Bats: roost occupancy and indices of bat activity—field sign

Version 1.0

This specification was prepared by Jane Sedgeley in 2012.

Contents

Inventory and monitoring toolbox: bats

DOCDM-590882

Department of Conservation
Te Papa Atawhai

Synopsis

Basic fieldcraft techniques can be used to establish whether a site has been, or is being, used by roosting bats. Bat sign at roosts most commonly takes the form of droppings, staining, scratching or food remains. On rare occasions, there may even be dead bats present (Walsh & Catto 2004; Stebbings et al. 2005). During the breeding season, male lesser short-tailed bats occupy mating or singing roosts and call from them at night to attract females (Daniel 1990; Lloyd 2005).

There are no prescribed techniques for locating roosts using presence of sign, and roost finds are usually rare and serendipitous. Long-tailed bats occasionally use caves and buildings where droppings often accumulate and can persist for many years, giving an insight into historical usage of sites (Daniel & Williams 1981, 1983, 1984) However, long-tailed bats primarily roost in small groups in relatively small cavities high in trees, so there is little obvious sign (Sedgeley & O'Donnell 1999). Lesser short-tailed bats are not currently known to use caves or buildings, although remains have been found in several such sites in the past. Tree roosts occupied by large colonies of lesser short-tailed bats can be quite noisy and smelly. If a roost has a large entrance that is relatively close to the ground, piles of faeces (droppings) may accumulate at the base of the tree. Singing roosts often have small entrances that are stained or polished smooth around the edges and a distinctive musty odour (Daniel 1990; Lloyd 2005; O'Donnell et al. 1999). Unfortunately, the chances of finding roost trees or singing trees in areas of forest where there have been no previous reports to focus searches are fairly remote.

Areas of staining on the ceilings of caves and accumulation of droppings on cave floors can be used to determine where bats are roosting. Overseas studies have related packing density (number of bats/m^2) to surface area of stains to estimate historic population size. Surface area of droppings on the ground and mass of droppings have also been used to estimate population size (Thomas & LaVal 1988; Kunz 2003; McCraken 2003). It is unlikely these techniques are relevant for counting relatively small clusters of long-tailed bats (< 100) that are currently the only species known to be using caves in New Zealand.

Presence of sign at bat roosts can be used to answer basic inventory questions: Are bats present or have they been present historically in an area? The quantity of droppings present may give a crude estimate of how many bats are using a site (many or few bats). Systematic survey of caves may build up a picture of the distribution of bats in an area or an inventory of roost sites in an area. Repeat visits may be necessary to determine if sites are used by bats because droppings may have been washed away by heavy rain or flooding. Presence of sign can also be used to monitor site occupancy over time. Other methods should be used to confirm the presence of bats such as 'Bats: counting away from roosts—automatic bat detectors' (docdm-590733) and 'Bats: trapping away from roosts—inventory and species identification' (docdm-590776). Occasionally, roost sites will be detected at night by observers picking up the high-pitched squeaking or 'singing' of male lesser short-tailed bats.

Assumptions

- All sign is made by bats.

Advantages

- Sign may persist.
- The method does not require highly skilled staff.
- The method does not require expensive equipment or high costs.

Disadvantages

- This method is not suitable for locating long-tailed bat tree roosts because long-tailed bats leave very little obvious sign of their presence at tree roosts.
- This method is unlikely to be suitable for locating lesser short-tailed bat tree roosts in areas that are not known to contain bats. It would literally be like searching for a needle in a haystack.
- In a sheltered environment, sign may persist for a very long time, and it may be difficult to judge how old the sign is. Bats may no longer be using an area even though sign remains. Repeat visits to a site might resolve this uncertainty.
- Sign is sometimes washed away by rain or flooding.
- Some people are not able to hear the high-pitched ‘singing’ of male lesser short-tailed bats.
- It is very difficult to distinguish between the droppings of long-tailed bats and lesser short-tailed bats.
- There is potential for disturbance to bats when assessing caves, buildings and mines.

Suitability for inventory

Presence of sign at bat roosts can be used to answer basic inventory questions: Are bats present, or have they been present historically in an area? The quantity of droppings present may give a crude estimate of how many bats are using a site (many or few bats). Systematic survey of caves may build up information on the distribution of bat cave roosts in an area. Repeat visits may be necessary to determine if sites are used by bats because droppings may have been washed away by heavy rain or flooding.

Suitability for monitoring

Presence of sign can also be used to monitor site occupancy over time. However, after the discovery of a site used by bats, it is likely that other methods would be used to monitor bat numbers (see ‘Introduction to bat monitoring’—docdm-590958).

Skills

Good observational skills are necessary. Observers need the ability to distinguish between sign left by bats from that of other animals (e.g. mouse and weta droppings). Observers need to be able to hear and correctly identify the high-pitched singing of lesser short-tailed bats. Two short videos of a lesser short-tailed bat singing from a beech tree in the Eglinton Valley, Fiordland, are available to view:

- ‘Short-tailed bat call 1’ (olddm-574399)
- ‘Short-tailed bat call 2’ (olddm-574400)

Resources

A torch and an angled mirror are useful for examining cracks, crevices and tree hollows. A ladder or climbing equipment may also be useful at some sites. More sophisticated equipment such as a small infrared sensitive camera and an endoscope can also be used. Taking photographs is always worthwhile, especially if there is uncertainty about particular sign. Small containers or plastic bags and a labelling pen are useful for collecting samples that might subsequently be sent to someone for identification.

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’s name and contact details.
- Name of location.
- GPS coordinates.
- Whether the site has been surveyed before, and whether there are any previous bat records.
- Basic description (tree species, cave name/type, building, etc.).
- Whether any sign is present and what type of sign (droppings, staining, dead bats, etc.).
- Prevalence or quantity of sign.
- If sign is present in a cave or a building, it is useful to map the exact location of the bat sign within the site. Photographs are useful here.
- Collect a sample of droppings and dead bats, etc. for positive identification.

Additional information such as roost measurements (e.g. stem diameter of tree, cave dimensions) could also be useful, particularly for advocating for the protection of roost sites, identifying potential roost sites and for studies of roost preferences.

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.

Survey results are best summarised in a spreadsheet (e.g. Microsoft Excel). Columns in the spreadsheet should include all data recorded on the original field sheet because the influences of factors such as location, observer, weather, etc. need to be accounted for in future analyses. At present, there are no standardised spreadsheets or databases maintained by DOC specifically for storing roost or singing tree survey data.

However, sightings and information on sign could be recorded in the DOC bat database (Fig. 1). Each DOC conservancy should have a separate Excel spreadsheet for this purpose. 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. Many of the data entry fields will not be relevant, but there are fields for location, GPS coordinates, and comments that could be used to describe survey results.

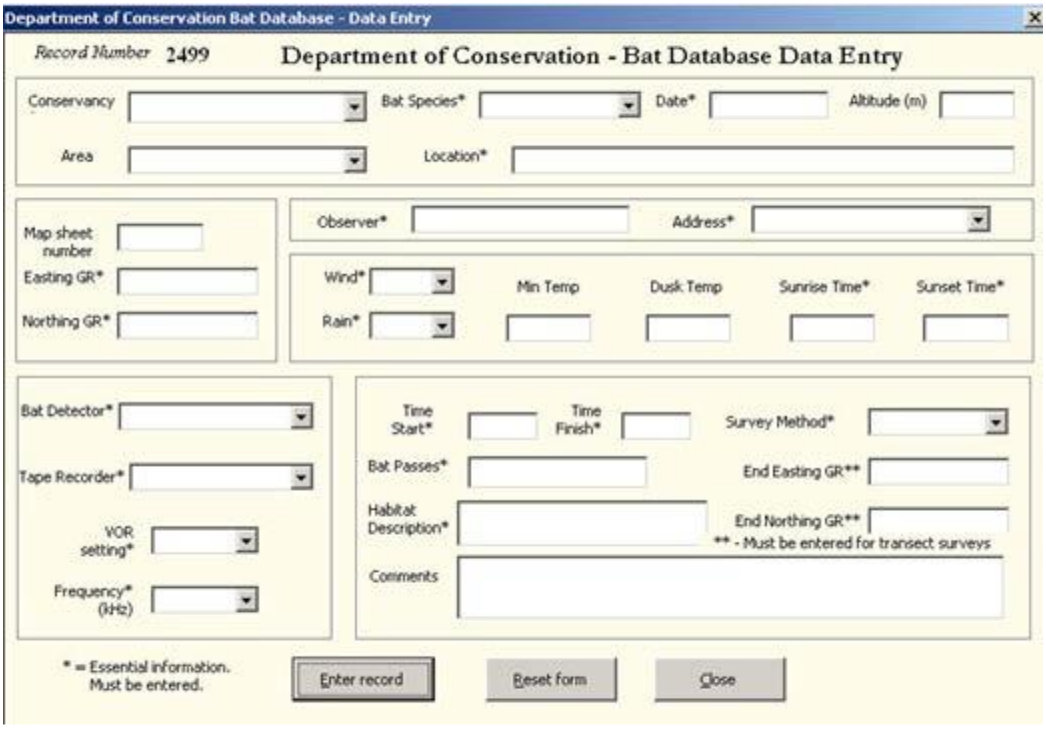

Figure 1. Data entry page from the DOC bat database.

Analysis, interpretation and reporting

Standardised analysis and interpretation allows comparisons to be made at different sites and at different times. Follow these instructions when analysing and interpreting data:

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

This method measures:

- Presence of sign
- Historic presence of bats
- Site occupancy over time
- Crude estimates of colony size

Interpretation based on field sign is limited. Identification of bat sign in an area confirms presence or historical presence, but not absence.

Simple statistics and maps can be reported for a study area, such as:

- Distribution maps of bat roosts based on presence of sign
- Distribution of singing trees
- Duration or frequency of occupancy of roosts, and frequency of use of singing trees

Case study A

Case study A: tree-climbing to search for long-tailed bat roosts in the Eglinton Valley

Synopsis

Sedgeley (2003) undertook a study of the roosting ecology of New Zealand bats. Part of that study examined roost preferences in tree-roosting long-tailed bats in the Eglinton Valley, Fiordland, and involved climbing random trees to assess whether they contained cavities that could be used by long-tailed bats. See Sedgeley & O'Donnell (1999a) for more details.

Objectives

The aim of Sedgeley & O'Donnell's (1999a) study was to test whether long-tailed bats selected cavities with characteristics that differed from random cavities, i.e. did bats prefer to roost in cavities with particular qualities. The aim of this case study is to demonstrate how difficult and impractical it is to use the presence of sign to find long-tailed bat roost cavities in trees.

Sampling design and methods

Cavities were sampled from a subset of random trees that were originally sampled using the point-centred quarter method. Each tree was climbed and examined for presence of cavities and bat sign. See Sedgeley & O'Donnell (1999a,b) for further details.

Results

Climbing a tree and finding, checking and measuring cavities took 1–3 hours per tree. Of the 141 random cavities examined, only three contained bat droppings, and none of the cavities were occupied.

Limitations and points to consider

This case study demonstrates the impracticability of searching for the presence of bat sign to identify new long-tailed bat roosts in trees. Only three new roosts were found, despite a considerable search effort in an area known to contain hundreds of bats. We would never recommend going to such lengths purely to locate roosts. However, in this case, useful incidental information was gathered.

References for case study A

Sedgeley, J.A.; O'Donnell, C.F.J. 1999a: Factors influencing the selection of roost cavities by a temperate rainforest bat (Vespertilionidae: *Chalinolobus tuberculatus*) in New Zealand. *Journal of Zoology (London) 249*: 437–446.

Sedgeley, J.A.; O'Donnell, C.F.J. 1999b: Roost selection by the long-tailed bat, *Chalinolobus tuberculatus*, in temperate New Zealand rainforest and its implications for the conservation of bats in managed forests. *Biological Conservation 88*: 261–276.

Sedgeley, J.A. 2003: Roosting ecology of New Zealand long-tailed and lesser short-tailed bats. PhD thesis, University of Otago, Dunedin.

Case study B

Case study B: monitoring lesser short-tailed bat singing activity on Codfish Island/Whenua Hou

Synopsis

Introduced Pacific rats (kiore) were eradicated from Codfish Island/Whenua Hou during winter 1998 following two applications of toxic baits containing the anti-coagulant poison brodifacoum (Sedgeley & Anderson 2000). One of the methods used to assess potential impact of the poison on a population of lesser short-tailed bats was to monitor bat activity levels before (1997, 1998) and after (1999) the poisoning operation using the frequency of occurrence of singing activity (presence/absence) at marked singing trees (Taylor 1997; Holborrow 1998; Golding 1999).

Objectives

The original study sought to monitor changes in lesser short-tailed bat activity before and after a brodifacoum poison drop.

Sampling design and methods

Five-minute counts were undertaken at marked singing trees in January and February. The presence/absence of singing within hearing distance of each tree was recorded nightly. Frequency was calculated as the number of times singing was heard each night, expressed as a percentage of the total number of trees monitored that night.

Results

Number of bat passes was similar between years. Frequency of occurrence of singing was similar in 1997 and 1998, but a little higher in 1999.

Limitations and points to consider

Unfortunately, while the data showed bats were present after the poisoning, this method did not provide information on how many bats were present, so it was difficult to determine if poisoning had an impact on the bat population.

References for case study B

Golding, C. 1999: The activity of short-tailed bats (*Mystacina tuberculata tuberculata*) on Codfish Island, January–February 1999. Report to the Department of Conservation, Invercargill (unpublished).

Holborrow, J. 1998: The activity of short-tailed bats (*Mystacina tuberculata tuberculata*) on Codfish Island, January–February 1998. Report to the Department of Conservation, Invercargill (unpublished).

Sedgeley, J.A.; Anderson, M. 2000: Capture and captive maintenance of short-tailed bats on Codfish Island and monitoring of wild bats during the kiore eradication programme winter 1998. Report to the Department of Conservation, Invercargill (unpublished).

Taylor, G. 1997. Short-tailed bat (*Mystacina tuberculata tuberculata*) activity on Codfish Island, January–February 1997: Report to the Department of Conservation, Invercargill (unpublished).

Full details of technique and best practice

There is no prescribed technique or best practice for locating roosts and singing trees using presence of sign. There are, however, some standard procedures for counting bats inside roosts. See the method ‘Bats: counting inside roosts’ (docdm-590915), the ‘DOC best practice manual of conservation techniques for bats’ (docdm-131465) and O’Donnell (2002) for more details.

Droppings and remains

Droppings may be reasonably easy to detect inside buildings or in caves (e.g. Fig. 2; Walsh & Catto 2004). Droppings may be present on the ground or lodged in crevices, and scattered droppings may be stuck on walls or in cobwebs. It is much more difficult to detect droppings in tree hollows because droppings frequently fall down inside the tree trunk and are not easily seen. Lesser short-tailed bats often occupy large crevices in trees and the droppings sometimes fall out and form a mound on the ground beneath the roost (Fig. 3). However, these can be washed away by rain. Long-tailed bat droppings inside caves can be washed away by floods. Repeat visits may be necessary to determine if sites are used.

Initially, it may be difficult to distinguish between droppings produced by bats and those produced by mice and possibly weta. Bats are insectivorous, and dry bat droppings will crumble into tiny fragments. In contrast, mouse droppings will smear when crumbled. Other remains, such as insect legs and moth wings, can sometimes be found among accumulated bat droppings.

Large numbers of droppings are good indicators of colony size and period of occupancy. The presence of droppings can be used to monitor roost use over time. Each time a roost is visited, plastic sheeting (or similar) can be placed either on the floor of a cave or on top of a guano pile beneath a tree, and the presence or absence of any new droppings recorded.

Figure 2. A pile of long-tailed bat droppings under a sack hanging from rafters in an old woolshed in South Canterbury (photo: Colin O'Donnell).

Figure 3. A spill of guano from the base of a lesser short-tailed bat roost tree in Eglinton Valley, Fiordland (photos: Colin O'Donnell).

Occasionally, dead bats or bones of bats are found inside caves or large tree hollows. These should be collected and sent, along with date and location details, to the National Museum Te Papa for cataloguing and identification.

Staining and scratching

If a site is used for a long time, bat urine or oil from bat fur can stain rocks, wood or any surface bats regularly roost on or crawl over. Hollows in tōtara trees used by lesser short-tailed bats for singing or roosting are often stained (Fig. 4).

Figure 4. Staining around the entrance of a short-tailed bat singing tree on Codfish Island/Whenua Hou (photo: J. Sedgeley).

Singing

During the breeding season, male lesser short-tailed bats occupy mating or singing trees or roosts, and call from them at night to attract females. Singing roosts often have small entrances, typically stained or polished smooth around the edges (Fig. 4). A distinctive musty odour is often present. On Codfish Island/Whenua Hou, bats were sometimes present inside singing trees (but not singing) during the day. Singing is high-pitched audible squeaking which some people think reminiscent of rifleman (forest bird) calls. It also has a strong ultrasonic component. Two short videos of a lesser short-tailed bat singing from a beech tree in the Eglinton Valley are available to view:

- ‘Short-tailed bat call 1’ (olddm-574399)
- ‘Short-tailed bat call 2’ (olddm-574400)

A scheme for monitoring activity at singing trees has been established on Codfish Island/Whenua Hou. See ‘Case study A’; Taylor (1997); Holborrow (1998); and Golding (1999) for further details.

Bat flies

A commonly encountered sign that lesser short-tailed bats have been roosting at a tree is the presence of bat flies—commensal parasites of bats. Occasionally, clusters of bat flies sit at a roost entrance after the bats have vacated the tree (Fig. 5). The bat flies will only survive for a few days after the bats have left.

Figure 5. Bat flies at a lesser short-tailed bat roost entrance about 2 m off the ground in the Eglinton Valley (Photo: Brice Ebert).

Survey aids

Binoculars, torches and ladders are useful when checking caves and trees. Angled mirrors, endoscopes or very small infrared video cameras can be used to look into tree hollows, rock crevices, joists in old barns, behind plasterboard and for checking inside artificial bat roost boxes (e.g. Reardon 2001) (Fig. 6). Small infrared video cameras are frequently used in New Zealand to check nests of burrow-nesting and tree-cavity nesting birds. Endoscopes and cameras have not been trialled for looking inside New Zealand bat roosts. Potential problems relate to focal distance, clarity of image, ability to see all of the roost cavity and potential for disturbance.

Figure 6. Small video camera and infrared light source used for inspecting bat roosts. Reproduced from Reardon (2001).

Health and safety and disturbance to bats

There are two options for assessing whether bats are using caves or mines, either (1) detect bats as they leave or enter the roost (at dusk or dawn) by watching, using bat detectors or video, or (2) enter the cave and search for sign. The second method has the disadvantages of potentially disturbing bats and it exposes bat workers to hazards of working underground. DOC staff working on bats must ensure that they operate under approved health and safety hazard plans (see the DOC health and safety management systems manual) and should consult the standard operating procedure (SOP) database (both available on the DOC Intranet) to check for appropriate procedures (e.g. when working in confined spaces, working at heights, and when doing roped tree climbing). Additionally, DOC staff must check local (area office) procedures relevant to hazard management. Some Australian bat workers (Armstrong & Higgs 2002) have formulated useful risk management protocols for working in confined spaces. These are worth reading.

Care must be taken not to disturb bats, particularly during winter months when the bats are in torpor (Thomas 1995). Also see 'Bats: counting inside roosts' (docdm-590915) and O'Donnell (2002) for more details on protocols to use for avoiding disturbance to bats while counting inside caves.

References and further reading

Armstrong, K.; Higgs, P. 2002: Draft protocol for working safely in confined spaces. *The Australasian Bat Society Newsletter 20*: 20–28.

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Daniel M.J.; Williams, G.R. 1981: Long-tailed bats (*Chalinolobus tuberculatus*) hibernating in farm buildings near Geraldine, South Canterbury. *New Zealand Journal of Zoology 8*: 425–430.

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O'Donnell, C.F.J. 2002: Variability in numbers of long-tailed bats (*Chalinolobus tuberculatus*) roosting in Grand Canyon Cave, New Zealand: implications for monitoring population trends. *New Zealand Journal of Zoology 29*: 273–284.

O'Donnell, C.F.J.; Christie, J.; Corben, C.; Sedgeley, J.A.; Simpson, W. 1999: Rediscovery of short-tailed bats (*Mystacina* sp.) in Fiordland, New Zealand: Preliminary observations of taxonomy, echolocation calls, population size, home range, and habitat use. *New Zealand Journal of Ecology 23*: 21–30.

Reardon, T. 2001: Infrared video camera for checking hollows and bat boxes. *The Australasian Bat Society Newsletter 20*: 41–43.

Sedgeley, J.A. 2001: Winter activity in the tree-roosting lesser short-tailed bat, *Mystacina tuberculata*, in cold-temperate climate in New Zealand. *Acta Chiropterologica 3*: 179–195.

Sedgeley, J.A. 2003: Roosting ecology of New Zealand long-tailed and lesser short-tailed bats. PhD thesis, University of Otago, Dunedin.

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Stebbings, R.; Mansfield, H.; Fasham, M. 2005. Bats. In Hill, D.; Fasham, M.; Tucker, G.; Shewry, M.; Shaw P. (Eds): Handbook of biodiversity methods: survey, evaluation and monitoring. Cambridge University Press, Cambridge.

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Walsh, A.; Catto, C. 2004: Survey and monitoring. In Mitchell-Jones, A.J.; McLeish, A.P. (Eds): Bat workers' manual. Joint Nature Conservation Committee, Peterborough, UK.

Appendix A

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

docdm-590733	Bats: counting away from roosts—automatic bat detectors
docdm-590915	Bats: counting inside roosts
docdm-590776	Bats: trapping away from roosts—inventory and species identification
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-574399	Short-tailed bat call 1
olddm-574400	Short-tailed bat call 2
docdm-146272	Standard inventory and monitoring project plan