DEPARTMENT OF PLANNING, INDUSTRY & ENVIRONMENT

‘Species credit’ threatened bats and their habitats

NSW guide for the Biodiversity Assessment Method

Cover image: Eastern cave bat *Vespadelus troughtoni* (lactating). Michael Pennay/DPIE

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1. Introduction

1.1 Purpose of this guide

The purpose of this guide is to aid accredited assessors when applying the Department of Planning, Industry and Environment’s (DPIE) Biodiversity Assessment Method (BAM) (DPIE 2020) to survey for threatened bat species or their habitat. Under the BAM some threatened bats or their breeding habitat, are treated as species credits (i.e. they cannot be predicted by habitat surrogates) and require appropriately timed on-ground surveys to determine their likelihood of occurrence at a development, biocertification or biodiversity stewardship site. The guide should be read in conjunction with the BAM.

Following this guide is not mandatory; however, proposals that fail to meet the guide for reasons of efficiency, cost or validity will need to provide an evidence-based rationale for an alternative survey approach (e.g. a peer-reviewed scientific paper, a published guideline or an expert report).

The guide will be reviewed and updated periodically to incorporate new information on threatened bats, e.g. survey techniques, new listings under the *Biodiversity Conservation Act 2016* and to reflect any legislative or policy changes.

A **threatened bat survey decision key** is provided in Appendix A. It steps through the approach to determine when a survey is necessary and the type of survey to be applied in accordance with this guide.

1.2 Background

In New South Wales, the *Biodiversity Conservation Act 2016* (BC Act), together with the Biodiversity Conservation Regulation 2017, outlines the framework for addressing impacts on biodiversity from development and clearing through the Biodiversity Offsets Scheme (BOS).

The BOS is underpinned by the Biodiversity Assessment Method (BAM), which creates a transparent, consistent and scientifically based approach to biodiversity assessment and offsetting for all types of development that are likely to have a significant impact on biodiversity.

In the context of the BOS, threatened bat species include critically endangered, endangered or vulnerable species and populations as listed under Schedule 1 of the BC Act[1]. For bat species listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), where applicable, the methods and techniques specified in this guide are consistent with the Commonwealth’s Survey guidelines for Australia’s threatened bats: Guidelines for detecting bats listed as threatened under the EPBC Act (PDF 744KB) (DEWHA 2010). However, the Commonwealth may require additional or alternative surveys for species.

The guide refers to land being assessed for threatened bats as the **subject land**. The subject land includes land that may be affected by development, or biocertification, or is proposed as a biodiversity stewardship site.

[1]Currently there are no bat populations listed as endangered populations, or bat species listed as critically endangered under the BC Act.

1.3 Survey data and biodiversity credit calculations

Under the BAM all threatened entities are allocated to one of two biodiversity credit classes: ‘ecosystem’ or ‘species’ credit species. Biodiversity credit classes are used to inform the calculation of the impacts of a proposed development or biocertification, or the effects of management actions, on biodiversity values.

Ecosystem credit species are species where the likelihood of occurrence of a species or elements of the species’ habitat can be predicted by vegetation surrogates and landscape features, or for which targeted survey has a low probability of detection.

Species credits species are species where the likelihood of occurrence of a species or elements of suitable habitat for that species cannot be confidently predicted by vegetation surrogates and landscape features and can be reliably detected by survey.

Under the BAM some threatened bats are ecosystems credits, some are species credits and some are a combination of the two; for example, foraging habitat is an ecosystem credit and breeding habitat is a species credit.

The BAM requires either a targeted species survey or an expert report to determine the presence of a species credit species or the habitat component relevant to the species credit assignment (e.g. breeding habitat)[2].

The information gathered from the targeted species survey is entered into the BAM Calculator (‘BAM-C’). The BAM-C operationalises the BAM by generating the number and type of credits required to offset the negative impacts on biodiversity of a proposed development or of land that is proposed to be biocertified, or the improvements in biodiversity value at a biodiversity stewardship site.

The BAM-C requires survey data as well as the information contained in tools such as the Threatened Biodiversity Data Collection (TBDC), to determine credit requirements.

1.4 Allocation of bat species to biodiversity credit classes

The threatened bat species allocated to each of the biodiversity credit classes at the date of publication are listed below. Occasionally, the biodiversity credit class of a species changes, generally in response to new information.

Bat species allocated to the ecosystem credit class include:

- hoary wattled bat (*Chalinolobus nigrogriseus*)
- little pied bat (*Chalinolobus picatus*)
- eastern false pipistrelle (*Falsistrellus tasmaniensis*)
- golden-tipped bat (*Kerivoula papuensis*)
- northern free-tailed bat (*Ozimops lumsdenae*)
- eastern tube-nosed bat (*Nyctimene robinsoni*)
- eastern long-eared bat (*Nyctophilus bifax*)
- eastern coastal free-tailed bat (*Micronomus norfolkensis*)
- Corben’s long-eared bat (*Nyctophilus corbeni*)
- yellow-bellied sheathtail bat (*Saccolaimus flaviventris*)
- greater broad-nosed bat (*Scoteanax rueppellii*)

[2] At a development or biocertification site species credits may be assumed to be present. If a species credits species (or breeding habitat) is assumed present a survey or expert report is not required, and the relevant credits are calculated accordingly.

- common blossom bat (*Syconycteris australis*)
- inland forest bat (*Vespadelus baverstocki*)
- large bent-winged bat (*Miniopterus orianae oceanensis*) – foraging habitat only
- little bent-winged bat (*Miniopterus australis*) – foraging habitat only
- grey-headed flying-fox (*Pteropus poliocephalus*) – foraging habitat only.

The above species do not require targeted survey; therefore, they are not included in this guide.

Threatened bat species allocated to the species credit class include:

- large-eared pied bat (*Chalinolobus dwyeri*)[3]
- bristle-faced free-tailed bat (*Setirostris eleryi*)
- southern myotis (*Myotis macropus*)
- eastern cave bat (*Vespadelus troughtoni*)[4]
- large bent-winged bat (*Miniopterus orianae oceanensis*) – breeding habitat only
- little bent-winged bat (*Miniopterus australis*) – breeding habitat only
- grey-headed flying-fox (*Pteropus poliocephalus*) – breeding habitat only.

The above species require targeted survey and are therefore included in this guide.

1.5 Objective of a targeted threatened bat survey

The objective of a targeted threatened bat survey is to establish, with a high level of confidence, the likely presence of a species credit bat species (or breeding habitat) on the subject land.

The survey aims to minimise 'false-negatives' (i.e. when a species is reported as absent from the subject land when it is present). A high level of confidence in the reported results can be assumed if the survey is undertaken by an appropriately skilled person (see Section 2.2) in accordance with this guide.

If present, the survey objective is to collect data to determine the area of suitable habitat on the subject land, which is used to calculate species credits.

This guide may also be used to assist in the assessment of prescribed impacts for bat species with roosting and breeding habitat in artificial culverts and other structures.

What is breeding habitat?

For the purpose of the BAM, breeding habitat is specific habitat features that are used, or presumed likely to be used, by threatened bat species as maternity sites.

Maternity sites (also known as maternity roosts or maternity camps) are locations where female bats give birth and form nursery colonies (Neuweiler 2000; Altringham 2011). Breeding habitat is considered present if there is:

1. potential breeding habitat, **and**
2. breeding individuals of the target species on the subject land.

[3] Whilst this species is a species credit species, breeding habitat requires additional consideration as it is listed as a potential serious and irreversible impact (see Section 9.1 of the BAM and the Guidance to assist a decision-maker to determine a serious and irreversible impact (DPIE 2019)).

[4] As above

Definitions for this guide

Breeding habitat: all areas of *potential breeding habitat* on the subject land where *breeding individuals* of a threatened bat species are determined, or assumed to be present.

Breeding individuals: at least one female bat of the target species that is pregnant, carrying pups or lactating, or a juvenile bat of the target species is present or has been previously recorded, or is assumed to be present (development and biocertification only), on the subject land.

Bank: the ‘high bank’ or high tide mark (for tidal bodies) of a creek, river or other waterbody.

Dusk: astronomical dusk, meaning the instant in the evening, when the centre of the Sun is at a depression angle of 18 degrees (18°) below an ideal horizon. At this time the illumination due to scattered light from the Sun is less than that from starlight and other natural light sources in the sky. The time of astronomical dusk at a specific location and date can be determined using online calculator tools.

Habitat: all areas of *potential habitat* on the subject land where the species is determined or assumed to be present.

Maternity site: a maternity site (also known as maternity roosts or maternity camps) is a location (a roost or camp) where female bats give birth and form nursery colonies.

Nursery colony: a group of female bats that have congregated at a specific roost or camp (a ‘maternity site’) to raise young bats until they are weaned and old enough to fly independently.

PCT: plant community type.

Potential breeding habitat: described for each relevant species in Chapter 3. These are habitat features that are used, or presumed likely to be used, by threatened bat species as maternity sites.

Potential habitat: the area(s) of the subject land that support any listed habitat constraints and plant community type(s) associated with the target species as per the TBDC. Potential habitat is described for each species in Chapter 3.

Roost/ camp: a place where bats shelter during the day. Some species roost only in tree hollows, others only in caves, and others in a mixture of natural and artificial structures. For flying-foxes the term ‘camp’ is used to describe the place where individuals congregate and rest during the day; it also refers to the animals in the camp. At different times of the year or life stages bats may use different roosts or camps.

Threatened Biodiversity Data Collection (TBDC): a publicly accessible online database that contains information for listed threatened species, populations and ecological communities.

2. Overall approach to the targeted threatened bat or habitat survey

2.1 Take a systematic approach

The guide describes a systematic approach to targeted threatened bat survey.

The survey approach should be considered in the planning phases of the subject land assessment and incorporates two elements:

1. a survey design that maximises the likelihood of detecting the targeted threatened bat species (and breeding habitat), including consideration of seasonal and temporal constraints
3. a field survey technique that aims to search a large proportion of an area of potential habitat at an appropriate intensity.

2.2 Identify the skills of the threatened bat surveyor

The targeted threatened bat survey must be undertaken by someone with appropriate experience who has good bat identification skills and a strong knowledge of bat ecology. An appropriate threatened bat surveyor (referred to as a surveyor) is someone who can demonstrate their relevant experience and qualifications in field survey for threatened bat species, and preferably experience with the target species.

The surveyor’s skills can be demonstrated by relevant qualifications and the following:

- a history of experience in survey methods (e.g. trapping/netting, handling, acoustic detectors) and threatened bat identification in New South Wales, and/or
- a resume giving details of threatened bat survey projects done in the relevant region over the previous 10 years, including employers’ names and periods of employment (where relevant).

Surveyors must have the required **licences and ethics approvals**, where relevant**,** to undertake the survey, as well as vaccinations required for handling bats. The Australian Immunisation Handbook recommends rabies (lyssavirus) vaccinations for anyone working with bats (ATAGI 2018).

If roost surveys of mines, caves or other confined spaces are planned then suitable experience or formal training for working in these confined spaces is recommended.

The threatened bat surveyor may or may not be an accredited assessor under the BC Act for the purpose of preparing a Biodiversity Assessment Report (BAR) under the BAM.[5] The experience and qualifications (including licence numbers) of the surveyor and any specialist responsible for analysis of any recorded bat calls must be documented in the BAR (see Section 2.10). **However, the BAR must be submitted by an accredited assessor.**

It is important to note that the threatened bat surveyor is not equivalent to an ‘expert’ as defined in Section 5.3, Box 3, of the BAM. To be considered an ‘expert,’ a person must demonstrate a high level of knowledge in relation to particular biodiversity values (such as a threatened bat species), as the opinion of an expert replaces the need for a field survey. Expert status is determined by the Environment Agency Head.

[5] This guide uses the general term Biodiversity Assessment Report (BAR) to refer to any of the assessment reports required by the BAM including a Biodiversity Development Assessment Report (BDAR), Biodiversity Certification Assessment Report (BCAR), or Biodiversity Stewardship Site Assessment Report (BSSAR).

2.3 Create a candidate species list

Section 5.2 of the BAM details the series of filters applied to generate the list of threatened species likely to occur on or use the subject land. Filters include the species biodiversity credit class (i.e. is a ‘species credit’ species), distribution, association with PCTs identified on the subject land, native vegetation cover in the surrounding landscape and the patch size of native vegetation on the subject land.

Based on these filters and site-based information the BAM-C generates a list of threatened species that require targeted survey. Additionally, if there are past records of a species credit bat species on the subject land then it must be included in the species list.

In accordance with Section 5.2 of the BAM the surveyor may further refine this list where:

- habitat constraints listed for the species in the TBDC, or microhabitats on which the species depend, are sufficiently degraded such that the species is unlikely to use the subject land, or
- an expert report,[6] is prepared (in accordance with Section 5.3, Box 3, of the BAM) stating that the species is unlikely to be present on the subject land.

To help determine whether a species credit bat species meets the above criteria the surveyor can interrogate the species profile available in the TBDC or any additional sources of information such as scientific journals and research reports.

The justification, including any relevant sources of information, for removing a species credit bat species from the list (thus assuming it is not present on the subject land) must be documented in the BAR.

All remaining species credit bat species are to be assessed further in accordance with this guide.[7]

2.4 Optimise the time of year for the survey

The TBDC provides general guidance on the appropriate time to survey for species credit species. The information is also displayed in the survey matrix section of the BAM-C. For species with species credits for breeding habitat, the surveyor should refer to the specific advice in Chapter 3 of this guide to further refine survey times, thereby optimising detectability.

Surveys must be conducted in weather conditions when bats are most likely to be active, generally hot, warm or mild and calm conditions (Mills et al. 1996; Fischer et al. 2009; Law et al. 2015). The survey effort described in this guide assumes surveys are undertaken in suitable conditions.

The surveyor may survey outside the times identified in this guide; for example, due to spatial or temporal variation in temperature or breeding seasons, with timing documented and justified in the BAR.

In some situations, surveying at the optimum time under suitable conditions to detect threatened bats may not be possible or feasible; for example, where project timeframes are constrained. The proponent may choose to use an expert report (in accordance with Section 5.3 of the BAM) to assess the species’ presence on the subject land. Alternatively, the

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[6] Note that an expert, for the purposes of preparing an expert report, needs to demonstrate skills and experience additional to those of the threatened bat surveyor, see Section 5.3, Box 3, of the BAM. The expert report must be authored by the expert and attached to the BAR.

[7] Assessment of the presence of these species must be undertaken at a development site but is optional at a stewardship site (if not undertaken, species credits will not be generated).

species can be assumed to be present at development and biocertification subject lands only. A species credit species cannot be assumed to be present at a biodiversity stewardship site (see Subsection 5.2.5 of the BAM).

If presence is assumed, species habitat should be mapped in accordance with the requirements outlined for the species in Chapter 3. If breeding is assumed, breeding habitat should be mapped in accordance the requirements outlined for the species in Chapter 3.

2.5 Identify areas of potential habitat on the subject land

Only the potential habitat of the target species within the subject land needs to be surveyed. To identify potential habitat, the surveyor will need to consider the subject land in relation to bat habitats. The BAM requires the subject land to be divided into relatively homogenous vegetation zones based on plant community types (PCTs) and condition.

The potential habitat for any species credit bat species may be related to one or a group of PCTs and/or a combination of PCTs and specific habitat features such as rocky outcrops. Information on the habitat to survey for each species is provided in Chapter 3. Examples of how to map these habitat features are provided in Figure 1 and Examples 1 and 2.

The surveyor will need to conduct onsite assessments to confirm the accuracy of any desktop assessment of habitat features, because:

- mapping and digital data may not accurately represent all topographic details
- the history of the site and its disturbance cannot be reliably evaluated from imagery
- microhabitat features are not easily evaluated remotely.

An expert report may be used as an alternative to survey. An expert report must address how potential habitat has been evaluated during onsite assessments, and with reference to definitions of breeding habitat for the purpose of the BAM (Section 1.5 of these guidelines).

2.6 Prepare a field survey plan

A field survey plan is to be prepared based on the list of species credit bat species likely to occur on the subject land (Section 2.3) and the habitat characteristics of the subject land (Section 2.5) as well as in accordance with Subsection 5.2.5 of the BAM.

The following steps outline the **generalised** method used to create a survey plan:

1. Identify areas of the subject land considered potential habitat for the target species. Only those parts of the subject land that are considered potential habitat require survey (refer to Chapter 3 for details).
2. Determine the survey methods and effort to be used for each target species (refer to Chapter 3 for details).
3. Determine the appropriate time of year to undertake the survey.
4. Select survey sites based on 1. and 2. Select dates for survey based on 3., allowing flexibility for unfavourable conditions.

If multiple target species share similar habitat and require the same method of survey (e.g. *Miniopterus orianae oceanensis* and *M. australis*), the survey effort for these species can be combined.

Survey effort for large potential habitat areas

The survey effort defined in this guide is designed to be flexible and is the minimum required for areas of habitat up to approximately 50 hectares (or for specific sites like flying-fox camps). For larger areas this minimum effort should be scaled appropriately.

For very large areas of potential habitat, advice should be sought from DPIE at bam.support@environment.nsw.gov.au. Options to reduce survey effort in these areas include dividing the proposed subject land into stages; refining the areas of potential habitat through site survey and an expert report; or reducing the survey area by realigning the boundaries or footprint of the proposed development or biocertification, thereby further reducing the area of impact.

2.7 Determine the required field survey effort

The guide uses **standard effort assumptions**. Unless otherwise stated, all field survey effort is expressed as total effort using **standard methods** (see Section 2.8.) for a minimum number of nights (per method). For example, 16 trap nights for a minimum of four nights requires four traps to be used for four nights, or two traps for eight nights. Where multiple methods are recommended for a species in Chapter 3, a survey need only select one appropriate method to meet requirements (after considering any requirements to identify breeding habitat and limitations of some methods). Some methods may be interchangeable (e.g. ‘harp trap *or* mist nets’ means either method can be used for the required amount of time), or exclusive (e.g. ‘harp trap’ *and* ‘roost search’, meaning both methods should be used for the specified time).

Consistent with the national threatened bat survey guidelines (DEWHA 2010) all effort is expressed for **areas** ≤50 hectares (DEWHA 2010). If the subject land is larger than 50 hectares, the effort should be scaled up; for example, at a 200 hectare site the required level of effort may be four times that expressed in this guide (as 200 hectares is four times 50 hectares). See Section 2.6 of the guide for further information on surveying large areas.

Any measurement using a **GPS** requires a positional accuracy of 10 metres or less.[8]

2.8 Use one or more standard survey methods

Bat survey methods in this guide refer to the following standard survey methods, unless specified otherwise.

Harp traps: *one trap night* is a full night using a standard 4.2 square metre catch area harp trap strung with 3 kilograms breaking strain (or less) monofilament nylon line. It is to be set before sunset and left open overnight, to be checked at least once during the night and then at or just before dawn. The location of each trap should be changed every night to minimise learned trap avoidance effects (see Appendix B). Traps should be placed at least 20 metres apart to sample intra-site variability.[9] Justification for placing multiple traps less than 20 metres apart (for example two traps spanning a creek) must be recorded in the BAR and should be considered as a single trap night as it samples a single point. For some open habitats with no overhanging tree branches or flyways, such as large open areas in forests, wide spans across rivers, creeks or isolated waterholes, the use of mist nets may be more appropriate than harp traps (Lumsden & Bennett 1995; Pennay 2005; Churchill 2008).

Mist nets: *one mist net night* is a full night using ultrafine 0.08 millimetre monofilament nylon nets equivalent to 12 metres in length and 3 metres in height. Mist nets are typically set in formations made up of multiple nets (Churchill 2008). Twelve metres could comprise a single 12 metre net (e.g. across a stream) or in formations (e.g. two by six metre nets in ‘T’ formation or two by three metre nets and a one by six metre net in a ‘Z’ formation). Nets should be set for three hours from dusk and monitored constantly until the end of the netting session. The locations of nets should be changed nightly to minimise learned trap avoidance effects (see Appendix B).

[8] As reported by the GPS accuracy estimate.

[9] If traps are placed along the same flyway (tracks or creek lines that bats tend to fly back and forth along) they should be placed further apart.

Passive acoustic detection: *one passive detector night* is an entire night using a single acoustic detector capable of recording and storing the calls of the target species automatically. The detectors should be set recording before sunset and stopped after dawn, placed in positions that maximise the likelihood of recording bats and at least 50 metres apart to sample intra-site variability.[10] Justification for placing detectors less than 50 metres apart must be recorded in the BAR. Detectors are to be moved to a different location after a maximum of four nights sampling. Recorded calls should be analysed for target species by a specialist skilled in bat call identification and acoustic recordings are to be retained and examples from the survey provided in the BAR as documentary evidence.

Active detection (southern myotis): *One active detection night* is an observer using a single handheld acoustic detector and visual aid to concurrently search for and observe foraging bats flying over suitable waterbodies[11] for at least two hours after dusk. During active detection the observer should move slowly along the bank actively searching above waterbodies for foraging bats. The observer must use a combination of the echolocation call and characteristic foraging pattern of southern myotis over water to identify the species. The handheld detector must be capable of detecting and displaying real time spectrograms of the target species calls, also recording and storing these calls. Visual aids such as a spotlight, infrared or thermal device may be used to allow the observer to observe small bats and their flight behaviour at a distance of at least 30 metres. Active detection may be undertaken by a single person, or two (or more) people with one monitoring the detector, and the other visually searching. When undertaken by multiple people it is still considered one active detection night. Unless restricted by available habitat, active detection should be undertaken at a different location each night to sample intra-site variability. Acoustic recordings are to be retained and examples from the survey provided in the BAR as documentary evidence.

Roost search (microbats): a search of a microbat roost is undertaken by looking for bats or signs of bats (urine stains, droppings, remains, and bat fly casings) in suitable roost habitat during the daytime. All roost searches should use a torch to shine in holes, cracks and crevices, and carry a handheld bat detector to locate (and identify) bats that may call. If bats are located observers must confirm the identity of the species and determine if the roost is a maternity roost. The roosts of some species are cryptic and very rarely found despite searches (Pennay 2008). For these reasons roost searches should only be conducted in addition to other recommended survey methods.

Daytime camp survey (grey-headed flying-foxes): surveyors move through a flying-fox camp during the day and, using binoculars, a spotting scope, or equivalent, observe individuals for signs of females with dependent young (young may be obscured by the mother's wings). The surveyor should work slowly and systematically through the camp, thoroughly checking all areas occupied by bats. Unless the camp is very small (<500 animals) each search should take at least two hours with searches repeated on at least three separate occasions, preferably once in October, November and December.

Nursing mothers tend to congregate in one area of the camp (often near the centre); however, all parts of the camp should be checked. Grey-headed flying-foxes (especially nursing mothers) are prone to heat stress; **surveys must not be undertaken if the temperature is 35°C or higher or if the bats are panting** (Snoyman et al. 2012).

Supporting technical information regarding survey methods and effort are provided in Appendix B.

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[10] If multiple detectors are placed along the same flyway (tracks or creek lines that bats tend to fly back and forth along), they should be placed further apart.

[11] A suitable waterbody is taken to mean a waterbody described as potential habitat in Chapter 3 of these guidelines, being any medium to large permanent creek, river, lake or other waterway (i.e. with pools/ stretches 3 metres or wider).

2.9 Do a preliminary evaluation of efficacy

Preliminary surveys should be evaluated against an expected outcome to assess the efficacy of survey effort and identify any problems with technique (e.g. equipment failure).

An expected outcome can be obtained by examining the results of published surveys using similar methods from the same or similar regions. Many threatened bat species have very low observation rates and more commonly observed species can assist in providing an indication of the effectiveness of the survey.

Supporting information on estimating expected outcomes is provided in Appendix C. Any apparent problems with survey effectiveness and steps taken to ameliorate these should be documented in the BAR.

2.10 Document the survey results

Biodiversity Assessment Report (BAR)

The BAR must be prepared in accordance with the BAM and requires documentation of targeted survey for species credit species including timing, design, method, effort and results (see Appendix K of the BAM).

In relation to bat surveys the BAR should include information on:

- **Timing:** the dates and weather conditions (minimum/maximum temperatures, rainfall recorded at the site) of each survey. Weather conditions can be recorded using a portable metrological station.
- **Method:** a description of each method used, including notes and explanations of any variation from the methods recommended in this guide.
- **Effort:** the type, number and GPS location of all traps/nets/searches/acoustic recordings; the number of trap/net nights; total number and types of **all** species captured or recorded acoustically; number, location and duration of any roost searches; and the surveyor’s qualifications/experience. Notes should be included on factors which may have affected effort (inclement weather, equipment failure, etc.) and any ameliorative steps taken.

Where species have been identified using acoustic detection, the identification and reporting of the surveys must align with the minimum standards specified in the Recommendations of the Australasian Bat Society Inc for reporting standards for insectivorous bat surveys using bat detectors (PDF 72KB) (Australasian Bat Society 2007), including examples of acoustic recordings for each species identified from the survey provided in the BAR as documentary evidence.

Species polygon

A species polygon must be mapped in accordance with Subsection 5.2.5, Box 2, of the BAM for each of the target species located on the subject land.

The species polygon must:

- be mapped using satellite (ADS–40) or the best available ortho-rectified aerial imagery of the subject land
- include the GPS locations of individuals of the species recorded on the subject land or area/s occupied by the species
- contain the specific habitat constraint(s) and any other feature or microhabitat associated with the species on the subject land (see examples in Figure 1).
- use GPS to confirm the location of the species polygon on the best available ortho-rectified aerial image of the subject land (see Examples 1 & 2 below).

The species polygon map for threatened bats must identify the habitat constraint(s) or feature(s) associated with the species on the subject land. This may be habitat features or both habitat and breeding habitat features for species credit species. For species where only breeding habitat is required to be identified, the species polygon should be restricted to features of breeding habitat. Refer to Chapter 3 below for details on what to include in the species polygon for each species.

A table detailing species habitat constraint(s) or features associated with the species and their locations (GPS coordinates) and abundance on the subject land should also be included in the BAR.

Note: Where the species is a potential SAII (serious and irreversible impact) species, the BAR must also address the assessment requirements in Section 9.1 of the BAM. These assessment requirements are not part of this guide.

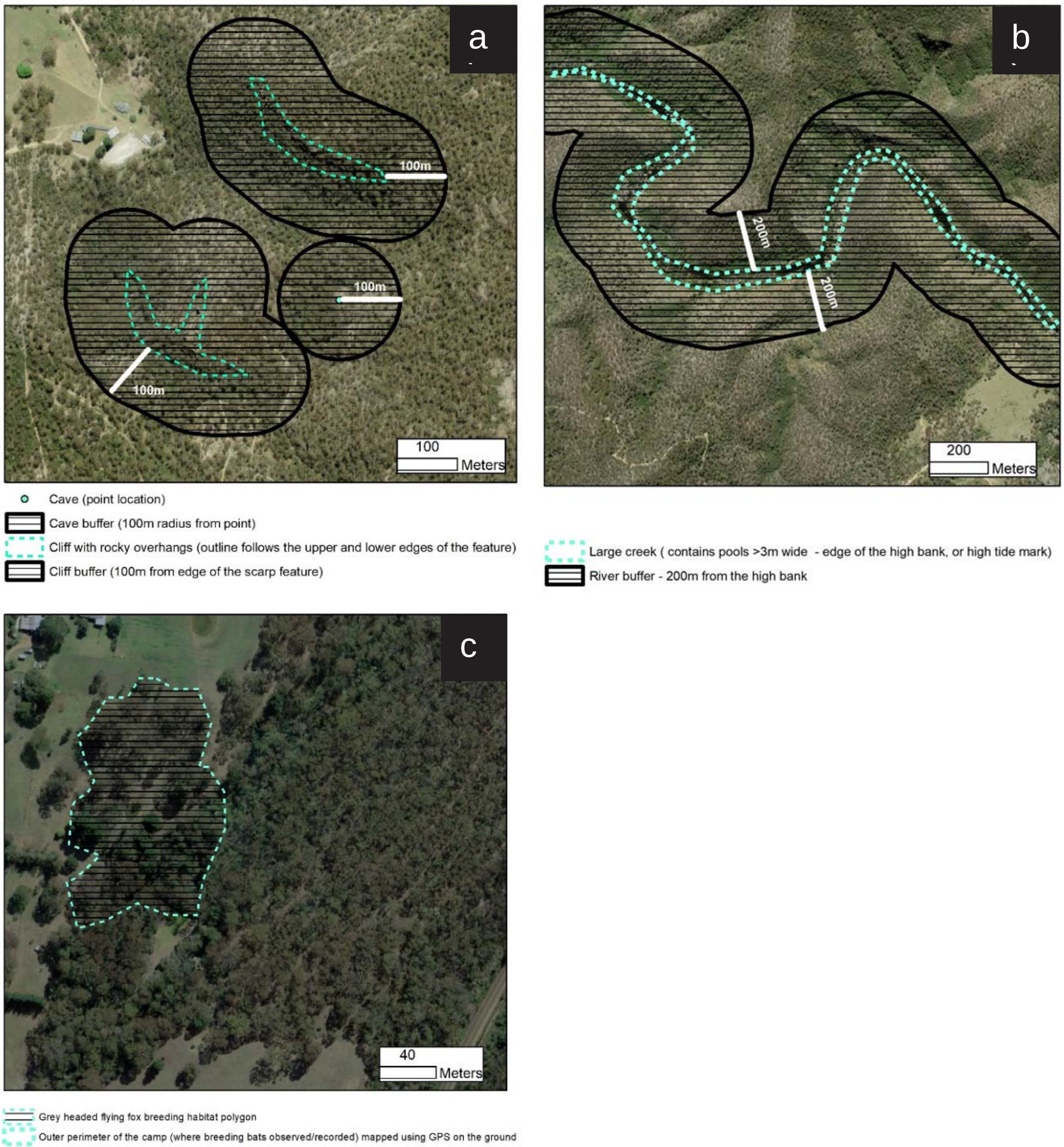


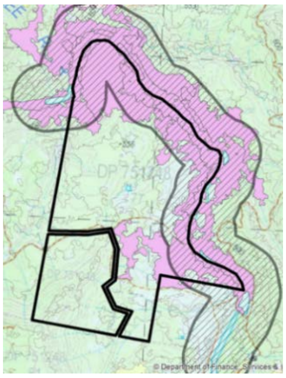
Figure 1 **Examples of how buffers may be drawn around habitat features for the purpose of identifying potential habitat, potential breeding habitat or creating species polygons: a) caves, cliffs and rocky areas, b) riparian areas and waterbodies, c) flying fox camps**

Example 1: How to create a species polygon using identified habitat features and constraints – *southern myotis*

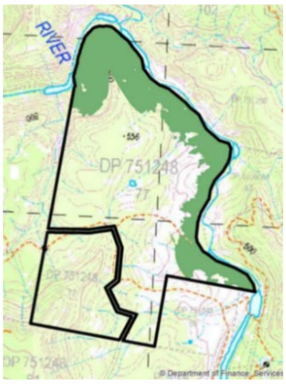
1. Use topographic maps and high resolution imagery to identify the habitat feature and create the required buffer around the feature (as per Figure 1).[12]

   For this species the habitat feature is any medium to large permanent creek, river, lake or other waterway and the buffer is 200 metres. Blue shading on the map below indicates the habitat feature plus buffer.

2. Select all PCTs on the subject land associated with the species in the TBDC. Also include any PCTs where the species has been recorded on the land even if not associated with the species in the TBDC. Pink shading on the map below indicates all included PCTs.



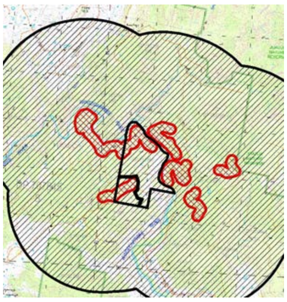
3. Where these PCTs fall within the subject land and within the 200 metre buffer (green shading on the map below):
   - This is **potential habitat** for survey purposes.
   - If the species is present or assumed present this is the **species polygon**.



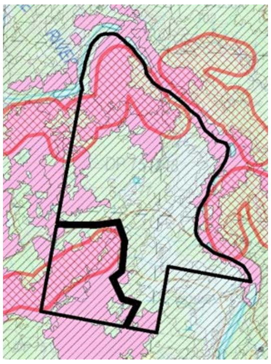
[12] These features and buffer sizes are specified for each species in Chapter 3.

Example 2: How to create species polygons for a species requiring polygons for both habitat features and breeding habitat – *large-eared pied bat*

1. Use topographic maps and high resolution imagery to identify habitat features within 2 kilometres of the subject land.[13] **Create two buffers:** one for breeding habitat (as described in Figure 1), and one for species habitat. For this species the feature is caves, scarps, cliffs, rock overhangs and disused mines and the buffer distances are 100 metres for breeding habitat (red areas on the map below) and 2 kilometres for species habitat (black cross-hatched area on the map).

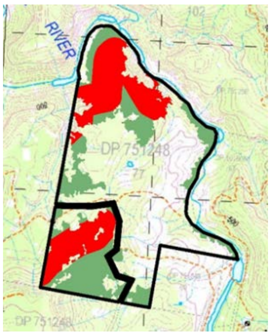


2. Select all PCTs on the subject land associated with the species from the TBDC. Also include any PCTS where the species has been recorded on the land even if not associated with the species in the TBDC. Pink shading on the map below indicates all included PCTs.



3. Where these PCTs fall within the subject land and within the buffers:
   - Those PCTs within the 100 metre buffer (red on the map below) are potential breeding habitat for survey purposes and are the species breeding habitat polygon if breeding individuals are recorded or assumed present.
   - The PCTs within the 2 kilometre buffer (green) are potential habitat for survey purposes and if the species is present this is the species polygon.

Note: If the species is present but no breeding habitat is found a species polygon is still required.



[13] These features and buffer sizes are specified for each species in Chapter 3.

3. Species survey requirements

The survey objective is to determine, with a high level of confidence, the species presence/absence on the subject land and, if present, to map the extent of habitat as a species polygon, in accordance with Subsection 5.2.5 of the BAM.

This chapter is divided into three parts, corresponding to the way species are considered under the BAM:

Section 3.1 details survey requirements for species where the BAM requires the species’ habitat to be identified: bristle-faced free-tailed bat *Setirostris eleryi* and southern myotis *Myotis macropus*.

Section 3.2 details survey requirements for species where the BAM requires only the breeding habitat to be identified: eastern bent-winged bat *Miniopterus orianae oceanensis*, little bent-winged bat *Miniopterus australis* and grey-headed flying-fox *Pteropus poliocephalus*.

Section 3.3 details survey requirements for species where the BAM requires both the species habitat and breeding habitat (if present) to be identified: large-eared pied bat *Chalinolobus dwyeri* and eastern cave bat *Vespadelus troughtoni*.

Total effort in the tables below means the minimum required effort for that standard survey method (Section 2.8) per 50 hectares, or 2.5 kilometre riparian length or less of potential habitat for the species. To meet the minimum survey requirements the ‘total effort’ for at least one standard survey method must be met.[14] For some species multiple methods may be used, but not all methods are appropriate for all species, particularly if breeding habitat is required to be identified. To avoid using inappropriate methods only use methods listed in this chapter for that species and note any limitations if breeding habitat must be identified.

Surveyors are only required to select one survey method from the list of suitable methods for the target species.[15] Where methods are listed together with an ‘or’ (for example *harp traps or mist net*) one method or a combination of both methods may be used to reach the specified total effort. Any methods not listed together with an ‘or’ may be used in combination but the total effort of at least one survey method must be met. For example, a survey for southern myotis could potentially use a mix of harp traps and passive acoustic detection (methods not listed with an ‘or’ in Section 3.1). However, in this case the total effort for at least one of those methods must be achieved – it cannot be met by combining the effort of unrelated methods (e.g. eight nights trapping plus eight nights of acoustic detection to reach 16 nights in total would **not** satisfy the criteria, whereas 16 nights of one of the methods would).

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[14] Noting that the total effort should be scaled proportionally for larger areas of potential habitat.

[15] This does not include supplementary methods. Supplementary methods should only be used in addition to standard methods, or where specific circumstances require. Care should also be taken to ensure the method chosen is appropriate for identification of breeding habitat if required.

3.1 Survey requirements for bat species where the BAM requires species habitat to be identified

Bristle-faced free-tailed bat *Setirostris eleryi*

Site	Per ≤50 hectares of potential habitat		
Survey method	**Survey period**	**Total effort**	**Min. no. of nights**
Harp trap or mist net	October – March	16	4

Survey methods: *Harp trap or mist net* placed in areas of potential habitat. The survey may use only harp traps, or a combination of harp traps and mist nets, with or without acoustic detection. Use of acoustic detection alone is not suitable for this species as the call is difficult to distinguish from other common species, particularly the little broad-nosed bat *Scotorepens greyi* (Pennay 2005).

Survey should sample the available range of suitable vegetation along riparian areas on the subject land. Traps or nets should be set near water holes (especially if isolated), under or beside large trees, in or beside creek beds, or in 'flyway' spaces between vegetation.

Potential habitat: All PCTs associated with the species (as per the TBDC) on the subject land where the subject land contains or is within 500 metres of a river, creek or riparian area (including dry river/creek beds).

Approach to create species polygon: Use aerial imagery to map river, creek or riparian areas (including dry creek channels, former creek channels, billabongs, etc.) on or within 500 metres of the subject land.[16] Species polygon boundaries should include all potential habitat (as described above) aligning with all PCTs on the subject land with which the species is associated (as listed in the TBDC) that occur on or within 500 metres of the banks of waterbodies mapped. If the species is recorded in any additional PCTs on the subject land these PCTs should also be included in the species polygon. [17] For assessment of biodiversity stewardship sites, the species polygon may include areas of degraded PCTs that are to be restored to recognisable PCTs associated with the species as part of an approved management plan for the site.

Southern myotis *Myotis macropus*

Site	Per <2.5 kilometre riparian length of potential habitat		
Survey method	**Survey period**	**Total effort**	**Min. no. of nights/time searching**
Harp trap or mist net	October – March	16	4
Passive acoustic detection	October – March	16	4
Active detection	October – March	8 hours	4
Roost search (artificial structures)	October – March	1 per structure	30 mins where required

[16] An example of this approach is illustrated in Figure 1b, however for this species the buffer distance is 500 metres, stream channels may be dry and there are no pool size requirements.

[17] Use the same approach as demonstrated in Example 1 (for southern myotis) but use a 500 metre buffer and PCTs associated with the bristle-faced free-tailed bat in the TBDC.

Survey methods:

Harp trap or mist net placed in areas of potential habitat. For larger waterbodies use of mist nets may be necessary where harp traps are not adequate to effectively cover the flyway. Traps or nets should be set beside or preferably over pools of water along creeks or rivers, particularly in flat or areas of low relief if present. Traps can be set under bridges or culverts, or overhanging branches. The survey may use only mist nets, or a combination of harp traps and mist nets.

Passive acoustic detection, with the microphone directed over pools of water along creeks or rivers or other waterbodies or *active detection* searching over suitable waterbodies in potential habitat using acoustic detectors and visual aids to confirm the presence of southern myotis.

Passive detectors or traps are to be set in areas of potential habitat, such as under bridges, culverts or overhanging branches. For larger waterbodies acoustic detection or mist nets may be necessary.

Roost search of artificial structures is a supplementary method, to be carried out where required. Note: The required search effort for artificial structures refers to the effort necessary to survey a single structure, such as a building or bridge. Survey of larger structures may require additional effort. For survey of very large artificial structures advice should be sought from DPIE at bam.support@environment.nsw.gov.au.

Potential habitat: All PCTs associated with the species (as per the TBDC) within 200 metres of the bank of any medium to large permanent creeks, rivers, lakes or other waterways (i.e. with pools/ stretches 3 metres or wider) on the subject land (Anderson et al. 2005).

Approach to create species polygon: Use aerial imagery, or ground data to locate and map the high bank (or high tide mark for tidal waters) of any medium to large permanent creeks, rivers or other waterbodies (as described above) within 200 metres of the subject land. An example of how this may be done is illustrated in Figure 1b. Species polygon boundaries should align with all PCTs on the subject land with which the species is associated (as listed in the TBDC) that occur within 200 metres of the high bank, or high tide mark of creeks, rivers or other waterbodies mapped. If the species was recorded in any additional PCTs on the subject land these PCTs should also be included in the species polygon. Example 1 above illustrates how this may be done. For assessment of biodiversity stewardship sites, the species polygon may include areas of degraded PCTs that are to be restored to recognisable PCTs associated with the species as part of an approved management plan for the site.

3.2 Survey requirements for bat species where the BAM requires breeding habitat to be identified

Section 1.5 of this guide defines the survey objective for species where breeding habitat must be identified either because it is a species credit or classified as a potential SAII.

All species in this category and the category described in Section 3.3 below require an assessment of the sex, age and reproductive condition of any bats observed, to identify *breeding bats,* unless the species is assumed to be present (development and biocertification sites only). If presence is assumed, breeding habitat is also assumed and mapped accordingly. Any bats of the target species observed (or previously recorded) that are pregnant, carrying pups, lactating, juveniles (i.e. less than six months old) should be considered positive confirmation of breeding habitat, which is to be mapped in accordance with the requirements outlined for each species below.

If breeding habitat is confirmed on the subject land before or during the survey the assessor may proceed to mapping breeding habitat for the subject area without undertaking further survey effort (unless the survey is also targeting other candidate bat species not yet confirmed).

Eastern bent-winged bat *Miniopterus orianae oceanensis*

Site	Per cave/mine/tunnel		
Survey method	**Survey period**	**Total effort**	**Min. no. of nights**
Harp trap	December – February	8	4

Survey methods: *Harp traps* placed close to exits of caves, mines or tunnels identified as potential habitat. Care should be taken to monitor traps to avoid overcrowding. Age, sex and reproductive status of captured bats must be assessed and recorded. A minimum of two traps per night over two nights, repeated at least two weeks later, is required.

Potential habitat: Caves, tunnels, mines or other structures known or suspected to be used by *M. orianae oceanensis* including species records in the NSW BioNet Atlas with microhabitat code 'IC – in cave'; observation type code 'E nest-roost'; with numbers of individuals >500; or from the scientific literature. All breeding habitat including the cave, or other features used for breeding, and the area immediately surrounding this feature.

Approach to create species polygon: Species polygon boundaries should have a 100 metre radius buffer around an accurate GPS point location centred on the cave/feature entrance. An example of how this may be done is illustrated in Figure 1a.

Note: The foraging habitat of this species is assessed as an ecosystem credit; only breeding habitat generates species credits.

Little bent-winged bat *Miniopterus australis*

Site	Per cave/mine/tunnel		
Survey method	**Survey period**	**Total effort**	**Min. no. of nights**
Harp trap	December – February	8	4

Survey methods: *Harp traps* should be placed close to exits of caves, mines or tunnels identified as survey habitat. Care should be taken to monitor traps to avoid overcrowding. Age, sex and reproductive status of captured bats must be assessed and recorded. A minimum of two traps per night over two nights, repeated at least two weeks later, is required.

Potential habitat: Caves, tunnels, mines or other structures known or suspected to be used by *M. australis* including species records in the NSW BioNet Atlas with microhabitat code 'IC – in cave'; observation type code 'E nest-roost'; with numbers of individuals >500; or from the scientific literature. All breeding habitat including the cave, or other features used for breeding, and the area immediately surrounding this feature.

Approach to create species polygon: Species polygon boundaries should have a 100 metre radius buffer around an accurate GPS point location centred on the cave/feature entrance. An example of how this may be done is illustrated in Figure 1a.

Note: The foraging habitat of this species is assessed as an ecosystem credit; only the breeding habitat generates species credits.

Grey-headed flying-fox *Pteropus poliocephalus*

Site	Per camp		
Survey method	**Survey period**	**Total effort**	**Min. no. of days**
Daytime camp survey	October – December	6hrs (two hours/day)	3 (one per month)

Survey methods: *Daytime camp survey* of flying-fox camp (see Section 2.8).

Potential breeding habitat: Any recorded flying fox camps, places where flying foxes are observed roosting during the day and roosting habitat likely to occur on the subject land. If a camp is located the survey only needs to take place in the camp (i.e. the area occupied by the species) to identify breeding females.

Approach to create species polygon: Use GPS to map the outer perimeter of the camp to create the species polygon. An example of how this may be done is illustrated in Figure 1c.

Note: The foraging habitat of this species is assessed as an ecosystem credit; only breeding habitat generates species credits.

3.3 Survey requirements for bat species where both habitat and breeding habitat must be identified

For the following species credit species breeding habitat is a potential serious and irreversible impact (SAII).

An SAII is listed under the BC Act as an impact that is likely to contribute significantly to the risk of extinction of a threatened entity. The BAM requires additional information to be provided in the BAR for any impact that is a potential SAII (see Section 9.1 of the BAM).

Currently, the breeding habitat of two bat species is listed as a potential SAII (see below). In accordance with Section 1.5 of this guide breeding habitat is considered present on the subject land if there is 1) potential breeding habitat, AND 2) breeding individuals of the target species. Where these criteria are not met but the species is present on the subject land the proposed impact is not a potential SAII, however standard species credits will still be generated.

Large-eared pied bat *Chalinolobus dwyeri*

Site	Per ≤50 hectares of potential habitat		
Survey method	**Survey period**	**Total effort**	**Min. no. of nights**
Harp trap or mist net	Mid Nov. – end of Jan.	16	4
Passive acoustic detection	Mid Nov. – end of Jan.	16	4
Radio tracking or roost search	Mid Nov. – end of Jan.	As required	Supplementary

Survey methods: *Harp trap (or mist net)* placed in areas of potential habitat, and potential breeding habitat (if present) on the subject land. The survey may use harp traps or a combination of harp traps and mist nets. Age, sex and reproductive status of captured bats must be assessed and recorded.

Passive acoustic detection may be used; however, this method does not allow for reproductive status to be identified. If acoustic detectors are the only survey method used and the target species is detected, breeding must be assumed, and all potential breeding habitat mapped as breeding habitat.

Radio tracking or roost searches are optional supplementary methods that may be used to pinpoint the breeding site and refine the species polygon when recommended survey confirms the presence of breeding habitat. However, these methods cannot be used to demonstrate the species is absent from the subject land.

Traps and/or detectors should be set in woodlands, valley floors, riparian areas and relatively fertile parts of potential habitat on the subject land where possible.

Potential habitat: All areas with the PCTs associated with the species (as per the TBDC) on the subject land where the subject land is within 2 kilometres of caves, scarps, cliffs, rock overhangs and disused mines.[18]

Potential breeding habitat: All potential habitat on the subject land where the subject land is within 100 metres of caves, scarps, cliffs, rock overhangs and disused mines.[19]

Approach to create species polygon: Two polygons may be required, one for species habitat for credit generation and one for breeding habitat (for the SAII consideration) if both the species and breeding individuals are present or assumed present. Use high resolution aerial imagery and topographic maps to identify and map potential roost habitat features such as caves, scarps, cliffs, rock overhangs or disused mines within 2 kilometres of the subject land.

Features to include in the species polygon(s): The species polygon boundary should align with all PCTs on the subject land that are within 2 kilometres of identified potential roost habitat features, and with which the species is associated (as listed in the TBDC). For assessment of biodiversity stewardship sites, the species polygon may include areas of degraded PCTs that are to be restored to recognisable PCTs associated with the species as part of an approved management plan for the site. Where breeding habitat is also present, an additional species polygon for the breeding habitat must include all breeding habitat on or within 100 metres of the subject land. The polygon must incorporate the habitat feature and a buffer of at least 100 metres wide (or 100 metres radius for point locations such as caves) with the breeding habitat features (may be multiple) as the centroid (see Figure 1a). Artificial structures should be inspected and included if the species is using these features for breeding. An example of how the species polygon(s) for this species may be made is provided in Example 2.

Note: Any breeding habitat identified for this species is a potential serious and irreversible impact.

Eastern cave bat *Vespadelus troughtoni*

Site	Per ≤50 hectares of potential habitat		
Survey method	**Survey period**	**Total effort**	**Min. no. of nights**
Harp trap or mist net	November – end of Jan.	16	4
Roost search (artificial structures)	November – end of Jan.	1 per structure	N/A
Acoustic detection	November – end of Jan.	16	4
Radio tracking/roost search	November – end of Jan.	As required	

[18] An example of how this may be done is illustrated in Figure 1a, noting the buffer distance for potential habitat is 2 kilometres.

[19] An example of how this may be done is illustrated in Figure 1a.

Survey methods: *Harp trap (or mist net)* placed in areas of potential habitat and potential breeding habitat (if present) on the subject land. The survey may use harp traps or a combination of harp traps and mist nets. Age, sex and reproductive status of captured bats must be assessed and recorded.

Passive acoustic detection may be used; however, this method does not allow for reproductive status to be identified. If acoustic detectors are the only survey method used and the target species is detected, breeding must be assumed, and all potential breeding habitat mapped as breeding habitat.

Radio tracking or roost searches are optional supplementary methods that may be used to pinpoint the breeding site and refine the species polygon when recommended survey confirms the presence of breeding habitat; however, these methods cannot be used to demonstrate the species is absent from the subject land.

Traps and/or detectors should be set in woodlands, valley floors, riparian areas and relatively fertile parts of potential habitat on the subject land where possible.

Potential habitat: All areas with the PCTs associated with the species (as per the TBDC) on the subject land where the subject land is within 2 kilometres of caves, scarps, cliffs, rock overhangs and disused mines.[20]

Potential breeding habitat: All potential habitat on the subject land where the subject land is within 100 metres of caves, scarps, cliffs, rock overhangs and disused mines.[21]

Approach to create species polygon: Two polygons may be required, one for species habitat for credit generation and one for breeding habitat (for the SAII consideration) if both the species and breeding individuals are present or assumed present. Use high resolution aerial imagery and topographic maps to identify and map potential roost habitat features such as caves, scarps, cliffs, rock overhangs or disused mines within 2 kilometres of the subject land.

Features to include in the species polygon(s): The species polygon boundary should align with all PCTs on the subject land that are within 2 kilometres of identified potential roost habitat features, and with which the species is associated (as listed in the TBDC). For assessment of biodiversity stewardship sites, the species polygon may include areas of degraded PCTs that are to be restored to recognisable PCTs associated with the species as part of an approved management plan for the site. Where breeding habitat is also present, an additional species polygon for the breeding habitat must include all breeding habitat on or within 100 metres of the subject land. The polygon must incorporate the habitat feature and a buffer of at least 100 metres wide (or 100 metres radius for point locations such as caves) with the breeding habitat features (may be multiple) as the centroid (see Figure 1a). Artificial structures should be inspected and included if the species is using these features for breeding. Example 2 illustrates how the species polygon(s) for this species may be prepared.

Note: Any breeding habitat identified for this species is a potential serious and irreversible impact.

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[20] An example of how this may be done is illustrated in Figure 1a, noting the buffer distance for potential habitat is 2 kilometres.

[21] An example of how this may be done is illustrated in Figure 1a.

4. References

Adams MD, Law BS and Gibson MS 2010, Reliable Automation of Bat Call Identification for Eastern New South Wales, Australia, Using Classification Trees and AnaScheme Software, *Acta Chiropterologica*, vol.12, pp.231–245.

Altringham JD 2011, *Bats: From Evolution to Conservation*, (2nd edition), Oxford University Press, Oxford, GBR.

Anderson J, Law B and Tidemann C 2005, Stream use by the Large-footed Myotis *Myotis macropus* in relation to environmental variables in Northern New South Wales, *Australian Mammalogy*, vol.28, pp.15–26.

Australasian Bat Society 2007, *Recommendations of the Australasian Bat Society Inc for reporting standards for insectivorous bat surveys using bat detectors*, ausbats.org.au/download/i/mark_dl/u/4008973680/4550855147/ABS_Anabat_survey_standards.pdf (PDF 72KB)

Australian Technical Advisory Group on Immunisation (ATAGI) 2018, *Australian Immunisation Handbook*, Australian Government Department of Health, Canberra, available at immunisationhandbook.health.gov.au

Berry N, O’Connor W, Holderied MW and Jones G 2004, Detection and Avoidance of Harp Traps by Echolocating Bats, *Acta Chiropterologica*, vol.6, pp.335–346.

Campbell S 2009, So long as it’s near water: variable roosting behaviour of the large-footed myotis (*Myotis macropus*), *Australian Journal of Zoology*, vol.57, pp.89–98.

Chambers CL, Vojta CD, Mering ED and Davenport B 2015, Efficacy of scent-detection dogs for locating bat roosts in trees and snags, *Wildlife Society Bulletin*, vol.39, pp.780–787.

Churchill S 2008, *Australian bats*, Allen & Unwin, Crows Nest, NSW.

Comer CE, Stuemke LA, Morrison ML and Maxey RW 2014, Comparison of systematic roost searches and acoustic detection to determine occupancy of rare forest bats, *Wildlife Society Bulletin*, vol.38, pp.103–110.

Department of Planning, Industry and Environment (DPIE) 2019, *Guidance to assist a decision-maker to determine a serious and irreversible impact*, NSW Department of Planning, Industry and Environment, Sydney NSW.

Department of Planning, Industry and Environment (DPIE) 2020, *Biodiversity Assessment Method*, NSW Department of Planning, Industry and Environment, Parramatta NSW.

Department of Environment, Water, Heritage and Arts (DEWHA) 2010, *Survey guidelines for Australia’s threatened bats*, Department of Environment Water Heritage and Arts.

Environmental Protection Authority (EPA) and Department of Environment and Conservation (DEC) 2010, T*echnical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment*, NSW Environmental Protection Authority and NSW Department of Environment and Conservation, Sydney.

Fischer J, Stott J, Law BS, Adams MD and Forrester RI 2009, Designing Effective Habitat Studies: Quantifying Multiple Sources of Variability in Bat Activity, *Acta Chiropterologica*, vol.11, pp.127–137.

Francis CM 1989, A Comparison of Mist Nets and Two Designs of Harp Traps for capturing Bats, *Journal of Mammalogy*, vol.70, pp.865–870.

Gonsalves L, Law B, Webb C and Monamy V 2012, Are vegetation interfaces important to foraging insectivorous bats in endangered coastal saltmarsh on the Central Coast of New South Wales? *Pacific Conservation Biology*, vol.18, pp.282–292.

Hill DA, Armstrong KN and Barden PA 2015, Preliminary assessment suggests that acoustic lures can increase capture rates of Australian echolocating bats, *Australian Mammalogy*, vol.37, pp.104–106.

Jackson S 2003, *Australian Mammals: Biology and Captive Management*, CSIRO Publishing.

Law B 2004, 'Challenges for managing bats in the State Forests of New South Wales', pp.748–760, in D Lunney (ed.), *The Conservation of Australia's Forest Fauna*, Royal Zoological Society of NSW, Mosman NSW.

Law BS, Anderson J and Chidel M 1999, Bat communities in a fragmented forest landscape on the south-west slopes of New South Wales, Australia, *Biological Conservation*, vol.88, no.3, pp.333–345.

Law B, Chidel M and Mong A 2005, Life under a sandstone overhang: The ecology of the Eastern Cave Bat *Vespadelus troughtoni* in Northern New South Wales, A*ustralian Mammalogy*, vol.27, pp.137–145.

Law B, Gonsalves L, Tap P, Penman T and Chidel M 2015, Optimizing ultrasonic sampling effort for monitoring forest bats, *Austral Ecology*, vol.40, pp.886–897.

Lloyd A, Law B and Goldingay R 2006, Bat activity on riparian zones and upper slopes in Australian timber production forests and the effectiveness of riparian buffers, *Biological Conservation*, vol.129, no.2, pp.207–220.

Luck G, Smallbone L, Threlfall C and Law B 2013, Patterns in bat functional guilds across multiple urban centres in south-eastern Australia, *Landscape Ecology*, vol.28, no.3, pp.1–15.

Lumsden LF and Bennett AF 1995, Bats of a Semi-arid Environment in South-eastern Australia: Biogeography, Ecology and Conservation, *Wildlife Research*, vol.22, pp.217–240.

Lumsden LF and Bennett AF 2005, Scattered trees in rural landscapes: Foraging habitat for insectivorous bats in south-eastern Australia, *Biological Conservation*, vol.122, no.2, pp.205–222.

Lumsden LF, Bennett AF and Silins JE 2002, Location of roosts of the lesser Long-eared bat *Nyctophilus geoffroyi* and Gould's wattled bat *Chalinolobus gouldii* in a fragmented landscape in south-eastern Australia, *Biological Conservation*, vol.106, pp.237–249.

Marques JT, Ramos Pereira MJ, Marques TA, Santos CD, Santana J, Beja P and Palmeirim JM 2013, Optimizing Sampling Design to Deal with Mist-Net Avoidance in Amazonian Birds and Bats, PLoS ONE 8(9): e74505, https://doi.org/10.1371/journal.pone.0074505.

McConville A, Law BS and Mahony MJ 2013, Mangroves as maternity roosts for a colony of the rare east-coast free-tailed bat (*Mormopterus norfolkensis*) in south-eastern Australia, *Wildlife Research*, vol.40, pp.318–327.

Mills DJ, Norton TW, Parnaby HE, Cunningham RB and Nix HA 1996, Designing surveys for microchiropteran bats in complex forest landscapes—a pilot study from south-east Australia, *Forest Ecology and Management*, vol.85, pp.149–161.

Neuweiler G 2000, *The Biology of Bats*, Oxford University Press.

Parnaby HE 1992, *An interim guide to identification of insectivorous bats of south-eastern Australia*, Australian Museum, Sydney South NSW.

Pennay M 2005, *Ecological study of the endangered Bristle-nosed bat (Mormopterus species 6) and survey of microchiropteran bats in Gundabooka National Park*, NSW National Parks and Wildlife Service.

Pennay M 2008, A maternity roost of the Large-eared Pied Bat *Chalinolobus dwyeri* (Ryan) (Microchiroptera: Vespertilionidae) in central New South Wales Australia, *Australian Zoologist*, vol.34, pp.564–569.

Pennay M, Law B and Lunney D 2011, ‘Review of the distribution and status of the bat fauna of New South Wales and the Australian Capital Territory’, pp.226–256 in B Law, P Eby, D Lunney and L Lumsden (eds), *The Biology and Conservation of Australian Bats*, Royal Zoological Society of NSW, Mosman NSW.

Pennay M, Law B and Reinhold L 2004, *Bat Calls of New South Wales*, NSW Department of Environment and Conservation.

Polkanov A 2007, ‘Use of dogs in bat surveys’, in LF Lumsden, P Eby, B Law and D Lunney (eds), *Royal Zoological Society of New South Wales and Australasian Bat Society Symposium on the biology and conservation of Australasian bats*, Mosman NSW.

Reardon T 2001, Infrared video camera for checking hollows and bat boxes, *Australasian Bat Society Newsletter*, vol.15, pp.46–47.

Reardon T, Adams M, Mckenzie N and Jenkins P 2008, A new species of Australian freetail bat *Mormopterus eleryi* sp nov (Chiroptera: Molossidae) and a taxonomic reappraisal of *M. norfolkensis* (Gray), *Zootaxa*, vol.1875, pp.1–31.

Snoyman S, Muhic J and Brown C 2012, Nursing females are more prone to heat stress: Demography matters when managing flying-foxes for climate change, *Applied Animal Behaviour Science*, vol.142, pp.90–97.

Stawski C 2010, Torpor during the reproductive season in a free-ranging subtropical bat, *Nyctophilus bifax*, *Journal of Thermal Biology*, vol.35, pp.245–249.

Tidemann CR and Woodside DP 1978, A Collapsible Bat-trap and a Comparison with the Trap and with Mist-nets, *Australian Wildlife Research*, vol.5, pp.355–362.

Turbill C and Ellis M 2008, Distribution and abundance of the south-eastern form of the Greater Long-eared Bat *Nyctophilus timoriensis*, *Australian Mammalogy*, vol.28, pp.1–6.

Appendix A: Threatened bat survey decision key

1. Do I need to survey for a threatened bat?
    a. Is the species known or predicted on the subject land?
        i. No....................survey not required
        ii. Yes....................go to 1b
    b. What is the credit class for the species? (Section 1.4)
        i. Ecosystem credit[22]....................survey not required
        ii. Species credit[23]....................go to 1c
        iii. Species credit for breeding habitat[24.]....................go to 1c
    c. Is suitable habitat present on the subject land? (Section 2.3)
        i. No....................survey not required
        ii. Yes....................survey required, go to 2
2. Threatened bat survey steps
    a. Choose survey approach (Chapters 2 & 3)
        i. Conduct survey....................go to 2b
        ii. Expert report....................go to 2b
        iii. Assume present (development and biocertification sites only)....................go to 2c
    b. Is the species present?
        i. No....................**document in BAR**
        ii. Yes....................go to 2c
    c. Do I need to identify breeding habitat? (Chapter 3)
        i. No breeding habitat requirements[25] .. **map species polygon, document in BAR**
        ii. Breeding habitat is a species credit....................Yes – go to 2d
        iii. Breeding habitat classified SAII[26] .. **map species polygon (habitat)** and go to 2d
    d. Is potential breeding habitat present on or near the subject land?[27]
        i. No....................**document in BAR**
        ii. Yes....................go to 2e
    e. Are breeding individuals present? [28,29]
        i. No....................**document in BAR**
        ii. Yes....................**map species polygon (breeding) and document in BAR**

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[22] Hoary wattled bat, little pied bat, eastern false pipistrelle, golden-tipped bat, northern freetail-bat, eastern tube-nosed bat, eastern long-eared bat, eastern freetail-bat, Corben’s long-eared bat, yellow-bellied sheath-tail bat, greater broad-nosed bat, common blossom bat, inland forest bat.

[23] Large-eared pied bat, bristle-faced freetail-bat, southern myotis, eastern cave bat.

[24] Eastern bent-wing bat, little bent-winged bat, grey-headed flying-fox.

[25] Bristle-faced freetail-bat, southern myotis.

[26] Large-eared pied bat, eastern cave bat.

[27] For ‘near’ refer to the species descriptions for proximity of the feature for each species. If assumed present in step 2a(iii) breeding habitat must also be assumed present at step 2d.

[28] Breeding individuals means a female bat of the target species that is pregnant, carrying pups or lactating; or juveniles of the target species present, assumed present or previously recorded on site. To determine the presence of breeding individuals you must have used a survey method capable of determining age/reproductive status, assumed presence or used previous records of breeding individuals.

[29] If assuming species present on site – breeding individuals (and breeding habitat) must also be assumed present.

Appendix B: Supporting information

This appendix provides additional details and scientific background to the recommended approaches provided in this guide.

Identification of breeding bats

Identification of breeding bats is an essential requirement of this guide (see Section 1.5). Identification must be done by a suitably qualified bat surveyor (see Section 2.2).

For the purposes of this guide a breeding bat is defined as a *female bat of the target species that is pregnant, carrying pups, lactating, and/or juveniles of the target species present on site.*

To avoid confusion or ambiguity the following advice is provided:

Determining sex

Female bats can be identified by the absence of a conspicuous external penis, obvious in most bat species (Figure 2); if you are unsure or unable to see any sign of a penis with close inspection, it is likely you have a female. Additional care is required in determining the sex of bent-wing bats (*Miniopterus* spp.) because the penis is small and slender and can easily be overlooked (Parnaby 1992). Likewise, female *Setirostris eleryi* have a genital projection which may be mistaken for a penis (Reardon et al 2008).

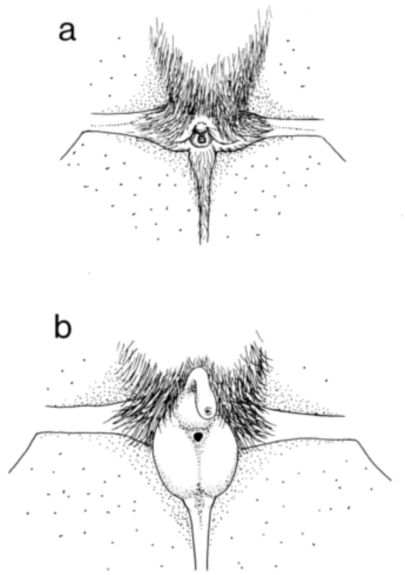

Figure 2 Bat genitals: a. female, b. male (from Parnaby 1992)

Determining reproductive condition

The reproductive condition of females can be identified by physical examination.

Pregnant bats

Females in the later stages of gestation are heavier than non-breeding females and males of the same species, and the foetus can be detected with gentle abdominal palpation (Churchill 2008). The foetus usually lies sideways across the abdomen (Churchill 2008). It is useful to examine males as experience is necessary to distinguish a full stomach from a pregnancy (Parnaby 1992).

Lactating bats

The condition of the teats, one located near each armpit, provides a guide to reproductive condition. Teats are examined by gently blowing on the fur close to the armpit to expose the teat. During lactation the fur around the nipple wears away and the nipple becomes enlarged. Sometimes the surrounding skin is raised or white milk can be seen beneath the skin (Figures 3b & 4)(Parnaby 1992; Churchill 2008).

Such features distinguish lactating bats from:

- females which have never given birth, where the nipple is very small and dome like. The surrounding skin is neither pigmented, raised nor wrinkled and is often surrounded by dense fur (Figure 3a).
- females that have previously raised young but not recently (adult regressed), where nipples are smaller and the surrounding skin often has darker pigmentation (Figure 3c).

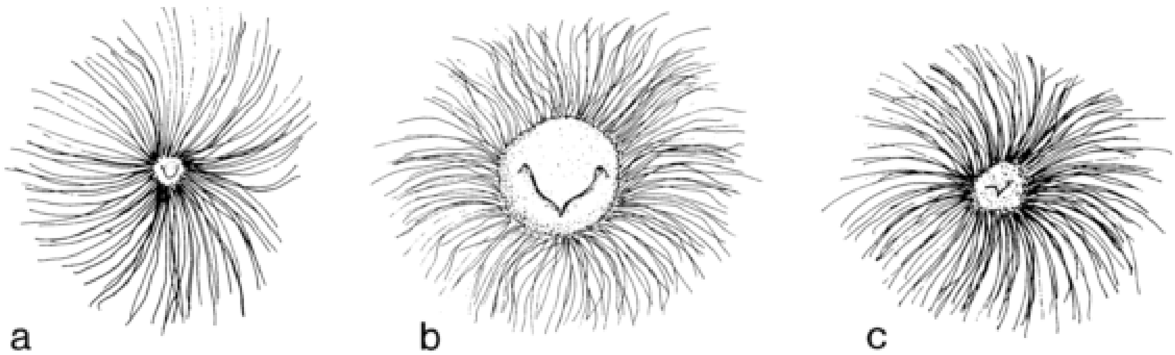

Figure 3 **Mammary area at different reproductive stages: a. subadult, b. lactating, c. adult regressed (Parnaby 1992)**

Figure 4 **Lactating female eastern cave bat *Vespadelus troughtoni*, red arrow indicating nipple. Photo: M Pennay**

Identifying juvenile bats

The guide uses the generalised term juvenile bats to refer to:

- newborn bats – easily identified as they are much smaller than adults, may be hairless or covered with fine velvety hair, are often attached to the mother’s teat
- dependent young bats – smaller than adults often with darker, greyer fur, the wing joints are not fused and show cartilage bands (Figure 5a)
- sub-adult bats – may be able to fly, smaller or approaching adult size, teeth are un-worn, fur and wing membrane clean and glossy and lacking the scarring of adult bats, and the wing joints show bands of cartilage and blood vessels (when backlit) (Figures 5b & 5c). In females the nipples are minute (similar to Figure 3a) and in males the testes have not descended and the epididymal sac is not visible (Figure 2b illustrates testes descended).

These features differentiate juveniles from adults. Adult bats often show signs of being reproductive (e.g. enlarged testes) or previous reproduction (e.g. regressed nipples). The teeth are often worn; the wing membranes show numerous small scars and the wing finger joints are fully formed with no indication of cartilage between the bones (Figure 5d).

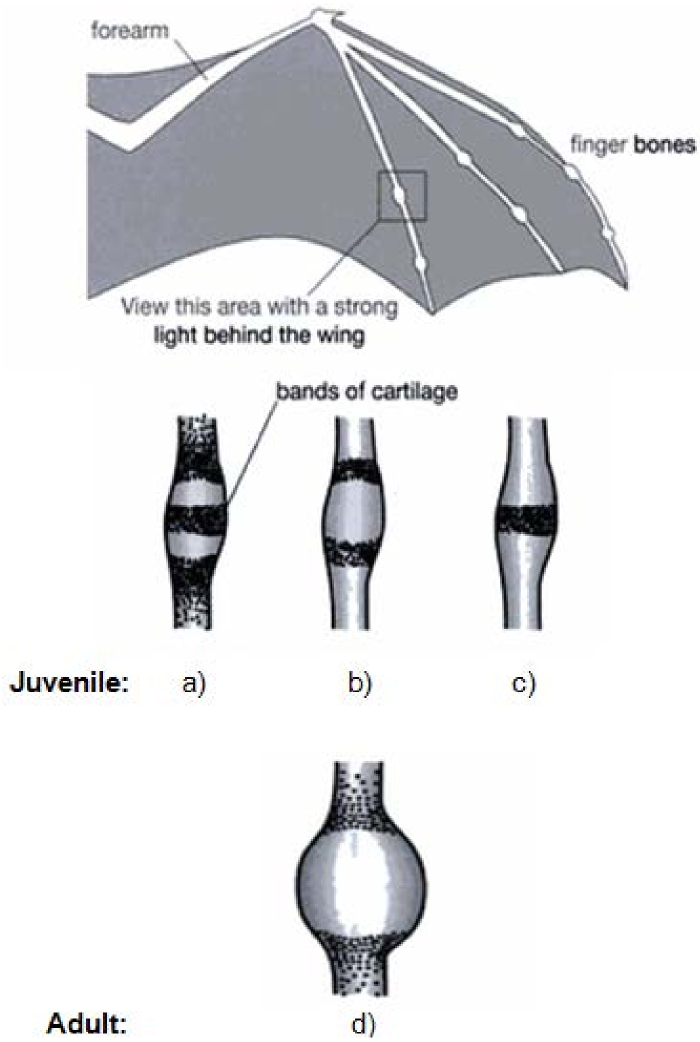

Figure 5 Bat finger joints: Juvenile: a) 0–1 month old; b) 1–2 months; c) 2–3 months; Adult: d) >3 months (from Jackson 2003)

Survey techniques

The guide predominantly recommends capture techniques; either harp traps or mist nets. Acoustic recording or observational methods are only recommended in specific instances.

Capture techniques are the most reliable methods for identifying bats; most captured bats can be positively identified by an experienced surveyor. Information about the sex, age, reproductive status and other characteristics of the bat can be assessed (Hill et al. 2015). Such information is required for surveys targeting breeding habitat.

A brief discussion of the key points of bat survey methods is provided.

Harp traps

Bat traps, known as ‘harp traps’ are the most commonly used tools for capturing microbats in Australia (DEWHA 2010). A harp trap consists of a 1.8 metre metal frame mounted on adjustable legs. The frame is strung vertically in two banks with fine monofilament fishing line (3 kilograms or less breaking strain) creating a 4.2 square metre catch area; a catch bag hangs below the trap (Tidemann & Woodside 1978; Churchill 2008; DEWHA 2010). Bats fly into the fishing lines and slide down into the catch bag from which they cannot escape (DEWHA 2010).

There are many harp trap variations. The description and suggested levels of effort specified in this guide are based on a commonly used model in Australia, the Austbat harp trap, produced by Faunatech. The threatened bat surveyor should consider adjusting survey effort if a harp trap model with a smaller catch area is used.

Harp traps work for whole nights, they are usually set in location during the day and then checked during the night and at dawn (Churchill 2008). Harp traps are suitable for capturing most species of microbats, in many situations they are more effective and efficient than mist nets as a capture method (Tidemann & Woodside 1978; Francis 1989). Mist nets may however be more effective over water in semi-arid zones (Lumsden & Bennett 1995).

Harp traps only sample an extremely small area relative to the large areas used by free flying bats so positioning of the trap is extremely important (EPA & DEC 2010). Harp traps can be placed in vegetation corridors, across paths, roads, rivers and streams, under overhanging branches, over water tanks, and at cave or mine entrances. Harp traps are conspicuous acoustic targets easily detected by bats, only a very small proportion of bats (less than 4%) that encounter a harp trap are captured (Berry et al. 2004).Traps work best if they are placed where bats are surprised, deceived or cornered (Churchill 2008; EPA & DEC 2010).

Harp traps must be set beside or under trees or other structures (caves, bridges, etc.). In treeless areas alternative capture methods should be considered such as mist netting over waterholes (Churchill 2008).

The placement of traps can affect the number and type of species captured (Law 2004); for example, traps set over roads tend to catch more bats than those set in vegetation (Mills et al. 1996). Suggested trap locations for each of the target species are provided in the individual species accounts in Chapter 3.

If the objective is to maximise captures (likelihood of detection) the trap should be moved nightly to avoid learned avoidance behaviour. There is evidence with mist nets (the same principle also applies to harp traps) that moving nets daily to minimise the avoidance effect significantly increases bat captures (e.g. by 70%, see Marques et al. 2013). Similar effects have been observed in *Nyctophilus bifax* in Australia by Stawski (2010).

Mist nets

Mist nets are very fine nylon or polyester nets that come in a range of sizes. When unfurled and tensioned properly the net contains horizontal pockets. A bat that flies into the net may fall into the pocket below and become entangled (EPA & DEC 2010). Entangled bats must be removed from the net immediately (DEWHA 2010).

Mist nets for trapping microbats must have very fine filaments (ultrathin 0.8 millimetre monofilament nylon nets) to minimise the sonic reflectance of the net (DEWHA 2010); mesh sizes of 15–20 millimetres are appropriate for most microbats.

Two-ply polyester 50–75 denier mist nets with a mesh size of 30–50 millimetres can be used to target *Nyctimene robinsoni* as it navigates visually; however, these nets are less suitable for microbats because of the thicker netting and larger mesh size.

Grey-headed flying-foxes can also be captured in large mist nets; however, mist netting is not a recommended targeted survey method for grey-headed flying-foxes because it is usually not necessary to capture flying-foxes to locate breeding habitat. Less disruptive methods are recommended.

In general mist netting is labour intensive and therefore rarely used in standard bat surveys (DEWHA 2010). Nets require constant attention and are generally less effective than harp traps (Tidemann & Woodside 1978; Francis 1989; Berry et al. 2004). Bats captured in mist nets are also active and alert, which makes them harder to handle and more likely to bite than bats that have settled in a harp trap and entered torpor.

In specific circumstances mist nets may be the preferred capture method; for example, in remote locations accessible by foot (mist nets are light weight and easily portable), or large open areas in forests, across rivers, creeks or isolated waterholes in arid/semi-arid regions (Lumsden & Bennett 1995; Pennay 2005; Churchill 2008). Mist nets are available in variable lengths up to 30 metres (Churchill 2008).

Like harp traps, mist nets should be moved nightly to maximise capture rates and minimise avoidance effects.

Acoustic detection

Ultrasonic detection

The echolocation calls used by microbats to navigate and hunt can be recorded using specialised purpose-built ultrasonic recording devices known as bat detectors. The calls captured by the bat detector can be transferred to sound analysis software and compared against libraries of known ‘reference calls’ of bat species by bat call analysis experts for identification (Pennay et al. 2004).

Echolocation call recording is a very popular method for surveying bats. It is non-invasive, bats are unaware they are being recorded and behave naturally. It is particularly valuable for detecting species that avoid traps or fly beyond the range of traps. Echolocation call recording is also less labour intensive than capture methods. Bat detectors can be set with minimal effort and record and capture large amounts of data remotely for extended periods of time (DEWHA 2010).

However, echolocation recording means identification is presumed rather than certain (discrimination between species can be difficult) and information about the sex and breeding status of individuals cannot be recorded (Pennay et al. 2004; Adams et al. 2010; DEWHA 2010).

Audible call detection

Acoustic detection and call recorders are used for wildlife with distinctive audible calls such as birds and frogs. These detectors have microphones and software sensitive to calls at lower frequencies in the audible spectrum. Some commercial detectors come with dual microphones for recording audible and ultrasonic calls.

Threatened bat species such as the eastern tube-nosed bat can produce an audible ‘whistling’ call (Churchill 2008). Their calls can be recorded with an acoustic detection recorder capable of recording calls in the audible frequency spectrum. The general principles for recording ultrasonic calls apply to the recording audible calls.

Bat detector requirements

The guide does not specify any particular type of bat detector for use in surveys; however, this information must be recorded in the BAR. At a minimum it should:

- be designed for passive recording and remote deployment (equipped with timer activated recording and suitable weatherproofing) if used for passive acoustic detection

or

  be designed for active detection and include a function that displays real time visual outputs of the calls being recorded to aid identification if used for active detection
- record the frequency range of all target bat species at comparable distances to other commercial bat detectors
- have a recording capacity (battery and data storage) capable of lasting at least several full nights of recording.

Radio tracking

Radio tracking has been successfully used to locate the maternity roosts of tree dwelling microbat species (Lumsden et al. 2002; Pennay 2005; Stawski 2010; McConville et al. 2013). Captured pregnant or lactating bats are fitted with very small radio transmitters and released; the bats are then tracked during the day to roost sites using radio telemetry. Radio tracking has also been used to locate maternity roosts in caves and tunnels (Law et al. 2005; Campbell 2009).

Microbat radio transmitters are expensive, have very short battery life (<2 weeks) and transmit over a very small range (typically only a few hundred metres and less in caves or tunnels)(Campbell 2009). Bats may fly many kilometres from the place where they are captured to the maternity roost (Lumsden et al. 2002; Law et al. 2005; Pennay 2005).

For this guide radio tracking can be used to pinpoint the location of maternity sites but cannot be used to confirm absence of maternity sites (i.e. if tracked individuals cannot be relocated on site).

Roost searches

Microbat roost searches can be done by looking for bats or signs of bats (urine stains, droppings, remains) in suitable habitat. Depending on the species this may be trees, caves or overhangs, old buildings and sheds or bridges, mines and culverts (Churchill 2008).

All roost searches should use a torch to shine in holes, cracks and crevices, and the surveyor must carry a handheld bat detector to locate (and identify) bats. Audible calls from microbats may also be heard when approaching. Scent detection dogs specially trained to locate bats have been used in other countries and have proven moderately effective at locating bat roosts in trees, caves and buildings; however, their use has not yet been widely adopted in Australia (Polkanov 2007; Chambers et al. 2015).

Small video cameras can be used to investigate hollows for roosting bats, and may help determine if roosts are maternity sites (Reardon 2001). If a roost is located observers must confirm the identity of the species and determine if the roost is a maternity roost.

Roost searches are labour intensive, and are less effective than other methods at locating bats (Comer et al. 2014). The roosts of some species are cryptic and very rarely found despite searches (Pennay 2008). For these reasons this guide considers roost searches to be supplementary to other recommended survey methods.

Alternative methods

There are a range of additional methods to capture individuals (e.g. shooting, trip lines, hand nets) or pinpoint the location of maternity sites; however, these methods tend to be very labour or resource intensive, are generally less effective or efficient, and/or not suited to the specific survey objectives of the NSW BOS, and are therefore not recommended in this guide.

Novel techniques are continuously being developed; for example, specialised bat camera traps set at watering points or acoustic lures. As these techniques are further tested and proven effective, they may be included in future versions of the guideline. Advice from DPIE should be sought if alternative capture methods are planned to be used in a targeted bat survey.

Appendix C: Estimating expected results

Preliminary results of the survey can be evaluated against expected results to identify any potential problems with survey effort. Ideally this should be done in the field so that remedies are immediate (e.g. by sampling additional nights).

A good indication of expected results can be gained from examining the results of other surveys using similar methods in similar regions or habitats. Non-target and common bat species often provide a good indication of whether a survey method has been applied successfully.

As an example, Law et al. (2015) report recording 183,890 bat calls over 408 detector nights in the Pilliga forests between the months of November and March in 2007 and again in 2012. On average they recorded 450.7 bat calls per detector night. If a hypothetical ultrasonic survey conducted in December in the cypress ironbark forests of northern New South Wales recorded only 12 bat calls per detector night, the significantly lower number than that of Law et al (2015) would warrant investigation.

Table 1 provides some sources to assist in assessing the indicative results expected from a successfully applied survey method.

Table 1 Sample bat surveys demonstrating effort and results across different methods and locations in New South Wales

Survey	Location	Season	Method	Effort/ night	Resulting bat records/night
Lumsden & Bennett 2005	Riverina	Jan. – April	Acoustic detection	120	246.9
Luck et al. 2013	Various regional towns	Sep. – May	Acoustic detection	340	129
Gonsalves et al. 2012	Central coast	March	Acoustic detection	36	32
Lloyd et al. 2006	North coast	Jan. – April	Acoustic detection	212	53.9
Lumsden & Bennett 2005	Riverina	Jan. – April	Harp trap	192	4.24
Turbill & Ellis 2008	Central and western NSW	Sep. – April	Harp trap	595	5.07
Mills et al. 1996	SE Forests	Feb. – Mar.	Harp trap	96	2.6
Law et al. 1999	SW Slopes	Jan. – Mar.	Harp trap	155	6.34
Lumsden & Bennett 1995	Mallee	Nov. – Feb.	Harp trap	595	5.07
Lumsden & Bennett 1995	Mallee	Nov. – Feb.	Mist net	595.2 (hrs)	1.1/(hr)

Some common explanations of poor survey results include:

- **weather:** survey may be affected by unsuitable weather conditions (wind, rain, cold). Solution: avoid surveying in unsuitable weather, reject and retake any survey effort affected by poor weather in suitable conditions.
- **trap placement:** trap or net placement may be inappropriate for the target species, for example in the open away from trees on which the species relies. Solution: if site unsuitable for trap type choose a more appropriate method or choose a more suitable site.

- **equipment failure:** equipment can fail to operate as expected; for example, bat detector ran out of batteries/ data storage/ timer failed. Solutions: always check recorder logs and data for unexpected low results, after sampling ensure batteries/timer/memory ready, resurvey as required.

Estimating expected likelihood of detecting threatened bat species

Threatened bats generally have a lower detection rate than other bat species (Pennay et al. 2011).

Pennay et al. (2011) reviewed over three million observations of bats in New South Wales over a 20-year period (excluding acoustic detections) and documented two measures that assist in understanding the relative likelihood of observing each bat species in New South Wales:

- mean density ratio (the average number of records for each individual species per 1000 records of all bat species within the species range), and
- mean annual observation rate (the percentage of bats reported each year within the species range belonging to that species) (see Table 2).

Table 2 provides an indication of the expected likelihood of finding the threatened species in this guide under general survey conditions in comparison with other species. For example, *Chalinolobus dwyeri* has an average ratio of 9.9:1000 bats and on average makes up 1.2% of captures in its range each year, equating to capture rates of about 100 bats in *C. dwyeri*'s range to catch a single *C. dwyeri*.

Table 2 Ratio (per 1000 captures) and observation rates of threatened bats in New South Wales (from Pennay et al. 2011)

Species	Ratio (per 1000 captures)	Annual observation rate
Chalinolobus dwyeri	9.9	1.2%
Miniopterus australis	280	24.9%
Miniopterus orianae oceanensis	190	19.9%
Myotis macropus	34	5.8%
Setirostris eleryi	0.2	0.5%
Vespadelus troughtoni	4.6	2.7%