinolobus tuberculatus). New Zealand Journal of Zoology 27(3): 207-221.

O’Donnell CFJ 2001. Home range and use of space by *Chalinolobus tuberculatus*, a temperate rainforest bat from New Zealand. Journal of Zoology 253(2): 253 – 264.

O’Donnell CFJ, Borkin K 2021. Chalinolobus tuberculatus. In: The handbook of New Zealand mammals. 3rd edn. (Eds CM King and DM Forsyth) Families Verspilionidae and Mystacinidae, pp 95-130. CSIRO Publishing, Melbourne.

O’Donnell CFJ, Christie JE, 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(2): 113-124.

O’Donnell CJF, Edmonds H, Hoare JM 2011. Survival of PIT-tagged lesser short-tailed bats (*Mystacina tuberculata*) through a pest control operation using the toxin pindone in bait stations. New Zealand Journal of Ecology 35: 291–295.

O’Donnell CJF, Sedgeley JA 2001. Guidelines for surveying and monitoring long-tailed bat populations using line transects. DOC Science Internal Series 12. Department of Conservation, Wellington. 20pp.

Page-Corney 2024. Investigating habitat structure and prey availability as predictors of long-tailed bat activity in fragmented landscapes. MSc Thesis, University of Auckland.

Parsons S, Toth C 2021. Mystacina tuberculata. In: The handbook of New Zealand mammals. 3rd edn. (Eds CM King and DM Forsyth) Families Verspilionidae and Mystacinidae, pp 95-130. CSIRO Publishing, Melbourne.

Scrimgeour J, Beath A, Swanney M 2012. Cat predation of short-tailed bats (*Mystacina tuberculata rhyocobia*) in Rangataua Forest, Mount Ruapehu, Central North Island, New Zealand. New Zealand Journal of Zoology 39: 257–260.

Sedgeley JA, O’Donnell CFJ 2004. Roost use by long-tailed bats in South Canterbury: examining predictions of roost-site selection in a highly fragmented landscape. New Zealand Journal of Ecology 28(1): 1-18.