Bat management guide

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Version 1

NZ TRANSPORT AGENCY
WAKA KOTAHI

Te Kāwanatanga o Aotearoa
New Zealand Government

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More information

NZ Transport Agency Waka Kotahi
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If you have further queries, call our contact centre on 0800 699 000 or write to us:

NZ Transport Agency Waka Kotahi
Private Bag 6995
Wellington 6141

This document is available on NZTA's website at www.nzta.govt.nz

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Guide summary

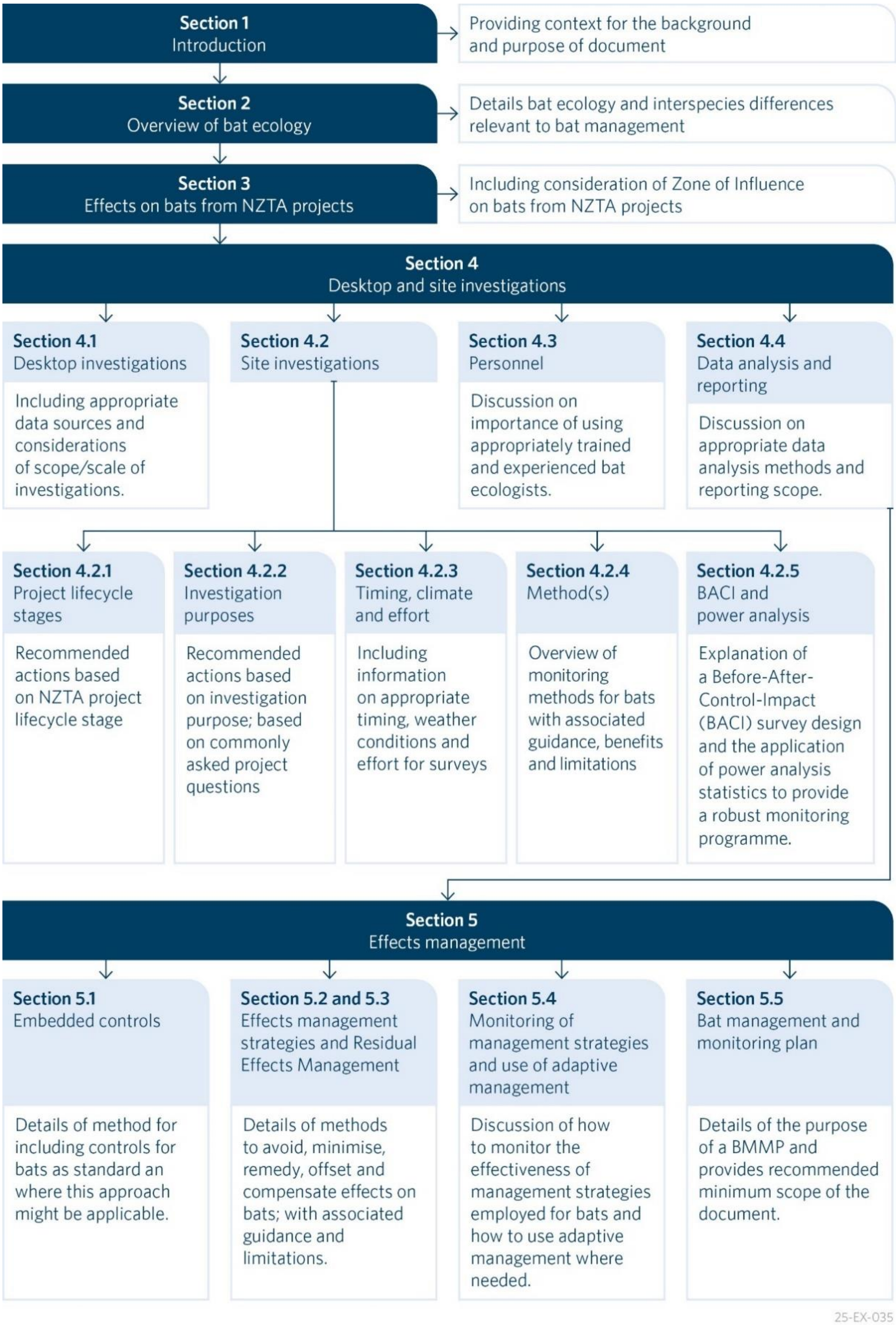

Figure 1: *Bat management guide* document structure

1 Introduction

- New Zealand has 2 endemic bat species (and 3 sub-species) that are protected and classified as threatened, and there are legal obligations associated with them.
- New Zealand bat species are commonly encountered on NZ Transport Agency Waka Kotahi (NZTA) projects, and bats and or critical habitat features can be present on land owned or managed by NZTA (Figure 2).
- The ecology of New Zealand’s bats makes assessing and managing effects on them and their critical habitats particularly complex.
- This *Bat management guide* provides a consistent, fit-for-purpose framework for assessing, managing, and monitoring the effects of transport network activities on bats.
- This guide provides necessary species-specific information for undertaking ecological impacts assessments (EcIA) and supports the NZTA *Ecological impact assessment guideline* (NZTA EcIA guide).

This *Bat management guide* has been developed to assist with the assessment, management, and survey/monitoring of the effects of constructing, operating, and maintaining transport networks, including on land that is owned by the NZ Transport Agency Waka Kotahi (NZTA), on native bats.

This guide provides species-specific information that supports the overarching NZTA *Ecological impact assessment guidelines* (NZTA EcIA guide) (NZTA, 2023). It aims to give projects and maintenance teams greater certainty around good practice for bat management and to ensure that NZTA meets its statutory obligations for managing effects on native bat populations. This guide helps implement NZTA’s Environment and Social Responsibility Policy commitment of ‘Protecting and enhancing the natural environment, including the health, integrity and connectivity of biodiversity, inclusive of ecosystems, indigenous species and their habitats’.

Figure 2: Surveys revealed long-tailed bats were present on the Waikato Expressway projects, utilising a range of habitat including forested gullies and farmland (source: NZTA)

1.1 Background

Aotearoa New Zealand is home to 2 species of bat, the long-tailed bat (*Chalinolobus tuberculatus*) and the lesser short-tailed bat (*Mystacina tuberculata*), both of which are of serious conservation concern. Under the New Zealand Threat Classification System (O'Donnell et al., 2022), the long-tailed bat is classified as 'Threatened – Nationally Critical' and, dependent on sub-species, the lesser short-tailed bat ranges from 'Threatened – Nationally Vulnerable' to 'At Risk – Declining'.[1]

Bats and their associated habitat features are distributed throughout New Zealand. They are often associated with the transport network and other NZTA-owned land and/or land affected by NZTA infrastructure and activities. This is particularly the case with long-tailed bats, which are highly mobile, occupy large home ranges (for example around 330 hectares for lactating females) and depend on a mosaic of habitats to survive. These habitats include foraging areas such as rivers, paddocks and forest edges; roosting sites in both exotic and native vegetation; and linear landscape features or 'flyways' used for movement. Short-tailed bats, while less frequently encountered by NZTA, present their own unique challenges. More detail about bat ecology is given in section 2.

Bats and their roosts are legally protected under the Wildlife Act 1953, and while the Resource Management Act 1991 does not explicitly mention bats, section 6(c) provides for 'the protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna', which includes bat habitat. Bat habitat is also protected under other policy documents or plans such as national and regional policy statements, district plans, and regional plans. Legal protection and policy regarding bats and their habitat are detailed further in appendix A.

1.2 Purpose and audience

The purpose of this guide is to provide a consistent, fit-for-purpose framework for assessing, managing, and monitoring the effects of transport network activities on bats. It enables early identification of ecological risks, and informed decision making to manage risk, including statutory compliance. Supporting the NZTA EcIA guide and aligned with national best practice, this guide helps project and maintenance teams integrate bat considerations into all stages of planning and delivery.

This guide is intended for everyone involved in the planning, design, construction, operation, and maintenance of the NZTA transport network, including on land that is owned by NZTA. This includes ecological consultants, planners, site managers, project/maintenance managers, and contractors. The guide is designed to be accessible and practical, supporting consistent understanding and application of bat-related ecological aspects across all project life stages.

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[1] Southern subspecies (*Mystacina tuberculata tuberculata*): Threatened - Nationally Increasing; Central subspecies (*Mystacina tuberculata rhyacobi*): At Risk – Declining; Northern subspecies (*Mystacina tuberculata aupourica*): Threatened – Nationally Vulnerable.

2 Overview of bat ecology

- Studies indicate road infrastructure poses risks to bat populations.
- Characteristics that make bats particularly vulnerable to transport infrastructure (both construction and operation) include having large home ranges, requiring a wide range of resources in large areas, small population sizes and slow population growth rates.
- Both long-tailed and short-tailed bats have a similar annual lifecycle, with females producing one pup per year.
- The 2 species have differing roosting, foraging, and mating ecology, leading to differences in distribution because of development.
- Long-tailed bats are the most encountered species (Figure 3) and have a threat status of 'Nationally Critical', which is the highest threat classification in New Zealand (the next classification is 'Extinct').
- Different resources long-tailed bats may use in the landscape include exotic and native trees, paddocks, rivers, streams and wetlands for foraging.

The primary threats to both bat species are habitat loss and fragmentation, as well as predation by introduced mammals. Evidence from New Zealand studies and international research (Jones et al, 2019; Smith et al, 2017; Borkin et al, 2016) indicates that road infrastructure and its operation pose a significant risk to bat populations. This risk is driven by key aspects of bat ecology, including:

- small population sizes, which increase their vulnerability to potential impacts from transport projects, and
- slow population growth rates, meaning that the loss of even a few adult individuals can jeopardise overall population viability.

To provide further context, a summary of bat ecology for the 2 species is presented in Table 1. While some aspects of the ecology of these species are shared, there are notable differences between the 2, which can have implications for transport networks.

The general lifecycle for both species is presented in Figure 4. Further information on the ecological and life history characteristics of both species is detailed in Smith et al (2017) and O'Donnell et al (2021).

Figure 3: Long-tailed bats (left) tend to be the bat species NZTA most often encountered however both short-tailed (right) and long-tailed bats can be present and affected by projects and infrastructure (sources: AECOM; Ben Paris)

Table 1: New Zealand bat ecology – long-tailed bat and lesser short-tailed bat

	Long-tailed bat	**Lesser short-tailed bat**
Distribution	Distributed widely but patchily across the North Island; on the east and west coasts of the South Island and on offshore islands such as Hauturu-o-Toi (Little Barrier Island), Aotea (Great Barrier Island), Kapiti Island, and Rakiura (Stewart Island). There are known peri-urban populations of long-tailed bats, which include Auckland, Hamilton, and Temuka (O'Donnell, 2005; Lloyd, 2005). While long-tailed bats are widely distributed, with large home ranges (up to c.5650ha for adult males and c.330ha (median) for lactating females (O'Donnell, 2001a)),[2] there are very few locations where their populations are currently stable, and these are likely to decrease through human impacts.	Thought to be mainly found in 13 populations in indigenous old-growth forests. These include one in Northland, 7 in the central North Island and one in the southern North Island; as well as 2 in the South Island, and 2 large off-shore island populations at Hauturu-o-Toi and Whenua Hou (Codfish Island) (O'Donnell C. F. J. et al, 2021). They may also have large home ranges in optimal habitats, up to c.6,250ha (Christie and O'Donnell, 2014).
Habitat	Long-tailed bats are found in all types of indigenous forest, including regenerating indigenous shrublands. They are known to use exotic vegetation such as pines, oaks and willows. They have been found to prefer relatively uncluttered vegetation structure and will utilise a range of habitats for roosting, feeding and breeding including peri-urban, agricultural, horticultural and plantations. They use a mosaic of different features within the landscape, primarily comprising foraging areas (such as waterbodies, linear edge habitat formed by forests (both native, exotic) and roadsides) (O'Donnell C. F. J. et al, 2021), flyways, and roost habitats (different requirements for lactating females).	These bats are primarily found in old-growth indigenous forests, with large stands of indigenous-dominated forest being an important factor in roost selection for solitary and communal roosts, as well as singing posts[3] (O'Donnell C. F. J. et al, 2021). Short-tailed bats have also been recorded in peri-urban and agricultural habitats, although there is limited evidence regarding roosting activity of short-tailed bat populations in these environments. Short-tailed bats use a mosaic of habitats in a similar way to long-tailed bats for foraging/commuting etc, but are generally found in less urbanised areas.
Diet	Long-tailed bats are insectivorous, and their diet will depend on their local environment, as well as seasonal changes in prey abundance. The species appears to prefer moths/butterflies, flying beetles and flies, but have also been found to predate mayfly, caddisfly and stonefly where available (Ling et al, 2023). See 'Behaviour: flight' with regards to feeding behaviour.	Short-tailed bats utilise a range of foraging strategies for both airborne and ground-based food sources such as insects, fruit, nectar, and pollen. They have a mutualistic relationship with *Dactylanthus taylorii,* whereby they feed on its nectar, and in turn, will pollinate the plant (Czenze and Thurley, 2018). Their specific diet will depend on seasonal food availability, sex, age and reproductive status (Daniel, 1979).

[2] Note that this information is based on studies conducted in optimal ecosystems; bats living in more degraded habitat will likely range more widely for resources.

[3] Singing posts are typically hollows in trees that male short-tailed bats sit outside of and 'sing' to attract a mate. These are usually on trees which surround the main colony roost tree, and may be used by more than one bat on a time-share basis.

	Long-tailed bat	Lesser short-tailed bat
Behaviour: torpor	Both species exhibit torpor patterns that range from short-term (eg daily cycles during daylight rest hours), to longer term (eg up to several days during inclement weather). There are some species differences; for example long-tailed bats generally occupy torpor for longer than short-tailed bats due to being able to forage in a wider range of environmental conditions. However, within species, differences are dependent on several variables such as body mass, ambient temperature, latitude, reproductive cycle, sociality, and fat deposits (McNab and O'Donnell, 2018). When food sources become scarce and/or energetic needs are reduced, bats seek out cool roosts and this period is typically characterised by reduced activity and a lowered metabolic rate, preserving energy until the availability of prey, or energetic requirements increase. Bats of both species will emerge periodically throughout the year when insects are active and/or energetic requirements demand. Lesser short-tailed bats can be active in winter at temperatures as low as −1.0°C (O'Donnell and McNab, 2018), and long-tailed bats have also been occasionally recorded at −1.0°C; although they are optimally recorded at temperatures around 8°C and upwards (Borkin et al., 2023).	
Behaviour: mating	Mating season occurs in autumn (generally March) (O'Donnell C. F. J. et al, 2021), with female long-tailed bats usually not becoming pregnant until their second season. They will then generally produce one pup per year until they are at least 9 years old (O'Donnell, 2001b). There is no known data on mate selection in long-tailed bats.	Similar mating ecology to long-tailed bats; with mating occurring in autumn; however, males are known to perform lekking behaviour during the summer and into the mating season. They will sit in small cavities in selected trees and 'sing' to the colony of females to encourage visitation for mating. These singing posts are generally distributed around the communal roost and may be time-shared between males (Toth, 2016).
Behaviour: reproduction	Following mating (March to April, and intermittently in May when weather allows), it is believed that female bats of both species temporarily halt gestation by either delaying fertilisation or halting embryo development until spring (September to November). Female bats of both species form maternity roosts during spring and summer for a period of at least 12 weeks to give birth and rear young. Generally, only one pup is born to each femaie in December or January, which remains under close care for 4–6 weeks, after which they can start to fly and hunt independently (Jones at al., 2019). This lifecycle is presented in Figure 4.	
Behaviour: roosting	Bats may come from distant areas to establish maternity roosts, and there is a strong fidelity, with many maternity roosts being reused every spring/summer. These colonies often work on a 'fission-fusion' model, whereby individuals may change roosts almost daily (depending on roost availability) and may change roosting partners as part of this process. Adult males are primarily solitary and are rarely recorded roosting with the main colony, especially during summer months. Roosts are normally in tree cavities with high, small entrances. Bats will also use peeling bark and fissures and splits in the trunk and large limbs of	Bats form very large communal roosts, with some recorded at over 6,000 individuals per roost (Lloyd, 2001). Adults of both sexes will be present in the communal roost, though there are more females than males generally present. Because of the size of the colonies, roosts are often found in large cavities within very large, generally indigenous trees, with large old trees being increasingly rare. These provide both space and a thermo-stable environment for the colony. Colonies may also roost in several communal roosts within a wider area, rather than all together. Some individuals will choose solitary roosts. These locations can vary, from unused communal roost cavities to smaller tree cavities, or even under/within epiphytes, flaking tree bark or tree ferns. There are also records of solitary roosts in buildings adjacent to indigenous forest areas (O'Donnell C. F. J. et al, 2021).

	Long-tailed bat	Lesser short-tailed bat
	large, old trees (although smaller, younger trees may sometimes also be utilised).[4] They have also been known to utilise artificial roosts ('bat boxes'); however to date, this has only been documented in Hamilton in the North Island (Robinson et al., 2023), and South Canterbury in the South Island (Pryde et al., 2006). Roosts are generally occupied for 1-2 nights, with night-time roosts sometimes only occupied for a few hours while bats rest between foraging activities. Solitary roosts are generally occupied for longer than communal/maternity roosts. In optimal ecosystems with numerous roosting opportunities, colonies have a large number of roosts in the local area, and will rarely re-use trees within the same season (O'Donnell and Sedgeley, 1999), while in peri-urban ecosystems and other habitats with few roosting opportunities, roosts are likely to be occupied more frequently and for longer periods.	Will occupy roosts for prolonged periods and have been recorded in the same roost for up to 58 consecutive nights, although c.6–11 nights is more usual (Lloyd, unpubl; Sedgeley, 2003).
Behaviour: flight	A moderate-, to fast-flying species that have been recorded travelling up to 60km/h (O'Donnell, 2001b). They have narrow, pointed wings suitable for 'aerial hawking' (using echolocation to hunt for insects on the wing in open, uncluttered environments). Will routinely reuse the same flight paths to travel between their roosting sites and preferred foraging areas. They prefer edge environments for both foraging and commuting, and are most frequently recorded along the tops, side edges and within gaps in forest stands and shelter belts (O'Donnell C. F. J. et al, 2021). Long-tailed bats are known to be quite light-averse (Schamhart et al, 2024) and so will use covered riparian and terrestrial pathways, as well as 'stepping stones' of shelter-belt habitat within peri-urban, open parkland and agricultural environments, to travel between high-value habitats (Dekrout et al., 2014).	Bats have shorter than average, comparatively rounded wingtips, which allow them to forage effectively between the canopy and the forest floor. When foraging around the forest floor, especially in cluttered environments they travel slowly (c.2.5km/h (Christie, 2006)) and often use a quadrupedal 'walking' gait to move along slowly the ground. When flying in uncluttered environments (eg when commuting between foraging and roosting locations) they can reach speeds of up 60km/h (Lloyd, 2001). Use quadrupedal movement to crawl along the forest floor whilst foraging for pollen, nectar, fruit and ground-dwelling insects.

[4] The *Protocols for minimising the risk of felling occupied bat roosts* (Bat Roost Protocols) (Department of Conservation, 2021), state that vegetation with the following features may potentially be bat roosts: hollows, cavities, knot holes, cracks, flaking, peeling, and decorticating bark, epiphytes, broken or dead branches or trunk, and/or cavities/hollows/shelter formed by double leaders.

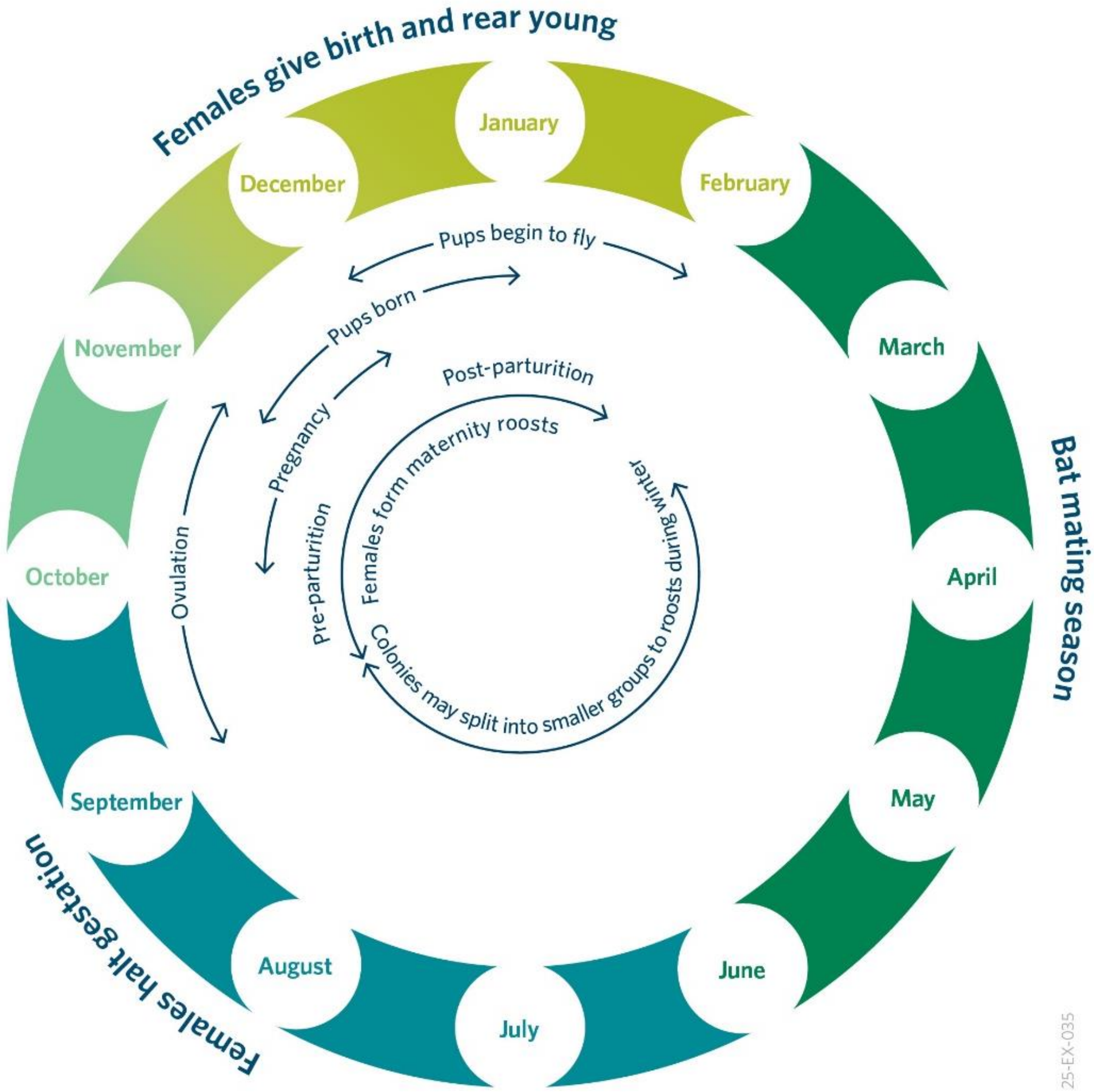

Figure 4: The general lifecycle of long-tailed bats and lesser short-tailed bats in New Zealand

3 Effects on bats from land transport

- Effects on bats can occur during both the delivery and maintenance and operation (M&O) project lifecycle stages.
- The zone of influence (ZOI) for project effects on bats is generally large, due to their large home range and reliance on a range of resource types within a landscape; but should be determined on a case-by-case basis.
- During the delivery phase, where a consent/permit application may be required, use the EIANZ guidelines (Roper-Lindsay et al., 2018) to assess the level of effect of a project activity on bats. For M&O activities guidance is provided in Appendix B.

Effects on bats from transport projects can occur during both the delivery and maintenance and operation (M&O) project lifecycle stages. An overview of these lifecycle stages and typical project phases is provided in NZTA's *Transport Services project management guide* (SM011)[5] and Table 4 of the NZTA EcIA guide (NZTA, 2023). Table 2 details the most common potential effects[6] on bats resulting from transport projects in relation to these stages. It should be noted that this is not an exhaustive list of effects and can be expanded depending on project scope.

During the delivery phase of a project, where a consent/permit application may be required, the methodology for assessing the level of effect of a project activity on bats is outlined in the EIANZ Guidelines (Roper-Lindsay et al., 2018).[7] The level of effect should be determined in relation to the zone of influence (ZOI) of the project on local bat populations. For M&O activities, Appendix B details how effects on bats should be assessed and managed.

3.1 Zone of influence

The zone of influence (ZOI) for project effects on bats is generally large, due to their large home range and reliance on a range of resource types within a landscape; but should be determined on a case-by-case basis. This should be considered when assessing effects. It is important to remember that although bats may have large home ranges, impacts at the local scale may have significant effects on movement, foraging ability and/or roost availability within the wider area; which could impact an entire local population. Therefore the ZOI of project effects can impact bats at a large scale.

The ZOI differs depending on how species (for example long-tailed bats compared to lesser short-tailed bats) and individuals (for example single non-breeding bats compared to a large maternity roost) use their environment (refer to section 2). For example, home range size and associated foraging, roosting and commuting behaviour is likely to be impacted for both species in response to development or changes in M&O activities; however, short-tailed bats are likely to be even less resilient to habitat fragmentation than long-tailed bats. Likewise, if a maternity roost associated with a local population is impacted by works, this would have a greater effect on the local population than if a few individual non-breeding individuals were impacted. These factors should be considered when planning surveys/monitoring in relation to likely local bat populations.

Additionally, the differences in bat ecology/behaviour between long-tailed and lesser short-tailed bats should be taken into consideration, as these may inform an assessment of project effects.

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[5] https://www.nzta.govt.nz/resources/project-management-guide-sm011

[6] The effects listed in Table 2 are all known effects on bats that have the 'potential' to occur during a transport project. These effects will be different for each project dependent on location, environment, bat species/population etc.

[7] Or subsequent versions.

Table 2: Potential effects on bats from transport projects

Activity	Effect	Effect type	Project phase		
			Implementation (design and construct)	Post-implementation (operation)	Post-implementation (maintenance)
Vegetation removal	Mortality or injury to bats	Direct	✓		✓
Vegetation removal	Loss of roost features (including dynamic roost use[8])	Direct	✓		✓
Vegetation removal	Removal of roost cover habitat and effect of microclimate on roosts	Indirect	✓		✓
Vegetation removal	Fragmentation of flight paths (that is, loss in connectivity) due to removal or alteration of vegetation	Indirect	✓		✓
Vegetation removal	Loss of foraging habitat	Direct	✓		✓
Machinery or vehicle operation	Mortality or injury to bats due to vehicle strike via presence of road, increased traffic, and/or additional edge habitat	Direct		✓	✓
Machinery or vehicle operation	Disturbance and displacement to bats and/or their roosts due to new or increased noise/vibration, dust, and light	Indirect	✓	✓	✓
Presence/ operation of the road	Fragmentation of flight paths (that is, loss in connectivity) through increased light, noise/vibration, and physical presence of the road	Indirect		✓	
Presence/ operation of the road	Presence of the road aiding pest animal dispersal in areas where they were previously not present.	Indirect		✓	
Presence/ operation of the road	Edge effects, including loss of bat habitat due to road effects, eg noise and light.	Indirect		✓	✓

[8] Vegetation, including roost trees, may be used by bats in different ways throughout the year, and in response to variables such as weather, light, noise and other changes in the wider landscape.

4 Desktop and site investigations

- Conducting a desktop investigation in relation to bats and their habitats at the outset of a project is vital to avoid project delays and/or additional costs.
- Planning site investigations involves defining project-specific questions to guide survey method selection.
- Decisions on effort levels are based on project stages and risk levels.
- Early consideration of investigation method(s) and design helps in assessing mitigation strategies effectively.
- Competent ecologists are essential for conducting bat-related works, meeting specified qualifications and certifications.
- Data analysis and reporting should include thorough documentation of methodology and results, ensuring clarity, transparency, and replicability.

4.1 Desktop investigations

Discovering the presence of bats or their habitat late in the planning process can lead to significant delays and additional costs, as well as reduced capacity to effectively avoid/minimise effects. Therefore, a desktop investigation (which includes bats) should always be conducted as a starting point to inform next steps.

When undertaking a desktop investigation, the ZOI of the project should be determined (see section 3.1). Once the ZOI has been established, several resources can be consulted to determine the likelihood of bats or bat habitat being present within the ZOI. These include the following:

- Satellite imagery, aerial maps (such as Google Earth, Retrolens) and local government GIS (for example Auckland Council GeoMaps) can provide information on geographical features in the area (terrestrial vegetation types, linear features, streams and wetlands etc). This can also provide some insight on potential bat habitat availability, and/or connectivity to a known bat population.
- The Department of Conservation (DOC) has a Bat Distribution Map (sometimes referred to as ‘Bat Observation Map’ in DOC resources) that is accessible online and contains locations on known bat records.
- The New Zealand Threat Classification System (NZTCS) provides the national conservation status of bats. Some local councils also provide a regional conservation status of bats. This status can be considered when assigning value (as per EIANZ Guidelines) to bats as part of an effects assessment.
- Reviewing published studies on terrestrial vegetation (for example ‘A classification of New Zealand’s terrestrial ecosystems’ (Singers and Rogers, 2014), or *Ecological regions and districts of New Zealand* (McEwen, 1987)) may provide information on potential bat habitat, and reviewing studies (from peer-reviewed articles etc) on bat ecology in the region can provide insights into their behaviour, habitat requirements, and distribution patterns particular to that region (for example bats in (peri) urban environments, farmlands and plantation woodland are known to roost in exotic tree species such as crack willow and oak trees).
- Collaborating with landowners, local iwi, wildlife/conservation groups, and/or experts can offer on-the-ground knowledge and expertise regarding bat populations in the area.
- Local NZTA maintenance staff should be consulted, as they are likely to have valuable knowledge on local ecology.

- Previous reports or studies in the local area may contain historical data such as bat sightings, roost sites or foraging areas. Reports also often include information on the broader ecological context of the area (such as vegetation types, land use), which may also provide information on potential bat habitat. NZTA holds copies of information from projects that may cover bats (EcIAs, monitoring reports etc) and you can request this information from the Environment and Sustainability team (environment@nzta.govt.nz) .
- Note that desktop investigations have the potential to provide false-negative results – that is a lack of bat records within a desktop search area does not mean that no bats are present; it may mean that they have not been adequately surveyed for in the area (Figure 5). As such, desktop investigations should be taken as an initial starting point only, including those records from DOC's Bat Distribution Map, whose disclaimer provides details of limitations of data. A suitably qualified and experienced professional (SQEP) should be employed to use their professional judgement to determine presence/likely absence of bats and/or appropriate next steps for site-based investigations.

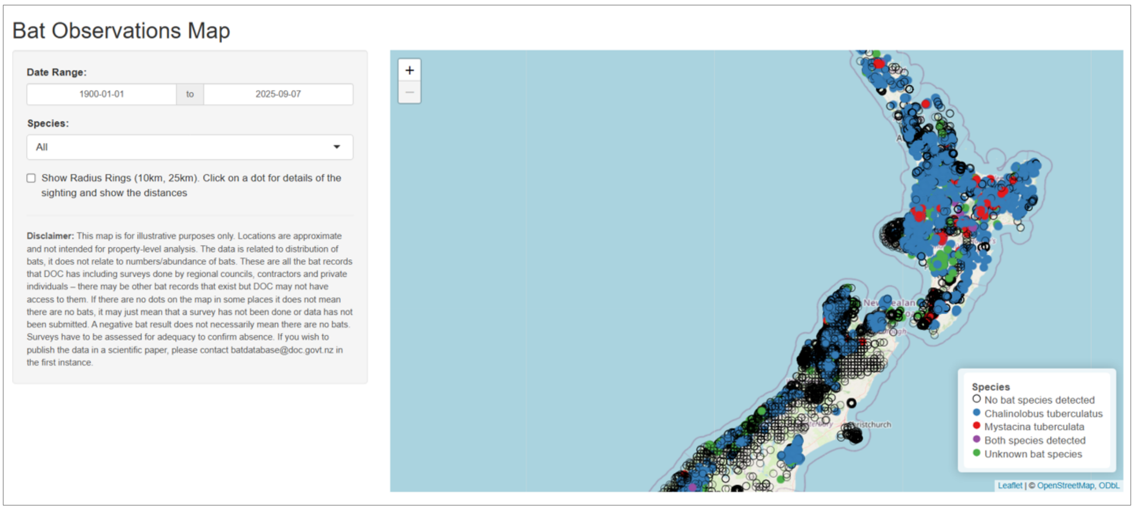


Figure 5: Desktop resources provide an initial starting point to understanding bat activity in relation to a project, such as the DOC Bat Observations Map in this screen shot (also referred to as the 'Bat Distribution Map'); however, they have significant limitations that must be considered (source: DOC)

Figure 6: Suitably qualified and experienced professionals are essential for conducting bat-related works such as bat roost assessments and meeting specified qualifications and certifications (source: AECOM)

4.2 Site investigations

Site investigations include baseline/detailed surveys and monitoring, and the extent of effort (scope and duration of investigations) should align with the project's risk level (see Figure 7).

In line with the NZTA EcIA guide, **surveys** are typically defined as a one-time or repeated assessment to gather information on bats and their populations. Surveys are often conducted to establish a baseline understanding of bat populations, including bat presence, identifying roost sites, foraging habitats, and commuting corridors. They are crucial for initial assessments before any management decisions are made.

In line with the NZTA EcIA guide, **monitoring** is defined as systematic, ongoing collection of data over time to track changes in bat populations, behaviours, or habitat use. Monitoring is often used to assess project effects (before, during and after) as well as the effectiveness of management/mitigation, and for informing adaptive management strategies (refer to section 5.4).

In exceptional circumstances, site investigations may not be required; however, this determination heavily relies on available information (that is desktop investigations – refer to section 4.1) and the risk associated with the project (refer also to section 5.1).

The following sections outline the types of site investigations that may be needed at different project lifecycle stages, survey/monitoring methods and survey planning considerations.

For M&O activities, Appendix B details the approach to undertaking site investigations.

Project scale impact To be determind by SQEP based on project scope/scale/location	**Habitat suitability for bats** To be determined based on desktop assessment and/or survey as appropriate by SQEP **Low** Bats may be commuting through unlikely foraging/roosting	**Moderate** Bats likely commuting/ foraging, may roost – likely small numbers	**High** Bats likely commuting, foraging and roosting – possibly large numbers
Low eg roundabout upgrades in city centre	Low potential risk	Low potential risk	Low-moderate potential risk*
Moderate eg road widening in rural context	Low potential risk	Moderate potential risk	High potential risk
High eg creation of new road through indigenous forest	Low-moderate potential risk*	High potential risk	High potential risk

25-EX-035

* SQEP to determine potential risk based on individual project scope

Figure 7: Scope and duration of investigations should align with the project's risk level, based on project impact and bat habitat suitability

4.2.1 Project lifecycle stages

Site investigations may be required at different project lifecycle stages, including development, delivery, and M&O. Table 3 provides an outline of project lifecycle stages (including typical project phases) and the type of site investigation that may be required.

The design of the investigation should be considered early in project development to facilitate the avoidance of effects or to allow effects and/or the effectiveness of mitigation to be assessed later. Site investigation purpose and design is detailed further in sections 4.2.2 and 4.2.4.

Table 3: Project lifecycle stages and associated site investigation types (for M&O activities, Appendix B details the approach to undertaking site investigations)

Project lifecycle stage	Typical project phase	Site investigation[9]	Site investigation purpose
Development	Investment case	Assume presence (likely absence) based on desktop records and habitat type OR Presence survey	• Determine likelihood of bat presence in area. • Input into NZTA environmental screen/options shortlisting. • Identify potential bat habitat to be avoided (Figure 8). **Note**: long-tailed bats are known to use non-typical habitat (eg occasionally roosting in buildings) and recent studies suggest lesser short-tailed bats may also show some habitat adaptability. Therefore, assessments should consider both typical and non-typical potential bat habitat. • Identify and assess potential project effects on bats to inform a preliminary technical assessment (PTA).
Baseline survey/ monitoring (pre-construction)	Pre-implementation project design, consenting and assessment of effects	Baseline survey/monitoring (pre-construction)	• Establish baseline, including distribution, activity and habitat use by bats, as applicable. • Collect 'before' works monitoring data to compare with 'during' and 'after' construction monitoring. • Identify and assess potential project effects on bats (eg from vegetation clearance, lighting, noise). • Determine location and outline design of mitigation measures (eg to maintain bat connectivity). • Inform EcIA and recommend impact management and monitoring design within a bat management plan.
	Implementation/ construction	Monitoring (during construction)	• Collect bat monitoring data during construction. • Assess construction effects and determine effectiveness of construction mitigation. • Implement vegetation removal protocols (using automatic bat monitors (ABMs)) – refer section 5.2.

[9] Site investigations should utilise data from previous surveys where available and build upon information gained.

Project lifecycle stage	Typical project phase	Site investigation[9]	Site investigation purpose
			• Assess compliance with bat management plan (including any triggers) and any related consent conditions. • Inform adaptive management.
Maintenance and operation	Operation	Monitoring (post-construction)	• Collect post-construction bat monitoring data. • Determine effectiveness of operational mitigation (Figure 8). • Inform adaptive management triggers to address any outstanding effects.

Figure 8: Early in project development potential bat roost features (left) should be identified as part of baseline surveys. The photo on the right shows an arborist taking eDNA swabs from inside a bat box, monitoring to see if it being used by bats (source: AECOM)

4.2.2 Investigation purpose

When planning site investigations, the purpose of the investigation and project specific questions should be determined, as this will guide the selection of the appropriate method(s) to be used.

Table 4 provides examples of the types of questions that may require answering and the site investigation type that may answer these questions. Information from the desktop investigations (section 4.1) should always be used.

Table 4: Examples of project questions and potential site investigation method(s)

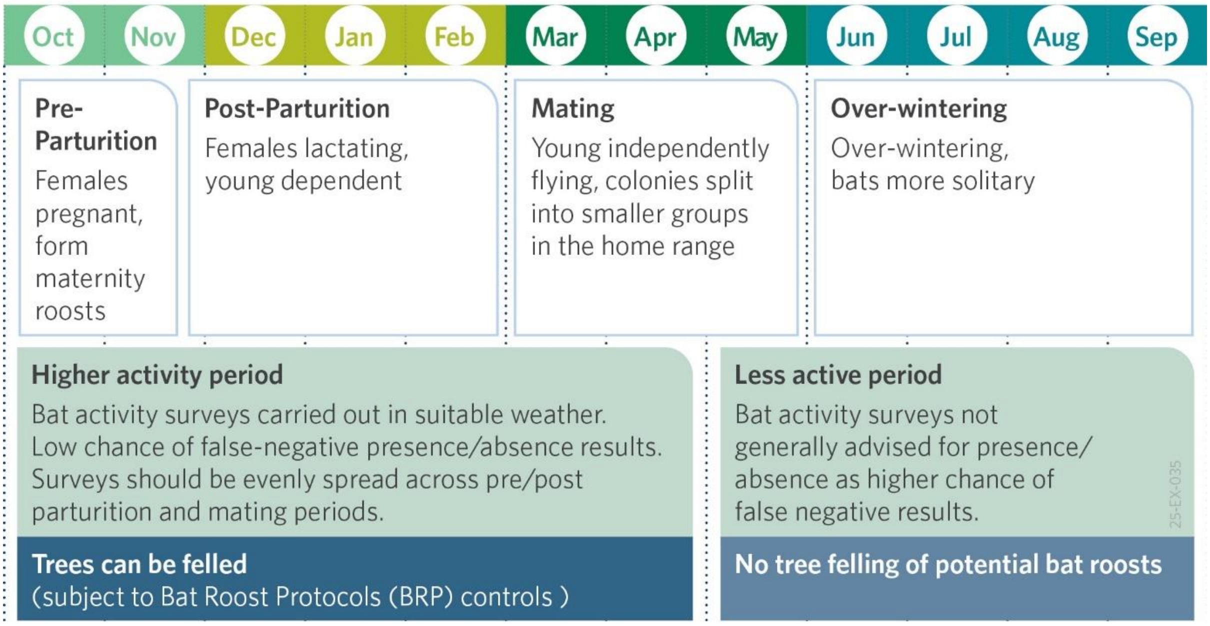
Example project question	Potential site investigation (refer Table 6 for further information on methods)	Site investigation output (indicative only)
How likely is it that bats are within the project ZOI?	• Walkover survey.	Indication of potential bat resources (eg habitats, roosts) within project ZOI.
Are bats present in the project area (before, during, and after project implementation/ mitigation)?	• Visual observations to identify potential roosting locations. • Survey using automatic bat monitors (ABMs) to identify presence/likely absence in the area.	Potential roost locations. Presence or likely absence.
Are there trees present where bats might be roosting (including hazardous trees and artificial roosts, eg bat boxes)?	• Bat roost potential survey to identify trees with roost features (Figure 8). • Roost watches (emergence and re-entry watches) – visual or using night vision aids (NVAs). • Targeted survey using ABMs at potential roost trees. • Manual search/endoscope survey. • Radiotracking (Figure 14). • eDNA swabs (to indicate use of artificial roosts). • Thermal imagery (detecting heat at entry of artificial roosts).	Trees with bat roosting potential. Roost locations.
Where are bats flying through the project area?	• Survey using ABM (survey effort proportionate to scale of project: should allow for robust analysis). • Radiotracking. • Observations at likely bat flyways using NVAs.	Flight path/fly-way locations.
Which areas are used for foraging and/or socialising?	• Survey using ABMs and call analysis (eg foraging/social calls detected). • Radiotracking.	Foraging and/or roosting locations
Does bat activity change before and after project implementation/ mitigation?	• Before-after control impact (BACI) monitoring (section 4.2.5). Methods could include ABM surveys.	Patterns of activity before, during, and after project.
Does bat behaviour (eg flight paths; areas of activity) change before, during, and after project implementation/ mitigation?	• BACI monitoring (section 4.2.5). Methods could include surveys using ABMs, observations with NVAs.	Bat behaviour metrics before, during, and after project.

Example project question	Potential site investigation (refer Table 6 for further information on methods)	Site investigation output (indicative only)
Is my mitigation appropriate?	• BACI monitoring (section 4.2.5). • eDNA swabs (sampling in bat boxes)	Measuring the effectiveness of mitigation and feeding into updated management strategies, where required.

4.2.3 Timing, climate, and effort

It is important to consider survey/monitoring timing and effort when planning site investigations. These should be aligned with periods of seasonal bat activity, which are somewhat changeable with geography and climate across New Zealand. As such, and with consideration of long-lead times for DOC-issued survey permits (such as for radio-tracking studies) it is important to plan well in advance of surveys taking place (for example a year or more may be required for large, high-impact projects). In addition, the extent of effort (that is, scope and duration of site investigations) should align with the project's risk level and will vary from project to project. This is detailed further in the sections below.

Table 5: General monitoring timings



Note: ground-based tree assessments to identify potential roosting features (PRFs) can be undertaken at any time of year by a SQEP with appropriate DOC competencies. If no PRFs are recorded and the tree is considered unlikely to support roosting bats, it can be felled at any time of year immediately following the survey. If PRFs are noted, or the tree is considered likely to contain PRFs which cannot be seen from ground level, further bat activity surveys may be required in line with the above timings, prior to the tree being felled.

Timing

Where surveys/monitoring rely upon bat activity to inform results, then site investigations should be completed when bats are most active (1 October to 30 April (inclusive)). It is recommended that any deviation from the above is discussed and agreed with a SQEP (refer to section 4.3), before undertaking investigations.

Bats will utilise landscapes and associated habitats differently dependent on their lifecycle stage (see section 2). As such, (at least) 2 or ideally 3 rounds, of site investigations (surveys using ABMs) are recommended, covering pre-parturition (Oct–Nov), post-parturition (Dec–Feb), and mating (Mar–Apr/May). This also helps to address the risk of returning false negative results – that is not detecting bat activity when they are actually present in the area.

The timing of site investigations around sunset and sunrise is particularly important due to bats being nocturnal.

- Surveys using ABMs should begin 1 hour before sunset and finish 1 hour after sunrise.
- For roost watches, that emergence surveys should begin 30–60 minutes before sunset (North Island/South Island, respectively) and continue until it is too dark for all surveyors to confidently observe potential roost features – typically this is 1.5 to 2 hours after sunset. Infra-red and/or thermal imaging cameras may be useful as a supplementary tool in this process.
- Re-entry roost watches should begin at least 2 hours before official sunrise and finish 1 hour after sunrise. Infra-red and/or thermal imaging cameras may be useful as a supplementary tool in this process.

These timings are based on guidelines published by the Bat Recovery Group (DOC Bat Recovery Group, 2024) and should be updated in line with the most up-to-date published guidance, as appropriate.

Figure 9: Bats are sensitive to temperature and other environmental factors. Some parts of the country and site may have small 'weather windows' for bat surveys which needs to be factored into project planning (source: Carol Bannock)

Climate

The location of bat populations within New Zealand will influence bat activity (Figure 9). Bats in the South Island where temperatures are generally colder, may be active at lower temperatures compared to bats in the warmer temperatures in the North Island.

Rain, humidity, and wind may also have an influence on bat activity. Recent evidence suggests that outside of persistent rain, temperature at sunset may have the biggest effect on nightly bat activity levels, with higher levels of false-negative results at temperatures less than 8°C in the North Island (Borkin et al, 2023).

The Bat Roost Protocols (DOC Bat Recovery Group, 2024) define a 'valid' survey night (across New Zealand) where bats are likely to be active to include the following:

- Survey using ABMs:
    - Temperature 8°C or greater for the first 4 hours after official sunset time for the North Island and 7°C for the South Island.
    - Ideally no to very little precipitation within the first 4 hours after official sunset, although a light mist or occasional drizzle may be acceptable as assessed by a SQEP who holds competency 3.1.
    - No to light wind within the first 4 hours after sunset.
- Roost watches:
    - Temperature greater than 8°C all night between sunset and sunrise for the North Island and 7°C for the South Island
    - Ideally no to very little precipitation within the first 4 hours after official sunset, although a light mist or occasional drizzle may be acceptable as assessed by a SQEP who holds competency 3.1.

It is recommended that any deviation from the above is discussed with a SQEP (refer to section 4.3) These conditions are based on guidelines published by the Bat Recovery Group (DOC Bat Recovery Group, 2024) and should be updated in line with the most up-to-date published guidance, as appropriate.

Figure 10: Climate conditions influence bat activity and effectiveness of tools such as automatic bat monitors (left) which detect bats and harp traps (right) used to safely capture them (sources: AECOM; Mt Messenger Alliance)

Effort

The extent of effort (scope and duration of site investigations) should align with the project's risk level, considering the suitability of the habitat to support bats, and the potential impact of the proposals on bats. The level of effort is also dependent on the method employed and, in some situations, such as BACI design, may be guided by statistical methods such as power analysis.

An indicative flow-chart for decision making is provided in Figure 11. This is a broad overview of project types and the level of survey/monitoring effort that may be appropriate. Survey design should always be determined and agreed with a SQEP and, where appropriate, in conjunction with DOC and relevant local authority permitting requirements.

Further information on survey types, including references to full survey instructions (DOC technical guidance) and appropriate survey effort levels is provided in section 4.2.4. Hypothetical case studies indicating appropriate survey effort in relation to different projects are provided in appendix C.

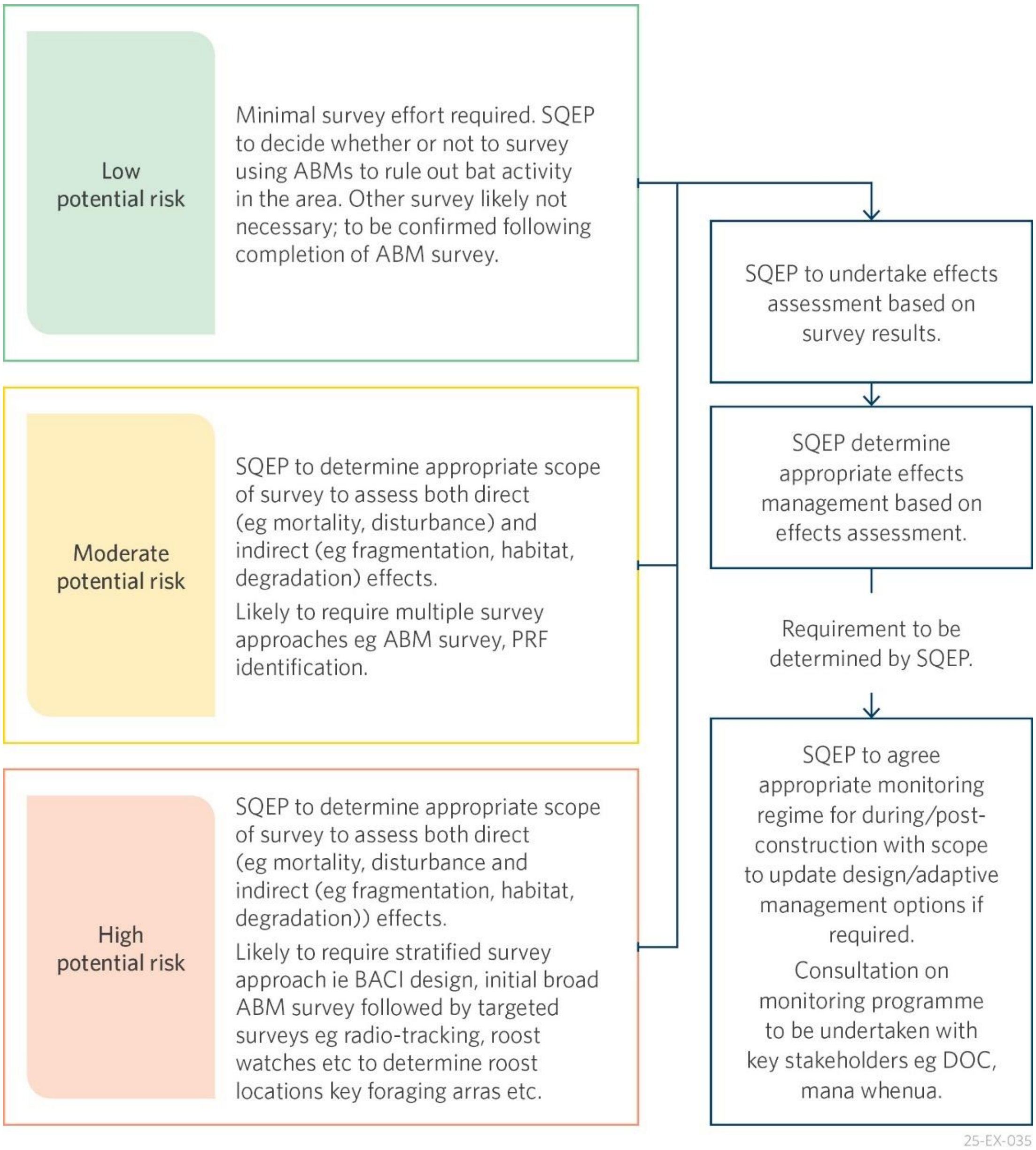


Figure 11: Bat survey effort flowchart. The survey design is to be determined by a SQEP, based on best practice

4.2.4 Method(s)

Project-specific questions (see Table 4) will determine the selection of site investigation method(s) and design. However, at each stage of the project lifecycle, decisions will be necessary regarding the methods and design used for site investigations to answer these questions. Table 6 details the potential survey methods, including available guidance, equipment required, planning considerations, and limitations.

It is important to note that where surveys rely upon bat activity to inform results, then site investigations should be completed when bats are most active (1 October to 30 April (inclusive)).

Table 6: Details of site investigation methods[10]

Site investigation method	Available information/guidance	Equipment and method design considerations for a transport project	Planning/cost considerations	Survey benefits	Limitations
Existing records (eg previous surveys using ABMs, DOC Bat Distribution Map)	Bat Distribution Map.	None.	Ensure records are relevant, eg Bat Roost Protocols require presence within 25km of proposed felling within last 10 years.	Low-cost methodology to provide snapshot into potential bat activity.	Lack of records, or surveys with a negative result do not necessarily indicate that bats are absent in the project area.
Visual observations to confirm potential roost features/ utilisation	DOC *Best practice manual of conservation techniques for pekapeka/bats in Aotearoa New Zealand* (Beath et al, 2025). *Bat roost protocols* (DOC Bat Recovery Group, 2024).	Binoculars. Undertaken through ground-based daytime search for potential roost locations.	Option to identify potential roost features.	Enables identification of specific trees/roost features to guide future monitoring efforts.	If low bat numbers are present, they may not leave visual evidence, leading to false negative results. Views can be obscured, such as by roost locations being high up in a tree Likely to require follow-up surveys to confirm utilisation.
Roost watches (emergence watches and re-entry watches)	DOC *Best practice manual of conservation techniques for pekapeka/bats in Aotearoa New Zealand* (Beath et al, 2025).	NVAs recommended to assist with observations. Handheld bat detector to listen for bat calls at exiting roost.	Availability of equipment (eg NVAs). Requires suitable weather conditions for bat activity. Only undertaken if there is a potential roost identified	Enables counting of bat numbers per roost, and associated classification of roost type.	Method is contingent on bats being observed by surveyor. Visibility of bats may be hindered by various factors such as roosts located high/far from viewpoint, view obscured by

[10] These guidelines may be updated over time. Surveys should always be based on the most up-to-date published guidance, as appropriate.

Site investigation method	Available information/guidance	Equipment and method design considerations for a transport project	Planning/cost considerations	Survey benefits	Limitations
	Bat roost protocols (DOC Bat Recovery Group, 2024).	As per the *Bat roost protocols* (DOC Bat Recovery Group, 2024), roost watches should include the deployment of ABMs and analysis of data for the night of the roost watch.	through other methods; eg ABM assessment, radio-tracking, visual survey.		surrounding vegetation/ environment etc. If roost watches are being used to estimate changes in population size, there is the risk that monitored roosts may be abandoned permanently or temporarily between monitoring periods, or the risk of double counting.
Surveys using ABMs	DOC *Best practice manual of conservation techniques for pekapeka/bats in Aotearoa New Zealand* (Beath et al, 2025). *Bat roost protocols* (DOC Bat Recovery Group, 2024). *Bat monitoring guidelines using automatic bat detectors* (DOC Bat Recovery Group 2025).	Surveys using ABMs (eg SM4 full spectrum and AR4). The same type of ABM should be used if surveys are being repeated. The number and location of ABMs should fit the survey/monitoring objectives (eg presence/likely absence versus targeted surveys in areas of high activity to inform potential impacts and develop a monitoring baseline). At least 2 survey rounds required between 1 October to 30 April to cover different lifecycle stages (see section 4.2.3). A minimum of 14 nights of data collection per survey required (Beath et al, 2025.	Availability of skilled staff (to interpret ABM data). Property access to deploy ABMs. Availability of equipment (eg SM4s, AR4s) and ensuring that the same make/model consistently used for monitoring. Requires suitable weather conditions for bat activity, as defined in the *Bat roost protocols* (DOC Bat Recovery Group, 2024).	Enables survey of bat activity over a wide area. Highlights activity hot spots and can provide indication of high-level roosting, foraging and/or social behaviour.	Requires ABMs to be left in-situ for a period (over a long period of time and/or repeated). Area of detection (approximately 50m) limited to the range of ABM (varies by equipment model). It is not recommended that surveys using ABMs are used to estimate changes in population size, as there is the risk of multiple counting of individuals.

Site investigation method	Available information/guidance	Equipment and method design considerations for a transport project	Planning/cost considerations	Survey benefits	Limitations
Handheld detectors (line transects)	DOC *Best practice manual of conservation techniques for pekapeka/bats in Aotearoa New Zealand* (Beath et al, 2025).	Handheld detectors.	Requires suitable weather conditions for bat activity.	Can identify hot spots of bat activity on a site and may include visual assessment of bat behaviour not gained through other means, eg surveys using ABMs.	Limited amount of data collected. Real time detection by in field surveyor. Area of detection (approximately 50m) limited by handheld device (varies by equipment model).
Manual search/ endoscope survey	No New Zealand-specific guidance; however, overseas guidance is available in the 'Method statement for the appropriate use of endoscopes by arborists' (Bat Conservation Trust, 2015).	Endoscope/endoscopic camera. Arborist equipment (if roost is only accessible by arborists).	Availability of skilled staff (eg access to some roosts may only be accessible by arborists). Availability of equipment (endoscope).	Enables confirmation of roosting bats within features (if accessible).	Endoscopes have a limited reach, therefore may not be able to access all areas of a bat roost. Bats must be present to confirm roosting. Visibility may be limited in dark or obstructed spaces, and the lighting provided by endoscopes may not be sufficient to fully illuminate the space being surveyed.
eDNA swabs to confirm roosting	Bat box monitoring: testing the efficacy of eDNA to confirm box use (Davies et al, 2024).	eDNA swab kit and laboratory analysis. Arborist equipment (if roost is only accessible by arborists).	Availability of skilled staff (eg access to some roosts may only be accessible by arborists). Costs of eDNA kits and analysis.	Enables confirmation of roosting bats within features (if accessible). Bats do not need to be present to confirm roost use.	eDNA has only been used to confirm artificial bat box use (Figure 8). eDNA may detect false positives and negatives.
Radiotracking	DOC *Best practice manual of conservation techniques for pekapeka/bats in Aotearoa New Zealand* (Beath et al, 2025). Acoustic lure detection distance trial report (Dennis and Pryde, 2022).	Trap: harp trap (ground-based or aerially deployed) or mist net. Lures may be utilised to increase trapping efficacy. Weighing bag and scales. Transmitters (including approved adhesive for attaching).	Availability of highly skilled staff with relevant bat handling competencies and equipment are required as per the DOC Bat Recovery Group's Bat Handling Competencies Authorisation. Intensive effort.	High-precision method to identify roosting sites/commuting and foraging routes, within short timeframes, depending on initial capture rates (Figure 15).	Most effective if roost locations are known in advance; however, unlikely for initial capture. Capture rates may be low at the start of a monitoring period (if bats not already tagged). Risk that bats may leave the project area/unable to be tracked.

Site investigation method	Available information/guidance	Equipment and method design considerations for a transport project	Planning/cost considerations	Survey benefits	Limitations
		Receivers. Triangulation method. Helicopters can be used to triangulate.	Availability of equipment. Requires a Wildlife Act authorisation if bats not already tagged) (long lead in times). Requires access for surveyors within area to track tagged bats. Alternatively, drones/helicopters can be used to triangulate. Requires suitable weather conditions.		Often a small sample size, therefore, can focus on only part of the population. Long lead in times for Wildlife Act authorisations. Invasive technique for bats, particularly where there are repeated sessions, which is often needed for data robustness.
Mark-recapture	DOC *Best practice manual of conservation techniques for pekapeka/bats in Aotearoa NZ* (Beath et al, 2025).	Trap: harp trap (ground-based or aerially deployed) or mist net. Lures may be utilised to increase trapping efficacy. Metal tags (with individual serial number). Wing bands and/or passive integrated transponder (PIT) tags. Weigh bag and wing rule.	Availability of highly skilled staff – relevant bat handling competencies are required as per the DOC Bat Recovery Group's Bat Handling Competencies Authorisation. Availability of equipment. Requires a Wildlife Act authorisation (long lead-in times). Requires suitable weather conditions for bat activity.	Can monitor specific population change (eg bat numbers and sex) and can increase the efficacy of future radio-tracking surveys.	Risk that capture rates are low. Often needs to be undertaken in tandem with radio tracking to locate and track roosts.
Observations with NVAs (eg flight paths/bat behaviour).	N/A	NVAs.	Availability of skilled staff. Availability of equipment. Requires suitable weather conditions for bat activity.	Enables the observation of behaviour not otherwise visible through alternative survey methods, enabling more detailed behavioural analysis.	Focused on one observation zone only (eg specific tree or commuting route).

4.2.5 Before-after control-impact (BACI) and power analysis

Depending on the scale and extent of impacts of a project, a SQEP should be consulted to advise on the applicability of before-after control-impact (BACI) and power analysis for planning monitoring programmes. The SQEP should seek input from a statistician in the event power analysis, or any other statistical analysis, is required.

BACI design provides the most robust results when undertaking monitoring that aims to answer specific questions (Roedenbeck, et al, 2007) and may incorporate multiple site investigation methods described in section 4.2.4. It is particularly useful for measuring the effectiveness of mitigation, which is described further in Section 5.4. The **before** (pre-construction baseline) and **during/after** (during construction or post-construction) states of a variable are compared, at both an **impact** site (where the impact is to take place) and at a **control** site (comparable reference site with no impacts; ideally in close proximity).

Power analysis can be utilised to design robust monitoring programmes (in consultation with a biostatistician). This is a statistical method that addresses the question of how much monitoring effort is required to be reasonably sure that a real effect or difference can be detected over and above normal 'background' variability in the measure of interest. The statistical modelling may involve multiple linear regression, where appropriate, and should consider external variables (such as distance to roads, vegetation, weather) as well as direct project impacts. Further guidance on power analysis and monitoring design is included in the *Bat monitoring guidelines using automatic detectors* (Bat Recovery Group, 2025)

4.3 Personnel

NZTA projects and maintenance contracts should ensure that ecologist(s) undertaking all bat-related works (site investigations, effects assessment, management etc), possess the necessary experience and competencies. This means the ecologist(s) should meet the requirements of a suitably qualified and experienced professional (SQEP) as outlined in Table 1 of the NZTA *Ecological impact assessment guidelines* (NZTA, 2023). An ecologist who holds a current Certified Environmental Practitioner (Ecology) accreditation[11] is preferred.

In addition, a Bat Competency Framework has also been developed by the DOC Bat Recovery Group.[12] The framework outlines a list of competency classes, which includes activities associated with catching bats, handling bats, and the implementation of the Bat Roost Protocols for tree removal. It is recommended for NZTA projects that the appropriate certification is held when undertaking any of the aforementioned activities. An application should be made to the DOC Bat Recovery Group (bathandler@doc.govt.nz) to achieve certification for a particular competency. For bat roost assessments that do not require bat handling, competency level 3.1 and 3.3 are needed.

To undertake any work that involves catching, handling, and releasing bats, a Wildlife Act authority (WAA) must be authorised by DOC. It is likely that the WAA will include requirements for personnel to be certified in specific competency classes for the work to proceed.

When procuring professional ecology services for bat-related work it is important that SQEP requirements and competency classes (if relevant) are specified in procurement documentation. Proof of SQEP and competencies can be obtained by reviewing CVs and further clarification may be sought from DOC if required.

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[11] https://www.cenvp.org/

[12] https://www.doc.govt.nz/nature/native-animals/bats-pekapeka/resources-for-bat-workers/

4.4 Data analysis and reporting

Reporting of survey/monitoring results may be required pre-construction as part of the EcIA, during/after construction or as part of maintenance activities. Raw data should be made available to NZTA to allow for further analysis in the future and/or for meta-analysis.

Reporting requirements for a preliminary technical assessment (PTA) and detailed EcIA are included within the NZTA EcIA guide (NZTA, 2023). When reporting the bat survey/monitoring results, it is important to clearly detail the methodology and findings to ensure replicability in future studies. As a minimum this should include the following:

- **Introduction/background**: details of the project, purpose of the site investigation, and the type of bat activity that is being assessed.
- **Methodology**: location and date of site investigation, competencies of surveyors, specific equipment or software used, effort applied during the investigation (for example number of sites/detectors and duration of ABM monitoring, and details of any kit failures/changes); and
- **Results**: results of site investigation data, weather conditions,[13] sunset and sunrise times, and any data analysis undertaken. Statistical analysis should be completed where possible (eg multiple linear regression to account for external variables). Additional data that may be beneficial in data analysis for transport projects includes:
    - distance between the survey/monitoring device(s) and the road/construction area edge and/or centreline (if monitoring occurs post construction)
    - distance between survey/monitoring device(s) and the nearest habitat edge (including the type of habitat)
    - traffic volume, including overnight traffic volume at the site
    - project stage or time lapsed since road construction (if monitoring occurs during or after construction)
    - data on traffic noise levels and light levels at the site, and
    - any other variables that may influence results (such as nearby active construction projects, new developments/housing).
- **Recommendations**: key findings and implications of the results in relation to mitigation and/or adaptive management, along with the need for any further surveys or monitoring.

All bat survey/monitoring results should be submitted to DOC.[14]

[13] Weather data can be retrieved from weather stations such as New Zealand's National Climate Database (accessed via Earth Sciences New Zealand's DataHub). If a weather station is not located near the monitoring location, then site specific weather data should be collected. Ideally, this weather data would be collected hourly, and include temperature, rainfall, and windspeed.

[14] Email DOC via batdatabase@doc.govt.nz. A copy of the bat records sample spreadsheet can be downloaded from https://www.doc.govt.nz/nature/native-animals/bats-pekapeka/resources-for-bat-workers/

5 Effects management

- Aspects of the effects management hierarchy (avoid, minimise and remedy) applies across the project lifecycle.
- Embedded controls are proposed as a strategy to navigate the inherent uncertainty in bat management and addresses it in a conservative and practical manner.
- Management strategies include avoidance, minimisation, and remediation, with monitoring essential to assess effectiveness of mitigation and to guide adaptive management.
- Residual effects management prioritises mitigation strategies before considering offsetting and compensation measures to address any remaining adverse effects.
- Monitoring the effectiveness of management strategies can be complex and requires careful planning in conjunction with the SQEP, project manager and project planner. Monitoring should be commensurate to the level of effect and scale of mitigation.
- Bat Management and Monitoring Plans should be prepared that includes information on how to manage and implement mitigation on a project, including performance measures/trigger levels and adaptive management.

Effects on bats should be managed at every stage of a project's lifecycle. The primary objective of management is to firstly avoid adverse effects on bats, adhering to the effects management hierarchy (also known as the 'mitigation hierarchy') (refer Figure 13). The hierarchy is the set of steps applied sequentially that seeks to avoid, minimise and remedy impacts of development on biodiversity (further information is provided in the NZTA EcIA guide). Only after these steps have been applied and an adverse effect remains (aka residual effects) should biodiversity offsetting or compensation be considered (the final steps of the effects management hierarchy). Management strategies in relation to the effects management hierarchy are presented in section 5.2 and 5.3.

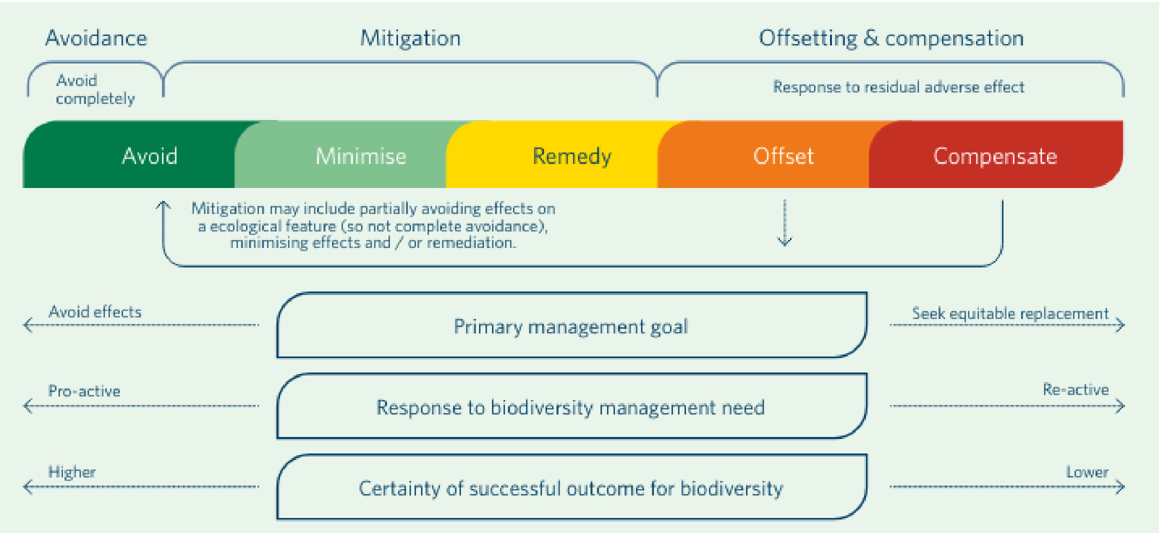

Figure 13: Effects management hierarchy (reproduced from NZTA EcIA guide)

Uncertainty surrounding the effectiveness of bat management poses a common challenge. Given the elusive nature of bats, the potential for false negatives during surveying, and the difficulty of surveying and/or monitoring in a way that is practical for transport projects, embedded controls are proposed as one potential strategy to navigate this uncertainty. This is further detailed in section 5.1.

5.1 Embedded controls

Embedded controls are proposed as a strategy whereby bat management is integrated into the project design or maintenance activities based on the assumption of bat presence (this should be integrated into an effects assessment process). Embedded controls are deployed where the project is in proximity to features likely to be of value for bats (such as linear terrestrial or aquatic features, or bush blocks). Noting, that the use of embedded controls will also have inherent benefits for other native fauna that may be present. Embedded controls are generally conservative and are appropriate in some situations where it may not be possible to implement a full suite of bat surveys to understand the population, such as when the project location is inaccessible/constrained, the project is fast tracked or is consented but will not be constructed for a significant time in the future. They may also be appropriate for maintenance activities. Alternatively, they may also be implemented where there is already sufficient knowledge available regarding local bat populations to have confidence in the likely success of the proposed strategies. For example, if works are proposed in an area where bat populations have been studied for a number of years and key foraging, commuting and roosting locations are already known.

Examples of embedded controls include:

- Creating and/or maintaining hop-overs, where road infrastructure intersects linear features, particularly along known flight paths such as streams, rivers, treelines, and bush remnants. The objective is to establish post-development landscapes where stream and riparian features maintain ecological connectivity between and throughout areas of development.
- Avoid or minimise artificial light near potential bat features (in particular hop-overs and areas of potential habitat in proximity to the road). Any artificial light to be introduced is to conform to internationally recognised best practice (Australian Government, 2023; Voigt et al, 2018), for example use of light with colour temperature ≤2700k; lowering and cowling lamps to reduce spill radius; increasing lamp spacing; and reducing hours of light (such as through motion-sensor technology). Refer to DOC Bat Recovery Group *Interim Advice Note: Steps to reduce the impact/effect of artificial light on pekapeka (bats): Version 1: 19 August 2025*.
- Avoid or minimise noise disturbance (for example considering road surface or setback distances) near potential bat features (including hop-overs and areas of potential habitat in proximity to the road). Refer NZTA Research Report 692, *Road edge-effects on ecosystems* (2022).
- Planting for long-term replacement of roosts and foraging areas and provision of artificial roosts (such as bat boxes). Refer to DOC *New Zealand Bat Recovery Group Advice Note – Planting to provide roosts for bats in the long-term*.

5.2 Effects management strategies

The following section outlines potential management strategies that can be employed (in accordance with the effects management hierarchy shown in Figure 13) to manage effects on bats. A brief overview of the application of avoidance, minimise and remedy strategies is discussed below. Full details on management strategies, along with guidance and limitations, is presented in Table 7. For simplicity, these have been presented collectively; however, we acknowledge that these will either achieve avoidance (complete/partial) or are a form of mitigation (minimise/remedy). Residual effects are further detailed in section 5.3.

Due to uncertainty related to possible effects at a landscape scale (even if avoidance strategies are implemented) it is possible that the next step in the effects management hierarchy may still need to be applied (that is, minimise/remedy), as other effects may persist.

As with any proposed management, monitoring should be required to assess the effectiveness of strategies, including adaptive management, in the event it is not achieving desired outcomes. This is detailed further in section 5.4.2.

5.2.1 Avoid

There is limited research available on the efficacy of mitigation efforts for bats in New Zealand, and considering the vulnerability of long-lived, slow-breeding species such as bats to environmental changes (Jones et al, 2019), avoidance is the most reliable strategy for managing effects on bats.

The simplest way to achieve avoidance is by completely avoiding known bat habitat during the project's development stage (options shortlisting). Throughout the project lifecycle additional changes may be required as more information becomes available regarding bat populations and habitat use within the area. For maintenance activities, full avoidance of bat habitats may not always be possible. However, partial avoidance should be considered, for example through the timing of works such as tree felling to avoid times of the year when bats are less active (refer to section 4.2.3). Further guidance for M&O is provided in Appendix B.

Avoidance of effects on bats can be complex, as projects generally occur in landscapes which comprise various habitats or features with differing ecological values for bats. It can be difficult to fully consider and quantify all these varying values to enable effective avoidance practices. For example, even if known roost trees are avoided, bats may still be impacted by landscape-scale effects, such as fragmentation of foraging areas, or loss in habitat connectivity due to presence of new infrastructure.

It is therefore likely that even if avoidance strategies are implemented, due to uncertainty related to possible effects on bat populations at a landscape-scale, the next steps in the effects management hierarchy will still need to be applied. This also applies for partial avoidance of an effect.

5.2.2 Minimise/remedy

Minimisation and remediation strategies are generally applied at the point of impact to reduce the duration, intensity and/or extent of the effect that cannot be completely avoided.

Minimisation involves reducing effects to the smallest amount reasonably practical. By implementing minimisation measures during the early stages of the project, for example route selection and design, it may help avoid more costly remediation and/or offset/compensation measures. These measures would focus on minimising the effect of the project on bats through alterations to the design and/or location of infrastructure, lighting, and landscape and urban design.

Remediation, also referred to as rehabilitation and restoration, involves measures to improve ecological features (such as habitat restoration) that may be degraded or removed due to project activities. It may also include measures to reduce or remove existing disturbances (for example light and noise), or the decommissioning of existing infrastructure or structures that impede bat movement. These measures are typically implemented towards the end of the delivery stage (implementation/construction) or during a maintenance or operation activity. However, these measures should be implemented as soon as it is practicable, ensuring time for remediation works (such as planting) to establish before the project (and subsequent effects) becomes fully operational.

M&O teams should be consulted to evaluate how maintenance of remediation measures will be undertaken (if this is required) during the operational phase.

Figure 14: For complex projects, radio-tracking bats can provide important data on how bats are using the landscape and where critical habitat features are. Radio-tracking this lactating female bat enabled the project to find a maternity roost and focus effort to protect it (source: Mt Messenger Alliance)

Figure 15: Bat boxes have been used successfully to remedy loss of roost features (source: AECOM)

Table 7: Summary of potential management strategies

Strategy	Effect management type	Potential effect that strategy seeks to address	Guidance	Limitations
Complete or partial avoidance of known bat habitat/features, including identification and protection of roosts.	Avoid	All effects, including: • mortality or injury to bats • loss of roost features (including dynamic roost use) • loss of foraging habitat • removal of roost cover habitat and effect of microclimate to roosts • fragmentation of flight paths (loss in connectivity) • disturbance, habitat fragmentation and displacement to bats and/or their roosts and flight paths due to new or increased noise/vibration, dust, and light (operation/construction).	*Landscape and urban design for bats and biodiversity* (Bat Conservation Trust, 2012).	• Availability of suitable areas for linear infrastructure that is not potential bat habitat. • Difficulties in reliably identifying roosts. • Bats may move roosts during project time frames. • Edge effects (eg although a feature is avoided, it may still be disturbed during construction or operation).
Lighting design management, including: • creation of 'dark zones' by completely excluding lighting elements from the design wherever possible, and usually in areas adjacent to sensitive features such as important flyways (eg watercourses) • reduction in lighting through consideration of lighting design in relation to type, placement and timing (to reduce illumination during peak bat activity periods – sunset and sunrise) • use of warm colour light temperatures (<2700 Kelvin (K)).	Avoid Minimise	• Operational disturbance and displacement to bats and/or their roosts. • Fragmentation of flight paths (loss in connectivity) through increased light.	*Interim Advice Note – Steps to take to reduce the impact/effect of artificial light on pekapeka (bats)* (DOC Bat Recovery Group, 2025)	• Potential conflict with human safety requirements.

Strategy	Effect management type	Potential effect that strategy seeks to address	Guidance	Limitations
Use of low-noise road surfaces and noise walls, or other noise-reduction measures.	Minimise	• Operational disturbance and displacement to bats and/or their roosts due to increased noise.	*Guide to assessing road-traffic noise* (NZTA, 2024)	• High cost if solely for bats. • Due to costs, more likely to be installed for other purposes, eg human; benefits to bats would be secondary.
Provision of buffers/corridors (ideally planted up to 120m[15] wide) between infrastructure and sensitive bat features, eg streams, roosts and other areas bats use for foraging/commuting.	Minimise	• Operational disturbance and displacement to bats and/or effective loss of their roosts through loss of connectivity. • Loss of foraging habitat.	NZTA Research Report 692, *Road edge-effects on ecosystems* (2022) *NZTA landscape guidelines* (2018)	• Permanent, legal protection of land to enable planting of buffer width. • Long-term maintenance required.
Design of structures (eg height or location of bridges/ underpasses) to facilitate bat flight paths.	Minimise	• Mortality or injury to bats due to vehicle strike. • Fragmentation of flight paths through physical barriers, and/or noise/light.	*UK bat mitigation guidelines* (Bat Conservation Trust, 2025) (section 8.2)	• Competing needs with safety and cost requirements. • Do we have information to inform design?
Roost identification through tree felling protocol.	Minimise	• Mortality or injury to bats during construction.	*Bat roost protocols* (DOC Bat Recovery Group, 2024) *Initial veterinary care for New Zealand bats* (Wildlands, 2023)	• The efficacy of the *Bat roost protocols* have not been tested to date. • Strategy does not consider effects management for unoccupied roosts that are destroyed when bats are not present at the time of felling.
Artificial roost provision with predator exclusion bands, including: • bat boxes (Figure 16) • artificial holes (drilled) in trees	Remediate (may also be considered offset/ compensation)	• Loss of roost features (including dynamic roost use).	*DOC Bat Recovery Group Advice Note – The use of artificial bat roosts* (DOC Bat Recovery Group, 2025) 'Occupation of artificial roosts by long-tailed	• Concerns over detrimental effects on bat population, including lower survival and productivity compared to natural roosts. • Limited information available on optimal design, placement, and

[15] Based on 'Road Effects Zones' established for similar Australian bat species (*Chalinolobus gouldii*) published in Bhardwaj et al (2021).

Strategy	Effect management type	Potential effect that strategy seeks to address	Guidance	Limitations
• opportunistic salvage of roost features and relocation during vegetation clearance.			bats *(Chalinolobus tuberculatus*) in Hamilton City, New Zealand' (Robinson et al, 2023)	microclimate of artificial roosts for New Zealand bats • Suitable as a temporary measure only and should not replace the need for replanting to provide alternative long-term natural roosting opportunities. • Maintenance of boxes is required.
Landscape or structures[16] to facilitate bat movement, including: • underpass/culvert • vegetated hop-overs (eg use of existing tree canopy) • road margin/verge/central reservation area design (eg retention of trees within flight paths) • decommissioning of existing infrastructure or structures that impede bat movement (coupled with robust remediation scheme to improve resulting habitat).	Minimise/remediate	• Mortality or injury to bats due to vehicle strike. • Fragmentation of flight paths through physical barriers, and/or noise/light.	*UK bat mitigation guidelines* (Bat Conservation Trust, 2025) (section 8.2) *Road edge-effects on ecosystems*. (Landcare Research Ltd, 2022)	• Detailed surveys required to inform correct placement/removal of structure. • Evidence overseas questions effectiveness. • Depending on planting time and type, there will be a time lag between planting and trees/vegetation reaching sufficient effective height. • If only some trees are retained, flight paths may still be impacted. Requires robust survey to identify flight paths to feed into verge design.
Restoration/enhancement planting of existing ecological features with importance to bats (eg known bat habitat, existing hop-overs, foraging areas such as stream corridors and wetlands).	Remediate (may also be considered offset/ compensation)	• Loss of roost features. • Loss of foraging habitat. • Fragmentation of flight paths through physical barriers, and/or noise/light. • Mortality or injury to bats due to vehicle strike.	NZTA Landscape Guidelines (2018) New Zealand Bat Recovery Group Advice Note – Planting to provide roosts for bats in the long-term	• Time lag between planting and any accrual of benefits to population.

[16] Road/foot-bridge – unvegetated are excluded from this list due to concerns over efficacy.

Strategy	Effect management type	Potential effect that strategy seeks to address	Guidance	Limitations
Tree trimming instead of felling to avoid roost features.	Minimise	• Mortality or injury to bats during construction. • Loss of roost features (including dynamic roost use). • Loss of foraging habitat.	DOC Bat Recovery Group, 2025)	• May require regular trimming, therefore more costly than felling the whole tree. • Potential roost features (include future) may still be affected.
Construction management, including: • placement of source of construction noise/light/vibration/dust away from sensitive features (eg known or potential roosts) • timing of construction work around potential/actual roost trees to avoid bat maternity period (December to February, inclusive) • ecological induction for construction staff, including bat awareness • accidental discovery protocol.	Minimise	• Disturbance and displacement to bats and/or their roosts during construction.	UK Bat Mitigation Guidelines (Bat Conservation Trust, 2023) (section 8.2)	• Lack of awareness in relation to the importance of implementing management controls.

5.3 Residual effects management

Offsetting and compensation involves implementing measures to offset and compensate residual adverse effects after the above management strategies have been applied.

Neither 'offsetting' or 'environmental compensation' is defined in the Resource Management Act 1991 (RMA), however it is defined in the National Policy Statement for Indigenous Biodiversity (NPS:IB) that 'offsetting' is a 'commitment to redress more than minor residual adverse effects' (NPS:IB, 2023) and involves measures taken to achieve a quantifiable no-net-loss or net-gain of biodiversity and must be like-for-like. Environmental compensation is used when it is not possible to offset impacts and doesn't necessarily result in quantifiable like-for-like outcome.

Further detail on offsetting and compensation is provided in the EIANZ guidelines and the NZTA EcIA guide). Both documents encourage the use of the guidance document *Guidance on good practice biodiversity offsetting in New Zealand* (New Zealand Government, 2014) to ensure best practice in offsetting. In addition, models such as the Biodiversity Offsets Accounting Model (BOAM)[17] and Biodiversity Compensation Model[18] can help assess the effectiveness of offsetting measures and ensure they meet the desired outcomes. Common types of compensation in relation to bats include animal pest control around roosts and habitat restoration to provide foraging and roosting areas. However, the effectiveness of these measures is still unknown, and requires population data, baseline data such as roost locations, and long-term monitoring.

Further detail on offsetting and compensation strategies are summarised in Table 8; if applicable to the project scope, it may be appropriate to apply several of these methods concurrently (for example if it is not possible to fully implement one strategy, it could be combined with others to maximise benefits).

M&O teams should be consulted to evaluate how maintenance of offset/compensation measures will be undertaken (if this is required) during the operational phase.

[17] https://www.doc.govt.nz/about-us/our-policies-and-plans/guidance-on-biodiversity-offsetting/biodiversity-offsets-accounting-system/

[18] https://www.tonkintaylor.co.nz/expertise/environmental/biodiversity-compensation-models/

Table 8: Summary of offset and compensation strategies

Offset and compensation strategies	Offset/compensation?	Guidance	Limitations
Predator control	Compensation	Controlling invasive predators enhances the long-term survival of endangered New Zealand long-tailed bats (*Chalinolobus tuberculatus*): implications for conservation of bats on oceanic islands (O'Donnell et al, 2014)	• Large areas of predator control required to be considered effective – >3000ha (O'Donnell et al, 2014). • Locations of roosts (ideally maternity) should be known to be effective. Radiotracking may be required to confirm roost locations. • Timing of programme should be long/indefinite to be considered effective. • Improves quality of remaining habitat but does not directly address fragmentation or habitat loss. • Land ownership may restrict options for predator control.
Enhancement and legal protection of existing habitat	Offset or compensation (dependent on context and purpose of the action)	Bats in New Zealand plantations: forest management guidance (Borkin et al, 2018) NZTA *Landscape guidelines* (NZTA, 2018) *New Zealand Bat Recovery Group Advice Note – Planting to provide roosts for bats in the long-term*	• Land ownership may restrict options for habitat enhancement locations. This could limit flexibility in selecting appropriate habitats. • Inappropriate location choice could be both costly and ineffective.
Planting of new habitat	Offset or compensation (dependent on context and purpose of the action)	Bats in New Zealand plantations: forest management guidance (Borkin et al, 2018) NZTA *Landscape guidelines* (NZTA 2018) *New Zealand Bat Recovery Group Advice Note – Planting to provide roosts for bats in the long-term*	• Land ownership (including long-term protection) may restrict options for new habitat planting locations. This could limit flexibility in selecting appropriate habitats. • Inappropriate location choice could be both costly and ineffective. • New habitat to be planted will take significant time to mature. Natural gains for bats unlikely to be realised for several decades at least. • Likely to require combination of new planting and predator control/enhancement (eg through provision of roosting features) to provide an effective offset/compensation result.

Offset and compensation strategies	Offset/compensation?	Guidance	Limitations
Protection of ‘critical’ habitat (‘averted loss')	Offset or compensation (dependent on context and purpose of the action)	None available	• Protection of critical habitat does not address fragmentation or loss of buffer habitat. • Land ownership (including long-term protection) may restrict options and limit flexibility in selecting appropriate habitats. • Requires detailed survey work to inform selection of habitat. • Inappropriate location choice could be both costly and ineffective. • Protection of only critical habitat could increase fragmentation over time.
Financial (or other) support for conservation efforts, research (could be included within project scope or independent) and innovation, improvement of adaptive management strategies, education, and outreach	Compensation	*Guidelines for ecological compensation associated with highways* (Cuperus et al, 1999).	• Does not address issue of impacts on bats at the source. • Research may not be directly linked to impacts as a result of the project; therefore, may not be relevant. • Difficult to quantify appropriate scale of financial compensation.

5.4 Monitoring of management strategies and use of adaptive management

Monitoring for bats can be complex and needs careful planning in conjunction with the SQEP, project manager and project planner. To assess the effectiveness of mitigation measures, and to ensure that potential impacts on bat populations are properly addressed throughout the project lifecycle and beyond its completion, monitoring should be undertaken and adaptive management actions be agreed upon. Monitoring and adaptive management should be commensurate to the level of effect and scale of mitigation.

The following steps outline recommendations to formulate a monitoring plan (in relation to mitigation and/or effects) for bats (adapted from van der Grift et al, 2013):

1. Identify SMART[19] goals and select measurement variables to be met. Some examples of SMART goals include:
    - Within 2 years of deployment XX% of bat boxes are utilised for roosting across the project area.
    - Statistically significant avoidance behaviour of bridges (compared with baseline and control sites) by bats is not observed during flight (that is, bats do not ‘turn back’ from a structure).
    - Bat activity levels show no statistical difference 5 years after project implementation, compared with baseline levels (prior to project).
2. Determine study design/scope/scale:
    - Time length of monitoring, frequency, replicates – for example before/after, BACI (refer to section 4.2.5). For high-risk projects, a power based statistical analysis is recommended to determine some of these factors (refer to section 4.2.5).
    - Select appropriate study sites (including control sites) and consider spatial scale of study in relation to zone of influence (refer to section 3.1).
    - Select survey methods (refer to section 4.2.4).
    - Study design examples are provided in Appendix C: Hypothetical case studies.
3. Measure or obtain data on other influencing variables, for example light, traffic (noise), distance to road centreline, other developments in the area (refer to section 4.2.5). This information can be used for statistical analysis, such as a multiple linear regression, which can account for external variables and improve the reliability of monitoring data.
4. Determine costs and feasibility. A comprehensive risk assessment should be undertaken before the monitoring plan is finalised to judge its feasibility, including costs. The monitoring plan should be adjusted based on the outcome. In some circumstances effective monitoring may not be technically or financially feasible. In these instances offset/compensation strategies may be considered appropriate to address uncertainty associated with unknown residual effects (refer to section 5.3).

Guidance on planning, conducting, evaluating and reporting on monitoring can also be found in the *Biodiversity monitoring, evaluation and reporting framework* (City of Melbourne, 2020).

Also refer to the *Bat monitoring guidelines using automatic detectors* (DOC Bat Recovery Group, 2025) which gives guidance on monitoring of bats using automated bat detectors.

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[19] Specific, measurable, achievable, relevant, and time-bound

5.4.1 Modification thresholds

Thresholds can be set that trigger modifications of management (or at least its review) and should be defined ahead of time in collaboration with advice from SQEPs, DOC and local authorities, as appropriate. These would usually be integrated as part of a bat management and monitoring plan (BMMP). Examples of thresholds include performance measures and trigger levels:

- **A performance measure**: a quantifiable SMART indicator used to assess how the project is achieving objectives, for example: Bat connectivity is maintained at installed hop-overs.
- **A trigger level**: a quantifiable SMART point/level at which corrective action must be implemented to ensure that the project meets objectives, for example: Thermal imagery captures a statistically reduced number of bats crossing bridges or roads compared with baseline or they are crossing at vehicle strike height.

5.4.2 Adaptive management

Adaptive management can be defined as actions that are implemented if it is identified that the project[20] is not meeting performance measures and/or has exceeded/not met a trigger level. These should be specified within the BMMP.

Monitoring associated with triggers and adaptive management should be designed with set timeframes. In some instances, such as where the success of monitoring cannot be guaranteed or adaptive management is considered unfeasible, it may be appropriate to implement offset/compensation strategies. These strategies should ideally be determined in advance to avoid uncertainty in relation to scope and costs.

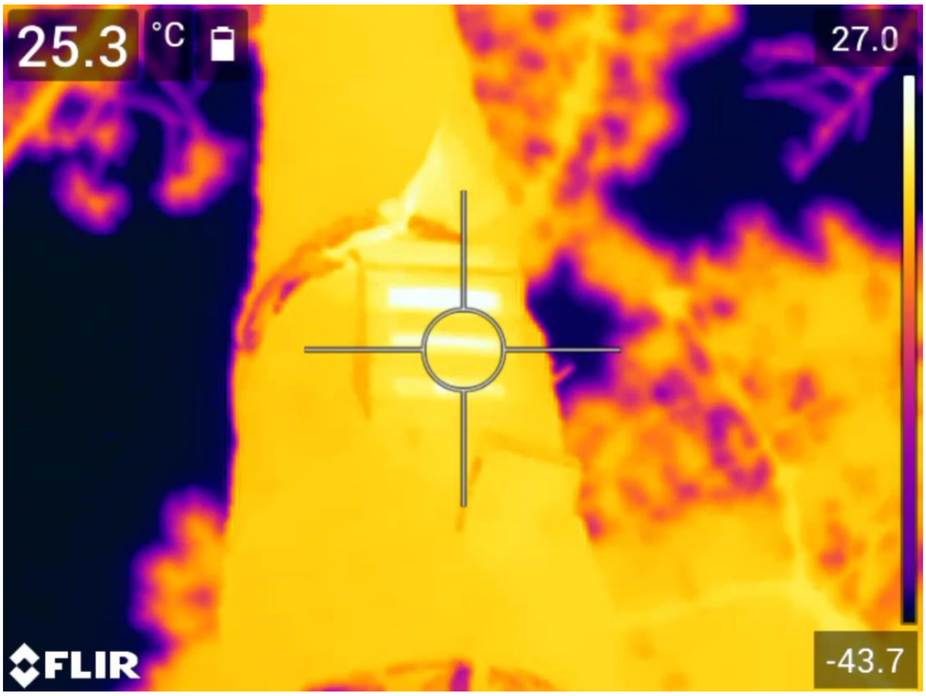

Figure 16: A thermal camera was used to see whether bat boxes had been accepted by bats as an alternative roost option after tree roosts were removed as part of a project. Results revealed successful use and provided evidence the intervention can work (source: AECOM)

[20] Adaptive management can also be used to inform future projects as part of a continual improvement cycle.

5.5 Bat management and monitoring plan

A bat management and monitoring plan (BMMP) should be prepared (as early as possible and ideally to support consent) that includes information on how to manage and implement effects management (section 5.2) and monitoring measures on a project, including performance measures/trigger levels and adaptive management (section 5.4). Further guidance for M&O on bat management plans is provided in Appendix B.

As a minimum, a BMMP should include the following information:

- An overview of the proposed project scope, including the location, nature and timing of works.
- The objectives of the BMMP.
- An overview (baseline) of known bat activity in the area, including locations of key habitat features for bats within the zne of influence, and the location of any other critical areas for the local bat population.
    - Indicate how the zone of influence was decided upon and how effects were assessed and how each effect will be addressed. This information should be based on either robust baseline studies, or significant prior data availability, such that there is confidence in the conclusions being drawn regarding proposed management measures.
- Details of the proposed management strategies, including (where appropriate) location and specifications of features installed for bats (such as hop-overs, underpasses, bat boxes). Development of management options should include discussions with stakeholder and iwi partners.
    - Include procedures for incidental bat discovery and/or injury. Relevant advice documents should be referenced.[21] [22]
- Details of who is responsible for each management strategy/action, and how/when actions will be completed.
- Details of a monitoring programme to measure the effectiveness of the proposed management strategies, and how adaptive management will be used during any required monitoring period.
    - This information should include appropriate triggers and/or performance indicators and should enable adaptive management measures to be implemented if it becomes apparent that triggers/performance indicators are not being met.
    - In certain circumstances, it may be appropriate to implement embedded controls, instead of designing and monitoring the effectiveness of a site-specific management plan. In these circumstances, the presumption is that there will be no monitoring of bats following project completion, and as such, no feedback regarding the efficacy of management actions. Controls should be of a sufficient scale to account for uncertainty.

The BMMP should cross-reference and feed into relevant project plans such as landscape plans and construction/environmental management plans, where appropriate.

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[21] *Advice for first responders* (Wildlands, 2019).

[22] Initial veterinary care for New Zealand bats (Wildlands, 2023).

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7 Glossary and definitions

Abbreviation/term	Definition
ABM	Automated bat monitoring unit/detector.
Adaptive management actions	Defined actions which are implemented if it is identified that the project is not meeting performance measures and/or has exceeded/not met a trigger level.
BACI	Before-after control-impact.
Baseline	Information that describes the environment in the absence of the proposed project, which is used to inform the assessment of impact.
Bat habitat	Collection of locations that provide the resources and conditions needed for bats to be present, and will include, but may not be limited to, areas that provide for breeding, roosting, foraging, and commuting.
BMMP	Bat management and monitoring plan.
Compensation	Biodiversity compensation is a commitment to redress more than minor residual adverse effects, and should be contemplated only after steps to avoid, minimise, remedy, and offset adverse effects are demonstrated to have been sequentially exhausted. Compensation must adhere to a series of principles, including: additionality, appropriate scale, preventing effects 'leakage', ensuring long-term outcomes, considering the landscape context and time lags, trading up, financial contributions (if applicable), consideration of science and mātauranga Māori (including stakeholder participation) and transparency. Compensation is not appropriate if the biodiversity to be affected is uncertain, irreplaceable or if there are no feasible options to be undertaken. (NPS:IB, 2023).
Detailed EcIA	Detailed ecological impact assessment – undertaken once the preferred option has been developed and approved to proceed to implementation.
DOC	Department of Conservation.
DOC Bat Recovery Group	A group that provides technical advice for the wide range of issues that come up in bat conservation and develops national strategies, advice notes, best practice guidance, and plans for bat recovery.
Dynamic roost use	Vegetation, including roost trees, may be used by bats in different ways throughout the year, and in response to variables such as weather, light/noise and other changes in the wider landscape.
Echolocation	The use of reflected soundwaves to determine the location of objects, such as prey.
EcIA	Ecological impact assessment.
Effect	The outcome to an ecological feature from the impact, eg a construction impact is vegetation removal, and an effect on bats could be fragmentation (loss in connectivity).
Effects management hierarchy/mitigation hierarchy	In sequential order avoid, minimise, remedy, offset and compensate.
EIANZ	Environment Institute of Australia and New Zealand.
Embedded controls	Strategies implemented in projects where bat presence is assumed (eg creating and/or maintaining hop-overs, avoiding/minimising light and noise disturbances, provision of artificial roosts).
ES	Environmental screen – a checklist of questions designed to identify and assess environmental opportunities and constraints.

False negative	Survey incorrectly indicated that bats are not present, when they are.
Impact	Project actions that result in changes to an ecological feature, eg vegetation removal.
Lekking	A type of courtship behaviour where males assemble in an area to perform for females to drive sexual selection.
Lux	The international unit of illuminance; whereby one lumen per square metre equals 1 lux.
Maternity roost	Roosts containing mostly pregnant/lactating females and juveniles.
Monitoring	Systemic, ongoing collection of data over time to track changes in bat populations, behaviours, or habitat use.
NVA	Night vision aids, eg infrared, thermal imagery.
NZTA	New Zealand Transport Agency Waka Kotahi.
NZTCS	New Zealand Threat Classification System.
Offsetting	Involves measures taken to achieve a quantifiable no-net-loss or net-gain of biodiversity. Principles broadly match those for biodiversity compensation, with the addition of a quantifiable net gain using like-for-like quantitative loss/gain calculations (NPS:IB, 2023).
Over-wintering	This term refers to bats which are simply surviving the winter; often this is done in smaller groups within the colony territory. They may be less active than during the summer months, due to more frequent inclement weather.
Performance measure	A quantifiable indicator used to assess how the project is achieving objectives.
Peri-urban	A hybrid, fragmented landscape comprising both urban and rural elements. Also known as rural-urban fringe; the eco-tone between city/town and countryside.
PIT chip/tag	Passive integrated transponder.
Post-parturition	Period after juveniles have been born, but before they are independent. Females stay in maternity groups as they nurse and wean their young, and towards the end of this time, the young start to fly and become independent.
Pre-parturition	Period when females are pregnant, but prior to juvenile bats being born. This is when pregnant females often start forming large communal colonies, known as maternity roosts.
Project lifecycle stages	Development, delivery, and maintenance and operation.
Project phases	Investment case,, pre-implementation (procurement, consenting), implementation (design and construct), post-implementation (operation and maintenance).
PTA	Preliminary technical assessment – an assessment that provides adequate detail regarding ecological risks and benefits to demonstrate the feasibility of the option before moving to implementation.
Residual effects management	Offsetting, compensation.
RMA	Resource Management Act 1991.
Roost	Any place that is used by bat(s) for shelter or protection.
Roost watches	Emergence surveys and/or re-entry watches of potential or known bat roosts.
Site investigations	Encompasses surveys and monitoring. Typically for bats, this includes walkover surveys, presence surveys, baseline/detailed surveys, and monitoring.
SMART	Specific, measurable, achievable, relevant, and time-bound
SQEP	Suitably qualified and experienced professional in relation to bat ecology.

Statistical power analysis	In the context of bat surveys this refers to the process of evaluating and optimising the survey design to ensure a high likelihood of detecting a true effect or change in bat activity, population, or distribution – if such an effect exists. This involves determining the appropriate sample size, survey duration, and frequency needed to confidently detect meaningful patterns or trends.
Survey	Typically, a one-time or periodic assessment to gather a snapshot of bat populations.
Torpor	Periods of low body temperature and metabolism used for energy conservation, like a mini hibernation. Can last a few hours or up to several weeks.
Trigger level	A quantifiable point/level at which corrective action must be implemented to ensure that the project meets objectives.
Wildlife Act authority (WAA)	A formal permit granted under the Wildlife Act 1953 from DOC that is required when interacting with native wildlife (eg to survey, catch, hold, release, or kill).
Zone of influence (ZOI)	The areas/resources that may be affected by the biophysical changes caused by the proposed project and associated activities.

Appendix A: Legal protection and policy

Key legislation and policy governing the protection and conservation of bats are the:

- Wildlife Act 1953
- Conservation Act 1987
- Resource Management Act (RMA) 1991, and
- National Policy Statement for Indigenous Biodiversity 2023.

These are discussed in more detail in section 3 of the NZTA EcIA guide (NZTA, 2023).

A1 Wildlife Act 1953 and Wildlife (Authorisations) Amendment Act 2025

The Wildlife Act 1953 and Wildlife (Authorisations) Amendment Act 2025 are administered by DOC and serve as the primary legal framework for the protection and management of wildlife in New Zealand. While these acts are not specific to bats, it includes provisions that offer general protection to native fauna, including long-tailed bats and lesser short-tailed bats.

Under these acts, all indigenous wildlife, including bats, are considered the property of the Crown, and it is illegal to harm, disturb, or kill them without lawful authority. The acts also provide for the establishment of regulations and permits for the management and conservation of protected species.

To undertake any work that involves catching, handling, and releasing bats, a Wildlife Act authority (WAA) must be authorised by DOC.[23] Reporting of accidental or incidental death or injury is also required.

Disturbance is not defined in the acts, however a Court of Appeal decision in 2018 and a Supreme Court decision in 2019 relating to shark cage diving provided an interpretation of 'disturbing' to mean: 'an action which physically or mentally agitates the protected animal to a level creating a real risk of significant harm'. In practice, this means applications related to disturbance will no longer be accepted by DOC, and whether the activities are an offence will depend on the risk of significant harm and the level of mental agitation it causes the wildlife. Applications to DOC relating to accidently killing bats (eg the removal of roosts) will not be considered.

A2 Conservation Act 1987

Concessions in relation to bats under the Conservation Act 1987 are only required if the project is located on land that passes through conservation land that contains bat habitat.

A3 Resource Management Act 1991

The Resource Management Act 1991 (RMA) focuses on managing the effects of land use and development on the environment. While the RMA does not explicitly mention bats, section 6(c) provides for 'the protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna', which includes bat habitat. Local authorities are responsible for considering the protection of biodiversity and ecosystems when making resource management decisions.

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[23] An animal ethics approval may be required for works that involve manipulation of animals if it does not constitute routine species management (eg banding or attaching radio transmitters to bats or inserting PIT tags). If applicants are uncertain whether they need to apply they should contact the current chair of the Animal Ethics Committee via DOC's National Office. It is likely that a DOC staff member would need to play a significant role within the project's research team for DOC to consider approving an application; due to requirements as part of the Animal Welfare Act 1999.

A4 National Policy Statement for Indigenous Biodiversity 2023

Issued under the RMA, the National Policy Statement for Indigenous Biodiversity (NPS-IB) provides guidance and direction to local authorities on the maintenance and restoration of indigenous biodiversity and ecosystems, aiming to ensure their long-term survival and sustainable management.

Under the NPS-IB, local authorities are required to take into account the protection and restoration of indigenous biodiversity when making decisions on resource management and land-use planning. This includes measures to conserve and enhance habitats that are critical for the survival of native species, such as bats. In addition, policy 15 states that areas outside of significant natural areas that support specified highly mobile fauna (which includes bats) are identified and managed to maintain their populations across their natural range, and information and awareness of highly mobile fauna is improved.

At the time of publication, not all local authorities have undertaken plan changes to implement the NPS-IB. In some areas (eg the Auckland region), many of the policy directions in the NPS-IB are already contained within existing statutory documents. However, the NPS-IB should be considered a critical framework for any projects that involve land use, development, or ecological impact assessments.

Appendix B: Maintenance and operations

Maintenance and operation (M&O) activities can impact bats and their habitat, which are protected under the Wildlife Act 1953. This appendix provides guidance for M&O on how to minimise harm to bats and be legally compliant while maintaining and operating the network.

B1 Desktop data

- Refer to section 4.1 of this guide for details on undertaking a desktop investigation to inform whether bats are a risk for maintenance activities. Further information on M&O-specific information is provided below. As a minimum check the DOC Bat Distribution Map.
- Handover information from projects on bats should be provided within documentation and is specified in B5 below.

B2 Identifying and managing effects to bats

- Environmental effects, including risk to bats and their roosts from maintenance activities, should be identified and managed as per the requirements of NZTA *Guideline for preparing and environmental management plan* (EMP guideline).
- The EMP guideline requires the identification of sensitive sites that are either located on the relevant network, or which are affected by the network's activities. For bats this includes critical habitat features (such as maternity roost trees and sensitive habitats), where bats may be harmed by transport infrastructure and/or activities. This may include retrofitting such as changes in lighting.
- Sensitive sites should be mapped for practical use by staff while managing/minimising any potential risk to bats this may cause, such as unwanted attention (for example the specific location of roost sites should be a 'need to know' basis with clear instructions to not disturb to those aware of them).
- Examples of high-risk maintenance and operation activities in relation to bats includes tree removal/trimming, including the removal of hazardous trees (see Tree removal below).
- Artificial light at night can impact bats and their prey (insects). The introduction of new lighting or retrofitting of existing lighting has the potential to negatively impact bats and should be minimised where possible.
- Separate procedures may be required as part of the environmental management plan (EMP) to manage effects on bats, for example hazardous tree removal (see B3).
- The EMP shall identify whether there are existing consent conditions regarding bats and any management, maintenance and or monitoring for bats and/or their habitat and refer to relevant plans (see B5).
- The EMP should provide information on key contacts when undertaking work that may impact bats. As a minimum this will be someone in the regional DOC office and potentially iwi partners.
- Many activities within the transport designation are permitted under council rules, for example exotic vegetation removal. However, other legislation such as the Wildlife Act 1953 may have requirements that need to be considered to ensure bats and their roosts are not harmed (refer to Appendix A).
- When programmed improvements of the current network and/or improvement projects within the existing transport corridor or transport designation are planned and bats and/or their roosts may be impacted beyond usual 'baseline' of maintenance and operation activities, an ecological impact assessment (EcIA) may be required (refer to section 3). For example, removal of trees and shrubs, widening of the carriageway that brings vehicles closer to a

significant natural area that has bat habitat, and/or introduction or altering of lighting adjacent to bat habitat.

- Where an EcIA is required, maintenance staff should be consulted as part of the initial assessment, as they are likely to have valuable knowledge.

B3 Tree removal

Tree trimming and removal is a common maintenance activity, generally associated with managing hazardous trees and maintaining site lines. Removal of vegetation, particularly trees, is a high-risk activity for bats across the country (except in very particular circumstances such as heavily urbanised environments).

The following steps should be incorporated into the existing hazardous tree assessment process to manage legal risk, minimise harm to bats and for works planning (including the need for ecology specialist or other suitably qualified and experienced person (SQEP), timing of works and costs). It is recommended the hazardous risk register has a column added to indicate whether a tree has bat potential or not.

- Look at the DOC Bat Distribution Map to see if there are existing records of bats within 25km of any hazardous tree site (see B1 above). If a hazardous tree GIS layer exists, it should be laid over the Bat Distribution Map to get a better understanding of the likelihood (risk) of bat roosts being present in those trees considered hazardous.
- As a minimum, all trees that have been programmed to be removed that year should be assessed for potential bat roost features by a SQEP. The SQEP needs to have successfully completed DOC bat training for competency 3.1 and 3.3. They do not have to be an ecologist (eg arborist). Where possible, consider extending this assessment to trees likely needing to be removed in the next funding round.
- For some trees a desktop analysis of bat roost potential may be sufficient. This is because for some trees it will be obvious to the SQEP that they are not suitable for bats (for example a photo might show that the tree species, age of tree, size of trunk diameter etc are not suitable). For many sites it may be more efficient to go straight to a site visit by the SQEP. How the trees are to be assessed can be decided by the team on a case-by-case basis, with effectiveness of the assessment and efficiency in mind.
- Where bat presence in the area is confirmed or likely (refer to B1) and a hazardous tree has bat roost potential, this should be indicated on the maintenance and operation contracts 'hazardous tree risk register' to manage risk to the project.
- Should the SQEP confirm that the hazardous tree(s) to be removed has bat roost potential, the DOC Bat Roost Protocols (refer to Table 7 of this guide) should be implemented prior to tree removal or trimming.
- Where bat presence in a hazardous tree is confirmed or likely, the last resort is to remove the tree completely. Where possible the tree should be pruned to reduce risk rather than removing the entire tree.
- Should a tree on NZTA land be identified as a maternity roost (by a SQEP), all steps (in consultation with DOC) should be taken to save the tree while ensuring it is not a safety hazard. If it is a pest tree, there should be consideration regarding potential environmental impact should it be saved.
- Should a bat be found injured during tree removal work, then the protocols as set out in the DOC Bat Roost Protocols should be followed. See *Advice for first responders* (Wildlands, 2009). An incident report should also be made in NZTA's Korero Mai.

- Report bat sightings to batdatabase@doc.govt.nz and environment@nzta.govt.nz. Record the location (including a GPS reference), time and date you sighted or recorded the bat and/or bat roost.

B4 Non-programmed/ or emergency works

- Non-programmed or emergency works may be required as part of M&O activities. Where possible, the contractor is encouraged to be proactive, identifying 'weak spots' of their network and transposing these with known sensitive sites (for example bat roosts) and identifying management strategies (where safety is not compromised etc). An emergency works procedure is a requirement of NZTA EMPs.
- When bats are known to be utilising habitat features on the transport corridor and transport land is adjoining DOC-owned land, a relationship with the local DOC office should be formed and clear communication pathways set up with regards to bats, particularly in relation to hazardous trees and emergency situations.

B5 Project to maintenance and operation handover

During the handover process, M&O are to ensure the following information is provided by projects, where relevant (this would usually be contained within the bat management and monitoring plan):

- location of any known habitats for bats (such as foraging areas, flyways, roosts) on or near the state high
- location of bat monitoring sites
- any agreements with partners and stakeholders
- clear methodology for monitoring and analysis of data collected
- what data means in terms of actions and/or adaptive management
- where data is sent/report requirements
- location of ecological management assets such as flyways, bat boxes and buffer areas and management requirements of these and outcomes of maintenance (for example condition).

B6 Bat roost potential assessment competencies

For assessing bat roost potential as part of the hazardous tree assessment, it may be in a contract's best interest to consider someone be trained to become a SQEP in bat roost assessments. Contact bathander@doc.govt.nz.

Appendix C: Hypothetical case studies

The following are hypothetical case studies to indicate the project risk and level of survey effort depending on different project types. These are based on the decision-making flow charts provided in Figure 7 and Figure 11 of this guide. They are examples only, with each project needing to be assessed by a SQEP on a case-by-case basis.

C1 Hypothetical case study A: widening of existing intersection in city centre

Works require removal of 4 trees, as shown in the figure below, and associated earthworks. As part of the proposal, additional lighting will be installed at the intersection.

Site boundary   Tree to be removed

Determining habitat suitability for bats

- This site is in a city centre, c.600m from the closest suitable bat commuting habitat (the riparian corridor to the north) and c.10km from the nearest bat record.
- The site is separated from suitable bat habitat by a dense, well-lit urban conurbation, minimising the chances that bats will be commuting to the site.
- A walked assessment was carried out which determined that none of the trees contained potential roost features (PRFs) and that the site was already well-lit by nearby buildings.
    - **Outcome**: low habitat suitability for bats.

Determining likely project scale impact for bats

- Project is impacting a small number of trees with no PRFs for bats.
- Additional lighting will not significantly increase the current light levels on site.
    - **Outcome**: low project scale impact.
    - **Overall outcome**: low potential risk for bats.

Determining suitable survey effort for effects assessment

- As the walked assessment confirms that the trees contain no PRFs, no follow-up surveys are required to determine presence/likely absence of roosting bats.
- As the site is within the city centre, over 600m from suitable commuting habitat and over 10km from the nearest bat record, surveys using ABMs are not considered necessary. In this instance, likely absence from site can be assumed.
    - **Outcome**: no further survey required.
        - Magnitude and Level of effect on bats is considered to be **Negligible.**
        - No further monitoring required.
        - No specific effects management for bats required.
        - Trees can be felled at any time of year.
        - In the case of incidental discovery of bats during or before tree felling, project works must cease and a SQEP contacted for further advice as bats are protected by law.

C2 Hypothetical case study B: maintenance operations (tree trimming) in a rural location

Works require trimming/limb removal along approximately 1km of rural highway, which is vegetated with semi-mature and mature exotic and native trees. The works will result in cut timber arisings.

Works area (tree/scrub to be removed within 6m of centreline of road

Determining habitat suitability for bats prior to any planned works and how to manage risk

- The contract's environmental management plan (EMP) outlines how environmental risk will be managed, including risk to species protected under the Wildlife Act such as bats.
- The DOC Bat Distribution Map had been used as part of a desktop assessment to inform the contractor's EMP. This meets NZTA EMP requirements to identify sensitive receivers on the network (both on and/or affected by NZTA activities) and providing an early indication of where bats might potentially be present.
- This desktop assessment identified several long-tailed bat records occurring within 25km of the state highway network within the last 10 years.
- The state highway passes through some small towns, but is primarily a mosaic of farmland, native and exotic forest with rivers and streams that all could be used by bats (such as foraging areas, flyways and roosting habitat). There is moderate habitat suitability for bats.

Determining bat roost potential of hazardous trees

- The contractor checks their EMP to see what environmental risks are associated with hazardous tree removal and notes that bats could be present in the area and they may roost in trees deemed hazardous and needing to be removed and/or trimmed.
- The EMP details that as part of hazardous tree planning the contractor must check the DOC Bat Distribution Map in case there are new bat records since the EMP was developed.

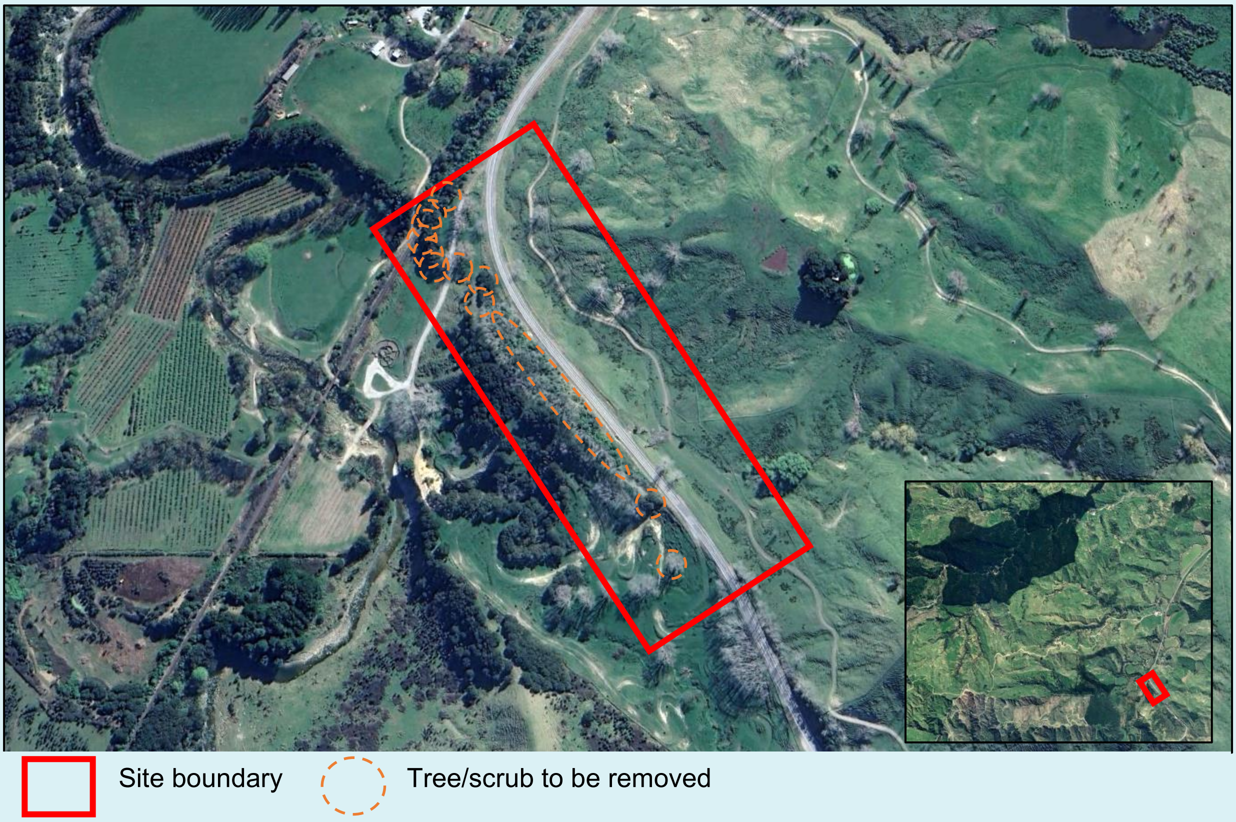
- The Bat Distribution Map shows bats are recorded c.2km away from where hazardous tree assessments are planned. From aerial photos the record is shown to be within pristine bush. The site is separated from the state highway network by farmland and occasional bush blocks.
- The bat desktop information is provided to the arborist who is undertaking hazardous tree assessments.
- Because the arborist has undertaken DOC training level 3.1 and 3.3 competency, they are suitably qualified to assess bat roost potential as part of the hazardous tree assessment. They are asked by the contractor to include bat roost potential in their assessment and reporting.
- The arborist, who meets the DOC competencies for bat roost potential assessment, undertakes a walked assessment of hazardous trees and looks for potential roost features (PRF).
- The arborist assessment includes photos of each hazardous tree as part of their report as well as GPS location. They note if the tree has bat roost potential (that is, whether there are any PRFs) and take photos of these where possible.
- The walked assessment determined that 10 of the trees to be trimmed that year contained PRFs, but the majority were lacking PRFs. Of the trees to be trimmed, 2 had PRFs on limbs that would be impacted by works.

Determining risk management approach

- As identified as above, the PRFs have been identified, and most trees do not have features.
- The trees due to be trimmed that do not contain PRFs can be trimmed at any time (within 6 months of the walked inspection) without further supervision.
- The 2 trees containing PRFs (including those where the PRF is not scheduled to be directly impacted) should be subject to either surveys using ABMs or emergence/re-entry survey for bats between October to May, during suitable weather conditions, immediately preceding the proposed works commencing.
    - The nature of the pre-works survey should be designed in liaison with the project SQEP.
    - Further details of survey methods are available in section 4.2.4, and are taken from the DOC Bat Recovery Group's Bat Roost Protocols (2024).
- If the surveys indicate that bats are roosting within the trees to be trimmed, then these must be left until absence of bat roosting is confirmed through further survey (ABM, endoscope or emergence/re-entry survey) as there is a risk to bats being harmed or killed and the contract being in breach of the Wildlife Act.
- Following completion of bat surveys (with the PRF found to be empty), trees should be felled immediately; otherwise, the process of surveys and management will restart.

C3 Hypothetical case study C: conversion of farm track into dual carriageway in a rural area

Works require removal of numerous trees and scrub areas as shown in the figure below, and associated earthworks. As part of the proposal, additional lighting will be installed along the route.



Determining habitat suitability for bats

- This site is in a rural area, directly adjacent to potential commuting habitat (gully system to the east and west) and c.2.6km from a large native forest block with suitable commuting, foraging and roosting locations in between. The western roadside comprises a steep, unlit, sparsely vegetated embankment; the eastern roadside comprises rough grassland and low scrub.
- The nearest bat record is c.500m away, from a bush block along the same gully system.
- A walked assessment was carried out, which determined that 3 of the trees to be removed contained potential roost features (PRFs), but the majority were immature and lacking PRFs.
- The site itself is not currently lit by adjacent building/infrastructure, but agricultural and residential buildings are present within 200m of the proposed works, causing some light spill.
    - **Outcome**: moderate–high habitat suitability for bats.

Determining likely project scale impact for bats

- Project is directly impacting c.1.7ha of potential bat roosting, commuting and/or foraging habitat through vegetation clearance. This may remove active or potential bat roosts, as well as impacting existing commuting and foraging locations and routes. The project may indirectly impact a wider area due to additional noise/light disturbance both during and following completion of works.
- Project has the potential to cause fragmentation at a wider scale; however, as the local area contains several gully systems, this is not the only available commuting route for local bats.

    - **Outcome**: moderate project scale impact.
    - **Overall outcome**: moderate potential risk for bats.

Determining suitable survey effort for effects assessment

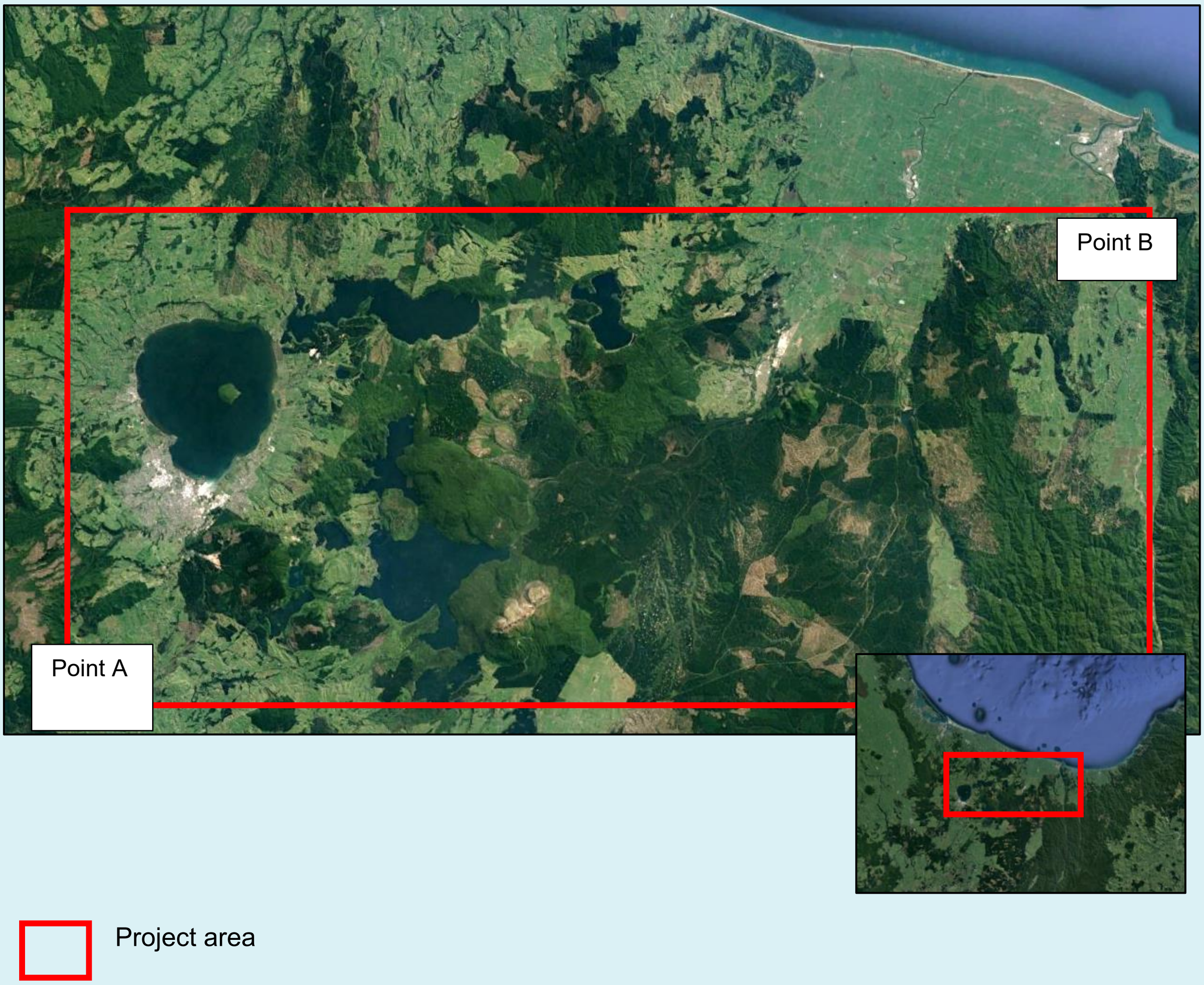
- Surveys should focus on determining both direct and indirect impacts on bats.
  A recommended suite of surveys is provided below:
    - Survey using ABMs to cover the site and the adjacent gully systems to determine local hotspots of activity. Minimum of 2 survey periods to be undertaken across the bat active season, to identify to identify seasonal differences in activity levels and hot-spots.
    - Radio-tracking survey could be undertaken to identify any nearby bat roosts (especially maternity roosts) that could be impacted/disturbed by the proposals.
    - Thermal imaging surveys of the proposed route could be undertaken to determine likely strike risk due to additional traffic on the widened road; however, this risk may be sufficiently mitigated through embedded controls, without the requirement for a survey. This should be determined by the project SQEP based on results of the initial surveys.

Further considerations

- Regardless of survey results, proposals may be subject to embedded controls (if used), such as:
    - Installation of buffer planting and/or road setbacks on either side of the proposed road. This will provide a light buffer, as well as creating a hop-over feature once the vegetation is mature, to force bats over the height of any additional traffic that may be using the new road.
    - Avoidance of light installations where possible. Where this isn't possible, lighting structures should be designed to minimise spill (such as through increasing spacing, use of cowls and/or low-level lighting), and to use warm colour temperature bulbs (≤2700k).
    - Planting to provide long-term roosting, foraging and commuting provision for bats.
    - Provision of bat boxes to temporarily replace potential roost features to be lost. These could be installed to offset the loss of potential roosting opportunities on site, and to bridge the temporal gap between installation of restoration planting and that planting becoming established such that it offers natural roosting options.

C4 Hypothetical case study D: creation of a new 4-lane highway between point A and point B

The project works require significant amounts of vegetation clearance, and will result in additional noise and light pollution to adjacent habitats.



Determining habitat suitability for bats

- Project area is largely rural/isolated and comprises a mosaic of habitat types, with much being highly suitable to support commuting, foraging and roosting bats. The majority of the area is dominated by native forest and both large and small waterbodies. The north-eastern extent of the project area is more modified; however, it is still bisected by a riparian system that may be used by commuting bats.
- There are bat records throughout the project area; although these are limited within the areas of dense native vegetation, likely due to a lack of survey effort in the area.
- The majority of the project area is not currently lit; although some lighting is present close to Point A and Point B.
    - **Outcome**: high habitat suitability for bats.

Determining likely project scale impact for bats

- Significant project footprint.

- Project has the potential to remove large areas of both potential and known bat foraging, commuting and roosting habitat. This in turn would cause habitat fragmentation at a wide scale; however, depending on the project and route design, this may be significant, or minimal.
    - **Outcome**: high project scale impact.
    - **Overall outcome**: high potential risk for bats.

Determining suitable survey effort for effects assessment

- Surveys should focus on determining both direct and indirect impacts on bats.
  A recommended suite of surveys is provided below:
    - Work with project engineers to identify appropriate survey areas for both desktop-based and site based (ABM/habitat suitability) assessments for bats. Results of desktop and site surveys should be used to scope future monitoring requirements, and could be used to refine design, as appropriate.
    - Following the initial scoping exercise, baseline monitoring should be undertaken to identify 'hot spots' of bat activity. As a minimum, this should include surveys using ABMs, to be undertaken **at least** 2 times throughout the bat active season, with the possibility of additional survey during autumn/winter to identify full range of seasonal variation to be investigated.
    - Simultaneously, radio-tracking surveys may be appropriate to identify potential maternity and day roost locations and key flight paths within the of the site and the adjacent ZOI. As above, it is recommended that **at least** 2 rounds of survey be carried out to identify seasonal movements within the colony. Additional survey effort (determined by the SQEP) may be required dependent on the outcome of the initial surveys.

Construction/operational stage monitoring

- Following identification of bat activity hotspots and roosting locations, work with project team to refine the route to avoid key areas for bats where feasible, and agree an appropriate suite of long-term monitoring surveys to inform adaptive management if required in future.
- Develop monitoring plan with SMART objectives, including:
    - identification of a suitable impact and control site (to inform BACI design)
    - baseline monitoring, which should commence at least 2 years prior to construction works
    - surveys using NVAs in any areas where there is considered to be a risk of fragmentation or flight-path interruption through the proposed works (for example if a bridge is proposed over a gully/stream which has known commuting and/or foraging uses for local bat populations)
    - continuation of wide-scale surveys using ABMs – if used, these should be designed using power analysis to determine survey effort, in conjunction with a bio-statistician in order to enable identification of changes in activity levels as a result of the works
    - monitoring of effects management devices (for example hop-overs, artificial roosts etc) for efficacy to enable adaptive management to be employed, where required.

Further considerations

- Regardless of survey results, proposals may be subject to embedded controls (if using), such as:

- Installation of buffer planting and/or road setbacks, either side of the proposed road. This will provide both a noise and light buffer, as well as creating a hop-over feature once the vegetation is mature, to force bats over the height of any additional traffic which may be using the new road.
- Avoidance of light installations where possible. Where this isn't possible, lighting structures should be designed to minimise spill (such as through increasing spacing, use of cowls, motion detectors and/or low-level lighting), and to use warm colour temperature bulbs (≤2700k).
- Planting to provide long-term roosting, foraging and commuting provision for bats.
- Provision of bat boxes to replace potential roost features to be lost. These could be installed to offset the loss of potential roosting opportunities on site, and to bridge the temporal gap between installation of restoration planting, and that planting becoming established such that it offers natural roosting options.